Mississippi Agricultural Experiment Station

Technical Bulletin No. 11

MISSISSIPPI BARK BEETLES*

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MISSISSIPPI
AGRICULTURAL EXPERIMENT STATION
Agricultural College, Mississippi
J. R. RICKS, Director
July, 1922

THE "DIXIE" PRESS, GULFPORT

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Mississippi Bark Beetles[*]

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It is generally recognized by all who have made a study of the forest insects of the country that the small beetles belonging to the superfamily *Ipoidea* (*Scolytoidea*) are responsible for a greater amount of damage both to living, standing trees and to dying or felled timber than the members of any other group. Yet in spite of their great economic importance and of the very interesting habits they exhibit the family is but poorly known to collectors and students of the *Coleoptera*. Without doubt this is due largely to their secluded habits of life, as a result of which specimens are but rarely taken by the ordinary methods of collection. Thus, of the several thousands of specimens of this group collected in Mississippi by the writer, less than a half dozen specimens were taken on the wing or at light.

It is then apparent that the collecting of bark beetles involves an entirely different sort of procedure from that used in nearly any of the other groups of beetles and the most useful collecting instruments are a small ax, a jack-knife and forceps rather than a net or traplight or any of the more ordinary aids used in the capture of specimens of other groups. In other words the beetles are sought for in their burrows in the bark or wood rather than on the wing. Such collecting to be successful must necessarily require some previous knowledge of the general habits of the group sought. This method of collecting has the advantage that usually a number of insects will be found together either in pairs, parental groups, families of newly transformed young or as colonies of such groups or families. It also has the further advantage in that a piece of wood infested with immature stages can be confined in cages and the insects bred from it, thus furnishing at the same time numerous specimens of the beetles,

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*Contribution from the Mississippi State Plant Board, The Mississippi Agricultural Experiment Station, and the Department of Forest Entomology (Contribution No. 36), New York State College of Forestry, Syracuse, N. Y.

specimens of the brood-galleries, more or less valuable data as to the host and its condition, the habits of the insect and at least fragmentary data as to its life history.

This paper is the third of a series of articles on the *Ipoidea* of Mississippi presenting the results of seven months of collecting and field study of the group in the state. The work was done under the auspices of the State Plant Board while the writer was on sabbatical leave from the New York State College of Forestry at Syracuse, N. Y. The writer wishes to express his thanks to Professor R. W. Harned, Entomologist of the Mississippi Agricultural Experiment Station and Secretary of the State Plant Board of Mississippi and to various members of his staff, for numerous courtesies and ready co-operation during the course of the work. My most sincere thanks are also due to Mr. E. A. Schwarz and Mr. W. S. Fisher of the National Museum for the identification of most of the beetles other than the *Ipoidea*.

VEGETATION AREAS AND DISTRIBUTION OF BARK BEETLES.

In the course of the field work the attempt was made to make observations and collections in as many localities of the state, showing as diverse condition of host plants as possible. In this connection the bulletin on "The Soils of Mississippi" by Wm. N. Logan* was found very useful as indicating in a general way the main vegetation areas and the distribution, and relative abundance of many of the trees which serve as the hosts of bark beetles. All of the large soil areas were visited and wherever possible collections were made at several localities in the same general area. As a usual thing all of the data for a single locality were collected in a period of from a day to a week but in the vicinity of Agricultural College which served as headquarters, intensive collecting over the surrounding country was carried on during every month from November 1 to May 25. In addition material infested with ipids obtained from the various regions visited was sent to headquarters where it was placed in breeding jars and a record kept of all insects emerging from it. In this way many specimens were obtained which were not in the adult stage when the field work was done and considerable valuable data were thus secured.

Following is a list of the various localities where collections were made arranged on the basis of the soils areas, the host trees and the ipids obtained from them. The numbers refer to the

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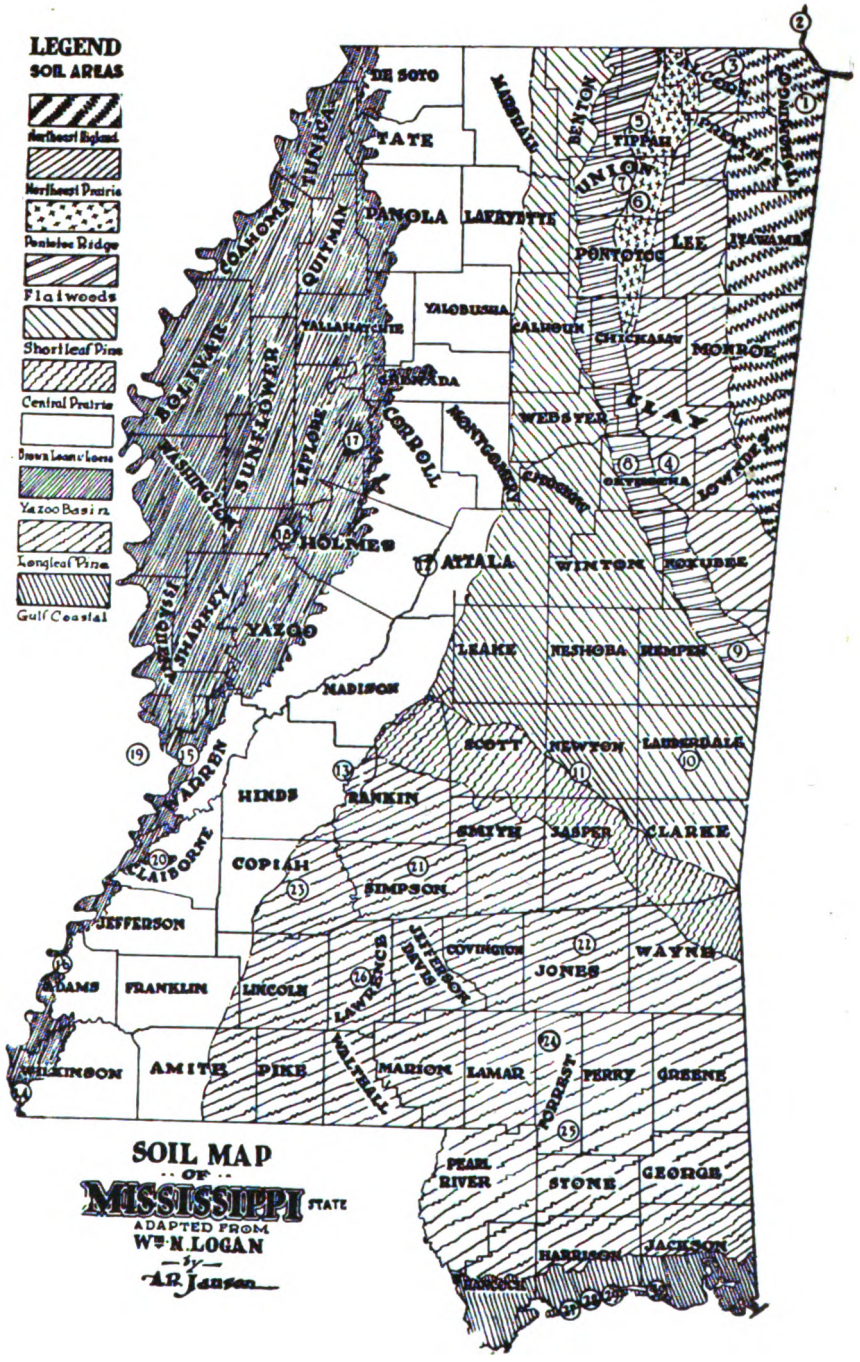
*The Soils of Mississippi, by William N. Logan. Miss. Agri. Exper. Sta. Tech. Bull. No. 7, 1916.



localities shown on the accompanying map.

I. Northeast Highland

Localities visited: 1, Iuka; 2, Shiloh Park, Tenn.; 3, Corinth (east).

Host—	Insect—	Localities
Pinus echinata Mill and *Pinus Taeda* L.	*Ips calligraphus* Germ.	1, 3
	" *grandicollis* Eichh.	1, 3
	" *avulsus* Eichh.	1, 3
	Orthotomicus caelatus Eichh.	1
	Pityophthorus pullus Zimm.	1, 3
	Pityophthorus lautus Eichh.	3
	Pityophthorus pulicarius Zimm.	1
	Stephanoderes quadridentatus Hopk.	3
Hicoria sp.	*Chramesus hicoriae* Lec.	1, 2, 3
	Thysanoes fimbricornis Lec.	1, 3
	Stephanoderes dissimilis Zimm.	1
Populus heterophylla L.	*Platypus compositus* Say.	1
	Xyleborus affinus Eichh.	1
Salix sp.	*Micracis swainei* Blackm.	1
Carpinus Caroliniana Walt.	*Hypothenemus nigripennis* Hopk.	1
Betula lutea Michx.	*Platypus compositus* Say.	1
	Pterocyclon mali Fitch	1
	Xyleborus pecanis Hopk.	1
	Xyleborus fuscatus Eichh.	1
Fagus Americana Sweet	*Stephanoderes dissimilis* Zimm.	3
Quercus Texana Buchl.	*Micracis opacicollis* Lec.	3
	Pseudopityophthorus minutissimus Zimm.	2, 3
	Stephanoderes sp. (near *flavescens* Hopk.)	3
	Thysanoes fimbricornis Lec.	1

Host—	Insect—	Localities
Quercus alba L.	*Micracis opacicollis* Lec.	3
	Stephanoderes dissimilis Zimm.	3
Liquidamber Styraciflua L.	*Pityophthorus liquid ambarus* Blackm.	3
Cercis Canadensis L.	*Micracis opacicollis* Lec.	3
	Micracis meridianus Blackm.	3
Rhus hirta Sudw.	*Pityophthorus scriptor* Blackm.	3
	Stephanoderes interstitialis Hopk.	3
Acer rubrum L.	*Lymantor decipiens* Lec.	1
	Xyleborus fuscatus Eichh.	1
	Xyloterinus politus Say.	1
Nyssa aquatica Marsh	*Hypothenemus nigripennis* Hopk.	1

II. Northeast Prairie

Localities visited: 4, Agricultural College and Starkville; 3, Corinth (west).

Pinus echinata and *P. Taeda*	*Carphoborus bicristatus* Chap.	4
	Dendroctonus terebrans Oliv.	4
	Gnathotrichus materiarius Fitch	4
	Hylastes sp.	4
	Ips calligraphus Germ.	3, 4
	" *grandicollis* Eichh.	3, 4
	" *avulsus* Eichh.	4
	Orthotomicus caelatus Eichh.	4
	Pityophthorus pullus Zimm.	3
	Pityophthorus lautus Eichh.	3, 4
	Pityophthorus granulatus Sw.	4

Host—	Insect—	Localities
	Pityophthorus nudus Sw.	4
	Pityophthorus pulicarius Zimm.	4
	Pityoborus comatus Zimm.	4
	Pityogenes meridianus Blackm.	4
	Platypus flavicornis Fabr.	4
	Trypodendron scabricollis Lec.	4
	Xyleborus pecanis Hopk.	4
Juniperus Virginiana L.	*Phloeosinus enixus* Blackm.	4
	Phloeosinus dentatus Say.	4
Hicoria (several sp.)	*Chramesus hicoriae* Lec.	3, 4
	Cryptocleptes dislocatus Blackm.	4
	Eccoptogaster 4-spinosus Say.	3, 4
	Platypus compositus Say.	4
	Thysanoes fimbricornis Lec.	3
	Xyleborus affinus Eichh.	4
	Xyleborus celsus Eichh.	4
	Stephanoderes dissimilis Zimm.	3, 4
	Stephanoderes interpunctus Hopk.	4
	Hypothenemus rumseyi Hopk.	4
Quercus Texana Buckl.	*Pseudopityophthorus minutissimus* Zimm.	4
	Pseudopityophthorus pruinosus Eichh.	4
Quercus alba L.	*Micracis opacicollis* Lec.	3
	Platypus quadridentatus Oliv.	4
	Stephanoderes dissimilis Zimm.	3
	Stephanoderes sp. (near *flavescens* Hopk.)	3

Host—	Insect—	Localities
Ulmus fulva Michx.	*Micracis langstoni* Blackm.	4
Celtis Mississippiensis Bosc.	*Chramesus chapuisii* Lec.	4
	Eccoptogaster muticus Say.	4
	Micracis langstoni Blackm.	4
	Phthorophloeus dentifrons Blackm.	4
	Hypothenemus germari Eichh.	4
Morus rubra L.	*Micracis langstoni* Blackm.	4
	Phthorophloeus frontalis Zimm.	4
Toxylon pomiferum Raf.	*Erineosinus squamosus* Blackm.	4
	Hypothenemus sp. (near *pruni* Hopk.)	4
Ficus sp.	*Hypothenemus* sp. (near *pruni* Hopk.)	4
	Hypothenemus nigripennis Hopk.	4
	Stephanoderes ficus Hopk.	4
Liquidambar Styraciflua L.	*Pityophthorus liquidambarus* Blackm.	4
	Platypus compositus Say.	4
	Xyleborus pecanis Hopk.	4
	Xyleborus saxeseni Ratz.	4
Prunus angustifolia Marsh.	*Eccoptogaster rugulosus* Ratz	4
	Phthorophloeus mississippiensis Blackm.	4
Prunus serotina Ehrh.	*Eccoptogaster rugulosus* Ratz.	4
Cercis Canadensis L.	*Micracis meridianus* Blackm.	4
	Micracis opacicollis Lec.	3

Host—	Insect—	Localities
	Pityophthorus natalis Blackm.	4
	Hypothenemus rumseyi Hopk.	4
	Hypothenemus sp. (near *nigricollis* Hopk.)	4
Gleditsia triacanthos L.	*Micracis langstoni* Blackm.	4
Rhus hirta Sudw.	*Pityophthorus scriptor* Blackm.	4
	Pityophthorus rhois Sw.	4
	Stephanoderes interstitialis Hopk.	4
Diospyros Virginiana L.	*Stephanoderes* sp.	4
Fraxinus Americana L.	*Leperisinus aculeatus*	4
	Hypothenemus sp. (near *nigricollis* Hopk.)	4
Berchemia scandens	*Thysanoes berchemiae* Blackm.	4
Smilax	*Hypothenemus punctifrons* Hopk.	4
	Stephanoderes sp. (near *nitidulus* Hopk.)	4
Grape	*Stephanoderes chapuisii* Eichh.	4
	Hypothenemus nigripennis Hopk.	4

III. Pontotoc Ridge

Localities visited: 5, Ripley; 6, Wallerville.

Pinus echinata and *P. Taeda*	*Ips grandicollis* Eichh.	5
Juniperis Virginiana L.	*Phloeosinus enixus* Blackm.	5, 6
	Phloeosinus dentatus Say.	5, 6
Quercus Texana Buckl.	*Micracis opacicollis* Lec.	5
	Platypus quadridentatus Oliv.	5
Morus rubra L.	*Phthorophloeus frontalis* Zimm.	5, 6

Host—	Insect—	Localities
Liquidambar Styraciflua L.	*Pityophthorus liquidambarus* Blackm.	5
Cercis Canadensis L.	*Micracis meridianus* Blackm.	5, 6
Rhus hirta Sudw.	*Pityophthorus rhois* Sw.	6
Fraxinus Americana L.	*Leperisinus aculeatus* Say.	6

IV. Flatwoods

Localities visited: 7, New Albany; 8, Trimcane Swamp; 9, Electric Mills.

Pinus echinata and *P. Taeda*	*Ips calligraphus* Germ.	8
	Ips avulsus Eichh.	8
	Pityophthorus granulatus Sw.	9
	Platypus flavicornis Fabr.	9
Hicoria (several species)	*Chramesus hicoriae* Lec.	9
	Cryptocleptes dislocatus Blackm.	9
	Eccoptogaster 4-spinosus Say.	9
	Micracis rudis Lec.	9
	Platypus compositus Say.	9
	Hypothenemus toxicodendri Hopk.	8
	Stephanoderes dissimilis Zimm.	9
Quercus Texana Buckl.	*Micracis opacicollis* Lec.	8
	Platypus quadridentatus Oliv.	7
	Pterocyclon fasciatum Say.	7
	Thysanoes fimbricornis Lec.	8
	Thysanoes lobdelli Blackm.	8
	Stephanoderes dissimilis Zimm.	8
	Stephanoderes interpunctus Hopk.	7

Host—	Insect—	Localities
Quercus alba L.	*Thysanoes lobdelli* Blackm.	8
	Stephanoderes dissimilis Zimm.	8
	Stephanoderes sp. (near *opacipennis* Hopk.)	8
	Stephanoderes quercus Hopk.	8
Acer rubrum L.	*Lymantor decipiens* Lec.	8
	Thysanoes lobdelli Blackm.	8
	Hypothenemus marylandicae Hopk.	8

V. Shortleaf Pine

Localities visited: 10, Meridian.

Pinus echinata and *P. Taeda*	*Ips avulsus* Eichh.	10
	Ips calligraphus Germ.	10
	Pityophthorus annectens Lec.	10
	Pityophthorus granulatus Sw.	10
	Pityogenes meridianus Blackm.	10
Hicoria sp.	*Eccoptogaster 4-spinosus* Say.	10
Quercus Texana Buckl.	*Pseudopityophthorus minutissimus* Zimm.	10
	Pseudopityophthorus pruinosus Eichh.	10
	Pterocyclon fasciatum Say.	10
	Pterocyclon mali Fitch	10
Quercus Phellos L.	*Xyleborus fuscatus* Eichh.	10
Magnolia foetida Sarg.	*Hypothenemus nigripennis* Hopk.	10
Malus angustifolia Michx.	*Xyleborus* sp.	10
Peach	*Xyleborus pecanis* Hopk.	10

Host—	Insect—	Localities
Cornus sp.	*Hypothenemus tenuis* Hopk.	10

VI. Central Prairie

Locality visited: 11, Newton.

Pinus Taëda	*Ips grandicollis* Eichh.	11
Hicoria sp.	*Hypothenemus* sp. (near *pubescens* Hopk.)	11
Quercus Texana Buckl.	*Pseudopityophthorus minutissimus* Zimm.	11
Liquidambar Styraciflua L.	*Hypothenemus robustus* n. sp.	11
	Hypothenemus puncti-frons Hopk.	11

VII. Brown Loam and Loess

Localities visited: 12, Durant; 13, Jackson; 14, Ft. Adams; 15, Vicksburg; 16, Natchez.

Juniperus Virginiana L.	*Phloeosinus enixus* Blackm.	16
	Phloeosinus dentatus Say.	16
Hicoria pecan Britt.	*Cryptocleptes dislocatus* Blackm.	14, 16
	Stephanoderes sp. (near *braziliensis* Hopk.)	13
Hicoria sp.	*Cryptocleptes dislocatus* Blackm.	12
Quercus Texana Buckl.	*Micracis opacicollis* Lec.	16
	Pseudopityophthorus gracilus Blackm.	16
	Hypothenemus asiminae Hopk.	16
Quercus nigra L.	*Thysanoes lobdelli* Blackm.	16
Toxylon pomiferum Raf.	*Hypothenemus* sp. (near *pruni* Hopk.)	16

Host—	Insect—	Localities
Sassafras sassafras Harst.	*Stephanoderes chapuisii* Eichh.	15
	Stephanoderes sp.	15
Crategus sp.	*Hypothenemus nigripennis* Hopk.	16
	Hypothenemus sparsus Hopk.	16
Prunus angustifolia Marsh.	*Eccoptogaster rugulosus* Ratz.	16
Fagara clava-hercules Small.	*Stephanoderes* sp. (near *rufesens* Hopk.)	15
	Stephanoderes texanus Hopk.	15
Berchemia scandens (Hill) Trel.	*Thysanoes berchemiae* Blackm.	12, 15
Locust	*Hypothenemus atomus* Hopk.	15

VIII. Yazoo Basin (Mississippi Delta)

Localities visited: 17, Greenwood; 18, Belzoni; 19, Mound, La.; 20, Port Gibson.

Juglans nigra L.	*Hypothenemus juglandis* n. sp.	20
	Stephanoderes sp. (near *georgiae* Hopk.)	20
Celtis Mississippiensis Bosc.	*Hypothenemus germari* Eichh.	20
Liquidambar Styraciflua L.	*Pityophthorus liquiambarus* Blackm.	19
Malus malus Britt.	*Xyleborus saxesceni*	18

IX. Longleaf Pine

Localities visited: 21, Mendenhall; 22, Laurel; 23, Hazelhurst; 24, Hattiesburg; 25, Maxie; 26, Monticello.

Pinus echinata Mill.	*Pityophthorus granulatus* Sw.	24
	Pityogenes meridianus Blackm.	24

Host—	Insect—	Localities
Pinus palustris Mill.	*Ips grandicollis* Eichh.	22
	Orthotomicus caelatus Eichh.	22
	Pityoborus comatus Zimm.	22, 24
	Xyleborus confusus Eichh.	22
Hicoria pecan Britt.	*Xyleborus affinus* Eichh.	24
	Platypus compositus Say.	23
Hicoria (other spp.)	*Chramesus hicoriae* Lec.	21, 25
	Chyptocleptes dislocatus Blackm.	25
	Eccoptogaster 4-spinosus Say.	21, 24, 25
	Micracis harnedi Blackm.	21
	Micracis bicornus Blackm.	21
	Stephanoderes rotundicollis Eichh.	21
	Stephanoderes approximatus Hopk.	25
Quercus Texana Buckl.	*Platypus compositus* Say.	22
	Pseudopithyophthorus pruinosus Eichh.	22
	Pterocyclon fasciatum Say.	22
	Pterocyclon mali Fitch	22
Quercus Marylandica Muench	*Pterocyclon mali* Fitch	22
	Pterocyclon fasciatum Say.	25
Quercus alba L.	*Pterocyclon mali* Fitch	25
Magnolia foetida Sarg.	*Platypus compositus* Say.	22
Magnolia glauca L.	*Hypothenemus nigripennis* Hopk.	22
Liquidambar Styraciflua L.	*Pityophthorus liquidambarus* Blackm.	24
	Hypothenemus punctifrons Hopk.	24
Malus malus Britt.	*Eccoptogaster rugulosus*	26

Host—	Insect—	Localities
Sour gum (*Nyssa* sp.)	*Platypus compositus* Say.	22
On wing in pine woods (*Pinus echinata*)	*Platypus flavicornis*	24

X. Gulf Coastal

Localities visited: 27, Long Beach; 28, Gulfport; 29, Mississippi City; 30, Ocean Springs.

Host—	Insect—	Localities
Pinus palustris Mill.	*Dendroctonus terebrans* Oliv.	29
	Ips calligraphus Germ.	29
	Ips grandicollis Eichh.	27, 28
	Pityoborus comatus Zimm.	27, 28
	Pityophthorus pulicarius Zimm.	27, 28, 30
Pinus Caribaea Mor.	*Ips calligraphus* Germ.	29
	Ips grandicollis Eichh.	27, 28
	Pityoborus comatus Zimm.	27, 28
	Pityophthorus granulatus Sw.	27, 28
	Pityophthorus pulicarius Zimm.	28, 30
Hicoria pecan Britt	*Xyleborus affinus* Eichh.	28
	Hypothenemus sp. (near *ferrugineus* Hopk.)	30
Quercus Virginiana Mill.	*Pseudopityophthorus pruinosus* Eichh.	29
Magnolia foetida Sarg.	*Platypus compositus* Say.	29

In a general study of this sort it was of course impossible to cover all of the regions of the state thoroughly, so that the lists of Ipidae obtained in the various natural areas of the state are of little value as showing the actual conditions in these several regions. Such a comparison to be of value in showing actual conditions should be made only after years of field study in which all of the areas have been collected over at all seasons and with equal thoroughness. In the present work the field studies in the vicinity of Agricultural College (4) were much more thorough than in any other locality. Thus within a radius of four miles

from the college 60 species of Ipidæ were taken—more than half of the number of species taken within the state. This by no means represents the total number of species occuring there for careful work over a longer period of time would nearly certainly increase the list by 30 per cent or more.

In other localities it is believed that fairly representative collections of the more common forms were taken at Iuka, Corinth, Meridian, and along the Gulf Coast. However, as the time spent in these localities never exceeded two weeks and as the season at which the collections were made was not always the best, it can not be hoped that they represent any but the more abundant forms.

It is of course not necessary to state that the species of bark beetles occurring in any region are dependent principally on three factors—climate, soil and vegetation. Of these three the apparent determining fact in many cases is the vegetation, for if the necessary host trees are absent the insect cannot exist. However, as the soil and climate determine the character of the vegetation these two are really the primary factors. Of all of the regions visited the number of species of trees appears to be most limited in the narrow belt along the Gulf coast. Although nearly two weeks were spent in field work in this region only ten species of bark beetles were taken and these were obtained from only five species of trees; while in the Long-leaf Pine area, the next adjacent area north, where about the same length of time was spent in field work, twenty-two species of ipids were obtained from twelve varieties of host trees and at Meridian in the Short-leaf Pine Belt eighteen species were obtained from nine kinds of host trees in four days' field work. It is believed through long-continued collecting that the fewest number of bark beetles would be obtained from the Gulf Coastal and Yazoo Basin areas on account of the smaller number of tree species found in these regions; while the greatest number would be found either in the Short-leaf Pine area or the North East Prairie on account of the greater diversity of vegetation and the greater range of climatic and topographic conditions.

THE HABITS OF THE BARK-BEETLES

No other family of beetles show such interesting habits as do the members of the family Ipidae. Nearly all of them are borers, both as larvae and as adults, either in the bark or the wood of trees or shrubs and all but a few hours of their existence is passed within their burrows. The family may be separated into three groups as regards the location of the burrow and the character of the food of the larvae and adults. Of these the True Bark-beetles construct their burrow either entirely in the

inner bark or at the junction of the bark and sapwood. The Wood-Eating beetles excavate their burrows from the sapwood or the sapwood and heartwood and feed upon the ligneous tissues at all stages of their active life. The Ambrosia beetles construct their burrows in the sapwood and feed both in the larval and adult stages upon fungi, known as ambrosia, which grows upon the walls of their tunnels.

The most outstanding biological characteristics of the family is the secluded life of all stages. Even the adults are in the open only long enough to leave the old burrows and to find a new host in the right condition. Before emerging from their old host each beetle as a usual thing makes its own separate opening, although in the case of some species of bark beetles, the larvæ of which live more or less together in a common chamber, a number of young adults may use the same emergence hole. In the case of the ambrosia beetles all of the migrating adults leave the colony by the one opening which has from the first served as both entrance and exit of the galleries.

Sometimes the entire brood from a single burrow leave the old host at the same time and in other cases a large per cent of the young from numerous burrows in the same or adjacent trees emerge at the same time, fly together and attack new hosts in swarms. However, the insects usually emerge singly and each flies in search of a suitable host and although such a tree is often attacked simultaneously by large numbers of the beetles these have migrated to the new host as individuals and not in a "swarm." Very often in the case of polygamous species the males will leave the old host some time before the females—often several days earlier. In other cases the males and females leave the old host at the same time, while in still other species only the fertilized females migrate to new trees.

The various species of the family for the most part breed in forest trees. A few species, however, live and rear their brood in fruit trees and even in herbaceous plants and, especially in tropical countries, a number of species occur in various seeds, nuts, etc., and even in the wood of casks containing water, wine or other liquids. For the most part, however, both adults and larvae live within the bark or wood of trees and feed either upon the inner bark, the woody tissue or upon ambrosial fungi grown within their burrows.

Usually a species of bark beetle shows a decided preference either for a single species of tree or for any of several closely allied species and will often construct its brood-burrow in no other. In other cases a considerable variety of tree species seem to serve equally well as hosts. However, these hosts are nearly always either closely related botanically or the bark or wood infested is similar in its general characteristics. It is very seldom

that the same species of beetle will breed in both coniferous and broad-leaved trees.

It is also true that certain species show an equally decided preference for a particular region of a tree. Thus certain species of *Pityophthorus* are to be found only in the smaller twigs of their host; other species construct their brood-burrows only in the limbs; while still other species are found only in the upper or the lower trunk region. This is, however, by no means universal. There are several factors which influence the choice of certain regions for breeding purposes such as actual height from the ground, thickness of the outer corky bark, relative amount of moisture retained by bark of different thickness, and the quality and quantity of certain food materials which varies with the various regions of the tree. Good examples of this selection of breeding places is shown by some of the common species occurring in pine in Mississippi: *Dendroctonus terebrans* Oliv. and *Orthotomicus caelatus* Eichh. breed only in the lower trunk region; *Dendroctonus frontalis* Zimm. is usually found only in the upper trunk region; *Ips grandicollis* Eichh. is characteristic of the thicker-barked portions of the tops and larger limbs; *Ips avuslus* Lec. and *Pityogenes meridianus* Blackm. are found in the medium-sized limbs; *Pityophthorus nudus* Sw. and *P. granulatus* Sw. are characteristic of the smaller smooth-barked limbs; and *Pityophthorus pulicarius* Zimm. breeds in the twigs.

In choosing a breeding place the bark beetles show an equally nice distinction with regard to the physiological condition of the host. Some will breed only in dead or decaying bark; others only in dying or recently felled timber; while still other species prefer trees which are apparently perfectly healthy or only slightly weakened. Bark beetles habitually found in trees or limbs which are slowly dying by suppression from over-shading are seldom to be found in felled trees or in slash. On the other hand beetles which usually breed in felled trees, will often, when sufficiently numerous, attack living trees. It is an interesting fact which may be frequently confirmed by field observation that certain species will, when very numerous, attack and kill living trees while the same species when present in only small or moderate numbers will attempt to breed only in badly injured or dying trees, or in felled timber. Large numbers of beetles of such species are necessary to overcome the resistance of living trees.

The food of both the larvæ and adults of the same species is usually similar. In the Ambrosia beetles both stages use the fungi which invariably grow in their burrows as their chief source of food, although at least some of the woody tissues derived from the excavation of their burrows is passed through their alimentary canals. In the wood-eating ipids, as the various species of *Micracis*, the woody tissues of the sapwood particu-

larly serves as food for both larvæ and adults. In the true Bark-beetles which construct their galleries at the juncture of the bark and sapwood, the food may be derived from either the bark or the wood or from both. In some species where the tunnels engrave both bark and sapwood deeply, both materials are doubtless used. In other cases, such as in *Eccoptogaster quadrispinosus* Say. where the burrows usually engrave the sapwood only very slightly, all or nearly all of the food is derived from the cambium.

In the great majority of species the young adults feed for a considerable time—usually for several days or even weeks—before emerging. When they transform late in the summer or in the fall they will usually remain in the old host over the winter and will emerge the following spring only after feeding for several days. Some bark beetles, however, emerge very soon after transforming to adults and feed elsewhere for a time before constructing their brood-burrows. Thus *Eccoptogaster quadrispinosus* has the habit of feeding for several days by boring into the bark and sapwood of twigs and into the petioles of the leaves of hickory. Several other species show a similar habit. Another modification from the usual habit is shown by *Phthorophloeus liminaris* Harr., *P. frontalis* Zimm., *Leperisinus aculeatus* Say. and others which emerge from the old hosts in the late summer or fall, bore into the outer bark of living trees, feed upon the sap and tissues of the outer portion of the living bark and hibernate in this position. Such habits are, however, not common, for most of the bark-beetles remain in their old larval hosts until sexually mature and when they emerge, immediately seek a new host and construct new brood-burrows.

As has already been intimated the newly emerged adults show a remarkable discrimination in the selection of new breeding quarters. They instinctively and without hesitation select a suitable species of tree and one in the proper condition for the rearing of their brood. Some will select injured or recently cut trees or broken trees or limbs; some will select trees sickly or dying either from suppression, from disease, from the work of other insects, or from other agencies; still others will, if sufficiently numerous, select apparently healthy and vigorous trees. Occasionally the breeding place chosen is unsuitable and either the parents or the newly hatched brood may be killed by an excessive flow of pitch or sap, by excessive dryness or by too much moisture. But in the great majority of cases the instinctive choice of the beetles is one favorable to the continuance of their kind.

TYPES OF BURROWS

The most striking physiological characteristic of the family is their habit of constructing brood-burrows either in the bark

or wood of trees or shrubs. In these burrows the adults lay their eggs and spend the remainder of their lives—usually dying there. These brood-burrows are of a variety of different types but those made by the same species conform very closely to the same general plan. In fact they are so characteristic that it is usually easy to identify the engraving as the work of a certain species, especially when the host and the locality are known. However, while the bark engravings show a great diversity of forms they all show several general characters in common. The entrance gallery usually extends diagonally through the bark to the surface of the sapwood; here it is either widened out to form an irregular cavity or is continued as one, two or several egg-galleries which may extend longitudinally, transversely or diagonally through the cambium. The eggs are laid either loosely in a heap in the irregular cavity or are placed singly in little conical or hemispherical cavities or egg-niches in the sides of the egg-gallery, in groups of several in larger cavities or egg-pockets, or in larger groups in long egg-grooves. The entrance-gallery and egg-galleries are only great enough in diameter to allow the passage of the beetles and are usually kept free of frass and excrement. On hatching from the eggs each larva usually excavates a separate mine which in the majority of cases is more or less straight and extends more or less at right angles to the parent egg-gallery. In some species, however, they are irregular or often winding. In a few species the larvæ do not mine out individual tunnels but work all together in a common chamber. Pupation occurs in a slightly widened chamber at the ends of the larval mine. The young adults usually feed for some time in the bark, often remaining there over winter and on emerging each bores a separate exit hole through the bark. These are just large enough for the passage of the beetles, are circular and when numerous give the appearance of having been made by a charge of shot—hence the common name of "Shot-hole Borers" for this group.

The burrows are of a variety of different general types and have been classified in various ways by different writers. The main varieties are given below but of course it should be understood that there is often considerable variation in those of the same general type—as in the number, diameter and length of the egg-galleries; distribution, arrangement and size of the egg-niches; number, length, diameter and direction of the larval mines; etc.

1. **The Cave Type of Burrow.**—This consists of an entrance gallery which in the simplest form leads directly into an irregular cavity made by the parent beetles. In this the eggs are laid, either in irregular masses at any part of the cave or in egg-niches or grooves at its periphery. The larvæ on hatching may excation of most of the beetles other than the *Ipoidea.*

vate individual mines radiating out from the parent cave or they may all work together by enlarging the common chamber. Examples of such broad chambers are those made by certain species of *Cryphalus* and *Pityophthorus* and in Mississippi are well illustrated by the work of *Erineosinus squamosus* Blackm. occurring in osage orange. This is the simplest and probably the most primitive type of bark-beetle gallery.

2. **The Irregular Elongate Burrows.**—In this type the gallery, instead of being widened to form an irregular chamber, is continued for a variable distance upon the surface of the wood and then irregularly widened to produce a place for the reception of the eggs. It is well illustrated by *Dendroctonus valens* Lec. and *D. terebrans* Oliv. In these species the entrance gallery is continued downward through the bark upon the surface of the wood for a distance of several inches—occasionally for a foot or more. Finally the chamber is irregularly widened, either on one or both sides, the eggs are deposited in one or more masses and walled off from the central gallery by a partition of frass.

3. **Simple Longitudinal or Transverse Burrows.**—These differ from the foregoing in that they are of the same diameter throughout their course. They may be longitudinal or transverse. They may be long or short. They may have a turning-niche or nuptial chamber at the juncture of the entrance gallery, or this may be wanting. They may have egg-niches arranged symmetrically along each side, arranged in groups, with vacant areas between or they may have one or more egg-grooves in which all of the eggs are deposited. Those possessing the latter characteristic approach very nearly to the irregular elongate type of burrow. The simplest burrows of this type are illustrated by those of *Eccoptogaster quadrispinosus* Say. and *E. rugulosus* Ratz., both common in Mississippi. Here the entrance gallery is continued as the egg-gallery without enlargement or niche at their juncture. *Phloeosinus dentatus* Say., *P. enixus* Blackm., *Chramesus hicoriae* Lec. and *C. chapuisii* Lec. construct similar longitudinal burrows except that at the juncture of entrance and egg-gallery there is a more or less elaborate nuptial chamber or niche. Other species including the Southern Pine Beetle, *Dendroctonus frontalis* Zimm. construct long winding burrows which quite frequently cross or anastomose with those of others of the same species.

4. **Forked Longitudinal or Transverse Burrows.**—This type differs from the preceding in that instead of one egg-gallery there are two arising from the entrance tunnel and either extending in a line in opposite directions or diverging at a very wide angle. The more common variety is well illustrated by the burrows of *Phthorophloeus frontalis* Zimm., *P. dentifrons* Blackm. and *Leperisinus aculeatus* Say., all of which are transverse in

direction. Those made by *Cryptocleptes dislocatus* Blackm. are longitudinal in direction, the two egg-galleries being usually nearly in a direct line. The eggs of this species are not placed in niches but are deposited in the very narrow gallery itself and packed in the frass derived from excavating the gallery, the female thus cutting herself off from any further communication with the outside or with her mate. In the burrows of *Pseudopityophthorus minutissimus* Zimm. and *P. pruinosus* Eichh. two short longitudinal galleries extend from the base of the entrance gallery in opposite directions. These are doubtless used as turning niches and not for the deposit of eggs. The two egg-galleries are transverse and extend in opposite directions from the entrance tunnel.

5. **Double Forked Transverse Burrows.**—This type of burrow forms a figure similar to that which would be produced by the joining together of two burrows of the forked type, of the *Phthorophloeus* variety by a short longitudinal gallery connecting with a single entrance tunnel. So far as is known *Pseudothysanoes drakei* Blackm. the burrows of which are described later in this article, is the only species which shows this type of engraving.

6. **Radiate or Star-shaped Burrows.**—In this type the entrance gallery leads directly into an irregular chamber at the juncture of inner bark and wood, known as the nuptial chamber, from which the egg-galleries radiate. This type shows several varieties. The egg-galleries differ in diameter and length according to the species. Their arrangement may be symmetrical without relation to the grain of the wood, as in *Pityogenes meridianus* Blackm. the galleries may be chiefly longitudinal as in *Ips calligraphus* Germ., chiefly transverse as in *Pityophthorus liquidambarus* Blackm. or irregular as in *Dryocoetes liquidambarus* Hopk. The engravings also differ in the arrangement of the egg-niches and in the diameter, course and length of the larval mines.

7. **Pith Burrows.**—Several bark-beetles such as *Micracis opacicollis* Lec., *Pityophthorus pulicarius* Zimm., and others often construct their egg-galleries in the pith instead of at the juncture of bark and wood. The galleries may be either one or more in number and may extend in either or both directions from the base of the entrance gallery. They occur only in small limbs or twigs. The larvæ feed either on the pith, the adjacent soft new wood or may pass through this and feed upon the bark.

8. **Wood Burrows.**—These are similar in general to burrows occurring in the bark and are excavated principally from the sapwood by various species of *Micracis* and *Thysanoes* and by *Lymantor decipiens* Lec. The entrance gallery leads directly through the bark into the wood. There it may be continued as a

simple egg-gallery, may be branched to give rise to two egg-galleries or may be expanded to form a nuptial chamber from which several egg-galleries arise.

9. **Simple Unbranched Ambrosial Burrows**—The burrows of Ambrosia beetles are always cut in the wood and are stained black by the action of the fungi which grow upon their walls and which serve as food for both young and adults. The simplest type are those made by *Xyleborus saxeseni* Ratz., *X. pecanis* Hopk. and others and usually consist of an unbranched gallery penetrating the bark and sapwood for a variable distance. In the sapwood the gallery is slightly widened by the adults and the eggs deposited here. The larvæ work together and continue to enlarge this cavity, forming a wide flat room of considerable area. It will be seen that this type of gallery is somewhat similar to Types 1 and 2 occurring in the bark.

10. **Branched Ambrosial Burrows.**—In this type the entrance gallery proceeds directly into the sapwood for some distance where it breaks up into several (often many) branches extending in various directions in the same general plane. The eggs are laid free in certain of the galleries and the larvæ live in the galleries, feeding upon the ambrosial fungi. The burrows of *Xyleborus celsus* Eichh. have numerous branch galleries. Those of *Anisandrus obesus* Lec. are fewer in number.

11. **Compound Ambrosial Burrows.**—The burrows of this type are somewhat similar to the last in that several egg-galleries arise from the entrance tunnel. They, however, differ in that the beetles make egg-niches in the upper and lower sides of the galleries. The larvæ remain in these niches and as they grow enlarge them more and more to form the larval-cradles characteristic of such forms as *Gnathotrichus materiarius* Fitch., *Trypodendron scabricollis* Lec., and the southern species of *Pterocyclon* and *Platypus*. In some species, as in *Xyloterinus politus* Say., there may be a double row of larval cradles above and below the egg-galleries, while others of the same species may have simple rows of larval niches.

REPRODUCTION

Fertilization of the female may occur in the old host which has served as larval food, but most commonly takes place in the new host. In certain species of Ambrosia beetles (*Anisandrus*, *Xyleborus*) the males are much smaller and weaker than the females and their wings are not sufficiently developed for flight. In such species the females must be fertilized before leaving their parent burrows.

Bark beetles may be either monogamous or polygamous and in some cases where several males and several females are associated in the formation of one brood-burrow the relations might

be described as promiscuous polygamy. The behavior of the beetles while constructing their burrows and the character of the brood-burrow differs according to whether they are monogamic or polygamic. In the monogamic forms it is the female which starts the new burrow and which does all or nearly all of the work of its excavation. The male may enter the burrow which is already begun and may assist in the construction of the nuptial niche and in the disposal of the frass from the egg-gallery but in other cases the only real duty he performs is that of fertilizing the female. The burrows of the monogamic beetles may be either of the Cave type (*Erineosinus squamosus*), the Irregular Elongate type (*Dendroctonus terebrans*), the Simple Longitudinal or Transverse type (*Phloeosinus dentatus*), the Forked Longitudinal or Transverse type (*Leperisinus aculeatus, Pseudopityophthorus pruinosus*) or Pith Burrows. In burrows in which there is a nuptial niche or nuptial chamber, fertilization of the female occurs at the juncture of either of these with the egg-gallery. In burrows in which the entrance gallery passes directly into the egg-gallery, copulation may take place at the juncture of these, or at the entrance with the male entirely outside of the burrow, or on the bark with both males and females outside of the burrow.

In the polygamous beetles it is the male which starts the burrow and does all of the early work in its preparation. The males begin leaving the old host in which they have been reared several days earlier than the females. A male finds a new host suitable for breeding purposes and begins the new burrow by constructing an entrance gallery diagonally through the bark. When the sapwood is reached he excavates an irregular-shaped cavity at the juncture of the sapwood and bark. This is the nuptial chamber and as soon as it is completed the burrow is ready for the reception of one or several females. The females apparently take no part in this early work, for on several occasions the writer has observed one or several females near the entrance of a recently started burrow apparently waiting for the male to complete the nuptial chamber.

When the nuptial chamber is completed the females—usually several—enter and each begins the construction of a separate egg-gallery leading off from the central nuptial chamber. The direction of this depends upon the species of beetle. In some species the egg-galleries have a general longitudinal direction. In others they may be transverse and in still others may bear any relation to the grain of the wood or bark. The egg-galleries are of uniform bore and are just large enough to admit the passage of the beetle. When they are more than usually long they may have at varying distances small alcoves—known as turning niches—into which the female may back up and reverse her di-

rection. In shorter egg-galleries and sometimes also in longer ones no such provision is made and here the female must back up to the nuptial chamber in order to turn around.

The female hollows out small hemispherical cavities or egg-niches in the sides of the wall and in these the eggs are deposited. Usually but a single egg is placed in a niche but in some cases—as in *Orthotomicus caelatus*—from one to six or more are laid in one cavity. The opening to the niche is plugged with frass mixed with saliva so that the eggs are protected from injury by the beetles while passing backward and forward in the egg-gallery.

Polygamous beetles most commonly live in burrows of the Radiate type but may also form the Cave type, Pith burrows or Wood burrows and bigamous forms occur in the Forked and Double Forked galleries. Ambrosial galleries may contain only females which have been fertilized before leaving the parent burrow or may also contain several males in which case the sexual relations are probably promiscuous.

In some bark-beetles one copulation is probably sufficient to fertilize all of the eggs laid. Such seems to be the case in certain species of *Pityophthorus* in which the female is excluded from the nuptial chamber as soon as she begins to deposit her eggs, by the filling of the egg-gallery with frass. Such must also be the case in *Cryptocleptes dislocatus* where the eggs are laid in the bore of the egg-gallery and packed in sawdust. In other cases the females are fertilized several times during the course of their egg-laying period.

An interesting habit possessed almost universally by polygamous bark-beetles and in many cases also by monogamous forms is that which the males have of guarding the entrance of the burrows. This entrance is only large enough to admit the beetles making it and when the male is not engaged in burrowing or removing the frass derived from the excavation of the egg-galleries by his mates he closes this opening by backing up to the entrance so that the declivity of his elytra is level with the surrounding bark. This seems to be an instinctive protective reaction which no doubt results in the exclusion from the burrow of enemies such as parasites or predators which would harm the eggs or young larvæ. That it is protective is shown by the promptness with which this guarding attitude is taken at the least sign of disturbance at the entrance. The passing of a shadow will often cause him to leave his other duties to close the entrance against possible danger. When in the guarding position it requires vigorous probing to dislodge him. The males very commonly die while in the guarding position and their bodies even after death afford some protection to the brood within.

The length of time required to complete the life cycle varies

not only with the species but with the temperature and moisture conditions. Under the most favorable conditions the average life cycle is completed in about two months and under favorable field conditions the average time required from the emergence of one generation to the emergence of its progeny is in the neighborhood of two and a half months—with the first representatives of the new generation emerging in less than two months. It will thus be evident that the long warm season in Mississippi furnishes ample time for the completion of several generations of bark-beetles each year. Perhaps the greater number of species rear at least two generations each year, some certainly rear three, four or even five generations in the southern portion of the state especially, where there is but slight interruption to continuous breeding throughout the year. That this must be true is indicated by the fact that beetles of several species, including *Pseudopityophthorus pruinosus, Pityophthorus pulicarius, Ips grandicollis* and others were observed starting new brood-burrows during the latter part of December, 1919. However, it may also be true that other species have but the one generation per year. It should also be remembered that excessive dry and excessive rainy weather slow up the life processes and prevent beetles from emerging and starting new colonies. This is notably true of the long period of dry weather during the summer in Mississippi.

ECONOMIC IMPORTANCE OF BARK-BEETLES

As has already been stated the bark-beetles and ambrosia beetles comprise a group responsible for a large per cent of the preventable damage to growing trees and to cut timber in the process of utilization. A number of species are neutral or even mildly beneficial but the vast majority are either well known to be destructive or are capable of becoming destructive when conditions are favorable for them. Neutral or mildly beneficial forms include those which breed only in dead limbs or tops and which never under any circumstances attack living wood. They do no harm and are of some benefit in that they hasten to some extent the conversion of the dead wood back to the soil. Good examples of such forms are the various species of *Hypothenemus* and *Stephanoderes*, certain species of *Micracis, Lymantor decipiens*, etc. Other species such as *Pityophthorus nudus* and *P. granulatus* are at times beneficial in that they breed in the lower limbs of pines dying by shading and thus hasten the process of natural pruning so necessary to the production of clear timber. But these same species may under other conditions be more or less injurious.

However, the injuries done by members of the family outweigh by many hundreds of times the benefits they confer. The results of their activities may be classified under the following

headings: (1) Injuries to reproduction; (2) Injuries affecting the general health and growth of trees; (3) The actual killing of trees; (4) Injuries to timber during the process of lumbering and manufacture; (5) Injuries to utilized timber.

(1) **Injuries to Forest Reproduction.**—The principal enemies to forest reproduction—that is to the flower, seeds, seedling or young tree up to the time it is able to produce seed—for the most part belong to other groups of insects. There are some ipids, however, which destroy seeds—such as various species of *Conophthorus* in the cones of coniferous trees—and do appreciable damage. The greater amount of damage to forest reproduction by bark-beetles is, however, done to recently transplanted young trees which are always more or less weakened by disturbing the roots and are often attacked and killed by bark-beetles.

(2) **Affecting the General Health and Growth of Trees.**—Quite a number of bark-beetles and ambrosia beetles will attack and often breed in healthy trees without necessarily killing them. Although the tree may not be killed its health is always more or less affected and it is either weakened to such an extent that it becomes easier prey for other insects, or its growth is reduced, or its timber value is affected. *Dendroctonus valens* in the north and *D. terebrans* in the south attack healthy pines near the base of the trunk and kill large areas of the bark near the ground level. The hickory bark-beetle (*Eccoptogaster quadrispinosus* Say.) kills many trees by breeding in the bark of the trunk and limbs, but considerable damage to others is done by the young adults burrowing into the twigs and leaf petioles in search of food, thus killing many twigs and weakening the tree. *Phthorophloeus frontalis* and others emerge from their larval hosts in the late summer or fall, bore into the bark of living mulberry or other trees, feed upon the tissue and juices of the outer part of the inner bark, thus weakening the tree and affecting its growth materially. As a rule ambrosia beetles will breed only in dying, cut or recently dead trees, but a few species will attack living trees and breed in the wood. Such a tree often survives and externally show little or no effect of beetle work, although hundreds of generations may have bred in it, but when converted into lumber the sapwood and heartwood is found to be riddled by recent or old burrows and the timber value destroyed or much reduced.

(3) **Killing Trees.**—The greatest amount of damage, however, taking the country over, is done by those forms which kill forest trees. Of these the greater number prefer to breed in felled, broken or weakened trees and if their number is not excessively large they will find adequate opportunities for breeding without damaging healthy trees. If injured, weakened or down trees are lacking or if these beetles become excessively numerous they will attack and kill healthy living trees. There are other

forms which seem to prefer living trees in which to breed. In virgin forest, under natural conditions, many isolated trees are killed in this manner every year. These are, for the most part, trees which are overmature, slightly injured or undernourished but which show no symptoms of disease and are by no means in a dying condition. This natural or normal loss which is inevitable in an unprotected forest while usually small in an ordinary sized timber holding amounts to a very large total of injury when the loss in a state or in the entire country is considered.

Often in localities where lumbering has been carried on for a number of years, or where considerable timber has been broken by a tornado or injured by fire or by flood, small more or less local outbreaks of bark-beetles occur. The beetles, which for the most part are secondary enemies, or those which normally breed only in felled, broken or weakened trees, have increased greatly in number due to the unusual opportunities for breeding offered by the slash, windfalls or scorched timber and are able to attack and kill healthy trees. Such sporadic outbreaks usually die out after several seasons, causing only local injury. They are easily controlled. However, such an outbreak if it involves a primary enemy or one which normally breeds in living healthy trees, is likely to increase from year to year, spread in all directions and do extensive damage.

Such attacks are spoken of as epidemic and often in a very few years involve an ever increasing area, resulting in the death of thousands of healthy trees. Good examples of such epidemic outbreaks are furnished by the Southern Pine Beetle (*Dendroctonus frontalis*) which on several occasions has killed a large percentage of the pines over wide areas in the south. Several other species of this same genus have been responsible for similar devastation of the forest in other parts of the country. In many of the northern states the Hickory Bark-Beetle has killed a large per cent of the larger hickories over vast areas. There is danger that similar destruction may occur to the hickories and pecans of Mississippi as this beetle is abundant in most regions of the state and in several localities has killed a considerable number of trees. Widespread devastation of this sort is often inaugurated by a seemingly slight change in the natural conditions such as a drought which, while it kills no trees outright, affects the general health of many. Once started, however, the abnormal conditions necessary for its starting are not necessary for its continuance.

The killing of forest trees in the United States by bark-beetles results in an annual loss of many millions of dollars. Much of this loss can be prevented by adopting proper methods of prevention and control not only in the National and State Forests but also in private holdings. Some damage is inevitable but much

of it can be prevented. Sporadic outbreaks are likely to continue to occur but widespread epidemic attacks can be prevented by taking the proper precautions and by controlling the pests before they become dangerous.

(4) **Injury to Timber During the Process of Lumbering.**—There are a host of bark-beetles and ambrosia beetles which prefer to breed in a recently cut tree rather than one in any other condition. Thus many species of trees become infested with bark-beetles within a very few days after they are cut. If the beetles are the true bark-breeding forms the damage they do is not usually great. Their activities serve to loosen the bark and sometimes allow the entrance of fungi which discolor the sapwood. The galleries of the ambrosia beetles, however, are in the wood, and timber cut during the season of the beetles' activity will nearly invariably suffer severe injury unless it is utilized at once. This is especially true in the south where lumbermen know from experience that it is wise practice to saw up their oak, gum, cypress, etc., felled during the warmer months within two weeks of the time it is felled. Otherwise the lumber when sawed will be found to be riddled by the black-stained burrows of ambrosia beetles which will destroy or greatly diminish its value.

(5) **Injuries to Utilized Timber.**—Injury by bark-beetles to utilized timber is of less importance than that by termites and other insects. Bark-beetle injuries are practically confined to timber from which the bark has not been removed. Fence posts, poles and round structural timbers more or less in contact with the ground from which they can obtain moisture are subject to injury by ambrosia beetles during the first year of their use—especially if they are utilized while still green or sappy. The burrows extend in through the sapwood and often into the heartwood, thus weakening the strength of the post or pole and allowing ready entrance to the fungi of decay. At least one species of the wood-eating ipidæ (*Micracis langstoni* Blackm.) is capable of doing considerable damage to posts, poles and unbarked structural timbers, its injuries being somewhat similar to those of the powder-post beetles.

FACTORS INFLUENCING INJURY BY BARK-BEETLES

There are a number of factors either natural or due to the agency of man which have a decided influence upon the development of local or widespread outbreaks of bark-beetles. Those which are favorable to such attack are such conditions as encourage or foster a more rapid development of the insects until their numbers which normally are insufficient to cause extensive damages are so augmented as to make it necessary that they attack and kill living trees in order to find suitable breeding places. Also conditions which serve to weaken trees to any extent and to

make them less able vigorously to resist insect attack may be responsible for the development of widespread damages.

Among the most potent factors favoring bark-beetle injuries are those incident to lumbering operations. The presence of stumps, slash, broken timber, cull trees, etc., offer such very favorable conditions that bark-beetles and others as well, breed in them in immense numbers. If lumbering is continued for several years an ever increasing horde of beetles emerges each year until eventually—especially if lumber operations are suddenly discontinued—the numbers come to be so great that they must attack living trees to find suitable breeding places. Such attacks are likely to be sporadic and if the attacking beetles are secondary enemies will usually die out in the course of a few seasons at most. But if they are primary enemies they will, unless controlled, continue to breed in living trees in ever increasing numbers, and the sporadic outbreak is likely to become epidemic and to devastate large areas of timber.

Forest fires, even though they be light ground fires, scorch and either kill or injure large numbers of trees. These serve as breeding places for bark-beetles, result in an increase in their numbers and are often followed by either local or more extensive injuries. Mechanical injuries to trees such as by wind-break, snow-break, frost crack, lightning injuries, etc., tend toward the same results. In Mississippi and other southern states widespread devastation is often created by tornadoes which sometimes blow down or break the trees over vast areas. The tornado injury is often followed by sporadic or epidemic outbreaks of bark-beetles. Similar results often follow where trees have been killed or weakened by flood. Trees weakened by disease are often killed by bark-beetles but trees so weakened are usually not numerous enough to result in any great increase in the number of beetles.

Unusual climatic conditions are often very important factors in insect outbreaks just as on other occasions they are very important checks upon insects. Severe drought results in weakening the resistance of trees and if destructive bark-beetles are present, is often followed by severe, even widespread, injury. Severe or unseasonable cold will have a similar effect. Such outbreaks are very likely to occur following an unusually cold winter, especially near the northern line of distribution of a tree species.

But by no means are all of the natural environmental conditions favorable to insect increase. Nature provides various checks and counter-checks which so long as conditions remain normal prevent any permanent increase or decrease in the number of a species. Where such an increase occurs as in the case of an epidemic outbreak it is due to some unusual condition such

as those discussed above. Eventually such an outbreak will run its course, the natural checks will assert themselves and the destructive species will be reduced to its normal numbers. In the case of forest insects, however, just as with those attacking agricultural crops many millions of dollars damage will often result before the natural control is accomplished and it is very poor economy supinely to await such an event. The factors or natural checks which under average normal conditions serve to keep down the numbers of destructive bark-beetles include parasitic and predaceous insects, predaceous birds and other animals, disease and climatic factors. Of these, perhaps the climatic factors are the most important. Their operation is, however, more obscure while the results accomplished by parasitic and predaceous enemies are much more apparent and more readily recognized.

An excellent example of natural control of a very destructive outbreak of *Dendroctonus frontalis* Zimm. was furnished by the epidemic of 1891 and 1892 in West Virginia and Virginia which resulted in widespread killing of various species of pine. This destructive epidemic was apparently absolutely checked and controlled by the very severe cold weather of the early months of 1893 which apparently killed all stages of this beetle while other species breeding in the weakened trees were unaffected. *D. frontalis* is a southern species which was able to increase and multiply during mild seasons in the Virginias but was unable to withstand the unusual cold, while the other species are more northern in their range and were not appreciably affected by it. Near Syracuse, N. Y., in the summer of 1915, a partial control of a bad infestation of the hickory bark-beetle was caused by the frequent heavy rains during the time when the beetle was on the wing and establishing its new breeding quarters. Many adults were doubtless killed before establishing themselves and many brood burrows were observed where the newly hatched larvæ had been drowned by the excessive flow of sap. Similar conditions existed in the burrows of *Ips pini* and several other forms occurring in pine. Excessive dry weather will sometimes have a similar effect and result in the death of a large proportion of the brood, especially if the temperature is at the same time more than usually high. Cool, moist weather will sometimes retard the development of the brood to such an extent as to prevent the completion of the development of the second brood in a double-brooded form. Direct sunlight upon infested logs or limbs in hot, dry weather will often kill a large majority of the contained brood, although sunlight, heat and moisture up to a certain optimum, which varies somewhat with different species, has the effect of hastening development.

Small parasitic hymenoptera are often bred from bark-beetle burrows in great numbers. The parents of these small wasp-like

insects have laid their eggs either within, upon or near the bodies of the bark-beetle larvæ and their young have lived within the body of the grubs feeding upon their tissues and eventually killing them. If such a burrow is opened after the parasites have emerged their empty cocoons will be found at the end of the mine of each parasitized larva. As a usual thing only a small per cent of a brood will be affected and some species of bark-beetles seem nearly exempt from attack. Other species, however, are very subject to hymenopterous enemies. In Maine I have opened many burrows of *Leperisinus aculeatus* Say. in which nearly every larva had been killed in this manner and from an examination of hundreds of burrows it is estimated that well over ninety per cent of the larvæ had been parasitized. Conditions nearly comparable to these have also been observed in New York for *Phloeosinus canadensis* Sw. in arbor vitæ.

Predaceous enemies of bark-beetles are perhaps not quite so important as are the parasites. The most important of these are the larvæ and adults of beetles of the family *Cleridae*. The adults are often found upon the bark of trees in which bark-beetles are constructing their burrows and at this time they kill many of the adult borers before they have had a chance to construct their burrows. They will also enter the brood-burrows and feed upon the burrowing beetles. They deposit their eggs either in brood-burrows or in cracks in the bark nearby and the larvæ feed upon any stage in the life history of the borers.

Of the larger predaceous animals the birds, especially woodpeckers, are by all odds the most important. They afford a valuable secondary check upon all species but can never be depended upon to control even a sporadic outbreak as their numbers are not sufficient. On several occasions the writer has examined sections of trees which had been nearly completely barked by woodpeckers in their search for the brood of bark-beetles. In every case a careful count established the fact that the young beetles, protected by the small fragments of bark still remaining, were more numerous than the parents which had entered the bark originally. As other trees nearby, harboring the same species, had been left nearly untouched by the birds it will be readily seen that the birds while valuable as accessories can not be depended upon to effect control unaided. They are, however, a valuable assistance in maintaining the balance of nature and in keeping dangerous forms down to normal numbers and as such should be encouraged in every well regulated forest.

PREVENTION AND CONTROL OF BARK-BEETLE INJURIES

Any artificial method of prevention or control of bark-beetle injuries must take into account the natural checks to their in-

crease and must be based upon these. Direct methods such as spraying which are effective against agricultural pests are here of no value and if they were effective would not be practical on account of the expense. All such measures must have for their aim the preservation or the restoration of normal conditions. Thus the aim in the forest should be to preserve the natural balance of nature, to keep the conditions such as to insure good healthy, vigorous trees, to prevent destructive insects from breeding in such numbers as to become dangerous, to protect and foster parasitic and predaceous insects and insectivorous birds and animals. Where remedial measures are undertaken against an outbreak already in progress the aim should be to reduce the numbers of the destructive form or forms to such an extent that these natural checks can again assert themselves and become effective.

To be more specific, in the well managed forest, systems of thinnings and cutting should be devised to maintain it in the best silvicultural condition. The forest floor should be protected against destruction by ground fires. Any excess of diseased trees should be removed. Broken or wind-blown trees should be utilized or treated before the horde of bark-beetles, which they are nearly certain to harbor, can reach maturity. A sharp lookout should be maintained for the first signs of trees dying from attack by the more dangerous forms and these trees should be treated before the brood can emerge from them and spread. Birds and other insectivorous animals should be encouraged. Timber killed or weakened by ground fires should be cut and utilized and all slabs and refuse burned before the insects breeding in them can emerge. If such material cannot be utilized at once it should be felled and burned or the standing trees barked and the bark burned.

Lumbering operations should be so conducted as to prevent an undue increase in the numbers of insect pests. The stumps should be cut as low as possible, the slash destroyed by fire and the cull logs and stumps either barked or scorched by piling the slash over them and burning it. Broken trees should be treated in the same manner. Such measures as these are especially necessary where lumbering operations which have been continued for a number of years in a locality are suddenly to be discontinued. As long as lumbering is continued without interruption the beetles will, as a usual thing, even though they have increased immensely in numbers, find sufficient places to breed in stumps, culls and slash, but if cutting is discontinued they are present in such numbers that primary enemies and even forms which are ordinarily secondary enemies are compelled to attack living trees and the result is an outbreak which must be controlled by drastic measures or result in serious loss. Proper treatment of stumps,

slash and cull logs during the last year or so of a cutting operation will prevent this loss—especially if these breeding places of injurious forms are allowed to become heavily infested before burning.

When injurious beetles are present in only moderate numbers in a forest—i. e. where the infestation has not reached the proportions of a sporadic or epidemic outbreak, an excellent preventive measure is the use of trap-trees. This consists of either felling or girdling certain strong sappy trees in some moderately shaded locality, allowing them to become infested and then either floating them in water, destroying by fire or removing and burning the bark. This measure is based on the assumption that even very injurious forms if present in only moderate numbers will attack such material in preference to living healthy trees. This is true even for serious primary enemies when the numbers are not excessive but if a serious outbreak is in progress the results are not likely to be satisfactory. Thus trap trees should be considered only as a preventive measure, of use in keeping the activities of the insects down to normal and not as a corrective or remedial measure to be employed in serious outbreaks already in progress.

In the use of this method it manifestly is necessary thoroughly to treat the trap-trees before any of the insects have reached the beetle-stage. If this is not accomplished thoroughly the results are likely to be more harmful than beneficial. The traps should be treated while all of the brood is either in the larval or pupal stage, especially if the bark only is to be removed and burned. The best method is to treat the entire log either by burning or by submerging in water for several weeks for then not only the bark-borers are killed but also all ambrosia beetles and other wood-inhabiting forms.

Remedial measures against serious outbreaks of primary forest tree enemies should have for their object not the extermination of the species, which is impossible or at least impractical, but should plan to reduce their numbers sufficiently so that the natural enemies such as parasitic and predaceous insects, insectivorous birds and mammals can assume the upper hand and assert their control. In other words the effort should be toward assisting in re-establishing the normal balance in nature. Usually even in the most serious epidemics a destruction of 75 per cent of the brood is sufficient to assure the return of normal conditions and to allow the natural checks to assert themselves. There are several methods of procedure all of which are based on the general principle mentioned above. The method to be used must depend upon which is best suited to conditions in the locality infested. Usually, except when the infestation is in a remote locality or the surroundings present more than usual dif-

ficulties, the control can be established at little or no ultimate cost and often, where a market is easily accessible, at a profit. For the most part these methods consist in only a slight modification of logging practices.

The simplest method consists in cutting and sawing up the infested trees and the burning of the slabs before the brood has had a chance to emerge. In this way the only modification of ordinary lumbering practice is the concentration of cutting on the infested trees, their prompt utilization and the immediate destruction of the refuse.

If it is impractical to saw the felled timber immediately it should either be barked and the bark immediately burned or if near water the logs may be immediately immersed for several weeks to kill the brood. If the beetles are forms which bore entirely on the surface of the wood and pupate in the innermost bark the mere barking of the logs will be sufficient, especially if the bark is exposed to the direct sunlight. But if the infestation is by species which go to the middle or outer part of the bark to pupate, the bark must be burned or submerged in order to kill the brood.

If the infestation occurs under such condition that it is impossible or not economical to utilize the trees they should be felled and the bark removed and treated as recommended above. Under these conditions, unless the log is in direct contact with the ground, the heartwood will remain sound for years and may be sawn several years after felling. Another method practical in some of the western forests is to fell the tree, lop the branches, pile them over the trunk and burn them, thus scorching the bark sufficiently to kill the contained brood.

In control work it should always be remembered that thoroughness is absolutely essential and satisfactory results can be accomplished in no other way. While it is usually necessary to destroy only about 75 per cent of the brood in order to establish control it is wiser to attempt to clean up all of the infested timber. If the aim is to do a 100 per cent job the results will usually be more than 75 per cent, but if the aim is a 75 per cent job the results are likely to fall below that. It should also be remembered that trees killed the preceding year can be ignored so far as control is concerned as all of the bark-beetles have left them. Therefore the efforts should be concentrated on dying trees, or trees just dead, from which the beetles have not yet emerged. The best time for control operations is in the winter when the brood is either dormant or at least developing less rapidly than at other seasons. Summer control work should only be done when special conditions make it necessary and then is best accomplished during the latter part of the summer. *Immediate* treatment of in-

fested trees which have been felled is then essential as otherwise the brood will continue to develop and if not treated will in any case emerge within a week or two. At such seasons it is recommended that the trees be immediately barked and the bark burned or that the timber be immediately submerged in water. Summer control by sawing the logs and burning the slabs is likely to be interrupted or delayed sufficiently to allow the brood to emerge and may result in more damage by aiding in dissemination than if the trees were undisturbed.

A very important form of beetle injury is that done to timber in the process of logging and after it has been sawed and piled for seasoning. The greatest damage done by the group with which we are concerned is that by the ambrosia beetles. There is perhaps not a species of commercial wood in the state which is not subject to injury by ambrosia beetles. They attack the felled trees within a few days after they are cut, bore into the sapwood and often into the heartwood, seriously injuring it and reducing its commercial value. The greatest amount of damage is done to such timber as cypress, oak and gum but the injury is by no means confined to these.

The best method to prevent such injuries is to saw the logs as soon after felling as possible. In the warmer months in the south during the active period of the beetles unbarked timber cannot remain in the woods more than two weeks without great danger of injury. Usually the ambrosial burrows will be started within a few days but if the timber is sawed within two weeks these burrows will for the most part not penetrate the wood far enough but that most of the burrows will come off in the slabs. If immediate manufacture is not possible injury can be prevented either by immersing the logs in water or by removing the bark. Rapid seasoning will often prevent injury to any but the outer sapwood of logs. Logs protected in this way must be free from the ground in a location where the sun will strike them at all hours of the day and should be turned every few days. A considerable degree of immunity from injury will thus be secured during dry, hot periods of bright sunshine, especially if other logs nearby in partially shaded, moist locations are allowed to remain as traps. In such cases all trap-logs should be either burned or submerged in water within two months after cutting.

Sawed timber with fragments of the bark still on is subject to injury not only by ambrosia beetles but by other borers. The bark should all be removed before piling. Considerable injury is also done to freshly sawed timber, especially of the larger dimensions, if it is placed in such close piles that it cannot dry out rapidly. The preventive is to pile in loose piles to facilitate rapid seasoning.

CLASSIFICATION AND DISCUSSION OF SPECIES

FAMILY *PLATYPODIDAE*

The **Platypodidae** are nearly entirely tropical and sub-tropical beetles and only a few species occur normally within the United States. These all belong to the genus **Platypus** Herbst Of the half dozen or so species three are quite common in the southern states and in the coastal belt may be found as far north as New Jersey. Other species are occasionally imported in tropical woods but are unable to withstand the climatic conditions and soon succumb. All of the species are ambrosia beetles and as a usual thing are not found exclusively in one particular species of tree but the same species is found in a considerable variety of hosts.

The beetles are readily distinguished from the other ambrosia beetles by their (usually) larger size, slender, cylindrical bodies; their large prominent heads, flattened in front; the very long slender tarsus, with the basal joint longer than the others combined; the slender thorax constricted about midway at the sides; and in the males by the spine-like projections of the elytra behind.

The **Platypus** beetles are more destructive than most ambrosia beetles because their burrows are usually more extensive and are often carried deep into the heartwood of the trees attacked, thus destroying to a large extent its timber value. The male beetles in a burrow apparently always greatly outnumber the females and according to Hubbard (1897) often engage in fierce battles for possession of the females using the spines projecting from the wing covers as weapons.

The eggs are laid in small clusters loose in the burrow, each female depositing from 100 to 200. The larvae live freely in the tunnels along with the adults and feed upon a minute fungus which forms a coating over the walls and which produces the black stain characteristic of the burrows. The larva requires five or six weeks to reach its full growth, when it excavates a small cell at one side of the main burrow. These are usually in groups of 8, 10 or more and always extend with the grain of the wood. In these cells the larvae transform to pupae and later to adults.

The beetles seldom or never attack trees in a healthy condition, for while the tree attacked may be in full leafage, the insects invariably seem to enter through some dead or dying area of the bark. Apparently a diseased or fermenting condition of the sap is necessary for the development of the ambrosial fungus upon which the young depend entirely and the adults depend largely for their food. Thus the **Platypus** beetles seldom if ever are the primary cause of the death of trees, but their damages consist in hastening the death of trees which are injured or sickly but which otherwise might survive, and in ruining the timber value of dying or recently felled trees. In the latter way especially they often do great damage to timber felled or girdled in the course of lumbering operations. Their burrows are carried well into the heartwood of large trees thus ruining or much decreasing their timber value.

Key to the Mississippi Species of *Platypus*

A. Ventral segments of the male without special modifications; disc of pronotum in both sexes with a small marginal pit at each side of the anterior end of a short median longitudinal sulcus ---------- **compositus** Say.--Page 39

AA. Ventral segments of the male with elevations; pronotum of male without marginal pits.

B. Posterior margins of 3d and 4th ventral segments of the male elevated, 3d with two coarse, blunt tooth-like elevations; larger size, more than 5 mm. long.
flavicornis Fabr.--Page 39

BB. Fourth ventral segment of male with a large acute tooth at each side of the middle line; smaller, less than 4.5 mm. long ---------- **quadridentatus** Oliv.--Page 40

Platypus compositus Say.

The adult is rather light reddish brown in color, about 4.5 mm. to 5 mm. long, four times as long as wide. The front of the head is broad and flat in both sexes, very coarsely, shallowly punctured, sub-areolate in the male; areolate above in the female, nearly smooth below. The pronotum is considerably longer than wide, finely, shallowly and rather sparsely punctured; with a distinct median, longitudinal sulcus on the posterior third, with a small pit the margins of which are elevated at each side near the anterior end of the sulcus The elytra of the female are 2 1-3 times as long as wide, with the posterior end sub-truncate, the declivity precipitous and transversely impressed near the apex. The elytra of the male are of the same general proportions but with the posterior end narrowed and modified as follows: the 1st, 3d, 5th and 9th interspaces each elevated posteriorly and ending in a more or less definite tooth; all of the region between the 3d interspace and the lateral margin prolonged to form a rather long, heavy process somewhat concave above and tridentate at the apex. Ventral segments without special modifications, reticulate, opaque, coarsely punctured; last one plano-concave.

This species is found throughout the entire southern states and has been taken as far north as Delaware Bay and southern Illinois. The writer has specimens from Mississippi City, Hazelhurst, Fayette, Laurel, Meridian, Electric Mills, Agricultural College and Iuka, Miss. It is common throughout the state and was taken from a variety of trees including hickory, pecan, yellow birch, cottonwood, weeping willow, sweet gum, sour gum, magnolia and red oak. It apparently will live in most any of the broad-leaved trees and has been reported as breeding in black oak, sugar maple, chestnut, basswood, red elm, beech and wild cherry (Hopkins, 1893). This insect is also responsible for a considerable amount of damage to recently felled or girdled cypress throughout the range of this tree. To guard against excessive damages to girdled cypress Hopkins (1907) has made several recommendations as follows:

1. Conduct the girdling operations in March, April, October or November.
2. Trees may be felled as trap-trees and should be in about the ratio of one for every fifty to seventy trees to be girdled.
3. If trees are to be girdled at other times than those recommended trap-trees should be provided a week or more before the girdling begins and should be located on the banks of streams where, when they become infested, they can be readily rolled into the water.
4. Trap-trees should never be used unless they will certainly be destroyed or placed in the water within two or three months after felling for if the brood is not destroyed before the beetles emerge the felled trees will tend to make them more numerous.

Platypus flavicornis Fabr.

The adult is dark reddish brown in color; about 5.5 to 5.9 mm. long, 3.88 times as long as wide. The front of the head is flat and broad, finely

reticulate and irregularly, rather coarsely punctured, with an indistinct elevated area extending between the bases of the antennae, in both sexes. The pronotum is moderately finely punctured in both sexes with the median line slightly elevated on the anterior third, sulcate on the posterior third; with a rather indefinite, shallow fovea, without margin at each side of the anterior end of the sulcus in the female. The elytral striae are rather deeply impressed in the male, less so in the female, with the punctures moderately small; interspaces more finely and sparsely punctured, the third one in the female elevated and granulate at the base. The elytral declivity of the female is moderately abrupt, weakly sulcate; with the area between the 5th and 9th interspaces prolonged to form a broad rather blunt process. The posterior process of the male is longer, sharper, with the outer edge toothed; the 3d, 5th and 7th interspaces are strongly elevated, the 3d especially so, and end in distinct teeth. The ventral segments of the male are reticulate and roughly punctured with the special modifications mentioned in the key; those of the female much more finely punctured and without special modifications.

P. flavicornis is nearly as widely distributed as P. compositus but apparently is much more limited as regards its hosts as it is at least most commonly found only in the various species of pines and other conifers. It has been reported from as far north as New Jersey (Smith '09) and is known to occur in all of the southern coast states and in Mexico. In Mississippi the writer has taken it at Trimcane Swamp, Agricultural College, Electric Mills and Hattiesburg. All of the specimens except from the last mentioned locality were dug from the wood or bark of loblolly pine. Two specimens were taken on the wing at Hattiesburg, in a pine forest. This species has also been reported from deciduous trees but, according to Schwarz, they live in the burrows of other insects. However this may be, it is certain that in Mississippi the chief damage is to pine trees and as these beetles are very powerful burrowers their burrows soon render worthless the lower portions of the trunks in which they work. Their presence in a pine trunk is indicated by the large quantity of frass or "sawdust" at the bases of the trees and in the crevices of the bark of the lower trunk. Trees attacked should be utilized at once as the beetles very soon render the wood unfit for use as timbers and very materially decrease its value, even for fuel.

Platypus quadridentatus Oliv.

The adult male is reddish brown with the posterior part of the elytra nearly black; 4.25 mm. long; 3.77 times as long as wide. The front of the head is finely scabrous; the thorax punctulate with the median line sulcate on the posterior two-thirds. The elytra are deeply striate, coarsely and closely punctured; the 1st, 3d, 5th and 7th interspaces more strongly elevated behind, the 3d ending in a large tooth, the 5th and 7th each in a smaller tooth; all are independent of the elongate, compressed, truncate, apical process which arises at each side from the region between the 5th and 9th interspaces. The ventral abdominal segments are reticulate, rather coarsely and densely punctured; with two sharp, acute, slightly curved teeth arising from near the posterior margin of the fourth visible segment.

Three specimens, believed to be the females of this species, are of the same size and color with the front of the head similar, the pronotum similar except for the presence of two sharply margined pits, much larger than in compositus, lying each side of the median sulcus about one-fourth of the distance from the posterior border. The elytral striae are not so deep as in the male and the punctures are smaller. The declivity from above has a superficial resemblance to that of compositus but is higher, steeper, more sulcate at the suture above and with two short, blunt posterior extensions at each side; the median one opposite the third interspace and the lateral

one involving the 5th to 9th interspaces.

This species of **Platypus** is by no means as common in Mississippi as are the other two as only seven specimens were taken. These were obtained at Agricultural College, New Albany and Ripley, the host trees being white oak and red oak. Hopkins (1893) reports this species from West Virginia in black oak and chestnut and it is also known from Florida to Texas (Blatchley and Leng, 1916). Two of the females described above were taken from the same burrows as the males and there can be little doubt of their relationships. I have seen no description of the female except the remark of Blatchley and Leng, p. 583—"Female similar to **P. flavicornus**"—which is rather misleading.

FAMILY *IPIDAE*

The family **Ipidae (Scolytidae)** is readily distinguished from the **Platypodidae** by the character of the tarsus—the first tarsal segment being shorter than the others united. The group includes both bark-beetles and ambrosia beetles and shows a much greater diversity not only of habits but also of structure. The family is represented by large numbers of species in tropical and temperate zones and a number of species extend up into the arctic regions as far or nearly as far as the northern limit of tree growth. (Swaine, 1919.) The family has been variously subdivided into subfamilies by different authors but the subfamilies as given by Swaine (1918) best suit our present purposes and will be used in this bulletin. The following key is taken from Swaine with a few modifications.

Key to the Subfamilies of the Family *Ipidae*

		Page
A.	Outer distal angle of the fore tibia produced into a prominent process ---------- Eccoptogasterinæ--	41
AA.	Outer distal angle of the fore tibia not strongly produced.	
B.	Head not concealed from above; pronotum usually not more strongly roughened in front----------Hylesininæ--	48
BB.	Head concealed from above by the pronotum; pronotum usually more strongly roughened in front.	
C.	Fore tibiae with the sides subparallel, neither strongly widened nor narrowed distally, outer edge very weakly or not at all serrate; antennal club compressed; funicle 4-6 segmented------Micracinæ--	64
CC.	Fore tibia widened distally; outer edge strongly serrate; antennal club variously modified; funicle with 1-5 segments ---------- Ipinæ--	75

THE SUBFAMILY *ECCOPTOGASTERINAE*

The greater number of the genera of the subfamily **Eccoptogasterinae** are tropical or subtropical in their distribution. But one genus, **Eccoptogaster** is represented in our collections from Mississippi, although probably **Cnesinus** also occurs and possibly others may be found in the extreme southern part of the state.

THE GENUS *ECCOPTOGASTER* HERBST.

The genus **Eccoptogaster** is readily distinguished from the other members of the subfamily by the outer apical angle of the fore tibia being produced to form a curved hook; by the short antennal scape; and by the out-

line of the venter of the abdomen ascending abruptly behind. All of the species are black or dark brown in color, are short, thick-bodied beetles, varying in length from 2 mm. to 5.5 mm. long.

All of the species of Eccoptogaster are true bark-beetles, breeding in both deciduous and coniferous trees. The majority of the species are monogamic in their breeding habits but several speces occurring in coniferous trees (E. piceae Sw. and E. unispinosus Lec.) are apparently normally bigamous and occasionally polygamous. The genus contains several species of well known economic importance. Only three species were taken in Mississippi and of these three two are known to be among the most injurious of bark-beetles, capable of attacking and killing trees apparently healthy or only slightly weakened.

Key to the Species of *Eccoptogaster*

Eccoptogaster muticus Say.

This species is readily separated from others of the genus by the characters given in the key. The males are distinguished by the front of the head being broad and flat, bordered with a fringe of long yellow incurved hairs; and by the presence at the posterior margin of the last ventral segment of a dense fringe of hair which is longer at each lateral angle forming two tufts. The front of the female is narrower, with finer and sparser hairs, and the fringe of hairs on the last abdominal segment is lacking. There is considerable variation in size—the specimens in my collection varying from 2.5 mm. to 4.7 mm., with the average size about 3.5 mm.

The Mississippi specimens in my collection were obtained March 23, April 9, 24, May 19 and 23, 1920, at Agricultural College. All were from limbs of the southern hackberry, Celtis mississippiensis Bosc. I have also a considerable series collected by myself from dead hackberry (Celtis occidentalis L.) June 10, 1920, at Lawrence, Kansas, and associated with Phthorophloeus dentifrons Blackm., and Chramesus chapuisii Lec. The Mississippi specimens were associated with the ipids C. chapuisii Lec., Phthorophloeus dentifrons Blackm., and Micracis langstoni Blackm.; the cerambycids Chion cinctus Drury, Neoclytus luscus Fabr., N. acuminatus Fabr., and Lepturges symmetricus Hald.; the buprestids Agrilus lecontei Saund., A. otiosus Say., and A. ferrisi Say.; the clerids Monophylla terminata Say. and Phyllobaenus dislocatus Say., the small Ptinid, Gibbium psylloides Czeny., and several undetermined parasitic hymenoptera.

The brood burrows of E. muticus are similar in general character to those of E. quadrispinosus. The species is apparently always monogamic, and the single egg-gallery extends with the grain of the wood for a distance of from one to two or more inches. The eggs are laid in niches in the sides

of the gallery and the larvae on hatching begin their mines at the juncture of bark and sapwood and at first extend them at right angles to the egg-gallery. Soon, however, the larval mines become more tortuous in their course and as the larvae become nearly full grown they extend their burrows not outward into the bark but into the sapwood. They often burrow for some distance through this and if they are at all numerous soon reduce the outer part of the wood to a mere shell. Pupation usually occurs beneath the surface of the wood and the young adults must burrow through the intervening wood and bark before they emerge. Infested limbs collected in the field March 23 contained numerous full-grown larvae in their burrows deep in the wood. This material placed in breeding jars gave rise to numerous adults, the first emerging April 9 and others continued to appear in the jar until June 1.

This species is perhaps never as injurious as are several other members of the genus as it breeds by preference in dead, dying or felled trees and in the broken, dying or dead branches of living trees. Its chief damage then is in hastening the decay of dead or felled hackberry and it may occasionally kill trees which are much weakened or dying from other causes. There are probably two generations per year in Mississippi although the duration of my stay in that state was such as to make it impossible to determine this point definitely.

Eccoptogaster rugulosus Ratz.

Readily distinguished from the other species by its smaller size, by the elytral interspaces being as deeply impressed as the striae, and by the elytra being well supplied with short hairs, equally distributed. The ventral abdominal segments are convex, strongly ascending and uniformly hairy.

This species which is commonly known as the "fruit tree bark beetle" attacks nearly all varieties of orchard trees and breeds as well in a number of our wild or native trees. It was originally imported from Europe and has been known in this country since 1878, having been reported as occuring in nearly all of the states east of the Rocky Mountains. In Mississippi the writer has specimens from Agricultural College, Vicksburg and Monticello—the hosts being apple, wild plum (**Prunus angustifolia**) and wild cherry **P. serotina.** Among the native trees and shrubs the wild plum is most often the host of this bark-beetle. Its brood each year kills large numbers of the stunted scrubby trees occurring in pasture lands, being especially numerous in trees more or less injured by the ground fires used each spring in clearing off the dead weeds and high grass stems of the preceding season. Under such conditions it does no harm as the wild plums are not only worthless but are a detriment to good pasturage. However, there is always danger of their becoming sufficiently numerous to attack adjacent orchards, especially if the orchard trees are allowed to become at all unhealthy.

The habits of the fruit tree bark-beetle are in a general way similar to those of the hickory bark-beetle. The young beetles emerge from their old host trees in which they have spent the winter during April and May (at Agricultural College, Miss.) and immediately attack a new host and excavate their brood burrows. They usually choose trees or limbs which are dying or weakened from other causes but sometimes when very numerous attack and kill trees which are apparently healthy. Their brood burrows have but a single egg-gallery (monogamic) which extends in a general longitudinal direction and the larval mines extend at first at right angles to the egg-gallery but later become quite tortuous. Both egg-gallery and larval burrows are at the juncture of the bark and sapwood and partly in each, so that the effect is to destroy the cambium and to cut off the supply of nour-

ishment. There are at least two generations each season and probably more than two in Mississippi.

This insect has been the subject of detailed investigations in several regions of the country, perhaps the most complete account being that found in Bull. 264 of the Ohio Experiment Station, Wooster, O. There are also several bulletins and circulars issued by the Bureau of Entomology which deal with both the scientific and practical aspects of the subject.

Prevention and Control.—The best method to prevent injury by the fruit tree bark-beetle and by other similar pests is by keeping the orchard trees in a healthy condition. Trees attacked are nearly invariably those which have had their vitality lessened by tree diseases, San Jose scale or other insects, weather conditions such as sun scald, mechanical injuries such as by rodents, or by poor nourishment due to root diseases or to poor soil or poor cultivation. Broken and diseased limbs should never be allowed to remain on the trees as they serve as breeding places for this bark beetle and also for other boring insects. Pruned limbs whether infested with insects or not should be burned and should never be allowed to remain in or near an orchard as they also serve as breeding places.

Infested trees should be severely pruned to remove all infested parts, the soil should be cultivated, fertilized heavily and the remaining part of the tree coated with a thick layer of whitewash. This coating must be thick and should be repeated several times during the season to prevent the later broods from entering the bark.

Eccoptogaster quadrispinosus Say.

This species may be distinguished from other species of the genus likely to be found in Mississippi by the nearly glabrous disc of the elytra, the striæ of which are more deeply impressed and more coarsely punctured than the rather narrow interspaces; and by the four acute spines on the ventral abdominal segments of the male. The venter of the female is strongly ascending and flat or slightly excavated. In the male the first segment is horizontal, fused with the second, which is strongly ascending and deeply excavated; with the anterior margin strongly extended, recurved and angulate at the middle; the surface opaque, impunctate, distinctly carinate in the median line, the posterior margin elevated and slightly extended at the lateral angles to form short spines; third segment much shorter, opaque, punctured, with a well developed spine at each posterior lateral angle, and at the middle; fourth segment more strongly punctured, with a median spine; fifth segment very short. The length varies from 3.3 mm. to 5 mm. or more.

The southern male specimens differ from those of New York in the greater development of the ventral spines. The extreme of this variation is shown by one specimen which in addition to the better development of the four characteristic spines, also has small spines at the posterior-lateral angles of the fourth ventral segment and more remarkable still a long slender spine on the second segment near the end of the median carina (see Fig. 21).

This species commonly known as the "hickory bark-beetle" breeds in all species of the genus Hicoria, including the pecan. The writer has also seen the beetles starting their brood burrows in the trunk of a butternut tree at Syracuse, N. Y., but it is not known whether or not the insects could complete their life history in this host. It is known that the adults feed upon the twigs of pecan and later readily enter the bark of felled pecan and breed there successfully.

The hickory bark-beetle is very widely distributed throughout the country and probably occurs wherever the various species of hickory occur naturally. The insects have been reported from Quebec to as far south as

Georgia and westward to Utah. So far as is known they have never before been reported from Mississippi but are nevertheless quite common there, wherever the hickory grows naturally. They were taken by the author at Corinth, Agricultural College, Electric Mills, Meridian, Hattiesburg, Mendenhall and Maxie, the latter locality being only about forty miles from the gulf. At Agricultural College they are especially abundant in the dying hickory trees of that vicinity. In all some 35 to 40 trees were found near the College during the winter which had the inner bark riddled by their burrows, the larvæ responsible for the damage still being present in their hibernating quarters. While some of these trees, especially those upon the College campus, were undoubtedly weakened or killed by other causes, there can be no doubt that many of the trees had been killed by the primary attacks of this beetle.

The brood burrows of the hickory bark-beetle are constructed by the adults in the bark of either the trunk or limbs of all species of hickory. The female starts the burrow and probably does all or nearly all of the work of excavating it. During the early work of excavation the males wander about over the surface of the bark or linger near one of the newly started burrows. They seldom enter the burrow and when they do so, remain only a short time. Fertilization takes place either at the mouth of the burrow with the female in the entrance and the male outside upon the surface of the bark, or with both male and female just within the entrance.

The entrance to the brood burrow is nearly at right angles to the surface of the bark but with a slightly upward angle. As soon as the surface of the sapwood is reached the direction of the mine is changed and it is continued at the juncture of the bark and sapwood and longitudinally with the grain of the wood. The brood burrow consists of a simple egg-gallery of a diameter just sufficient to allow the passage of an adult beetle and nearly invariably extends upward from the entrance, very seldom downward. At each side of the egg-gallery the female gouges out little niches in each of which she deposits a single egg, covering the opening with a plug of "sawdust" held in place with mucilaginous saliva from her mouth.

The niches are usually at nearly regular intervals on each side, although not necessarily so. The number of eggs laid by a female varies considerably as does also the length of the egg-gallery. The egg-galleries are usually from one to two inches long and have from 20 to 60 egg niches. However, burrows have been studied which measured as much as 3½ inches in length and with as many as 140 egg niches.

The larvæ on hatching burrow mostly in the cambium at right angles to the egg-gallery. The larval mines are straight at first and parallel to each other, but as the larvæ become larger they diverge more and more, resulting in an engraving such as shown in Fig. 77. The larval mines extend for a distance of three inches or more and as the trunks and large limbs of a tree are nearly always attacked by a large number of broods at the same time the flow of sap through the cambium is soon cut off and the tree is injured past recovery in a very few weeks and usually killed outright within a month. Where the brood attacking a tree is not so numerous only the upper portion of the tree may be killed the first year, and it will require several years to complete its destruction.

When nearly full grown the larvæ leave the cambium and bore into the outer part of the inner bark. If they reach full growth in the late fall as is normally the case in the northern states, they remain in the bark during the winter and transform to pupæ and later to adults in the following spring or early summer. In Mississippi, however, there is more than one generation a year so that only the larvæ of the second generation hibernate. The adults on emerging usually fly immediately to living trees and for a period of several days feed voraciously upon the young twigs and the petioles of the leaves. The cavities made in feeding often extend nearly through the

twigs and petioles, causing the leaves to wither and often weakening twigs to such an extent that they are broken by the wind and fall to the ground, or remain hanging on the tree by a few shreds of bark or woody tissue. The feeding habits of the beetles often do considerable damage to a tree, but do not cause its death. After feeding for a time the adults attack the trunk and larger limbs and construct their brood burrows. It is the work of the adults and larvæ in the brood burrows which does the greatest damage and which nearly always causes the death of the trees attacked.

There are without doubt normally at least two generations of the hickory bark-beetle each year in Mississippi. On May 10, 1920, numerous beetles were observed just starting their burrows in the bark of a recently felled tree near the Agricultural Collge. The next day a number of beetles were taken as they emerged from a hickory tree killed by them the preceding year and were confined in a jar with a piece of the trunk of a small native pecan tree about 2 inches in diameter and a foot long. In the course of the next few days a number of the females constructed their brood burrows and deposited their eggs. On leaving Mississippi in the latter part of May the infested material was packed and shipped to Syracuse. It was not examined until July 6 and by then was very dry. However, in spite of the excessive drying a large number of the beetles emerged during August, the first appearing Aug. 5. From numerous observations made upon this and other species of bark-beetles there can be no doubt that the life processes of the larvæ were retarded by the drying of the wood in which they bred and by the cooler climate to which they were removed. However that may be, the adults emerging late in August or early in September would give rise to larvæ which would have ample time to complete their larval growth before the advent of weather cold enough to prevent further feeding.

In the southern part of the state it is likely that a partial third generation occurs—i. e. that the third generation passes the short winter season as half-grown larvæ. On November 21, burrows were found at Hattiesburg which contained larvæ less than half-grown. It is possible that these represented the laggards of the second generation, but it seems more likely that they were of the third generation. However, two generations per year is certainly the rule for a greater part of the state.

This insect has caused the death of thousands of hickory trees in New York state and in other regions of the north. It is by all odds the most widespread and deadly enemy of this genus of trees. Where the beetles are numerous they attack trees which are apparently in perfect health, killing them in a single season and where they are very numerous hundreds of trees are killed in a limited locality. One such instance was under observation at Syracuse, N. Y., for a number of years. Occasional trees had been dying for several years but in 1913 a group of a dozen or more trees were found infested—some of them dead, others only partly dead. . This group of infested trees was at one corner of a pasture woodlot comprising about four acres of mixed hardwoods of which about 70 per cent was hickory. In the following year (1914) 76 per cent of the remaining hickories—111 trees—were killed and at the end of another season less than a half dozen live trees remained on the four-acre tract.

Similar infestations have occurred in various localities in the northern states, but so far as is known no such locally disastrous outbreaks have taken place in Mississippi. Indeed, so far as can be learned from the literature the insect had never before been reported for the state. In spite of this, however, it is not only widespread throughout the state but in several localities is very common and in at least one locality is doing considerable damage. At Agricultural College practically all dying, dead or felled hickories contained either the brood of this beetle or showed numerous brood burrows from which they had already emerged. Many of these trees gave every appearance of having been killed by the insects and the engravings

were certainly numerous enough to have killed the trees.

While the native hickories are valuable trees as nut producers and especially as the source of the most suitable wood for spokes, tool handles, etc., perhaps the greatest danger to be feared from this insect is to the very valuable pecan groves of the state. While injury to pecan trees has never been reported so far as is known, the writer has determined by experiment that the beetles readily enter pecan and breed in it successfully—apparently just as successfully as in other species of hickory. Should a serious outbreak of the beetles ever occur in the vicinity of a pecan grove it is not unreasonable to suppose many of the trees would be killed—at least the less sturdy ones or those weakened by other causes.

Control and Preventive Measures.—The only practical methods thus far devised of controlling an infestation of the hickory bark-beetle are those recommended in Circular 144 of the Bureau of Entomology. It should be noted, however, that this circular was prepared for conditions as they exist in the north and the dates within which effective measures of control may be undertaken must of necessity be modified to correspond to the differences in the seasonal history of the insect as it occurs in Mississippi and other regions of the south. The following recommendations are modified to fit southern conditions.

Locate and fell all dead or dying trees in the infested area within an area of several miles of the center of infestation. This should be done between December 1 and April 1 in central and northern Mississippi and by March 15 in the southern half of the state. All of the infested trunks, stumps and branches should be so treated as to destroy the brood before it has a chance to transform to beetles and infest new trees. This may be done in any of the following ways: (a) by using for fuel before March 15; (b) by using for commercial purposes and burning all slabs and refuse; (c) by removing bark and burning this and the branches; (d) by placing the trunks in water and burning all branches and tops.

These measures in order to be effective must be thorough as otherwise the effects will be only partial, temporary or very local. All property owners in the infested area must co-operate if permanent good results are to be effected. Infested trees should, in so far as possible, be located and marked before the leaves have been lost in the fall as they are much more easily recognized at that time. It should be realized that the more widespread and thorough the control, the more lasting will be the results obtained.

It is recommended further that owners of pecan orchards keep a sharp lookout for the work of this beetle not only in their planted pecan trees but also in the native pecans and hickories in their neighborhood. If dying hickories or pecans are noted, samples of the bark and limbs should be sent to the State Entomologist. If these show the work of the hickory bark-beetles it is only the part of wisdom to make every effort to destroy the brood whether the infestation is in native or in planted trees. Control of this insect in the native hickories will without reasonable doubt prevent destructon in pecan orchards so long as the latter are kept in good health by proper methods of cultivation.

Eccoptogaster fagi Walsh

This species resembles the hickory bark-beetle more closely than do any of the others. The interspaces of the elytra are wide, each with a rather sparse row of fine punctures; the disc is nearly glabrous; the ventral segments are without spines in either the male or female; length usually over 5 mm.

No specimens of this species were taken in Mississippi, but as it has been reported from Illinois and also from Texas, it very likely occurs in the state. The host plants are hackberry and beech.

THE SUBFAMILY *HYLESININAE*

The members of the subfamily **Hylesininae** are readily distinguished from other **Ipidae** by the characters given in the key:—the anterior tibia with the outer distal angle not strongly produced; the head visible from above; the pronotum not usually more strongly roughened in front. The members of the family are true bark-beetles, some species breeding in deciduous trees while others breed in conifers. Some are monogamic while others are polygamous.

Key to the Genera of the Subfamily *Hylesininae*

(Adapted from Swaine)

THE GENUS *CARPHOBORUS* EICHHOFF

The members of this genus may be readily recognized by the characters in the key. They are further characterized by the 5-jointed funicle of the antenna, the flattened, oval antennal club with three distinct sutures; the densely, rather finely punctured thorax; the very coarsely punctured elytral

striæ; and by the vestiture of fine, cinereous scales. Only one species was taken in Mississippi, but a second species is likely to occur.

Carphoborus bicristatus Chap.

The adults are dark brown, with numerous small cinereous scales; 1.6 mm. to 1.8 mm. long. The thorax is finely and densely punctured; the elytra striate with moderately coarse strial punctures; 1st interspace slightly elevated, 3rd very strongly elevated and joined near the apex with the 9th interspace and from here continued to the suture. The front of the head in the female is densely clothed with hairs of moderate length; the male front is densely punctured, with sparse short hairs and with a small tubercle in the median line between the eyes.

This species has been reported from the middle and southern states. In Mississippi it is very numerous near Agricultural College, but was not taken elsewhere. It occurs in countless numbers in the bark of pine limbs cut during the preceding winter. Specimens were taken in the field May 8, 10 and 23, 1920. On the earlier date they had but recently started their brood burrows, each burrow being occupied by one male and from one to eight females. In some of the burrows no eggs had yet been deposited on May 8, while in others a few of the eggs had already hatched and the young larvæ had begun to mine through the inner bark.

These beetles are decidedly polygamous in their habits as the brood burrows usually have from 3 to 8 egg-galleries, each occupied by a female. The most common ratio is one male to five females. The burrows are of the true radiate type and the egg-galleries may bear any relation to the grain of the wood. The nuptial chamber and egg-galleries are nearly entirely in the sapwood, while the larval mines involve both wood and inner bark but are at first nearly entirely in the bark. The egg-galleries are usually not excessively long, usually being from 1½ to 2 inches, but occasionally longer. The engravings are often so crowded that in advanced stages it is difficult to distinguish the limits of individual ones.

The beetles have two or more generations each season, the adults of the first generation being able to re-enter and rear another brood in the same limbs which served as their own larval host. Infested material brought from the field May 8 was placed in breeding jars. The young of the new generation began emerging in considerable numbers the first week in July —the life cycle having been completed in nearly exactly two months. Many of these young adults re-entered the same material and their progeny was emerging throughout most of September.

This species is probably of little economic importance as it seems to breed by preference in the limbs of recently cut pine trees. It also attacks limbs which have suffered mechanical injury and occasionally breeds in limbs still alive but weakened by excessive shading. It has never been taken by the writer in healthy limbs. However, there is always danger of such insects attacking and killing healthy trees, especially when local practices allow them to become unduly numerous. To avoid this it is recommended that limbs and tops of pine should be burned within six weeks after they are cut. In this way the slash if allowed to lie several weeks acts as a trap in attracting breeding insects and if burned within six weeks all of the brood is destroyed before the new generation of beetles has a chance to emerge.

This species was associated with **Ips grandicollis, Pityophthorus pulicarius** and **P. nudus** in the twigs and small branches.

Carphoborus bifurcus Eichh.

While no specimens of C. bifurcus were taken in Mississippi it has been

reported from New Jersey, District of Columbia, Tennessee and Florida and very likely occurs in the state. It differs from C. bicristatus in the smaller size (1.5 mm.), coarser elytral punctures, narrower interspaces; in the front of the head not being hairy in either sex but ornamented with two tubercles in the male. Its habits are probably similar to those of the sister species. Packard reports it from Montgomery, Alabama, breeding in the bark of pine, the egg-galleries being described as long and sinuous. Those he figures, however, appear to have been made by **Pityophthorus annectens.**

THE GENUS *CHRAMESUS* LeCONTE

The genus **Chramesus** is characterized by its short, oval, strongly convex, "humpbacked" form; by the extraordinary antennæ the club of which is very large, long oval, unsegmented, with the 5-jointed funicle attached to it at one side. The pronotum is much wider than long, is roughened at the sides; the elytra are elevated and serrate at the base, the interspaces ornamented with suberect bristles and with smaller hairs or scales. Two species occur in Mississippi.

Key to the Species of *Chramesus*

		Page
A.	Front of head in female without median pit; striæ wider; interspaces sparsely clothed with scale-like hairs, each with a row of longer bristles; males with the antennal scape ornamented with only a few short hairs----------**hicoriae** Lec.--	50
AA.	Front of head in female with a small median pit or fovea; striæ narrower; interspaces densely clothed with small scales and with a row of short bristles; males with the antennal scape ornamented with a brush of long hairs--------**chapuisii** Lec.--	51

Chramesus hicoriae Lec.

Dark brown or black with cinereous hairs and bristles; 1.5 to 1.8 mm. long; 1.6 times as long as wide. Front of head in female flattened, subopaque, weakly punctured, pubescence fine, short and sparse, with an arcuate raised line between the bases of the antennæ; in the male, deeply concave, with the raised line as in female. Antennæ as described for the genus. Prothorax much wider than long, strongly asperate, more strongly in front; disc granulate-punctate, median line slightly elevated. Elytra with anterior margin elevated and serrate; striæ impressed, closely punctured; interspaces uniserially granulate with a thick, moderately long, suberect bristle from each granule and sparsely clothed with short scale-like hairs; declivity oblique.

Chramesus hicoriae has been reported from various parts of the eastern, middle and western states and from Canada. Its distribution is most likely nearly as extensive as that of its host plants—the various species of hickories—in this country. In Mississippi it was found by the writer at Maxie, Mendenhall, Electric Mills, Agricultural College, Corinth, Iuka, and at Shiloh Park, Tenn. Everywhere it seemed to be as numerous as in central New York—perhaps more so. It was found only in the various species of hickory. Specimens were taken November 12, December 3, 24 and 26, 1919 and January 21, 22, April 13, 14, 19, 26 and May 19, 1920.

This small beetle constructs its brood burrows in the twigs and smaller branches of hickory. They are most often found in limbs cut or broken from the parent tree or in limbs or sprouts seriously injured or killed by fire or otherwise. The entrance to the burrow nearly invariably occurs

near the base of a smaller branch, a leaf scar or at some other place where the bark is sufficiently roughened to furnish a foothold for the beetle in starting its burrow. This species is always monogamic and the female not only constructs all of the egg-gallery but also starts the burrow.

The gallery made by the parent beetles is of the simple longitudinal type consisting of a single longitudinal egg-gallery as in **Eccoptogaster quadrispinosus** but differing from that of this species by having a nuptial recess near the juncture of the entrance tunnel with the egg-gallery. This alcove or niche is occupied by the male and also serves as a turning niche for the female before and after an egg is laid. The egg-gallery is from ¾ to 1½ inches long, longitudinal to the grain of the wood and nearly straight. The nuptial recess is a small niche about 1-16 of an inch deep and nearly at right angles to the egg-gallery. The eggs are placed in niches at each side of the burrow and vary from 15 to 60 to an engraving.

The larvæ burrow at the juncture of bark and sapwood, grooving both. In very thin-barked twigs or limbs most of the larval mine is in the sapwood while in limbs with thicker bark a greater proportion is in the bark. The larval mine starts perpendicular to the egg-gallery, but soon the direction is changed and it is continued nearly parallel to the woody fibres. These larval tunnels are usually about two inches long. Very often as the larvæ approach full growth the burrow is carried into the sapwood and continued for a distance of ¼ of an inch or more just under the surface of the sapwood and parallel to it. Ordinarily, however, unless the bark is unusually thin the larval burrow only grooves the sapwood deeper and deeper and even the later part remains visible from the surface when the bark is removed. The young adults emerge through small "shot-holes" in the bark about 1-25 of an inch in diameter. In the northern states there is one generation of this beetle each season but in Mississippi most likely two generations occur each season. ,

As this insect attacks only the twigs and smaller branches, and of these only such as are badly injured or dying, it is perhaps never strictly injurious. If it should ever become so it can be readily controlled by cutting and burning the infested limbs while the brood is still present.

This species was found associated in the same limbs or twigs with **Micracis rudis** Lec., **M. harnedi** Blackm., **M. bicornis** Blackm., **Cryptocleptes dislocatus** Blackm., **Thysanoes fimbricornis** Lec., **Stephanoderes dissimilis** Zimm., and the two clerids **Monophylla terminata** Say. and **Orthopleura damicornis** Fabr.

Chramesus chapuisii Lec.

Description of the adult female.—Brown with cinereous hairs and scales; 1.48-1.97 mm. long; 1.7 times as long as wide.

Front of the head plano-convex, with a transverse arcuate elevation extending from base to base of the antennæ; rather weakly but evidently punctured, with scanty, short, appressed pubescence directed mesad and dorsad; with a distinct but small pit but little larger than a coarse puncture at the center just above the elevation. Eyes elongate oval, inner margin entire, slightly more coarsely granulate than **hicoriae**. Antenna similar to that of **hicoriae** but with the scape slightly more hairy.

Pronotum 1.38 times as long as wide (relatively narrower than in **hicoriae**); widest posteriorly, with the sides nearly evenly arcuate, base sinuate; disc moderately punctured with a smooth, slightly elevated median longitudinal line; sides asperate, strongly in front, weakly behind. Vestiture consisting of cinereous hairs on the smoother disc and coarse, spatulate bristles in the asperate areas.

Elytra wider than thorax; 1.1 times as long as wide; with the anterior margin strongly elevated and serrate; the sides subparallel for two-thirds of their length, broadly rounded behind; striæ impressed, narrower and not so deep as in **hicoriae** with punctures moderately coarse and close (finer and more widely spaced than in **hicoriae**); interspaces much wider, about four times as wide as striæ, densely clothed with small wide scales, with a sparse median row of granules from which arise short, thick, sub-erect bristles in each interspace. Declivity convex, oblique, without special modifications.

First, second and fifth visible abdominal segments longer than third and fourth; last four obliquely ascending; vestiture progressively longer and more abundant posteriorly.

Male of about the same size and proportions; frons concave, with weak, rather sparse punctures and fine nearly white hairs, the latter more numerous at the sides and between the concavity and the eyes; outer side of antennal scape densely pubescent, with long, light colored hairs (readily distinguished from the male of **hicoriae** by this character alone).

The author's series of this species consists of six females and two males obtained from their burrows in the limbs of hackberry. Four were taken at Agricultural College, Miss., May 19, 1920, and four at Lawrence, Kans., June 10, 1920. The specimens were compared with LeConte's type and the females agree very closely. The female of this species is readily distinguished from **C. hicoriae** Lec. by the small frontal pit in **chapuisii**, by the narrower elytral striæ and the wider elytral interspaces which are densely clothed with scales in **chapuisii** and more sparsely clothed with hairs in **hicoriae** and by the shorter elytral bristles in **chapuisii**. The males of the two species are readily separated by the dense brush of long hair on the antennal scape of **chapuisii** and by the same elytral characters as in the other sex.

C. chapuisii is by no means as common in Mississippi as is **C. hicoriae.** Only four specimens were taken in the state. The brood burrow is very similar to that of the sister species and indeed could not be distinguished from it except for the host tree, which is hackberry (**Celtis occidentalis** L. and **Celtis Mississippiensis**). The length of the egg-galleries in the engravings studied varies from ⅝ to 1⅞ inches long and the egg niches from 38 to 108 in each gallery. The larval burrows are of about the same length as in **C. hicoriae** but do not show such a strong tendency to become longitudinal. The insects have been found only in broken limbs of the common hackberry and it is believed that ordinarily they are not injurious.

C. chapuisii is associated in the limbs of hackberry with **Phthorophloeus dentifrons** Blackm., **Eccoptogaster muticus** Say., and **Agrilus lecontei** Saund.

THE GENUS *PHTHOROPHLOEUS* REY.

The genus **Phthorophloeus** Rey. is readily distinguished from other American genera of bark-beetles by the loosely jointed antennal club, each of the three segments of which are extended on the inner side forming a sublamellate structure. The antennæ arise from the sides of the front; the elytra are distinctly striate, the interspaces granulate and more strongly granulate or serrate on the declivity; the sides of the pronotum are moderately asperate or merely punctured.

Three species were taken by the writer in Mississippi and at least one other is likely to occur. All of these species appear to be monogamic in their breeding habits and all of those found rear their young in the inner bark of deciduous trees.

Key to the Mississippi Species of *Phthorophloeus* Rey.

Phthorophloeus frontalis Zimm.

Dark brown with yellowish suberect pubescence; 1.8 to 2.2 mm. long; 2.22 times as long as wide. Front of head in male broadly concave, with a small erect spine at each side near the base of the antenna; antennal club with laterally extended segments nearly twice as wide as long. Disc of pronotum granulate punctate, sides asperate toward the front. Elytra with anterior margins serrate, separately arcuate; striæ deeply impressed, with rather coarse, closely placed, shallow punctures; interspaces of equal width, with a single row of coarse granules, declivity convex, with posterior lateral border strongly serrate; striæ narrower and with finer, deeper punctures than on the disc; interspaces relatively wider, with higher but not coarser granules. Elytral vestiture consisting of suberect, moderately fine hairs.

P. frontalis occurs throughout the region east of the Rocky Mountains, its distribution probably being comparable to that of its chief food plants—the mulberries. It is said to breed not only in the native species of mulberry but also in the paper mulberry and in hackberry. All of the specimens taken by the writer were obtained from native species of mulberry, but injuries to the bark of paper mulberry were observed which were doubtless made by this same species, although all of the beetles had left. No sign of its work was seen in hackberry although a closely allied species **P. dentifrons** Blackm. was very common in the limbs. It is possible that these two species have been confused.

The adults of **P. frontalis** emerge from their larval hosts in the fall and burrow into bark of living mulberry trees. They remain here during the

winter, their burrows often extending into the outer part of the living inner bark. Their presence in the bark causes an irritation and stimulation of the living tissues, evidence of which is seen in abnormal swellings and a blackening of the outer bark which resembles in a general way similar growth produced by certain fungi. Considerable damage is done to trees by this habit of the beetles, but it is not likely that they are often actually killed by the hibernating burrows alone. The living tissue in which the beetle burrows, however, is often riddled and that immediately adjacent turns black and dies. Also, a considerable amount of sap is lost from the wounds in the spring and doubtless also a considerable quantity is eaten by the beetles. When the same tree has been attacked in this manner for several years in succession it is nearly completely girdled by the beetles and in many cases so weakened that it is completely killed by the brood burrows of this beetle or by other boring insects. Several cases were observed of dead trees which showed the characteristic hibernating quarters of P. frontalis in the lower trunk while the bark above this injury had been riddled by the brood burrows, thus killing the tree completely.

In the spring the beetles leave their winter quarters and construct their brood burrows in the bark of either the same tree or of others of the same species. They usually choose trees which are still alive but which are weakened from some cause and they breed by preference in bark of moderate thickness. They are monogamic and the burrow is of the Forked-Transverse variety (Fig. 69), the egg-galleries extending one on each side of the base of the entrance tunnel and always in a transverse direction. One of these egg-galleries or forks is nearly invariably much shorter than the other and doubtless is a later modification or development of what was originally a turning niche or nuptial recess. Occasionally only one egg-gallery is made and in such burrows the other is represented by an unmodified nuptial recess.

The length of the egg-galleries varies from 1⅛ to 3½ inches, the average being a little more than 2 inches long. The number of egg-niches varied from 30 to 93 in a number of brood burrows studied, the average being about 75. The larvæ burrow both bark and sapwood, even grooving the surface of the wood. Normally the larval mines are straight and extend with the grain of the wood, but when obstructions are met with the burrow is carried around these and then continues longitudinally. The completed engravings are much more perfect than usual with bark-beetles because the young adults emerge very soon after transforming and obtain their adult food from the bark of living trees. There are probably two generations per year in Mississippi.

This insect, as has already been pointed out, prefers to breed in trees considerably weakened or even dying from any cause or in the stumps or trunks of felled trees. As has already been stated, however, the feeding and hibernating burrows made by the adults may in a few years so reduce the vitality of otherwise healthy trees as to make them fit places in which to rear the brood. Such weakened trees are thoroughly infested and are killed in a very short time by the brood burrows. The beetle can be controlled by destroying all trees infested by the brood. To be effective this should be done either early in the summer to destroy the first generation of the brood or late in the summer for the second brood. Destruction of the trees containing brood burrows, during the winter, will accomplish little or nothing as at least the vast majority of the young beetles have emerged and gone into their winter quarters. The young beetles may be destroyed in immense numbers by removing and burning the bark in which they are hibernating but this will involve the killing of trees which might otherwise survive. Very likely these hibernating adults could be killed by the use of some penetrating wash or spray but so far as is known no experiments have been conducted along these lines. Carbolineum carefully painted

upon the infested bark during the winter months would probably penetrate sufficiently to kill a considerable number of the insects.

This species was found in the same material as **Micracis langstoni** Blackm. and the ostomid, **Corticotomus cylindricus** Lec. was associated in one instance.

Phthorophloeus dentifrons Blackm.

Black with light grey nearly white bristles; 1.2 to 1.6 mm. long, 2.29 times as long as wide. Smaller and slightly more slender than P. **frontalis** but closely allied to it. Readily distinguished from it by the darker color, smaller, more slender form, coarser, shorter hairs which are grey rather than yellow, by the smoother, more sparsely punctured and more sparsely pubescent front; by the more finely granulate eyes, more finely sculptured thoracic disc; by the more strongly elevated and serrate anterior margin of the elytra; by the much narrower interspaces with finer granulation. The secondary sexual characters are similar to those in P. **frontalis**.

P. **dentifrons** is a common species at Agricultural College, Miss., where it breeds in great numbers in the dying and broken limbs of hackberry, preferring those less than 1½ inches in diameter. Specimens were taken March 23, 24 and May 19, 1920. The writer also collected a number of specimens from a broken hackberry on the campus of the University of Kansas, Lawrence, Kans., June 10, 1920. It is therefore widely distributed and it seems likely that records of P. **frontalis** occurring in hackberry really should refer to this species.

In habits this species differs very markedly from the mulberry bark-beetle in that the adults hibernate in the same limbs which served them as a larval host. They can be found in great numbers in their last season's engravings at any time during the winter and early spring. There are presumably two generations a year. The engravings are quite similar to those of the mulberry bark-beetle, but of course are noticeably smaller, both in diameter and length, due to the smaller size of the insect. When completed their regularity is usually destroyed by the young adults which continue to feed in the old host for a considerable time after transforming. The beetles attack the smaller, broken, injured or dying limbs and no instances were observed of any real damage to trees.

P. **dentifrons** was associated with **Eccoptogaster muticus** Say., **Chramesus chapuisii** Lec. and **Agrilus lecontei** Saund.

Phthorophloeus liminaris Harris.

This species is characterized by the segments of the antennal club being strongly extended and more than twice as wide as long. The thorax is wider than long, strongly narrowed in front with the anterior outline very broadly rounded, the disc and sides densely and rather finely punctured and with fine yellowish, upright pubescence; the elytral striæ are impressed, the strial punctures coarse and close; the interspaces are about equal in width to the striæ, are slightly rugose and with distinct, though low granules; the declivity is convex with the granules more prominent; the second interspace narrower and with smaller granules than the first and third. The front of the head is somewhat flattened in the female with a transverse arcuate carina; in the male the carina is similar but with slight concavities above and below it. The form is stout, 2 mm. to 2.3 mm. long and nearly exactly twice as long as wide.

This is the common peach tree bark-beetle which occasionally does considerable damage to peach orchards in the northern states. It has been found in New Hampshire, New York, Pennsylvania, Maryland, Virginia, West Virginia, North Carolina, Ohio, Michigan and in Ontario and doubt-

less occurs in others of the northern states. No specimens were taken in Mississippi but it is probable it occurs at least in the northern part of the state. Its life history, habits and methods of control have been the subject of numerous state and government publications. One of the best of these is Bulletin 264 of the Ohio Experiment Station.

The burrows are transverse, similar to those of the mulberry bark-beetles but are often rather more irregular. There are two generations per year even in the northern states. Most of the adults of the second generation emerge from their larval hosts and construct hibernating burrows in the bark of the trunks of either healthy or diseased peach or cherry trees—even in the various species of wild cherry. The control measures are similar to those recommended for the fruit tree bark-beetle (page 44).

Phthorophloeus mississippiensis Blackm.

This species is similar in color and general appearance to **P. liminaris** but is smaller (1.8 mm. long) and slightly more slender (2.14 times as long as wide). The extensions of the segments of the antennal club are not so wide as in **liminaris**; the frontal hairs shorter and more scanty; the pronotum shorter with the anterior margin very broadly emarginate, disc densely and roughly punctured with shorter and coarser pubescence; elytra very similar to **liminaris** but more broadly rounded behind, the declivity with all interspaces similar; elytral vestiture shorter and stouter than in **liminaris.**

This species was found breeding in the bark of dying and injured wild plum (**Prunus augustifolia** Marsh.) at Agricultural College, Miss. It especially seemed to favor the shrubs or small scrubby trees occurring in pastures, which had been more or less injured by grass fires. In some cases the brood burrows of this species were in the same branches as those of **Eccoptogaster rugulosus,** while in other cases they were alone. The burrows are similar to those of **P. liminaris** but are considerably shorter and are more likely to be irregular. The egg-galleries are very often not transverse but oblique and sometimes nearly longitudinal in direction.

This beetle was found breeding only in the scrubby wild plums and in no other host. The first two adults were taken in their larval host January 21, 1920 and in the same burrows were found nearly full grown larvæ. This material was placed in jars and on March 28 a single adult emerged. On March 30 over twenty specimens were taken in the field, some from their larval burrows in partly dead bark and others just constructing their brood burrows in living portions of the same tree. Whether or not the adults ever leave their larval host in the fall and hibernate in the bark of living trees cannot be stated positively but it is probable that those do so which become adults early in the fall.

THE GENUS *DENDROCTONUS* EICHHOFF

The genus **Dendroctonus** is characterized by its cylindrical, rather stout body; the broad prominent head, visible from above; the eyes oval without emargination; the well developed epistomal process; the antennæ with a 5-jointed funicle, and a broad compact club, thickened at the base and compressed distally; the large, broad, strongly punctured pronotum; the elytra with the striæ more or less impressed and the punctures small or moderate.

This genus is by all odds more destructive to forest trees in the United States than any other. A large per cent of the total damage to standing timber in the forested regions of the country is due to the work of the several species of this group. While by far the greatest amount of damage has been done by species occurring in the extensive forests of the Rocky Mountain and Pacific Coast region, several disastrous outbreaks have occurred in the pineries of the southeastern section of the country, the destructive insect in these cases being the "Southern pine beetle" **Dendrocto-**

nus frontalis. The genus has been thoroughly monographed by Dr. A. D. Hopkins of the Bureau of Entomology and those desiring more detailed information than here given are referred to Technical Series, No. 17, part I and to Bulletin 83, part I of that Bureau. But two species of the genus are likely to occur in Mississippi and but one of these was actually taken by the writer. These may be readily distinguished by the following key.

		Page
A.	Larger, 5 to 8 mm. long, and stouter; median frontal groove and elevations lacking; pronotum narrowed and constricted anteriorly, strial punctures very distinct----------**terebrans** Oliv.--	57
AA.	Smaller, 2.2-4.2 mm. long, and more slender; with elevations at each side of a median frontal groove; pronotum but little narrowed anteriorly; strial punctures not so distinct--------- **frontalis** Zimm.--	58

Dendroctonus terebrans Oliv.

Dendroctonus terebrans commonly known as the black turpentine beetle is black or dark brown, stout, 5 mm. to 8 mm. long. The front of the head is convex, closely and roughly punctured with a moderately wide epistomal process the sides of which are oblique; the eyes are elongate, moderately finely granulate, with the inner margin entire; the pronotum wide posteriorly, considerably narrowed anteriorly, with coarse, shallow punctures upon the disc; elytra widest near the base, disc punctuate striate, interspaces coarsely rugose; declivity convex with striæ more deeply impressed; disc nearly glabrous, sides and declivity with longer and more numerous hairs.

The black turpentine beetle occurs throughout the southern states from Texas to Florida and extending as far north as New Hampshire. In Mississippi the writer took specimens at Agricultural College and at Mississippi City, those from the northern part of the state being from short leaf pine while those from near the gulf were from long leaf and swamp pine. It attacks all species of pine within its range and also occasionally breeds in red spruce. Adults were taken November 3, December 18, 1919; January 20, March 22 and May 12, 1920, and it is in the adult stage that the insect most commonly passes the winter. All of these were taken from newly started burrows in living and otherwise apparently healthy trees, the presence of the beetles being indicated by the freshly made pitch tubes.

On emerging from their larval hosts, the young beetles fly in search of new hosts in which to rear their young. They usually choose injured or unhealthy trees or the stumps of newly felled trees, but in many cases attack trees which are apparently healthy in all respects or trees injured very slightly. Most of the specimens from Agricultural College were obtained from a single tree which was apparently normal in all respects except that it had happened to occur in the line of a wire fence and had been used instead of a post to attach the wires to. It was, however, only a few yards from a tree which had been killed the previous summer and from which the beetles had evidently emerged.

The beetles usually enter the bark at the base of the tree. The burrow is first extended upward for a short distance, then downward from the entrance tunnel in a general longitudinal direction. They vary considerably in length from a few inches to more than a foot and may consist of simple galleries but little wider than the beetle making them, may be branched or may be irregularly widened at various places. It is usually at such widened places that the eggs are deposited rather loosely at one side of the burrow. No separate or individual egg niches were observed in any case but usually the irregular masses of eggs were separated from the main gallery by a loose partition of sawdust-like frass. The burrows are of the irregular longitudinal type.

The activities of the beetles in constructing their brood galleries in the living bark nearly always results in a more or less abundant flow of resin or pitch. While this doubtless to some extent retards the beetle it does not prevent it from continuing its burrow, as this and numerous other bark-beetles can live for some time embedded in resin and will continue their tunnels although these are entirely filled with pitch. Much of this material is pushed out through the entrance and built up into a chimney-like structure often called a "pitch tube." Very often the presence of these pitch tubes is the only outward indication that a tree is being attacked by this or other bark-beetles.

When the larvæ hatch they do not construct separate tunnels through the bark but all continue to work together, feeding upon the bark and extending the cavity made by the parents till often it covers an area of several square feet. The larvæ also have the power of continuing to live and work although surrounded by resin, with which their burrows are sometimes partly filled. There are apparently one complete generation and a partial second generation in northern Mississippi, while it is likely that two complete generations are common along the Gulf coast.

While this species of **Dendroctonus**, like the closely related northern species, D. **valens** Lec., frequently attacks living trees and occasionally is the primary cause of their death, its principal importance is in the injuries it effects on living trees without actually killing them. As has been pointed out by Dr. Hopkins the wide triangular scars at the bases of trees which are usually referred to as "fire scars" really represent the old brood burrows of the turpentine beetles. These when left by the insects are filled with frass and pitch and covered by dead bark which is readily burned off by later ground fires, leaving the bare wood exposed. This is subject to decay and to later injuries by fire so that often the tree is so weakened as eventually to be broken by the wind or its vitality so sapped as to be subject to further insect injury.

In regions where the cutting of pine timber is continued year after year, living healthy trees are seldom attacked by this beetle as more favorable conditions for it are found in the numerous freshly cut stumps. When cutting is discontinued in a region where the beetles are numerous in the stumps, it is likely to result in numerous healthy trees being attacked the following year. This may be prevented by removing the bark from the infested stumps or by piling the slash about them and burning it, the result in either case being the destruction of a large per cent of the brood. When pitch-tubes showing the presence of the beetle are observed on especially valued trees the brood may be destroyed by chiseling into the bark beneath the entrance burrow and destroying the parent beetles and brood. If this is done soon after the beetles have entered the bark considerable damage to the tree attacked will be prevented. If the beetles are numerous in a locality all stumps, injured and infested trees should be barked while the brood is still present. Simple barking is sufficient to kill the larvæ as they soon die on exposure to the air, but adults should be killed.

Dendroctonus frontalis Zimm.

The southern pine beetle is slender, brown or black, 2.2 to 4.2 mm. long. The front of the head has a distinct longitudinal groove with a distinct elevation at each side; the prothorax is as wide as the elytra but slightly narrower anteriorly, with the disc distinctly punctured; the strial punctures of the elytra are rather indistinct; the interspaces rather coarsely rugose; the declivity is convex with a few longer hairs.

No specimens of this beetle were taken in Mississippi but there can be no doubt of its occurrence within the state as it has been recorded from all of the adjacent states. It ranges from District of Columbia to Florida and

westward to Texas and Oklahoma. The food plants include all of the species of Pinus within its range and also Picea rubens and P. excelsa. It is without doubt one of the most destructive forest insects in the south and when conditions are favorable, it often kills the pines and spruce over a considerable area. One of the most notable cases of injury took place in 1891 and 1892 when the pine forests over large areas of Virginia and West Virginia were killed by this beetle. According to Dr. Hopkins there are four or even five generations of this beetle each season and in the Gulf region these overlap so complexly that the various generations are difficult to distinguish.

In standing trees the brood burrows are constructed mostly in the upper and middle regions of the trunk. The brood burrows are long and winding but are in a general longitudinal direction. The eggs are laid in separate niches in the sides of the egg-galleries at rather irregular intervals of a half inch or more. The larval mines are at right angles to the egg-gallery and at first very narrow but later quite broad. In living bark they are usually short but in dead bark may be considerably longer. The full grown larvæ bore into the dead outer bark and there pupate. For further details as to their habits and seasonal history you are referred to Bulletin 83, part I of the Bureau of Entomology, in which Dr. Hopkins gives the results of his own observations and of those made by other members of his division.

The first evidence of the attack of the southern pine beetle upon living trees is the presence of pitch-tubes in the middle and upper trunk and of the reddish boring dust in the loose scales of the bark and at the foot of the tree. In about two weeks this is followed by a fading of the foliage, which first becomes yellowish and later reddish. By the end of a month, if the attacking beetles have been sufficiently numerous the tree is entirely killed above the point of attack and the contained brood will be about ready to emerge. By the time the leaves become reddish-brown, most of the beetles will have already left the trees. Usually the trees are killed in small isolated patches and such extensive devastation as that in Virginias in 1891-92 is very unusual.

This bark-beetle can be controlled by removing the bark of trees still infested and burning this. Mere removal of the bark of trees infested by this insect is not sufficient as the larger larvæ, pupæ and young adults are to be found in the outer bark and will mature just as readily in the removed bark as they will from the undisturbed trees. If special conditions make it preferable, the entire trunk may be scorched, placed in water or sawed into lumber and the slabs burned. In Mississippi these measures of control should be completed between December 1 and March 1, during which period the brood is more or less inactive. The above recommendations are in accord with those made by Dr. Hopkins and much more detailed instructions will be found in the bulletin by him cited above.

THE GENUS *PHLOEOSINUS* CHAPUIS

The genus Phloeosinus is characterized by the five-jointed antennal funicle with the distal segments wider; the connate antennal club which is much longer than wide with the sutures oblique; the frons with the epistomal process lacking; the deeply emarginate eyes; the moderately widely separated fore-coxæ; the punctured pronotum; and the elytral declivity with the first, third and alternate interspaces more strongly serrate or tuberculate. They are small brown or black, stout, cylindrical beetles from 2 mm. to 3.5 mm. long.

Three species of this genus were taken in Mississippi, two being in the common red cedar Juniperus virginiana L., while the third breeds in cypress, Taxodium distichum. They may be distinguished by the following key:

Phloeosinus dentatus Say.

Dark brown or black in color; 2.2 to 2.7 mm. long, nearly two times as long as wide. The front of the head is convex, moderately coarsely granulate, with a small crescentic or irregular-shaped impression at the center; eyes elongate, deeply emarginate; antennæ much lighter in color; with the sutures of the club curved and oblique; pronotum considerably wider than long, deeply and rather closely punctured, with a slightly elevated median line and a distinct impunctate callus at each side; elytra with the striæ very narrow, deeply impressed with the strial punctures obscure; interspaces very wide, densely and strongly granulate; declivity convex with the first and alternate interspaces more elevated and more strongly dentate, the second and alternate interspaces somewhat flattened but still distinctly granulate. The front of the male is weakly carinate on the lower half and the declivity is more strongly dentate.

P. **dentatus** occurs throughout the eastern section of the country from Texas to Massachusetts. In Mississippi it was taken by the writer at Natchez, Agricultural College, Wallerville and Ripley. All of the specimens are from the common red cedar **Juniperus virginiana** L., the dates of collection being November 6, 1919; March 11, 22, April 21 and 23, 1920. The insects breed by preference in recently cut trees or broken limbs of trees, but also are often found in those weakened by suppression or injured by fire or otherwise. In one case the beetles were found in their burrows in a tree otherwise apparently healthy, showing that under proper conditions it may become a serious primary enemy to the cedars. In addition to red cedar it also in its more northern range breeds in arbor vitæ, **Thuja occidentalis** L.

This beetle is monogamic in its breeding habits. The egg-gallery is longitudinal, from one to two inches long, with the egg-niches normally placed quite close, and at regular intervals on each side. Near the juncture of the entrance tunnel and egg-gallery there is usually a distinct nuptial chamber involving an excavation of both sides of the egg-gallery, but in some engravings this is represented by a single turning niche or nuptial recess cut in but one of the side walls. The egg-gallery may extend either upward or downward from the entrance, but the former is more common, especially when the burrows are in the trunks of standing trees. These insects may be controlled by cutting and burning infested trees or by barking the usable parts and burning all refuse. As in all other cases these measures must be carried out while the brood is still in the tree.

Phloeosinus enixus Blackm.

Dark brown or black in color; 1.9 to 2.6 mm. long, slightly less than

twice as long as wide. The front of the head is plano-convex, with a more or less evident median carina; the pronotum is 1 1-3 times as wide as long, deeply and densely punctured, with a faint median line, lateral calli lacking; the elytra have the striæ narrow, deeply impressed and obscurely punctured; the interspaces wide, densely granulate; the declivity convex with the first and alternate interspaces coarsely, uniserially dentate, second and fourth flat and devoid of granules, punctured. In the male the front is narrow and more flattened, with a subcircular impunctate central area bisected by a distinct median carina, and the declivital denticles are coarser.

This species is very similar in its habits to P. dentatus. It was taken by the writer at Natchez, Agricultural College, Wallerville and Ripley, Miss., in red cedar, usually occurring in the same trees as the other species. Its work is similar and it can be controlled in the same manner.

Phloeosinus taxodii n. sp.

Description of the Adult Female.—Brown or dark brown in color with the elytra lighter, 2.21 mm. long, 1.98 times as long as wide.

The front of the head is plano-convex, granulate-punctate, with a faint median carina; the eyes large, deeply emarginate, coarsely granulate; the antennal club elongate with the sutures oblique.

The pronotum is 1.27 times as wide as long, widest as the base, with the sides arcuate behind, constricted in front of the middle and the anterior margin broadly rounded; median line elevated behind, disc closely and deeply, rather coarsely punctured, with a slight depression near the base at each side of the median line, lateral calli nearly lacking; with a distinct transverse depression between the anterior lateral constrictions, anterior border lighter in color. Mesosternum distinctly punctured; with fine short hairs, obliquely ascending between the coxæ.

The elytra 1 1-3 times as long as wide, wider than pronotum, with the basal margins separately arcuate, elevated and serrate, sides subparallel, rather broadly rounded behind; striæ very distinctly, deeply impressed, narrow, with large distinct punctures, not closely placed; interspaces broad, with numerous confusedly arranged granules (not in uniseriate rows); first interspace widened, second, third, etc., narrowed posteriorly, all becoming more coarsely granulate or dentate toward the declivity with a tendency for the granulations to become uniseriate. The declivity convex, with the striæ more finely punctured than on the disc; first and third interspaces elevated with definite dentate granules in single rows, second interspace flat with fewer and smaller granules. Vestiture consisting of numerous moderately fine, yellowish hairs from the interspaces.

The male is similar in size and proportions; the front flattened, slightly concave at the center below, less coarsely granulate, with granules and punctures lacking at the median line which is brightly shining with a distinct elevated carina; pronotum with distinct lateral calli; elytral interspaces more coarsely granulate on the disc, the first, third and alternate becoming coarsely dentate or tuberculate on the declivity; second interspace flat, distinctly punctured, devoid of granules.

Described from a series of 125 specimens collected at Columbus, Miss., Sept. 4-10, 1921, by Dr. C. J. Drake from the branches of cypress, **Taxodium distichum** (L.) Richard, in which the species was breeding in considerable numbers. The work of the insect was also seen in dead cypress at Fulton, Durant, Lexington, Yazoo City, Vicksburg, Port Gibson, Natchez, and Meridian. The burrows are similar to those of other species of **Phloeosinus** occurring in arbor vitæ and red cedar. (Fig. 81.)

THE GENUS *LEPERISINUS* REITTER

The genus **Leperisinus** is readily distinguished from other genera likely to occur in Mississippi by the characters given in the key. The elytral declivity is not abrupt but there is a gradual descent from the base and a more rapid descent beginning about two-thirds of the way back. But one species of this genus was taken in Mississippi.

Leperisinus aculeatus Say.

Dark brown with color marking formed by light colored scales; 2.1 to 3 mm. long, about twice as long as wide. The front of the head is convex above, flattened below, closely, deeply and rather finely punctured, with numerous, rather fine, cinereous hairs; eyes scarcely emarginate; antennal funicle 7-jointed, club elongate fusiform, compressed; pronotum considerably broader than long, with distinct rather coarse and broad asperities on the anterior and side margins, anterior outline broadly and feebly emarginate, cinereous scales longitudinal, outlining a darker, diamond-shaped area on the disc and an irregular longitudinal area at each side; elytral striæ impressed, narrow, distinctly punctured; interspaces wide, coarsely granulate and densely scaly; the cinerous scales forming three fairly definite subtransverse, slightly angular bands; the declivity gradual, with the first and third interspaces slightly elevated, second flat and slightly narrowed behind. The male is usually smaller with the front flattened and more hairy.

The distribution of **L. aculeatus** is apparently nearly identical with that of its host trees, the various species of ash. Its distribution at least includes the section of the United States and southern Canada east of the Rocky Mountains. In Mississippi the writer obtained numerous specimens from Agricultural College and Wallerville, all from their burrows in the bark of white ash, **Fraxinus americana** L.

The adults emerge from their larvæ hosts in the fall and enter the bark of living or felled trees where they construct short hibernating and feeding burrows in which they pass the winter. In living trees the irritation caused by their presence in the living tissues causes an abnormal condition very similar to that in mulberry produced by **Phthorophloeus frontalis** already described. In the early spring the beetles leave their winter quarters and construct brood burrows in the trunks and limbs of weakened, dying or recently felled ash trees.

In 1920 the ash bark-beetles were first noticed to be active March 25 at Agricultural College, Miss. At this time they were found in great numbers attacking a recently felled white ash tree. Some were just entering the bark, others had their egg-galleries well started and many eggs laid while others were still upon the surface of the bark. At that time none of the burrows were more than two weeks old and most of them had been started within two or three days. But one larva, a recently hatched one, was taken. It was interesting to note that no burrows had been started upon the uppermost side of the felled tree but the sides and underside were well peppered with the entrance holes. This may possibly be associated with the greater difficulties which would be experienced in removing the frass from the burrows, but is more likely to be due to an instinctive avoidance by the beetles of the inevitable annoyance and danger from having their burrows flooded by the frequent rains which occur in this region in the spring and early summer.

A section of this infested trunk was taken to the laboratory and segments of the bark removed at convenient intervals of time in order to note the progress of their life history (Fig. 68). On April 4th the egg-galleries were not yet completed but quite a number of the larvæ had hatched and

some had extended their larvæ tunnels as much as 7 mm. On April 24th the adults had completed their burrows and about half of them were dead in their galleries. The larvæ mostly were from half to full grown and a very few had transformed to pupæ. In three burrows a very few eggs had not yet hatched. On May 8 nearly all of the parent adults were dead, but a few still remained alive in the egg-galleries. About one-fifth of the brood were still larvæ, about one-fifth were young adults and the remaining three-fifths were in pupal stage. The first young adult emerged May 16 and from that time they continued to emerge until the last of June, when all were out. It will thus be seen that the life cycle is completed in from two to two and one-half months. Three generations per season would thus seem to be the rule in Mississippi and even the laggards have ample time for the completion of two generations.

The brood burrows of **L. aculeatus** are very similar in essential respects to those of **Phthorophloeus frontalis** but are both coarser and larger, as would be expected from the larger size of the beetle (Fig. 73). The entrance tunnel connects with two transverse egg-galleries, one on each side. Near the juncture is a small niche only a few millimeters deep, which serves both as a turning niche and as the nuptial recess. The combined egg-galleries vary in length from 20 mm. to 60 mm., the average of 30 engravings taken as they occurred being 39.8 mm. and the average burrow having from 40 to 60 egg niches.

The engravings are usually very regular and symmetrical, the egg-galleries being nearly exactly transverse, unless some obstruction is encountered and the larvæ mines being longitudinal, regularly spaced, short and of even length. The engravings are never injured by feeding mines made by the newly transformed adults. In fact the young adults feed very little if at all in their larval host, but emerge as soon as their chitin has hardened and obtain their food from a fresh host.

So far as the writer's observations extend the ash bark-beetle does but little real damage. They occasionally enter trees weakened by injury or disease or damaged by fire and certainly hasten the death of such trees, but no case was observed where apparently healthy trees were attacked. If at any time they should prove markedly injurious they can be readily controlled by simply barking the tree—if this be done while the brood is still in the larval or pupal stage; by felling and burning infested trees, or by felling the tree, submerging the logs in water and burning the refuse.

As a usual thing this beetle seems to be kept down to moderate numbers by its natural enemies. It is very subject to control by parasitic enemies as has been pointed out by Swaine (1918). I have observed several cases where the majority of the pupal cells of this species were occupied by the cocoons of hymenopterous parasites. In one case studied over 90 per cent of the brood had been killed by such enemies. In Mississippi another more or less effective enemy is the small clerid **Enoclerus quadriguttatus** Oliv. which was very numerous and active on the bark in which the ipid was starting its burrows.

THE GENUS *HYLASTES* ERICHSON

In the genus **Hylastes** the antennal funicle is 7-jointed, the club oval, not compressed, distinctly annulated, with the first segment comprising about half of the club; the fore coxæ are narrowly separated, the third tarsal joint but little widened and emarginate, not bilobed; the bases of the elytra forming a nearly straight line, not separately rounded; the mesosternum not protuberant, the center of the abdomen not ascending strongly behind, ventral segments one and five longer than the others. The color varies from reddish brown to black and the beak is short and stout but better developed than in other **Ipidæ**, approaching some of the **Cossoninae** in this respect. But one species was taken in Mississippi.

Hylastes sp.

One specimen possibly of **H. exilis** Chap. but possibly new (Fig. 50) was taken at Agricultural College, Miss., May 19, 1920. It is a small slender black beetle 2.7 mm. long and 2.87 times as long as wide. The front of the head is granulate-punctate, the beak moderately broad, not carinate, sulcate above, transversely impressed below; the eyes moderately coarsely granulate, with the inner margin entire; the antennal scape short, fitting into a groove on the beak, funicle 7-jointed with the distal segments wider, club compact, oval, made up of 4-segments, the basal one about as long as the others combined; pronotum considerably longer than wide, widest near the middle, with the sides behind subparallel, slightly convergent behind, broadly rounded, very weakly and broadly emarginate in front; disc densely and coarsely punctured and with rather coarse, rounded, shining granules or tubercles, median line elevated to form a low impunctate carina; elytra punctate striate, punctures rather coarse and close; interspaces anteriorly as wide as striæ, narrower posteriorly, densely rugose and granulate; rather sparsely pubescent with fine short hairs on the disc, which become more numerous on the declivity.

This specimen was compared with the specimens of **H. tenuis** Eichh., and **H. exilis** Chap. in the LeConte Collection but does not agree with either. The thorax is considerably wider than in either, and is roughly and coarsely granulate-punctate while in **tenuis** and **exilis** the surface between the punctures is polished with only a slight tendency toward granules in **exilis**. In LeConte's specimens also the sides of the thorax are more nearly evenly curved. The strial punctures are not so coarse as in **tenuis**, about the same as in **exilis** but with the striæ not so much impressed. The interspaces are wider than in **tenuis** and much rougher in sculpture than in **exilis**. The frons and beak are broader than **exilis** but similar otherwise. This specimen may represent a distinct undescribed species or it may be the other sex of the form labelled **exilis** in the LeConte Collection.

The single specimen was taken on the wing while the writer was removing other bark-beetles from a recently felled pine log. It was apparently attracted by the odor of pine and probably breeds in pine. The food plant of **H. exilis** is not recorded but is probably pine.

THE SUB-FAMILY *MICRACINAE*

The characters as given in the key are sufficient to distinguish this subfamily from other Ipidæ. In addition the known American forms have been treated more or less fully from the taxonomic standpoint in a recent paper (Blackman, 1921). For this reason the taxonomic treatment of this group will consist only of keys to the genera and species and very brief descriptions and for further details the reader is referred to Technical Bulletin No. 9 of the Mississippi Experiment Station.

As regards habits the **Micracinæ** include both bark-beetles and true wood-boring beetles. Of these the former have their brood-burrows at the juncture of the bark and sapwood, both the larvæ and adults feeding largely upon the inner bark. In the wood-boring forms the brood-burrow is usually constructed entirely in the wood and all stages apparently feed upon the ligneous substance. A variation of this latter habit is shown by some species which excavate their egg-galleries in the pith and both adults and larvæ feed upon this and upon the adjacent woody tissues.

Key to the Genera of the Subfamily *Micracinae*

Page

A. Antennal club with distinct sutures on the outer face, antennal scape clavate or flattened and subtriangular; antennal funicle 6-jointed.

B. Posterior end of elytra drawn out to form an acuminate sutural apex ---------- Micracis LeConte-- 65
BB. Posterior end of elytra conjointly rounded, without sutural apex.
C. Pronotum longer than wide, widest near the middle, with the sides subparallel behind, the summit not high, and the area posterior to it horizontal; fore tibia wide, with the distal end squarely truncate or slightly oblique, terminal mucro entire.--Thysanoes LeConte-- 71
CC. Pronotum wider than long, widest posteriorly, the outline approaching a semi-circle or triangle in form, summit high, posterior area sloping; fore tibia narrow, with the distal end very obliquely truncate; terminal mucro sometimes bifurcated at end-------- Pseudothysanoes Blackman-- 73
AA. Antennal club without distinct sutures on its outer face; antennal scape clavate, funicle 4-6 jointed.
B. Antennal funicle 6-jointed, club small; vestiture of body consisting of hairs and clavate bristles; distal end of fore tibia with 3 submarginal teeth--Cryptocleptes Blackman-- 73
BB. Antennal funicle 4-5 jointed, club larger; vestiture consisting of hairs and short broad scales; distal end of fore tibia with 2 submarginal teeth---Erineosinus Blackman-- 74

THE GENUS *MICRACIS* LeCONTE

This genus differs from all other known North American Micracinae by the possession of the acuminate sutural apex. The antennal scape is either clavate or flattened and subtriangular and is ornamented with hairs, varying from a few moderately long ones to numerous very long ones; the funicle is 6-jointed; the club is flattened, with distinct sutures on both the outer and inner face.

Insofar as the habits are known the species are all wood-boring as distinguished from bark-boring forms. In all but one of the species here treated the egg-galleries are excavated from the sapwood and both larvæ and adults feed upon the woody tissue. In M. opacicollis Lec., however, the brood burrow is in the pith.

The following key will serve to separate the subgenera and species.

Key to the Mississippi Species of the Genus *Micracis* Lec.

Page

A. Eyes widely separated beneath, inner margin entire.
B. Antennal scape club-shaped, not triangular, with a few short to moderately long hairs, club with first suture broadly curved, elytra shining, sculpture coarser, sutural apex coarse; eyes small, very widely separated beneath; fore tibiæ slightly wider distally, with the sides sinuate; outer edge weakly serrate, distal end with 3 or 4 submarginal teeth.

Subgenus *Micracisoides*

C. Front of head deeply concave.
D. Frontal concavity with two circular spongy areas small, hemispherical, arising from the side walls of the concavity, antennal club nearly circular in outline, declivity with a slight elevation in last stria rudis Lec.-- 66

DD. Frontal concavity with two blunt horns separate in the males but laterally connate in females except at distal end, declivity with the sutural interspace smooth; smaller, more slender body form. **bicornus** Blackm.... 67

CC. Front of the head not deeply concave.

D. Front of head granulate, not densely pubescent; declivity with sutural interspace smooth, with a large tooth at each side.....**harnedi** Blackm.... 67

DD. Front of head ornamented with a brush of short hairs; declivity with the sutural interspace strongly granulate, declivity with 2d interspace smooth. **langstoni** Blackm.... 67

BB. Antennal scape triangular, flattened, with numerous very long hairs; club with first suture angulate or narrowly curved; elytra sub-opaque, sculpture finer, sutural apex less prominent; eyes larger, more coarsely granulate, moderately widely separated beneath; fore tibiæ with sides subparallel, nearly straight, outer edge entire, distal end with 5 submarginal teeth.

Subgenus *Micracis*

C. Antennal club more than 1½ times as long as wide; fore tibia widest toward the distal end; sculpture of elytra coarser; elytra of the males with clavate bristles; fore tibiæ narrower.....**meridianus** Blackm.... 69

CC. Antennal club less than 1½ times as long as wide; elytral sculpture finer; pubescence fine and abundant and similar in both sexes; fore tibiæ wide, heavy, narrower toward the distal end.....**swainei** Blackm.... 70

AA. Eyes very large, very coarsely granulate, not widely separated beneath, inner margin emarginate.

Subgenus *Pseudomicracis*

Eyes narrowly but distinctly separated beneath; front of head without longitudinal carina, elytral striæ faintly impressed ..... **opacicollis** Lec.... 70

Micracis rudis Lec.

This species which is typical of the subgenus Micracisoides is sufficiently characterized in the key. It is very closely related to M. biorbis Blackm., but is readily separated by the size and position of the two spongy areas in the deep concavity on the front of the head. In rudis these areas are much smaller and arise from the sides of the excavation while in biorbis they are larger and lie at the bottom of the concavity. The declivity has a slight elevation in the first stria. There are other constant differences but the frontal characters are the most striking.

M. rudis has been recorded from Michigan, Indiana, Pennsylvania and District of Columbia. The hosts cited are hickory, hackberry and black-locust. The writer has two specimens collected by him at Electric Mills, Miss., Nov. 12, 1919. Both were cut from the wood of a hickory limb slightly less than an inch in diameter which had been broken off but a short time as the limb bore mature nuts and was still sappy. In both cases the insects had but recently entered the wood, gaining entrance through tissue long dead but extending their burrows into the still sappy wood. As both of the specimens are probably males nothing of the character of the brood could be learned. So far as is known, this species attacks only limbs

or small shoots and is therefore probably not of any considerable economic importance.

Associated forms include **Chramesus hicoriae** Lec., **Cryptocleptes dislocatus** Blackm. and **Stephanoderes dissimilis** Zimm.

Micracis bicornus Blackm.

This species resembles **M. rudis** more closely than any other **Micracis** taken in Mississippi, but can be readily separated by the characters given in the key. The front of the head is hemispherically excavated, with two blunt horns arising from the depth of the concavity, separate throughout in the males but laterally connate, except at the ends, in the females. The declivity has the sutural interspace smooth and the first stria has no elevation. The character of the frons is sufficient to separate this species from all other known forms.

The type series of this species was taken by the writer at Mendenhall, Miss., December 26, 1919. Both larvæ and adults were found burrowing in the wood of hickory limbs which had been cut the spring or summer before. The infested limbs were for the most part less than a half inch in diameter and the wood containing the burrows showed little signs of decay as only the parts free of the ground were infested. However, the wood was riddled by the burrows of both larvæ and adults.

The entrance gallery extends directly through the bark and into the sapwood for some distance. Here it is widened out to form an irregular gallery—the nuptial chamber. From this one or several egg-galleries extend more or less obliquely, the diameter of which is often irregular. The eggs are laid in the sides of these galleries and the larvæ on hatching bore through the wood in a longitudinal direction often for a distance of from 2½ to 3½ inches. The young adults extend this burrow only for a short distance then curve it toward the surface and emerge.

M. bicornus is of little or no economic importance as it apparently attacks only cut or broken limbs. It was found associated with several other wood, or bark-boring insects including the ipids **Chramesus hicoriae** Lec., **Cryptocleptes dislocatus** Blackm., **Micrasis harnedi** Blackm. and the buprestid **Acmæodera tubulus** Fabr. Numerous other borers occur in similar material and on occasion are doubtless associates, but those listed were actually found in the same branches.

Micracis harnedi Blackm.

This species resembles **M. rudis** and **M. bicornus** in the characters of the eyes, which are short and very widely separated, both above and below, and of the antennæ which have the scape clavate and ornamented with a few moderately long hairs and the club short oval with the sutures broadly curved or sinuate. It, however, differs from these in that the front of the head is not concave but is convex and granulate and in that the declivity has a large tooth at each side, which in the males is slender and arises from the sutural interspace near the summit and in the females is broadly conical and lies farther down on the declivity and in line with the second stria.

The type series of this species consists of nine specimens taken by the writer at Mendenhall, Miss., December 26, 1919. They were cut from the same dead branches of hickory as were the specimens of **M. bicornus** and their habits are similar.

Micracis langstoni Blackm.

This species is readily distinguished from others of the genus in Mississippi by its black or nearly black color, larger size, more robust form and

by the brush of short, coarse, yellow hairs upon the front of the head. The antennæ are of the Micracisoides type, the sculpture of the elytra is coarser, the declivity with the third, seventh and ninth interspaces elevated and dentate.

This species was described from a series of over 90 specimens collected at Agricultural College, Miss., February 9, 20; March 3, 24 and May 12, 1920. The host trees are honey locust, hackberry, slippery elm and mulberry. It differs from the other Micracis collected in that the beetles breed not only in the limbs but in the trunk of dying or dead trees. The larger number of the specimens were obtained from honey locust where they were especially numerous in the trunk of a tree about 6 inches in diameter. Other specimens were obtained from the dead, exposed portions of the wood of a large hackberry.

The burrows of this species were studied in somewhat more detail than those of the preceding. In dead wood the entrance gallery extends directly through the bark and into the sapwood for a distance of less than a centimeter. There, well under the surface of the sapwood, several—usually from two to five—egg-galleries branch off and proceed diagonally or transversely for a distance of from 1.5 to 2 cm. Most commonly these are unbranched but occasionally branches containing egg-niches occur and perhaps more frequently short alcoves or turning niches are constructed. The eggs are laid in little pockets in the sides of the galleries and the larvæ bore through the wood parallel with the fibers.

When the bark is still living or sappy, as is often the case when this beetle attacks a tree, the burrow is modified in an interesting manner. In addition to the true brood burrow which is entirely in the wood and is of the general character described above, the beetle also constructs a more or less elaborate system of galleries at the juncture of the bark and sapwood. These are rather aimless in their course (Fig. 74), frequently branch and anastomose and very often the entrances to several brood burrows are connected by these irregular channels. What the immediate purpose of these accessory burrows is can only be guessed at. It is certain that they are not egg-galleries as they contain no egg-niches and no larval mines originate in them. Possibly the beetles in such cases derive some of their food from the inner bark. Whatever the immediate purpose, it is, however, apparent that the effect of these burrows would be to kill that portion of the bark more quickly by cutting off the flow of sap and perhaps render the wood beneath more habitable for the larvæ. As such accessory mines apparently occur only in living or sappy bark, their construction is probably the reaction of the beetle to the excessive moisture.

M. langstoni is polygamous in its habits. The entrance burrow is constructed by the male and is guarded jealously by him in the same manner as by the males of many of the polygamous bark-beetles—by his backing out to the entrance where his declivity fills the entire doorway and presents an impenetrable barrier to his enemies. The egg-galleries which vary in number from two to five are constructed by the females and in old burrows the dead body of the female is usually found near the end of each gallery.

This species, on account of its habit of attacking the trunk of living trees of considerable size, is capable of doing considerable damage, especially as it is quite common and lives in a variety of hosts. Perhaps the greatest damage is done, however, to recently cut or broken trees and to timbers used in posts and in construction. This latter is especially marked where the bark has been left on, for while the beetles will enter peeled timber and even cut surfaces, they seem much to prefer to enter through the bark. The injury to the wood is very similar to that by the powder post beetles as the larval mines in a badly infested material are closely crowded together, packed with a fine powdery frass and often riddle the entire sapwood.

These beetles will also attack slightly weakened or injured trees and by the activities of several generations extending over a period of several years will eventually kill them. An excellent example of this was furnished by the honey locust tree from which a large per cent of the specimens were obtained. This had been killed during the summer of 1919 and when found, February 9, still contained the brood—larvæ and young adults. An examination of the trunk showed that this tree had been subjected to the attacks of several successive generations. The original point of attack was through a strip of deadened bark about two inches wide and two feet or more in length. From this the burrows were carried into the adjacent living tissue which was soon killed. The next generation bred in the recently deadened portion and in the still living but weakened tissues next to it, killing this more rapidly by constructing the accessory burrows described above. Thus, in the course of several generations the entire circumference of the trunk was riddled and the tree killed.

Living or dead standing trees attacked by this beetle should be destroyed while the brood is still in it in order to prevent undue increase of the beetles and thus save other trees. Excessive injury to posts and to poles used in rough structural work may be prevented by removing the bark and by thorough seasoning before using. Removal of the bark will exclude all but a few of the beetles, but if the post is set in the ground while still green the wood will remain moist and a few may enter. If it is peeled and thoroughly seasoned there is little or no likelihood of attack by Micrasis.

M. langstoni was found associated in the same material with Eccoptogaster muticus Say., Phthorophloeus dentifrons Blackm., Lepturges symmetricus Hald., Neoclytus luscus Fab., Agrilus ferrisi Dury, and A. lecontei Saund., in hackberry and P. frontalis in mulberry.

Micracis meridianus Blackm.

This species shows a considerable difference from those thus far treated. It is rather closely related to M. suturalis Lec., which is the genotype and is also the type of the subgenus Micracis and possesses the characters listed for that subdivision in the key. The antennal club is more than 1½ times as long as wide and subquadrilateral in shape; the fore tibiæ wider distally; the elytral striæ are moderately finely punctured, the hairs of the interspaces clavate in the males.

This species was described from a type series of 68 specimens collected by the writer at Corinth, Ripley, Wallerville, and Agricultural College, Miss., from the limbs of the redbud. The dates of collection were March 26, April 13, 21, 23, May 3, 10, 19, 1920.

The beetles appear to attack only recently dead limbs of redbud from a half inch to one and a half inches thick. The entrance burrow is carried directly through the bark into the sapwood, where it frequently separates into two or more branches and from there the egg-galleries, varying in number from two to five, originate and diverge in various directions through the wood (Fig. 72). The egg-galleries vary from a half inch to two inches in length and may be either unbranched or branched as shown in the photograph of an actual brood-burrow (Fig. 72). These egg-galleries are usually nearly uniform in diameter but occasionally are irregular. The egg-niches are placed irregularly at any part of the surrounding wall of wood. The larval mines are for the most part longitudinal and of considerable length. The insects pass the winter in their burrows either as larvæ or young adults and the adults emerge early the following spring. Newly started burrows were found during the early part of May 1920, each inhabited by one male, guarding the entrance, and several females in their egg-galleries. The males and females differ considerably in appearance and there is little wonder that the sexes of the closely allied M. suturalis which

shows similar secondary sexual differences should have been described as separate species by LeConte.

As this species was found only in the smaller branches of redbud it is perhaps of little or no economic importance. It was found only in dead branches. It was associated with **Rhopalophora longipes** Say., **Anthaxia quercata** Fab., **Ptosima gibbricollis** Say., the clerid **Cymatodera inornata** Say., and several undetermined Hymenoptera.

Micracis swainei Blackm.

This species is of the same general type as **M. meridianus** but is readily distinguished by its smaller size, finer sculpture, shorter and broader antennal club, more dilated antennal scape, by the wider, heavier fore tibiæ and by the elytral vestiture of the males being similar to that of the other sex.

This species was described from 21 specimens collected by the writer at Iuka, Miss., April 26, 1920, from the wood of a small willow apparently killed by fire the preceding spring. The beetles are similar in habits to **M. meridianus**. They are polygamous with the egg-galleries well under the surface of the sapwood, often near the heartwood. The larval galleries are often extremely long, sometimes reaching a length of over seven inches. The material when found contained dead adults and living larvæ and pupæ. Several of the latter were carefully removed and placed in dry vials where they transformed to beetles in eight or nine days. The insects were found only in the dead wood of small limbs an inch or less in diameter and are likely of no economic importance.

Micracis opacicollis Lec.

This species is typical of the subgenus **Pseudomicracis** and differs from all of the other species of **Micracis** taken in Mississippi in the very large, coarsely granulate eyes, emarginate on the inner line and very narrowly separated beneath. The antennal scape is somewhat flattened and dilated distally (but much less so than in the subgenus **Micracis**), ornamented with moderately long hairs; the club is oval, with narrowly rounded (but not subangulate) sutures; the fore tibia has the inner margin sinuate, the outer margin somewhat irregular but not serrate and the distal end with five submarginal teeth, the outermost of which is well past the outer distal angle.

M. asperulus Lec. is a synonym of **M. opacicollis**.

This species seems to be rather generally distributed throughout the eastern portion of the country, having been reported from Michigan, New York, Pennsylvania, New Jersey, District of Columbia and Virginia. In Mississippi it was taken by the writer at Corinth, Ripley, Trimcane Swamp, and Natchez, showing a general distribution throughout the state. The insect has been reported as breeding in oak, chestnut and witch hazel twigs. The writer's specimens were taken from water oak, white oak, red oak and redbud.

The brood-burrows of this species were found only in dead twigs and shoots less than a half inch in diameter. They were especially numerous in rapid growing shoots or sprouts from the stumps of cut trees killed by ground fires and about a quarter of an inch thick. The entrance gallery is carried directly through the bark and sapwood to the pith. Here one or more egg-galleries extend in each direction through the pith, which in rapidly growing shoots is often of considerable diameter. The larvæ on hatching likewise burrow through the pith, often extending their burrows for several inches. When, as frequently happens, they are so numerous as to

destroy all of the pith, they attack the woody walls of the pith-cavity and derive some of their nourishment from them, but rarely or never extend their burrows for any considerable distance entirely within the wood. The entrance gallery is often, but not always, started through the leaf scar just beneath one of the lateral buds.

These insects appear to do little or no damage as a plentiful supply of their most favorable breeding places is furnished by the prevailing custom of annually burning over with grass fires the pastures and pasture-woodlots, thus killing large numbers of young shoots and sprouts. They were found associated with **Thysanoes fimbricornis** Lec., **T. lobdelli** Blackm., **Stephanoderes dissimilis** Zimm., **S. quercus** Hopk., **S. chapuisii** Eichh., **S. sp.** (near **opacipennis** Hopk.), S. sp. (near **flavescens** Hopk.) and **Hypermallus villosus** Fabr.

THE GENUS *THYSANOES* LeCONTE

This genus differs from **Micracis** in the absence of the acuminate sutural apex, the posterior end of the elytra being conjointly rounded. The antenna has the scape roughly club-shaped and ornamented with a moderate number of rather long fimbriated hairs, the funicle 6-jointed, with the segments rather loosely joined, the club flattened, with sutures on both sides but with the first one on the inner face interrupted at the center; the pronotum is longer than wide; the elytral sculpture is fine or moderate; the body vestiture consists of hairs or bristles, or both, with true scales in some species; the fore-tibiæ are flattened with the sides subparallel, the outer edge entire, the inner distal angle with a strong recurved mucro, the outer part of the distal end truncate, with three submarginal teeth.

The beetles belonging to this genus are similar in habits to **Micracis** in that their brood burrows are entirely in the wood and both adults and larvæ are lignivorous.

Key to the Species of *Thysanoes*

		Page
A.	Mature color yellowish brown; elytral vestiture more abundant and longer, punctures finer; eyes coarsely granulate; front of head with a small pit or fovea at the center; club of antenna narrower, first segment more than ¼ of the length of the club. **fimbricornis** Lec.	71
AA.	Mature color dark brown to black; elytral vestiture shorter, punctures coarser, eyes more finely granulate; front of head without fovea; club of antenna broader, first segment less than ¼ of the length of the club.	
B.	Front of head in female longitudinally carinate and punctate above; summit of pronotum much lighter in color, asperities stronger and more numerous; fore tibia with the distal end only slightly oblique and the outer angle fairly prominent ---------- **lobdelli** Blackm.	72
BB.	Front of head in female longitudinally sulcate below, granulate-punctate above; summit of pronotum little if any lighter in color, asperities weaker and less numerous; fore tibia with the distal end more oblique and the outer angle rounded ---------- **berchemiæ** Blackm.	73

Thysanoes fimbricornis Lec.

In this species the club of the antenna is subquadrate, the first seg-

ment more than ¼ of the entire club, the funicle loosely jointed with the last segment nearly as wide as the base of the club; the eyes coarsely granulate; the front of the head widely, shallowly concave with a small pit at the center; the elytral vestiture consisting of clavate bristles longer and stouter behind. The females are 1.8 mm. long, three times as long as wide, with the thorax longer than wide and yellowish brown in color. The males are shorter and broader, with the thorax wider than long.

This species was described from Pennsylvania and has been reported from New Jersey and District of Columbia, the reported host in all cases being hickory. In Mississippi numerous specimens were taken by the writer at Corinth, Iuka and Trimcane Swamp, all in the northern part of the state. The hosts were red oak and hickory, and the dates of collection March 29, April 25, 26, May 19, 23, 1920.

The beetles are polygamous. The entrance burrow extends through the thin bark of the twigs or small branches which serve as a host, into the sapwood. Just beneath the surface of the sapwood a number of egg-galleries—usually from two to four in number and usually less than an inch long—radiate from a slightly enlarged nuptial chamber. These are sometimes entirely enclosed by sapwood but often just beneath the surface so that the removal of the bark sometimes exposes a small portion of the gallery. The nuptial chamber is continued down deeper into the sapwood and a second system of egg-galleries, sometimes three or four in number, arises from it. These deeper egg-galleries are usually shorter, but both these and the superficial ones have numerous, closely placed egg-niches in their walls. The larvæ burrow entirely in the sapwood—even those from the superficial egg-galleries seldom penetrating its surface—the mines being longitudinal in direction and usually about 1½ inches long.

This beetle was found associated in hickory with the ceramycid **Euderces exilis** Casey, and the ipid **Chramesus hicoriæ** Lec.; while in oak its associates were **Micracis opacicollis** Lec. and **Thysanoes lobdelli** Blackm. **T. fimbricornis** is not injurious as it apparently breeds only in dead twigs and shoots.

Thysanoes lobdelli Blackm.

This species is dark reddish brown in color, with the summit of the pronotum lighter; the frons in the female shallowly concave, shining on a nearly square area below, with the upper part of concavity divided by a longitudinal carina, with a lock of downwardly directed hairs and without fovea; the antennal club is shorter, with the first segment less than ¼ the total length of the club; the pronotal asperities are better developed than in **fimbricornis**; the vestiture of thorax and elytra less so; the elytral punctures considerably coarser.

This species was described from a series of 70 specimens collected by the author at Vicksburg and Trimcane Swamp, Miss., from the small limbs and twigs of water oak, red oak, white oak, and red maple, the dates of collection being March 5, 27, 29, 30, April 24 and May 19, 1920.

The insects were found only in twigs and limbs less than a half inch in diameter. The entrance burrow extends some distance into the sapwood, and from it egg-galleries, usually two in number, extend longitudinally well under the surface of the wood and often near the pith but not in it. The larvæ often riddle the entire sapwood. A number of other ipids were found in the same material. These include **Lymantor decipiens** Lec. in red maple; **Micracis opacicollis** Lec. and **T. fimbricornis** Lec. in red oak; **M. opacicollis** Lec., **Stephanoderes** sp. and **S. dissimilis** Zimm. in white oak and the minute cerambycid **Cyrtinus pygmæus** Hald. in water oak.

Thysanoes berchemiae Blackm.

In this species the color is dark reddish brown, with the summit of the pronotum usually of the same color; the frons in the female is shallowly concave shining and with a median longitudinal sulcus below, granulate-punctate with short upwardly directed hairs above; the antennæ are smaller than in the other two species, with fewer and shorter hairs on scape and funicle; the elytra are similar in general respects to the other two species with the punctures intermediate in size and the vestiture similar to lobdelli.

This species was described from a series of 44 specimens taken by the writer from the wood of dead or dying "supple-jack" **Berchemia scandens** at Agricultural College, Durant and Vicksburg, Miss., February 20, March 1, 6, and April 10, 1920. It breeds in wood from ¼ to 1½ inches in diameter, in dying branches or in the main stem of the vine.

A number of brood burrows were dissected and they conform in general to the following plan. The entrance gallery extends perpendicular to the surface directly through the bark and well into the sapwood. Here usually two egg-galleries are excavated usually at first extending longitudinally and in opposite directions. These may continue longitudinally to the end but usually after extending for a variable distance (¼ to 1 inch) each sends a branch across grain, either toward the center of the stem or circumferentially. The eggs are placed in niches throughout the extent of the egg-galleries but are especially numerous and close in the transverse portion. The larval mines are longitudinal and usually nearly straight but in the vicinity of a branch or knot often become very tortuous. This insect can hardly be classed as injurious.

THE GENUS *PSEUDOTHYSANOES* BLACKMAN

No specimens of this genus which is sufficiently characterized in the key have been taken in Mississippi but it is likely that one or more species occur there. There are three species: **P. rigidus** Lec. described originally as of the genus **Cryphalus** and more recently included in **Thysanoes**, the host of which is unknown, recorded from Michigan and Canada; **P. drakei**, Blackm., which works as a bark-beetle in basswood in central New York; and **P. lecontei**, Blackm., from oak twigs at Washington, D. C.

In **P. drakei** the brood burrows are very unusual in character. They lie entirely in the outer part of the porous inner bark and apparently never upon the surface of the sapwood as is usual with bark-inhabiting forms. From the entrance gallery a short branch extends longitudinally in opposite directions—the combined length usually being about a fourth of an inch. This is apparently used as a nuptial chamber and turning niche. From the end of each of these branches an egg-gallery extends transversely on each side. The egg-niches are only in the transverse galleries and the larvæ bore the bark longitudinally. It will be seen that each division of the brood-burrows bears a distinct resemblance to the entire burrow of such forms as **Leperisinus, Phthorophloeus**, etc. Two of such burrows joined together by a short longitudinal gallery connecting with a single entrance would nearly exactly resemble the entire parent burrow of **P. drakei.**

These beetles are apparently normally bigamous, a female being responsible for each pair of transverse galleries. Occasionally the male succeeds in attracting but one female and then the resulting brood burrow is strictly of the forked transverse type as in **Leperisinus.**

THE GENUS *CRYPTOCLEPTES* BLACKMAN

There is but one described species of this genus, **C. dislocatus** Blackm. It is light to dark brown in color; the female 1.3 mm. long, 2.84 times as long as wide, the males shorter and stouter. The antennal funicle is 6-

jointed, the club small, subtriangular, the outer face shining and without definite sutures; the pronotum is wider than long, the asperities confined to a small median area just in front of the summit, the summit very high, lighter in color, the posterior area sloping from it; the elytra are slightly narrower, punctate-striate, faintly rugulose; the declivity is normal; the vestiture consists of clavate bristles. The males are shorter and stouter, lighter in color, with the pronotal asperities more numerous.

This species was described from a long series of specimens taken by the writer from the bark of twigs and limbs of hickory and pecan. It is a very common species in the small limbs and twige of all species of **Hicoria**. The localities and dates of collection are as follows: Agricultural College, June 6, 21, 22, April 10, 1920; Electric Mills, November 12, 13, 1919; Durant, March 1, 1920; Maxie, December 24, 1919; May 23, 1920; Fort Adams, December 30, 1919; Natchez, March 16, 1920.

This species is a true bark-beetle as its brood burrow is constructed at the juncture of the bark and sapwood. It is a bigamous species, the entrance gallery extending only through the bark where the two egg-galleries branch off and extend longitudinally in opposite directions. The females are fertilized soon after entering the burrow, as the male has no access to either mate after each has laid her first eggs as the entire female gallery is closely filled with frass. The male is short-lived and dies at the opening of the entrance burrow soon after the females have begun to deposit their eggs.

The egg-galleries are very narrow but quite long for the size of the insect constructing them, often exceeding 1½ inches and sometimes 2 inches in length. The manner of placing the eggs is different from that of any other bark-beetle known to the writer. The eggs are not placed in niches, pockets or grooves in the side of the egg-gallery but in the bore of the gallery itself, where they are closely packed in the sawdust-like frass which completely fills it. The eggs are relatively large, oval in shape and are placed at intervals of a millimeter or less, with their long axis nearly crosswise of the gallery. When the size of the eggs is considered the number laid by one female is surprising, varying in the burrows studied from 12 to 53 or an average of 29.6. It is certain that the abdomen of the female could not at one time contain even the minimum number of fully matured eggs and it is therefore equally certain that the egg-laying activities of a beetle extend over a period of many days, thus allowing the later eggs to mature after the first ones have been laid. This is also evidenced by the fact that the females are found alive and still laying eggs long after the male is dead and the larvæ from the first eggs have hatched. The larval mines are at first transverse in direction but soon become more or less longitudinal or winding in their course.

These insects while very common are of little economic importance as they breed perhaps entirely in broken, cut or dying twigs and small branches. They are often found associated in the same limbs and twigs with **Chramesus hicoriae** Lec., **Stephanoderes dissimilis** Zimm. and **Stephanoderes approximatus** Hopk.

THE GENUS *ERINEOSINUS* BLACKMAN

This genus differs rather markedly from all of the other North American genera of Micracinae in the number of joints in the antennal funicle which is here 4-jointed in the males and 5-jointed in the females. The fore tibiæ are of the same general type as in other genera of the subfamily. Only one species is known.

Erineosinus squamosus Blackm.

The beetles are leathery brown in color, stout cylindrical in form; the

females 1.08 mm. long, 2.37 times as long as wide; the males 0.88 mm. long, and stouter. The eyes are oval with the inner margin entire; the antennal scape is clavate, the funicle 4 or 5-jointed, with the pedicel subglobose and longer than the distal segments combined, the club large, flattened, oval, without sutures; the prothorax is sparsely asperate in front in the male, granulate in the female; the elytra have the base elevated and toothed, the striæ distinctly impressed, the interspaces narrow, with hairs and scales alternating, the declivity is convex and evenly arched without particular modifications.

This species was described from a series of 16 specimens taken from the inner bark of the osage-orange (**Toxylon pomiferum** Raf.) by the writer at Agricultural College, Miss., February 20, 21 and May 19, 1920. It appears to be by no means a common species even in the type locality and was found at no other place, although search was made for it in various parts of the state. A long series of this species was taken in September 1921 at Holly Springs by Dr. C. J. Drake.

Regarding its habits little can be said except that it breeds in the inner bark of the osage-orange, working entirely as a bark-beetle and never entering the wood. The parent burrows are of the cave type, consisting of a simple irregular shaped chamber from which the larval mines, which have a general longitudinal direction, originate. This species was found associated in the same dying and dead limbs with **Hypothenemus** sp. (near **pruni** Hopk.) and **Dorcaschema alternatum** Say.

THE SUBFAMILY *IPINAE*

Members of this subfamily may be readily recognized by the following characteristics: the head is subglobose and is retracted into the pronotum so as not to be visible from above; the antennal funicle has from one to five segments; the pronotum is asperate or otherwise roughened on the anterior area; the body is clothed with hairs, bristles or scales, sometimes nearly glabrous; the fore tibiæ are serrate on the outer margin, widened distally and never strongly produced at the outer distal angle.

The range of variation of most of the body structures within the subfamily Ipinae is very considerable as would be expected in a group containing so many genera and species. Recognition of this fact has led several workers upon the group to limit the subfamily to Ips and its very close allies and to include the greater number of genera in two or more other groups of co-ordinate grade. The subfamily is here used as in Swaine's monograph and includes all forms having the characters given above. The group contains both true bark-beetles and ambrosia beetles. Some genera include only forms breeding in deciduous trees, others only forms living in conifers while other genera contain species some of which live in hard woods while others live in soft woods.

Key to the Genera of the Subfamily *Ipinae*

(Adapted from Swaine, 1918.)

AA. The eyes not divided; antennal club with sutures at least at the apex.

B. The antennal funicle 2-jointed; fore tibia but little widened distally, with the entire outer margin serrate and with transverse ridge on its outer face.---Pterocyclon Eichh.--- 80

BB. Antennal funicle 3-5-jointed; fore tibia more or less strongly widened distally.

C. Vestiture consisting of scales, scale-like hairs or bristles; pronotum rather acutely margined at the side, asperities comparatively few in number; elytra rather strongly striate; body small.

D. Antennal funicle 4-jointed, the fourth segment narrow. ---------- Hypothenemus West.-- 82

DD. Antennal funicle 5-jointed, distal segments widened. ---------- Stephanoderes Eichh.-- 89

CC. Vestiture consisting of hairs, often nearly wanting; pronotal asperities small and numerous.

D. Pronotum margined behind with a fine raised line; meta-episternum nearly concealed by the elytra, visible only in front.

E. Body form slender, very smooth, with punctures and pubescence nearly obsolete except on declivity; pronotum densely not strongly asperate in front; summit before the middle, transversely arcuately carinate. ---------- Gnathotrichus Eichh.-- 95

EE. Body form slender to moderately stout, more or less strongly punctured and pubescent; pronotum rather strongly asperate, summit near the middle, without a definite transverse carina, but with the disc transversely impressed behind the summit.

F. Antennal club with first segment narrower than others; pronotum and elytra densely and minutely punctulate and clothed with very fine, short pubescence; prosternal process elongate and acute; front of head in the male with long hairs. Pseudopityophthorus Swaine-- 98

FF. Antennal club with first segment subequal in width to the others, pronotum and elytra finely or coarsely and rather sparsely punctured and pubescent; prosternal process short and wide.

G. Antennal club twice as long as funicle, oval with first and second sutures strongly chitinized and slightly arcuate; asperate region of pronotum extending not more than one-third of way back at sides, the female with a patch of plush-like pubescence at each side before the middle, corresponding area in male devoid of asperities, punctate or at most granulate; elytral declivity only very slightly impressed in the first stria. Pityoborus new Genus-- 96

GG. Antennal club much smaller proportionally; first and second sutures usually chitinized; asperate region of pronotum extending nearly one-half way back at sides; elytral declivity more or less strongly sulcate; females often with the front ornamented with longer or more numerous hairs.____ Pityophthorus Eichh.__ 100

DD. Pronotum not margined behind; meta-episternum visible for its entire length.

E. Antennal funicle 5-segmented.

F. Pronotum precipitous or oblique in front; rather strongly asperate; punctured, not granulate behind.

G. Fore tarsi moderately widened distally; the elytral declivity toothed and excavated.

H. Intercoxal process of prosternum short and wide; antennal club flat, with sutures on both sides; declivital spines much coarser in the males; front of female often excavated (not in P. meridianus, however) __ Pityogenes Bedel.__ 110

HH. Intercoxal process long and acute; sutures on inner face of antennal club wanting or only at tip; declivital spines usually but little coarser in the males; front of females not excavated.

I. Concavity of declivity bordered posteriorly by an acute, horizontal, plate-like extension which is distinct from the apical margin of elytra; club of antenna flat, with distinct sutures.____ Ips DeGeer__ 111

II. Concavity of declivity bordered posteriorly by an acute but short extension; club of antenna thickened at the base and obliquely truncate distally on the outer face, sutures confined to the truncate distal face.____ Orthotomicus Ferr.__ 115

GG. Fore tarsi strongly widened distally; prosternum very short in front of coxæ; distal segments of antennal club completely telescoped; males much smaller than females.____ Xyleborus Eichh.__ 116

FF. Pronotum feebly convex, not precipitous in front, the entire surface granulate, but little more strongly in front; antennal club thickened at base, obliquely truncate

at tip on outer side; declivity convex or slightly flattened, feebly granulate_____ Dryocoetes Eichh.__ 120

EE. Antennal funicle 4-segmented; club flattened, sutured on both sides; pronotum arcuate on sides, anterior area weakly asperate, posterior area deeply, coarsely punctured, elytral punctures deep, coarse, not arranged in striæ.__ Lymantor Lœv.__ 121

THE GENUS *XYLOTERINUS* SWAINE

The characters given in the key readily distinguish this genus from **Trypodendron** with which it has until recently been included. It includes but one species.

Xyloterinus politus Say.

The females are brown or nearly black in color with the elytra paler; 3.1 to 3.3 mm. long, 2.67 times as long as wide; the males of similar color and proportions, but smaller, about 2.8 mm. long. The front is convex and granulate with a median carina in both sexes; the antenna is without true sutures but with the corneous basal portion marked off distally by a fairly distinct arcuate line; the pronotum is slightly wider than long, wider than the elytra, with the sides arcuate, broadly rounded in front and the anterior margin armed with four median teeth; the summit is well behind the middle, the anterior area asperate, the posterior area sloping and very finely punctured; the elytra have the striæ finely punctured and rather indistinct on the disc but more readily seen at the sides; the interspaces are still more finely punctured; the declivity is convex with the striæ impressed; the pubescence is moderately abundant but very fine.

Xyloterinus politus is an ambrosia beetle well distributed over the eastern portion of the United States and Canada. It has been reported from oak, hickory, ash, beech, birch, chestnut, alder, maple, magnolia and even from the conifers spruce and pine. The writer has found it rather common in birch, beech and maple in the Adirondacks and has several specimens from white birch, sugar maple and hemlock from Maine. In Mississippi it was found only in red maple at Iuka, April 15, 1920.

The beetles usually attack trees which are diseased or injured, but always apparently trees in which there is still some life as the presence of sap is necessary for their proper development. The entrance burrow is carried directly through the bark and into the sapwood where it usually is forked and often has secondary branches. The eggs are laid in little niches hollowed out of the wood in the sides of the burrow and the brood passes all of its larval and pupal life in these niches which are extended to form larger and larger cradles to accommodate the increasing size of the larvæ. The larval food consists of ambrosia—the cropped off conidea of fungi planted in the burrows. This material is supposedly gathered by the parent beetles and placed in the opening of each larval cradle so that the growing larvæ have a constant supply of food. Both males and females are found in the newly started burrows. As with all of the ambrosia beetles the walls of the burrows are stained black by the ambrosial fungus which the beetles grow in their burrow and which serves as food both for young and adults.

The chief damage done by this beetle is that to injured and diseased trees and to recently cut trees. In weakened trees the presence of the beetle further weakens them, both on account of the loss of sap and also by

the introduction of fungi. The injury to recently cut trees, due to the presence of the "black holes" in the timber renders it worthless for some purposes and decreases its value for any purpose. Very little damage will be done to felled trees if these are placed in the sun and more or less free of the ground so as to hasten seasoning. The presence of considerable moisture is necessary for the proper development of the ambrosial food of both the beetles and their brood.

THE GENUS *TRYPODENDRON* STEPHENS

This genus is readily distinguished from Xyloterinus by the character of the antennal club as given in the key. If males are present they can be readily recognized by the concave front of the head and by the shortened and sub-truncate pronotum. The genus is typically northern in its distribution and while several species are common in the northern half of the country and in Canada but one was taken in Mississippi.

Trypodendron scabricollis Lec.

Dark reddish brown in color; female 3.6 mm. long, male 3.1 mm. long. The head of the female is convex, roughly granulate, with a distinct median carina below; the antennal club is large, light brown, with the basal corneous portion extended at the middle and separated from the distal portion by a strongly angulate line; the eye is completely divided; the prothorax is one-fourth wider than long, with the sides arcuate, and the anterior outline obtusely subangular, strongly and coarsely asperate in front with the asperities continuing at the sides nearly to the posterior line but becoming gradually smaller; elytra distinctly punctate striate, with the striæ slightly impressed, the punctures shallow and rather coarse, interspaces sparsely and very minutely punctured; the declivity is convex with the strial punctures slightly smaller but distinct, with the first and third interspaces slightly elevated, the first granulate, the second flat.

T. scabricollis has been reported as occurring in New York, Pennsylvania, District of Columbia, West Virginia and New Mexico. The hosts given are pine, witch-hazel and hemlock. In Mississippi it was taken by the writer at Agricultural College in the wood of loblolly pine, March 30, 1920. At the time the specimens were taken the burrows were under construction, some less than a half-inch deep while others were much farther advanced—some of the larvæ having already hatched.

The entrance gallery is carried directly through the bark and into the wood for a distance of from one-fourth of an inch to an inch. Usually, two branches, sometimes more, start from the inner end of the entrance gallery and extend circumferentially in opposite directions, often continuing in the same ring of growth (Fig. 78). The eggs are laid in little niches in the sides of the egg-galleries and these niches are enlarged by the larvæ and both the larval and pupal stages are passed entirely within the cradles so constructed.

The beetles breed by preference in injured or slowly dying pine trees, often being found in the injured larger limbs of trees otherwise healthy. When they occur in the trunk region their burrows, of course, greatly lessen the timber value of the tree, and when in an injured branch they hasten its death. The burrows are stained black by the ambrosial fungus and this often spreads in the surrounding wood causing unsightly bluish black stains. The burrows also allow the entrance of decay fungi. Rapid seasoning of the recently cut trunks will prevent much of the damage.

With this insect was associated a single specimen of Xyleborus sp. (near pecanis Hopk.) which had but recently started its burrow.

THE GENUS *PTEROCYCLON* EICHHOFF

Pterocyclon is characterized by the two-jointed antennal funicle, the second joint being smaller, narrower and closely joined to the club. The fore tibia are transversely ridged or asperate, and are not greatly widened distally. The body form is cylindrical, moderately slender to slender, with but small differences in the size and structure of the sexes. Two species were taken in Mississippi, both breeding as ambrosia beetles in the wood of deciduous trees.

Key to the Species of *Pterocyclon* Eichh.

Pterocyclon mali Fitch.

The adult is reddish brown, with the base of the thorax often lighter in color; about 2.3 mm. long, 3.1 times as long as wide. The front of the head is convex above, finely punctured and with very fine short hairs, transversely impressed below with a distinct epistomal process; antennal club large, flattened, with distinct sutures, that of the female with a fringe of longer hairs at the distal margin; eyes strongly emarginate; prothorax considerably longer than broad, with the sides parallel behind, broadly rounded in front, the anterior area rather weakly asperate, posterior area minutely punctulate; elytra widest anteriorly, the sides subparallel, the posterior end broadly curved and notched at the center, the surface smooth, feebly shining, the striæ feebly indicated by fine, inconspicuous punctures; declivity oblique, sulcate at the suture, with two distinct, widely separated teeth at each side; surface of pronotum and elytra nearly devoid of pubescence except on the declivity.

This beetle is common throughout the eastern part of this country and Canada. It has been reported from a considerable number of deciduous orchard and forest trees and from pine and several other conifers. In Mississippi it is one of the common ambrosia beetles, having been taken by the writer at Maxie, Laurel, Meridian and Iuka during the months of November and December, 1919, and April 1920. The hosts in Mississippi include red oak, jack oak, white oak and yellow birch.

In general the burrow of Pterocyclon is very similar to that of Trypodendron except that the diameter of the gallery is much smaller and the egg-galleries are often longer and more branched. The following account by Hubbard (1897) is of considerable interest. "The eggs are loosely packed in pits with chips and material taken from the fungus bed which she has previously prepared in the vicinity and upon which the ambrosia has begun to grow. The young larvæ, as soon as they hatch out, eat the fungus from these chips and eject the refuse from their cradles. At first they lie curled up in the pit made by the mother, but as they grow larger, with their own jaws they deepen the cradles, until, at full growth they slightly exceed the length of the larva when fully extended. The larvæ swallow the wood they excavate, but do not digest it. * * * A portion of the excrement is evidently utilized to form the fungus garden bed. The mother is constantly

in attendance upon her young during the period of their development, and guards them with jealous care. The mouth of each cradle is closed with a plug of the food fungus, and as fast as this is consumed it is renewed with fresh material. The larvæ from time to time perforate this plug and clean out their cells, pushing out the pellets of excrement through the opening. This debris is promptly removed by the mother and the opening again sealed with ambrosia. The young transform to perfect beetles before leaving their cradles and emerging into the galleries."

This ambrosia beetle seldom or never attacks any except dying, badly injured or recently cut trees. Sickly or dying trees or branches of both forest trees and fruit trees are often attacked and there can be no doubt that in some cases the burrows of the beetles hasten the death of the infested wood. However, by far the greater amount of damage is done to recently felled trees which happen to have been cut at a time when the young adults were on the wing in search of a new breeding place. This is especially true if the logs are allowed to lie in a shaded situation where the proper seasoning of the timber will be slow and the wood will for a longer time afford an attractive breeding place for ambrosia beetles and other destructive borers. The injuries caused by this species and by P. **fasciatum** are very common in the sawed lumber of oak especially, forming the defect commonly known as "black holes" or "pin holes." The presence of these defects very much decreases the value of the timber as it renders it unfit for use either for finish or for structural timber where high class material is demanded.

It is impractical to destroy ambrosia beetles after they have once infested recently cut timber in any numbers. Their burrows are in the wood and the beetles can only be destroyed by burning, by dry kilning or by treating the timbers with creosote or some other similar preservative. Where the wood is to be used as posts or ties the impregnation with a preservative will destroy all ambrosia beetles already established and will prevent others from entering. Thorough dry kilning will also destroy contained insects and by removing the moisture will make the wood unsuitable for the entrance of others. Neither of these methods will, however, remedy damages already done and it is much better to so conduct the logging operations as to obviate in so far as possible the damages by pests such as these. A study of local conditions will show that timber cut at certain seasons will be very greatly damaged while that cut at other times will suffer very little if any damage. This must be determined for each general locality and the only general recommendation which can be made at present is to avoid cutting in the late winter and early spring.

Recently cut timber should be seasoned as rapidly as possible so as to render it less attractive to ambrosia beetles and to other borers. Or, if water is at hand, the recently cut logs can be floated and thus be protected from attack. If the timber is to be used for posts or ties it should be barked at once and piled in such a way as to hasten seasoning, thus rendering it less attractive as a breeding place for beetles.

Associated forms included **P. fasciatum** Say., **Platypus compositus** Say. and **Pseudopityophthorus pruinosus** Eichh. in oak, and **P. compositus** Say., **Xyleborus pecanis** Hopk. and **X. fuscatus** Eichh. in yellow birch.

Pterocyclon fasciatum Say.

Adult dark brown with the central part of the elytra pale yellow; about 2.7 mm. long, 3.1 times as long as wide. The front of the head is somewhat flattened, punctured at each side of a nearly impunctate median area; pronotum 1 1-3 times as long as wide, similar in shape and sculpture to **P. mali**; elytra similar in sculpture and in general shape, the central part, or sometimes the entire basal, three-fourths pale yellow, the posterior part black or

very dark brown; the declivity steeper, with a single tooth at each side near the summit; the disc of elytra nearly glabrous, very hairy behind. The female differs from the male in the finer punctures of the frons which is depressed in the median line and in the fringe of long hairs at the distal margin of the antennal club.

This species appears to have about the same distribution as **P. mali** and has been reported from many trees both deciduous and coniferous. It also bores in wine casks. In Mississippi the writer obtained specimens from Maxie, Laurel, Meridian, Starkville and New Albany during the months of November and December 1919, and March and April 1920. The hosts were red oak and white oak. One specimen was taken on the wing at Starkville, March 15, 1920.

The habits are very similar to those of the sister species. The burrows are not distinguishable except for their slightly greater diameter. The two species are often found in the same host tree and in the field are distinguished by the yellow band on **P. fasciatum** and also by the larger size of this species. Associates other than **P. mali** Fitch include **Platypus compositus** Say., **P. quadridentatus** Oliv. and **Pseudopityophthorus pruinosus** Eichh.

THE GENUS *HYPOTHENEMUS* WESTWOOD

In this genus the pronotum is acutely margined at the sides, the elytra distinctly striate, the antennal funicle four-jointed with the distal segment little or not at all wider, the club flattened, but little longer than wide, with three sutures on the anterior face, the first of which is partly chitinized. They are minute forms rarely more than 1.25 mm. long, brown, reddish brown or black in color with the elytra ornamented with scale-like bristles.

The genus includes a large number of species which are very much alike in general appearance and at present can be determined only by comparison with the types on account of the large number of closely related forms and the unsatisfactory descriptions and key. The determinations here given were made by direct comparison with the types in the National Museum, but on account of the lack of time available no attempt could be made at redescribing the types and constructing suitable keys. All of the comparisons were made by the writer, except those for **atomus, marylandicae** and **toxicodendri,** for which I am indebted to Dr. C. J. Drake.

The species of this genus breed principally in the inner bark of dead limbs and twigs of a great variety of trees. Numerous specimens have, however, been taken in old cotton-bolls, seeds, etc. For the most part the species are not confined to any particular host, although, so far as the observations go, some are. They are of little economic importance as the beetles seem to prefer dead or even decaying material, are only occasionally found in dying twigs and so far as is known are never responsible for the death of twigs or small limbs.

The writer believes that his collection of this genus from Mississippi contains several undescribed species but it is not considered best to describe any but two of these at the present time. A detailed study and redescription of all of the American species should be made before much can be done with the group. For this reason many of the names here given are merely approximations. The short descriptions given in the following pages should not be considered as redescriptions of the species to which they refer as they were not taken from the type specimens. They are merely brief characterizations of specimens which have been compared with the type and which seem identical or nearly so.

The first three species listed below differ from the others in the much stouter body form, the narrowly rounded or sub-triangular pronotum and in the absence of the septum in the first suture of the antennal club. The lat-

ter character would exclude them from the genus **Hypothenemus** as characterized by Hopkins. In this paper they are, however, left provisionally in this genus.

Hypothenemus sp. a. (near *atomus* Hopk.)

The adult beetle is light brown with the elytra darker; 0.83 to 0.91 mm. long, 2.2 times as long as wide. The front of the head is convex, opaque, with a distinct short median sulcus; pronotum slightly wider than long with four marginal teeth, the median ones being slightly larger and closer together, asperate area lighter in color, posterior area opaque, finely granulate punctate; the elytra very slightly wider, feebly shining, the striæ impressed, distinctly punctured, interspaces very finely punctured, rugulose.

The specimens of this species were taken by the writer at Vicksburg, Miss., March 6, 1920, from a small dead limb of locust.

Hypothenemus marylandicae Hopk.

The adult beetle is dark brown to black in color with the summit of the pronotum reddish brown; 0.74 to 0.85 mm. long, 2.1 times as long as wide; with the front of the head convex, subopaque, with a short median line; pronotum subtriangular with four marginal teeth, the two median ones being much larger; elytra shining, striæ feebly impressed, rather coarsely punctured, interspaces rugose, with a uniseriate row of broad, flattened, cinereous bristles.

A series of 15 specimens of this species was taken from the bark of dead seedlings of red maple about ¼ to ½ inch in diameter, at Trimcane Swamp, Miss., March 29, 1920. The burrows were in the inner bark and had but recently been started.

Hypothenemus toxicodendri Hopk.

The adult beetle is dark brown in color with the elytra darker than the pronotum; 0.85 to 0.95 mm. long, 2.2 times as long as wide; the front of the head is convex, opaque, with the median line distinctly but finely sulcate; the pronotum with from 4 to 6 marginal teeth, the median pair larger; the elytral striæ rather coarsely punctured, very faintly impressed, interspaces narrow, dully shining, with uniseriate, wide, flattened bristles.

Four specimens of this species were obtained from the inner bark of dead hickory twigs at Trimcane Swamp, Miss., March 29, 1920.

Hypothenemus germari Eichh.

Six specimens obtained by the writer from hackberry at Port Gibson, March 13, and at Agricultural College, March 23, 1920, are placed tentatively in this species after comparison with identified specimens in the National Museum. The specimens are 1.1 mm. long, 2 2-3 times as long as wide; the front of the head is granulate, with a median shining line; the pronotum is concolorous, wider than long, broadly rounded in front with six moderate-sized teeth on the anterior margin, the two median ones closer; the elytra are equal to the thorax in width with the sides subparallel, rather narrowly rounded behind, the surface shining, striæ broad and distinctly punctured, interspaces narrow, with conspicuous, uniseriate, suberect, scale-like bristles. The color is dark brown, nearly black.

The beetles were found in the inner decaying bark of dead branches of hackberry in the same limbs inhabited by **Eccoptogaster muticus** Say.,

Chramesus chapuisii Lec. and **Phthorophloeus dentifrons** Blackm. The material was in such condition that the character of the burrows did not show well. It has been previously reported from Mexico.

Hypothenemus hispidulus Lec.

A single specimen of what appears to be this species was taken by the writer from sweet gum at Agricultural College, Miss., November 4, 1919. The body is 1.17 mm. long, 2.56 times as long as wide, the color dark brown; the front of the head is finely reticulate, transversely impressed below, finely punctured and with moderate hairs, with a small pit in the median line and above it a shining impressed longitudinal line; the pronotum is wider than long, moderately rounded in front, with six small equally spaced marginal teeth; the elytra are slightly wider than the pronotum, the sides subparallel and the posterior end narrowly rounded, the surface feebly shining, the striæ distinct, broad, moderately punctured; the interspaces narrow, with erect scale-like bristles. Readily distinguished from the foregoing by its larger size and by the differences in the pronotum and frons.

The single specimen collected was taken from the inner bark of a dying branch of sweet gum where it was associated with numerous specimens of **Pityophthorus liquidambarus** Blackm.

Hypothenemus sp. b. (near *nigricollis* Hopk.)

The body is black or dark piceous brown; 1.06 mm. long, 2.55 times as long as wide; the front of the head is subopaque, reticulate above, punctured below, with a slightly elevated median line which becomes sulcate above; the antennal club light testaceous; the pronotum slightly wider than long (14:13), the posterior angles not rounded, the sides very faintly arcuate, moderately broadly rounded in front, with six marginal teeth, two of which are sometimes smaller, the summit sometimes dull reddish brown; the elytra equal in width to pronotum, feebly shining, the striæ scarcely impressed, moderately closely punctured.

Numerous specimens were obtained at Agricultural College, Miss., from dead limbs of ash and redbud, March 23, 24 and 26, 1920. In redbud it was associated with **H. rumseyi** Hopk. to which it is closely allied and in one lot of material with **Pityophthorus natalis**, Blackm. These specimens are closely allied to **H. nigricollis** Hopk. but are distinct from it and its described relatives.

Hypothenemus sp. c. (near *pruni* Hopk.)

The female is 1.03 mm. long, 2.55 times as long as wide, the color black with the asperate area of the pronotum reddish brown. The front of the head is opaque or subopaque, reticulate above, reticulate punctate below, with a small oval pit in the median line at the level of the upper angle of the eyes; the pronotum slightly wider than long (14:12.5), the posterior angles rounded, the sides arcuate, moderately rounded in front, with six marginal teeth, the outermost of which are smaller; the elytra are shining, scarcely wider than pronotum, with the sides subparallel to behind the declivital origin, moderately narrowly rounded behind; the striæ are faintly impressed, rather closely punctured, the interspaces narrow.

The male is similar in color, 0.84 mm. long, 2.35 times as long as wide, the frons and the body sculpture similar.

My collections from Mississippi include forty-five specimens obtained from osage orange, fig and sweet bay at Agricultural College, Starkville,

Natchez and Laurel, Miss., the dates of collections being November 19, 1919, January 31, February 20, 21 and March 16, 1920. In fig it was associated with **H. nigripennis** Hopk., **Stephanoderes ficus** Hopk., **Eupogonius vestitus** Say. and **Lepturges symmetricus** Hald.; and in osage orange with **Erineosinus squamosus** Blackm.

Hypothenemus rumseyi Hopk.

The length of the body in this species varies from 1.08 mm. to 1.18 mm., is 2.64 times as long as wide; the color varies from dark brown to black with the summit and anterior part of the pronotum reddish. The front of the head is convex, finely granulate, densely punctured, moderately pubescent below, with a fine elevated median line above; the pronotum is slightly wider than long, moderately broadly rounded in front, with eight marginal teeth the outermost pairs of which are smaller; the elytra are slightly wider than the pronotum, shining, the strial punctures rather coarse but shallow, the interspaces narrow, with uniseriate, grey, scale-like bristles.

Numerous specimens of this species were obtained near Agricultural College, Miss., November 7, 1919, January 22 and March 23, 1920, both from redbud (**Cercis canadensis**) and from hickory. In redbud the beetles were found both in twigs and in limbs about 2 inches in diameter. In hickory the beetles were taken only in or near the buds of recently cut branches where they were probably not breeding but merely feeding during the less active winter season. The brood burrows consist of irregular, longitudinal galleries in the inner bark from which the larval mines lead off. In redbud **Pityophthorus natalis** Blackm. was found breeding in the same limbs. It has previously been reported (Hopkins, 1915) from Little Falls, W. Va., in the dead dry bark on the trunk of redbud.

Hypothenemus asiminae Hopk.

The beetle is about 1.15 mm. long, 2½ times as long as wide, nearly black in color. The front of the head is dully shining below, finely punctured, with an indistinct elevated median line; the pronotum is very slightly broader than long, broadly rounded in front with six marginal teeth, the median pair closer together; the elytra are slightly wider than the thorax, moderately narrowly rounded behind, the surface moderately shining, distinctly punctate, striate with the striæ scarcely impressed and the punctures of moderate size but rather deep, interspaces moderate, ornamented as usual with uniseriate bristles.

A single specimen taken from water oak at Natchez, Miss., March 9, 1920, has been referred to this species. It was found in the bark of small dead limbs and was associated with **Pseudopityophthorus gracilus** Blackm. It has previously been reported (Hopkins, 1915) from Plummer's Isd., Md., in **Asimina triloba.**

Hypothenemus sp. d, (near *H. tenuis* Hopk.)

The species here considered is of the same type as **tenuis** but is probably not this, but a closely allied species. The color is nearly black, with the summit of the pronotum reddish brown; the body is from 1 to 1.1 mm. long, about 2 2-3 times as long as wide; the front is opaque, finely granulate punctate, moderately pubescent, with a slightly elevated median line; the prothorax is a little wider than long, with the sides parallel behind, rather broadly rounded in front, with six nearly equal and several smaller marginal teeth, the surface behind feebly shining; the elytra are black or nearly

so, equal in width to the pronotum, the sides subparallel or slightly tapering posteriorly, the posterior end moderately narrowly rounded, the surface shining, distinctly punctate-striate with the striæ scarcely impressed, the interspaces narrow, with uniseriate, scale-like bristles.

About 30 specimens of this species were taken from the bark of a small dead limb of dogwood at Meridian, Miss., November 14, 1919.

Hypothenemus punctifrons, Hopk.

The beetles are dark brown, nearly black in color with the pronotal summit lighter; the length of the females varies from 1.07 to 1.5 mm., 2.53 times as long as wide. The front is opaque, finely reticulate above, granulate-punctate below, with a shining median line; the pronotum is 1.15 times as wide as long, rather broadly rounded in front, with six small marginal teeth, the two outermost smaller, the two median ones closer together; the elytra are slightly wider than the pronotum, 1.64 times as long as wide, narrowly rounded behind, the surface shining, striæ impressed, rather deeply, rugosely punctured, the interspaces moderately narrow, very finely granulate, with uniseriate bristles which are yellowish and less conspicuous than usual. The males are lighter in color, 0.83 mm. long, 2.10 times as long as wide; the prothorax 1¼ times as wide as long; the pronotal and elytral vestiture not so scale-like.

A series of 22 specimens including several males was obtained from the bark of dead smilax at Agricultural College, Miss., February 19, 1920, where it was associated with **Stephanoderes** sp. (near **nitidulus**). This species has previously been reported from Lakeland, Fla., in **Quercus** sp. by Hopkins (1915).

Another species near **H. punctifrons** but distinct from it and very likely new, was taken at Hattiesburg, November 21 and at Newton, December 12, 1919, in the dead bark on the uppertrunk and limbs of sweet gum. The species is similar to the above but differs especially in the more slender form (2.65 times as long as wide) and slightly finer elytral sculpture. The frontal and pronotal characters aside from proportions are quite similar. It was found in the same material as **Pityophthorus liquidambarus** Blackm., at Hattiesburg and was associated with **Hypothenemus robustus** n. sp. at Newton.

Hypothenemus nigripennis Hopk.

In the females the length varies from 1.06 to 1.15 mm., 2.55 times as long as wide; the color is black with the rugose area of the pronotum reddish brown. The front of the head is dully shining below, opaque above, granulate-punctate, with a faintly elevated median line; the pronotum is very slightly wider than long, broadly rounded in front with four larger marginal teeth separated by more than their width and one or two smaller ones at each side; the elytra are slightly wider than the thorax, moderately narrowly rounded behind, shining; the striæ are impressed, rather coarsely and closely punctured, the interspaces narrow, with rows of well marked scale-like bristles. The male is much lighter in color, smaller, 0.78 mm. long, 2.31 times as long as wide, the elytra brown, the pronotum yellowish brown.

The author's collection from Mississippi contains some 200 specimens belonging to this species or closely allied to it. They include specimens from Iuka, Agricultural College, Starkville, Meridian, Laurel and Natchez, taken at various times during November, January, February, March, April and May. The host trees include grape, smilax, sumach, fig, redbud, crategus, magnolia, sweetbay, ironwood (**Carpinus**) and tupelo-gum. This ap-

pears to be the commonest and most generally distributed of any member of the genus in Mississippi. It was found not only in decaying bark but also in firm, only recently dead bark as well.

In grape it was found associated with **Stephanoderes chapuisii** Eichh., in **Crategus** with **H. sparsus** Hopk. and in fig with **H.** sp (near **pruni** Hopk.), S. **ficus** Hopk., and with the cerambycids **Eupogonius vestitus** Say. and **Lepturges symmetricus** Hald.

Hypothenemus sp. e, (near *pubescens* Hopk.)

The female beetle is black or very dark brown with the rugose area of the pronotum brown; 1.1 mm. long; 2.57 times as long as wide. The front of the head is finely granulate-punctate, sub-opaque, ornamented with a few short hairs below, the median line elevated, inconspicuous, interrupted midway by a small indistinct pit; the pronotum slightly wider than long, with the posterior angles rounded, the sides arcuate and the anterior margin moderately rounded and ornamented with six minute teeth; the elytra are little if any wider than the pronotum, with the sides subparallel or very slightly tapering, moderately narrowly rounded behind, the surface shining, the striæ scarcely impressed, with the punctures of moderate size but shallow, the interspaces moderately narrow, very finely punctured, with uniseriate, yellowish, scale-like bristles; the declivital interspaces with median rows of bristles and with a few fine hairs at the sides.

This species is closely allied to **pubescens** but differs in the body color, the number of the pronotal teeth, the sculpture of the elytra and the amount of hair on the declivital interspaces. My specimens were taken from the dead limbs of hickory at Newton, December 12, 1919. **H. pubescens** has been reported from Key West, Fla., by Hopkins (1915).

Hypothenemus sp. f, (near *ferrugineus* Hopk.)

The body is 1.11 m. m. long, 2.6 times as long as wide; the elytra brown to dark brown, the pronotum light brown with the rugose area yellowish. The front of the head is subopaque, reticulate-punctate, with an indistinct elevated median line; the pronotum slightly wider than long, with the sides faintly arcuate, rather broadly rounded in front, with four rather widely spaced marginal teeth, and several smaller ones at each side; the elytra are scarcely wider than the pronotum, moderately rounded behind, shining, with the striæ scarcely impressed, distinctly, rather deeply punctured, the interspaces narrow, with short scale-like bristles, the declivity with interspacial hairs as well as bristles.

These small beetles were quite numerous at Ocean Springs, December 22, 23, 1919, in dead limbs and twigs of pecan. The species is allied to **H. ferrugineus** but is slightly more slender and differs in a number of minor structural details. **H. ferrugineus** has been found in Guatemala by Hopkins (1915).

Hypothenemus sparsus Hopk.

The female is 1.2 mm. long, 2 1-3 times as long as wide; the elytra are black, the pronotum black with the summit dark reddish brown. The front of the head is opaque above, shining below, with a shining median line; the pronotum is distinctly wider than long, with the sides distinctly arcuate, rather narrowly rounded in front, with three equal marginal teeth and one slightly smaller; the elytra are slightly wider than the pronotum, dully shining; the striæ are impressed, rather coarsely roughly punctured, the in-

terspaces narrow, faintly granulate posteriorly, with uniseriate bristles, on disc and declivity.

The single specimen from Mississippi is very slightly larger than the type of **H. sparsus** and is darker in color but agrees very closely in other characters. It was taken by the writer from beneath the bark of a small dead limb of **Crategus** sp. at Natchez, Miss., March 16, 1920.

Hypothenemus juglandis n. sp.

The female is uniform black or very dark brown, occasionally with the summit slightly lighter in color; 1.06 to 1.2 mm. (Type 1.19 mm.) long; 2.56 times as long as wide.

The front of the head is convex, reticulate; opaque above, finely punctured and very feebly shining below, the median line slightly elevated, more shining below especially at the epistomal margin, very narrowly and shallowly sulcate above; the eye is short, rather finely granulate with the inner line narrowly emarginate; the antenna is pale brown, the scape club-shaped, the funicle 4-jointed, the pedicel wider than the scape and longer than the remaining three joints of the funicle combined, the segments slightly widened distally, the club oval, flattened, with three sutures on the outer face, the first of which is partly chitinized and distinctly notched at one side.

The pronotum is slightly wider than long (15:14), the posterior angles are somewhat rounded, the sides arcuate, moderately broadly rounded in front, the anterior margin with six marginal teeth, the center ones being largest and the others at each side progressively smaller; the anterior area is rather strongly asperate, the posterior area subopaque or feebly shining, densely rather finely punctured; the entire surface ornamented with erect, scale-like bristles interspersed with finer less conspicuous hairs.

The elytra are slightly wider than the pronotum (16:15), 1.7 times as long as wide, the sides subparallel (very slightly tapering) to the level of the declivity, moderately rounded posteriorly; the surface is feebly shining; the striæ are impressed, deeply, moderately coarsely punctured, the interspaces moderately narrow; the declivity is regularly convex; the elytral vestiture consisting of minute appressed hairs from the strial punctures, erect uniserially arranged scale-like bristles on the interspaces of disc, which on the declivity are supplemented by finer hairs. The first and fifth visible abdominal segments are subequal in length, the second, third and fourth progressively smaller. The legs are yellowish brown in color.

The male is black in color, much smaller, 0.88 mm. long, 2.39 times as long as wide with similar sculpture and vestiture.

Described from a series of 67 specimens taken by the writer from dead sprouts of black walnut at Port Gibson, Miss., March 8, 1920. The burrows were not only in the inner bark but also extended into the wood of the dead and decaying sprouts from a walnut stump. It was associated with **Stephanoderes** sp. (near **georgiae** Hopk.).

Hypothenemus robustus n. sp.

Description of the adult female.—The color is black with the summit of the pronotum dark reddish brown; 1.48 mm. long, 2.26 times as long as wide.

Front convex, subopaque, reticulate, finely, not densely punctured with a few very fine hairs, with a distinct, slightly elevated, shining, impunctate, median longitudinal carina, broad below, narrowed above. **Eyes** large, moderately finely granulate, with the inner line emarginate. **Antennae** testaceous, scape and club subequal in length and each twice as long as the funicle; pedicel equal to scape in width, as long as the three distal funicular

segments combined; club large, oval, flattened, the first suture partly chitinized, the first and second bisinuate, the third nearly straight.

Prothorax 1.16 times as wide as long, widest posteriorly, with the posterior angles rounded, the sides arcuate, moderately round in front, the anterior margin with four large teeth and two smaller ones; the anterior area asperate, the summit not strongly elevated; posterior area subopaque, punctures numerous and moderately fine, with short, fine, inconspicuous, recumbent hairs, interspersed with longer, erect, spatulate bristles or scales, all directed toward the summit.

Elytra wider than thorax, widest behind the middle, the sides subparallel for two-thirds of their length, moderately narrowly rounded behind; surface moderately shining; striæ distinctly impressed, coarsely and closely punctured, with each puncture bearing very fine, recumbent, inconspicuous hairs; interspaces wider than usual in the genus but not as wide as striæ, with numerous, very fine, inconspicuous punctures each of which bears a coarse, erect spatulate or scale-like bristle, which are uniserially arranged in each interspace; declivity weakly but regularly convex, unmodified in sculpture and vestiture. First and fifth visible abdominal segments subequal, second, third and fourth shorter, subequal; outline of abdomen behind second segment ascending.

Described from four specimens taken by the writer at Newton, Miss., December 12, 1919, from beneath the bark of a dying limb of sweet gum (**Liquidambar styraciflua** L.). It was associated with **H. punctifrons** Hopk. It is apparently the largest North American species of the genus.

THE GENUS *STEPHANODERES* EICHHOFF

The genua **Stephanoderes** is rather closely related to **Hypothenemus** but is readily distinguished by the following characters: Body form rather stout, color dark brown or black, pronotum wider than long with distinct side margins, asperate, with anterior margin toothed; elytra with striæ distinct and punctured; antennal funicle 5-jointed in the females, 4-jointed in the males with the last segment wider, club flattened, with three sutures on the anterior face, the first septate, the sides sinuate. In general the body is larger than in **Hypothenemus** but some of the largest of the latter species are about the same size as the smaller **Stephanoderes.** The males are smaller than the females and always much less numerous or rare and in many species not known.

The genus contains a large number of species, many of which are very similar and often difficult to determine, due to the very brief descriptions and the incomplete keys. The determinations were made by direct comparison with the types in the National Museum but in some cases are only tentative. It is regretted that the time available did not allow a redescription from type of all of the species here treated. The short descriptions here given are from the writer's specimens which have been compared with types and should not be considered as authentic redescriptions of the species.

The species are of little economic importance as they for the most part breed in dying or dead branches of trees. The brood burrows and feeding burrows are constructed either in the bark, the wood or the pith.

Stephanoderes dissimilis Zimm.

The adult female varies in length from 2 mm. to 2.34 mm.; 2.36 times as long as wide; black with the summit of the pronotum sometimes very dark reddish brown, the antennæ and feet yellowish brown. The front of the head is convex, subopaque, aciculate, punctured and moderately pubescent below, with a shining impunctate median line; eyes emarginate, rather

finely granulate; antennal club large, the first suture curved, second and third bisinuate; pronotum 1.2 times as wide as long, the sides strongly arcuate, the anterior outline subangulately rounded, with two large, flat teeth; the anterior area very sparsely and coarsely asperate, the summit high, rather finely closely and roughly punctured, with abundant moderately short pubescence; elytra wider than pronotum, the surface shining, the striæ impressed, moderately punctured, the interspaces wide, finely punctured, the declivity rather abrupt, convex, each interspace with a central row of moderately short hairs and with numerous minute, appressed scales. In the males the body is smaller and the marginal teeth of the pronotum shorter.

The specimens were compared with Zimmerman's types in the LeConte Collection at Harvard.

This species is distributed all over the eastern portion of the country from Canada to Florida, having been reported from Quebec, New York, New Jersey, Michigan, Indiana, District of Columbia, West Virginia, North Carolina and Florida. It has been taken in a variety of hosts, hickory, oak, grape, wild cherry, fig, pear and pine. In Mississippi the writer obtained specimens from Corinth, Iuka, Agricultural College, Trimcane Swamp, and Electric Mills, the hosts being hickory, beech, red oak and white oak.

The burrows are in the wood of twigs and small branches and are very irregular and variable. The entrance gallery extends through the bark into the sapwood. The burrows may be entirely near the surface of the sapwood, or the gallery may be continued in to the pith where branches go off in both directions, or the entrance gallery may be continued entirely through the limb to near the under surface of the bark on the opposite side. In some cases where the number of beetles were more than ordinarily numerous the entrance gallery extends through the twig or small branch with two or more galleries leading lengthwise from it in the outer wood, in the pith and in the sapwood near the bark on the other side. A fairly typical burrow is shown in figure 71. Here the entrance gallery extended through the bark (removed before the photograph was taken) and sapwood to the pith. Several galleries proceeded from it in the outer sapwood, two more midway between the surface and the pith and two more in the pith. The beetles breed in either recently dead or dying branches or in those recently broken.

S. **dissimilis** was associated in hickory with **Chramesus hicoriae** Lec., **Cryptocleptes dislocatus** Blackm., **Micracis rudis** Lec., **Chrysobothris chrysoella** Illig., and in oak with S. **interpunctus** Hopk., **Micracis opacicollis** Lec., **Thysanoes fimbricornis** Lec. and **T. lobdelli** Blackm.

Stephanoderes chapuisii Eichh.

This species is of the same general type as S. **dissimilis** and has been considered as a synonym of it by Eichhoff and Schwarz (1896) and by Swaine (1909) but seems to be distinct although very closely allied. It can best be characterized by comparison. The body is slightly but distinctly smaller than **dissimilis**, being less than 2 mm. long; the front is narrower but more coarsely sculptured; the asperities of the pronotum are similarly arranged but distinctly smaller with the two marginal teeth greatly reduced, and the interspaces of the elytra are more coarsely punctured. The male is much smaller, 1.37 mm. long, exactly twice as long as wide; the pronotum strongly asperate but with the marginal teeth entirely lacking.

The species was described from Texas. In Mississippi the writer collected specimens from sassafras at Vicksburg, from grape at Agricultural College and from redbud at Corinth, the dates of collection being March 6, February 19 and April 13, respectively. The habits seem to be very similar

to those of **S. dissimilis.** In grape it was associated with **Hypothenemus nigripennis** Hopk. and in redbud with **Micracis opacicollis** Lec.

Stephanoderes quercus Hopk.

The female is very dark brown nearly black in color, 1.7 mm. long, the front of the head aciculate and punctured at the sides, with a rather wide, shining, impunctate, median line; the pronotum 1.3 times as wide as long, the sides strongly arcuate, the anterior outline subangulate with two moderate sized flattened teeth, the asperities coarse and sparse, the summit high, reddish brown, with the region posterior to it sloping, reticulate, subopaque, moderately punctured; the elytra wider than thorax, moderately shining, the striæ impressed, distinctly punctured; the interspaces rugulose, obscurely punctured, the declivity moderately sloping, convex; the interspaces with rows of scale-like bristles.

The species was described from West Virginia in **Quercus prinus.** But one specimen was taken in Mississippi from a twig of white oak at Trimcane Swamp, March 30, 1920. It was associated with **Micracis opacicollis** Lec. and **Thysanoes lobdelli** Blackm.

Stephanoderes rotundicollis Eichh.

The female is dark brown, nearly black; 1.67 mm. long, 2.25 times as long as wide; the front is convex above, slightly flattened below, subopaque, finely punctured except for the broad, shining median line; the pronotum is 1.34 times as wide as long, with the sides arcuate and evenly rounded to the apex, which is armed with two rather large teeth with their bases contiguous; asperities sparse and coarse, summit high, with posterior area sloping, distinctly punctured; elytra widest behind the middle, narrowly rounded behind; striæ strongly impressed, rather coarsely punctured, interspaces wide, somewhat convex, minutely punctured, with uniseriate, spatulate bristles; declivity convex, the interspaces narrow, each ornamented with a median row of bristles and with numerous fine short hairs.

This species has been reported from southeastern U. S. in oak (Hopkins, 1915). In Mississippi the writer took five specimens at Mendenhall, December 26, 1920, from the wood of hickory limbs cut the preceding spring. The species was associated with **Chramesus hicoriae** Lec., **Micracis bicornus** Blackm. and **M. harnedi** Blackm.

Stephanoderes quadridentatus Hopk.

The female is black or very dark brown; 1.68 mm. long, 2.48 times as long as wide; the front of the head is opaque, reticulate, finely punctured, with a few hairs, with a narrow, shining, median line, sulcate above; the eye is distinctly emarginate, the antenna light yellowish brown; the pronotum 1.16 times as wide as long, with the sides arcuate, narrowly rounded in front with four small marginal teeth, the asperities moderately numerous and of moderate size; posterior region and sides opaque, reticulate, punctured, ornamented with fine hairs and spatulate bristles interspersed; elytra slightly wider than thorax, widest behind the middle, narrowly rounded posteriorly, the surface dully shining, striæ impressed, coarsely and closely punctured, interspaces moderately wide, very finely punctured, with uniseriate bristles which are slightly longer on the declivity.

The species was described from specimens obtained at Morgantown, W. Va., in spruce. Three specimens were taken by the writer at Corinth, Miss., March 11 and 25, 1920, in beech and pine. In beech it was associ-

ated with **S. dissimilis** and in pine with **Pityophthorus pullus** Zimm. and **P. lautus** Eichh.

Stephanoderes sp. a, (near *opacipennis* Hopk.)

The female is very dark brown, almost black in color; 1.52 mm. long, 2.22 times as long as wide. The front of the head is convex, subopaque with a rather wide shining median line; the pronotum is 1.27 times as wide as long, with the sides distinctly arcuate, moderately rounded in front, with four larger marginal teeth and a smaller one at each side more widely spaced; the elytra are slightly wider, with the surface subopaque, striæ impressed, more strongly on declivity, punctures moderate; interspaces moderately wide, finely punctured, rugose, with stiff suberect bristles, longer on declivity.

The single specimen from Mississippi differs considerably from the type of **opacipennis** and is probably not the same species but is closely allied. It was taken from white oak twigs at Trimcane Swamp, Miss., March 30, 1920.

Stephanoderes sp. b, (near *flavescens* Hopk.)

The female is brown to dark brown in color, 1.6 mm. long, 2.38 times as long as wide. The front of the head is opaque, reticulate, finely and sparsely punctured and pubescent, with a narrow, shining median sulcus, the pronotum 1.23 times as wide as long, with the sides arcuate, moderately broadly rounded in front, with six-marginal teeth, the outermost one on each side smaller, asperities rather numerous, sides and posterior region opaque, reticulate, with numerous rather fine punctures; elytra dully shining, the striæ moderately impressed, closely and moderately coarsely punctured; the interspaces moderately wide, minutely punctured, with uniseriate bristles becoming longer on the declivity.

Thirteen specimens of this species which is either Hopkins' **flavescens** or is very closely allied to it were taken from oak twigs at Corinth, March 25, 1920. They differ from the type in color and to some extent in frontal characters. **S. flavescens** was described from Tallahassee, Fla.

Stephanoderes sp. c, (near *rufescens* Hopk.)

The female has the elytra very dark reddish brown with the pronotum lighter; 1.47 mm. long, 2.39 times as long as wide. The front is convex, subopaque, with a shining narrow impressed median line; the pronotum is 1.26 times as wide as long with the sides arcuate, moderately narrowly rounded in front, with four marginal teeth; the elytra are slightly wider, with the surface feebly shining, striæ impressed, coarsely and closely punctured, interspaces narrow, rugose, with moderately short, broad, clavate bristles in uniseriate rows.

Three specimens were obtained from dead twigs of prickly ash at Vicksburg, Miss., March 6, 1920.

Stephanoderes sp. d, (near *nitidulus* Hopk.)

The female is very dark brown or black; 1.53 mm. long, 2.27 times as long as wide; the front of the head subopaque, very finely and sparsely punctured, with the median line shining below; the prothorax wider than long, with the sides arcuate, moderately rounded in front, with four teeth,

the two median ones slightly larger and closer together, the asperities moderately numerous, the posterior area opaque or subopaque, the sides feebly shining; elytra shining, the striæ moderately impressed, more strongly behind, rather coarsely and closely punctured, the interspaces of moderate width, each with a row of erect bristles.

The species here represented is very closely allied to **nitidulus** but is not identical with the type which was described from Cuba. The Mississippi specimens were obtained by the writer from dead smilax at Agricultural College, Miss., February 19, 1920.

Stephanoderes approximatus Hopk.

The female is very dark brown, nearly black, with the summit of the pronotum reddish; 1.37 mm. long, 2.31 times as long as wide. The front of the head is transversely impressed below, shining, convex above, opaque, reticulate and finely sparsely punctured, with a shining median line, sulcate above and ending in a small flat tooth at the epistomal margin. The pronotum 1.17 times as wide as long, the sides very faintly arcuate, moderately rounded in front, with four rather large marginal teeth and several smaller ones at each side, asperities moderately numerous and rather fine. The elytra are feebly shining, with the striæ impressed, the strial punctures coarse, the interspaces narrow, rugose, each with a row of scale-like bristles.

The single specimen agrees fairly closely with the type except in coloration, which is much darker in my specimen. The type is from Columbus, Texas. My specimen was taken from hickory at Maxie, Miss., December 24, 1920. It was associated with **Cryptocleptes dislocatus** Blackm.

Stephanoderes interpunctus Hopk.

The female is dark brown or black in color; 1.47 mm. long, 2.24 times as long as wide. The front of the head is opaque, shining below with a short, very shallow sulcus above. The pronotum is 1.22 times as wide as long, the sides arcuate, moderately rounded in front, with four marginal teeth of moderate size, and sometimes with smaller ones at the sides, asperities fairly numerous and well developed. The elytra are wider than the pronotum, narrowly rounded behind, dully shining, the striæ impressed, closely and moderately coarsely punctured; the interspaces of moderate width, distinctly but finely punctured, with uniseriate rows of clavate bristles which are considerably longer on the declivity.

In the type the elytra are "nearly glabrous except on declivity" but this is certainly due to abrasion. The type is from Brownsville, Texas. In Mississippi specimens were obtained at Agricultural College from hickory, January 22 and at Trimcane Swamp, from oak, March 29, 1920. In oak twigs it was associated with **S. dissimilis.**

Stephanoderes interstitialis Hopk.

The female has the elytra dark brown with the pronotum lighter brown; 1.56 mm. long, 2.26 times as long as wide. The front is shining below, convex above, opaque with a distinct, narrow, shining, median sulcus. The pronotum is wider than long, with the sides weakly arcuate, moderately rounded in front, with four equal, moderately large marginal teeth. The elytra are slightly wider, dully shining, the striæ impressed, with moderate punctures closely arranged, interspaces moderately wide, finely but distinctly punctured, ornamented with clavate bristles which become longer posteriorly.

This species was described from Texas. The Mississippi specimens

were taken from dead or dying sumach at Agricultural College, February 14, and at Corinth, April 11, 1920. The beetles were found not in the wood but in burrows in the inner bark. They were associated with **Pityophthorus rhois** Sw. and **P. scriptor** Blackm.

Stephanoderes lucasi Hopk.

The female is brown in color; 1.56 mm. long, 2.39 times as long as wide. The front of the head is subopaque, reticulate above, punctured, with a few fine hairs, the median line sulcate and shining. The pronotum 1.17 times as wide as long, with the sides arcuate, rather broadly rounded in front, with from five to seven (usually six) equal teeth and several smaller ones, the asperities numerous and of moderate size. The elytra are slightly wider, moderately rounded behind, the surface shining, the striæ weakly impressed, with moderately coarse, close punctures, the interspaces narrow, minutely punctured, with scale-like bristles, uniseriate in each interspace and similar on disc and declivity.

The Mississippi specimens were sent in to the Agricultural College from Carthage by Mr. W. E. Wall, August 24, 1919, in cotton bolls. The type in the National Museum was obtained from the stomach of a humming bird, the locality not being given.

Stephanoderes ficus Hopk.

The female is dark brown in color; 1.43 mm. long, 2.48 times as long as wide. The front of the head is opaque, with a distinct shining sulcus, the eye weakly emarginate, the antenna but little lighter in color than the rest of the head. The pronotum is 1.06 times as wide as long, with the sides very weakly arcuate, rather broadly rounded in front, with six moderately small marginal teeth the outermost one of which on each side is smaller, asperities numerous, of moderate size, posterior area and sides opaque, with short wide scale-like bristles. The elytra are scarcely wider than the pronotum, with the sides parallel, rather narrowly rounded behind, the surface feebly shining; the striæ moderately impressed, with the punctures moderately coarse and close, the interspaces narrow with uniseriate bristles, scarcely longer on the declivity.

The species was described from specimens taken in Alabama from the branches of fig. In Mississippi the writer took but one specimen, November 6, 1919, at Agricultural College, from dead sprouts of fig. It was associated with **Hypothenemus nigripennis** Hopk.

Stephanoderes texanus Hopk.

The female is dark brown, nearly black in color with the pronotum slightly lighter; 1.43 mm. long, 2.35 times as long as wide. The front of the head is convex, opaque with a very distinct, shining median sulcus, the eyes distinctly but not deeply emarginate, the antennæ reddish brown. The pronotum is 1.1 times as wide as long with the sides weakly arcuate, moderately broadly rounded in front, with six marginal granules which become progressively smaller toward the sides, disc subopaque, finely, moderately closely punctured. The elytra are slightly wider, the surface moderately shining, the striæ weakly impressed, with moderately coarse punctures, the interspaces rather narrow, minutely punctured, with upright spatulate bristles but little longer posteriorly.

Two specimens of this species were taken by the writer at Vicksburg, Miss., March 6, 1920, from dead twigs of prickly ash. The species is described from Columbus, Texas.

Stephanoderes sp. e, (near *georgiae* Hopk.)

The female has the elytra black, the prothorax very dark brown, nearly black; 1.47 mm. long, 2.42 times as long as wide. The front of the head is subopaque, with the median line slightly elevated, sulcate along its center with a minute elevation below just above the epistomal margin and another just above the level of the upper angle of the eyes, minutely punctured at the sides with very fine, sparse pubescence. The pronotum is 1.1 times as wide as long, with the sides faintly arcuate, moderately rounded in front with six marginal teeth, the outer one on each side much smaller and separated from the others by a wider space. The elytra are slightly wider, the sides subparallel, rather narrowly rounded behind; the surface shining, the striæ impressed, rather strongly, closely, rugosely punctured, the interspaces rather narrow, with uniserially arranged, spatulate, yellowish bristles.

This species is slightly larger than **georgiae**, darker in color, the frontal characters more strongly developed with the median line more distinct, more strongly sulcate and the posterior elevation more pronounced; the pronotum is similar structurally but is concolorous; the elytral interspaces are slightly wider and the scales wider and more conspicuous. It was associated with **Hypothenemus juglandis** n. sp. described elsewhere in this paper.

Stephanoderes sp. f, (near *braziliensis* Hopk.)

The female has the elytra dirty brown, the pronotum with the asperate area slightly lighter brown and the sides and posterior region light testaceous; 1.38 mm. long, 2.38 times as long as wide. The front of the head is transversely impressed below, with a median shining line, convex above, slightly elevated at median line, opaque or subopaque; eye emarginate; antennal club darker than head. The pronotum is 1.13 times as wide as long, with the sides faintly arcuate and converging anteriorly, moderately narrowly rounded in front, with six nearly equal marginal teeth, asperate area sordid brown in color, asperities numerous and moderate in size, sides and posterior area light yellow-testaceous, subopaque, ornamented with clavate bristles. The elytra are dark sordid brown, slightly wider than the thorax, with the sides subparallel, moderately narrowly rounded behind; the surface shining; striæ weakly impressed, strongly, rather coarsely punctured, the interspaces moderate, rugulose with uniseriate clavate bristles.

The species here considered is slightly smaller than the type of **braziliensis** with the elytral punctures slightly coarser and the color lighter throughout, especially on the sides of the pronotum. The writer has two specimens from pecan twigs sent in to Agricultural College from Jackson, Miss., by Mr. E. G. Wade, June 21, 1920.

THE GENUS *GNATHOTRICHUS* EICHHOFF

The genus **Gnathotrichus** is characterized by the elongated slender body form, the surface smooth and shining, with very fine punctures and nearly devoid of pubescence except on the declivity; the antennal funicle is five-jointed, the eyes emarginate; the prothorax longer than broad, the anterior area asperate, the posterior area very finely punctured, with the summit well before the middle and marked by a sharp, transverse, arcuate carina.

But a single species was taken by the writer in Mississippi.

Gnathotrichus materiarius Fitch.

Dark brown, shining, elytra slightly paler; about 3 mm. long; 3.25

times as long as wide. The front of the head is slightly flattened, rather strongly punctured, with fine short hairs, divided by a slightly elevated, finely aciculate carinal space; pronotum nearly 1¼ times as long as wide, sculpture as described for the genus; elytra widest at about the middle, with the sides subparallel, surface smooth, with the striæ indicated by rows of fine punctures; declivity oblique, with the second interspace slightly narrowed and depressed, third with a row of fine granules, apical margin slightly produced; vestiture consisting of very minute strial hairs on the disc, with more numerous and longer strial and interstrial hairs on the declivity.

G. **materiarius** is found throughout eastern Canada and eastern United States as far south as Florida and Texas. It is most often found in the various species of pine in its range but is not uncommon in spruce and larch. I have also taken specimens from their burrows in balsam and hemlock. In Mississippi this species was taken only at Agricultural College and only from loblolly pine. It, however, doubtless occurs throughout the state and breeds in all of the native pines. The dates of collection were November 4 and 5, 1919, and May 8 and 19, 1920. On the latter date the larvæ were numerous, each in its own individual cradle.

The burrows are similar in type to those made by **Pterocyclon** and **Trypodendron** but are very slightly larger in diameter than those of **P. mali** and considerably smaller than those of **Trypodendron**. The brood burrows are constructed in dying trees or in the stumps and trunks of recently cut trees, the entrance being made while the bark is still green and sappy. Slowly dying trees and stumps are chosen in preference to felled trunks, due doubtless to the more rapid seasoning of the latter. This suggests that much damage to saw-logs can be prevented by so piling them as to insure rapid seasoning. They may also be protected by floating in water as soon as cut.

G. **materiarius** was found associated with **Platypus flavicornis** Fabr., **Ips calligraphus** Germ. and the clerid **Thanisimus dubius** Fabr., which doubtless preys upon this as well as other ipids.

THE GENUS *PITYOBORUS* (NEW GENUS)

This genus is erected to include the form originally described by Zimmerman (1868, p. 143) as **Crypturgus comatus**. In the appendix to the same paper (p. 155) LeConte places **comatus** in the genus **Cryphalus** Erichson and in the later monograph on the "Rhyncophora of America North of Mexico" (1876, p. 355) he places it in the genus **Pityophthorus** Eichhoff. This species, however, differs markedly from all the species of **Pityophthorus** known to the writer and is therefore separated on the basis of the following generic characters.

Antennal club very large, twice as long as funicle, broad oval with first and second segments comprising more than half of the club, first and second sutures strongly chitinized, slightly procurved; asperate region of the pronotum extending not more than one-third of the way back at the sides, the female with an oval patch of yellow plush-like pubescence before the middle at each side, the corresponding area in the male devoid of asperities, punctate or at most granulate-punctate; elytra punctured in fairly definite rows, declivity regularly convex, not sulcate but with the first striæ faintly impressed; general body form more flattened than in **Pityophthorus**.

Pityoborus comatus Zimm.

Zimmermann's original description is as follows: "Long lin. ¾. Brown, antennæ and feet yellow; prothorax roughly tuberculate in front, ornamented each side with a patch of thick yellow silky hair; elytra very finely

but distinctly punctate-striate, obtusely rounded at tip and without tubercles. South Carolina."

The type series consists of but one specimen, a female, now in the LeConte collection at Cambridge, Mass. This was studied in connection with my own series of 60 specimens collected in Mississippi and the following more complete description prepared.

Description of the female beetle.—Brown to nearly black in color with the antennæ and feet yellow or yellowish-brown; 1.8 to 1.9 mm. long, 2.6 times as long as wide.

The front of the head is plano-concave below, moderately finely punctured and rather sparsely pubescent with a fringe of longer hairs at each side, the epistoma broadly emarginate at the center with a marginal fringe of rather short yellow hairs; the antennæ are yellow in color, with the funicle five-jointed, the distal segments being slightly wider, the club is relatively very large, twice as long as the funicle, broad oval in form, with the first two sutures strongly chitinized, slightly procurved, the third suture not septate, more strongly arcuate; the eyes are large, moderately coarsely granulate, very deeply emarginate.

The pronotum is as wide as long or slightly wider, with the posterior angles rounded, the sides weakly arcuate, constricted in front of the middle, rather broadly rounded in front; the anterior margin is serrate; the anterior area moderately asperate, asperities extending less than one-third of the distance back at the sides and limited at each side by an oval patch of yellow plush-like pubescence lying just in front of the middle; summit low, with a very slight impression posterior to it; posterior region finely reticulate, feebly shining, rather finely punctured, pubescence scanty.

The elytra are scarcely equal in width to the thorax, 1.7 times as long as wide, with the sides subparallel, moderately narrowed, rounded behind; the striæ are composed of nearly regular rows of rather fine closely placed punctures, the interspaces nearly impunctate on the disc. The declivity is convex, not sulcate but with the sutural striæ slightly impressed, the suture is rather wide, slightly elevated, with a few minute granules and a sparse row of hairs, second interspace flat, impunctate, third interspace with a row of several very minute granules each bearing a longer hair. The surface is shining, the disc nearly glabrous with only an occasional hair from the interspaces, these becoming more numerous on the declivity.

The male is similar in color, size and general proportions. The front of the head is plano-convex above, transversely excavated below, more coarsely and sparsely punctured, sparsely and finely pubescent, with a distinct, elevated, median, longitudinal carina; the pronotum is as in the female with the pilose area lacking, the asperities extending less than a third of the way back at the sides; the elytra similar in general to those of the female.

P. comatus is listed by Swaine (1918) as "extremely rare in collections." The only references I have been able to find in the literature are to the single type specimen which was obtained in South Carolina. The author's collection includes 60 specimens of the beetles as well as larvæ and pupæ taken at Agricultural College, Laurel. Hattiesburg, Gulfport and Long Beach, Miss., during the months of November and December, 1919. The host trees are short-leaf pine, swamp pine and long-leaf pine, especially the two latter.

The beetles breed by preference in the shaded out lower branches of the southern pines—especially those of the long-leaf and swamp pine. The insects are polygamous and each of the engravings have from two to five egg-galleries (Fig. 79). The egg-galleries are quite short and as they occur in limbs having relatively thin bark, groove the wood rather deeply. The first two galleries are transverse or nearly so in direction, but if more than two are present the later ones may bear any relation to the grain of the wood. The

eggs are laid in niches in the sides of the egg-galleries and the larvæ feed upon both the inner bark and the sapwood. They, however, differ from the majority of bark-beetles in that they do not each construct a narrow individual tunnel at right angles to the parent gallery, but each at first constructs a wide, short alcove, never longer than 6 or 8 mm., which remains connected with the egg-galleries (Fig. 80). As the larvæ grow and widen out their burrows, these come to communicate with neighboring ones so that several larvæ are often found feeding together in a group. In the advanced engravings also larvæ are often found in the egg-galleries feeding upon its side walls and extending its width. When full grown each larva constructs its own individual pupation chamber. This is oval, about 2.5 mm. long, is never more than a few millimeters from the egg-gallery and usually extends at right angles to it. It may be surrounded by the undisturbed wood and bark, but most often is constructed in the area bored by the larvæ. In the latter case the larva before pupating constructs a sort of cocoon by surrounding itself with a wall of frass and debris compactly held together by some secretion from its body. In this chamber pupation occurs and in it the transformation to the adult stage occurs. The young beetles feed for a time on the inner bark and wood and each emerges by a separate hole through the bark.

The beetles breed in pines, by preference in the lower branches which are still alive but which are weakened by shading. Doubtless they are occasionally injurious but most often are of little economic importance or perhaps might be considered mildly beneficial in that they hasten the natural pruning of the lower branches. That they never have been notably injurious in the past is indicated by the fact that the references to this species in entomological literature are all to a single specimen. That it is not an uncommon species, and that it has at least a fairly wide distribution is, however, indicated by the number of specimens collected (many more could have been readily obtained) and by the several localities at which it was taken. It was often associated with **Ips grandicollis** Eichh. and on one occasion with **Pityophthorus pulicarius** Zimm.

THE GENUS *PSEUDOPITYOPHTHORUS* SWAINE

In this genus the body form varies from slender to moderately slender, the pubescence from rather scanty to plentiful; the prothorax is rather strongly asperate in front, the summit near the middle, not carinate but with the disc distinctly impressed just posterior to it and the posterior portion and sides finely punctulate; the elytra with very fine punctures usually not arranged in strial rows; declivity not strongly sulcate; the antennal club has the first segment narrower than the others, with the sutures arcuate; the tibia are widened distally and strongly serrate on the outer margin; the intercoxal process is long and pointed. The males are readily distinguished from the females by a brush of long yellowish hairs on the frons.

Three species were taken in Mississippi by the writer, one of which is new. These may be readily separated by the following key.

Key to the Species of *Pseudopityophthorus*

		Page
A.	Elytral punctures very numerous, not arranged in definite strial rows on the disc.	
B.	Elytral pubescence plentiful, the hairs on the declivity distinctly longer; the declivity slightly but distinctly impressed lateral to the suture; stouter...**pruinosus** Eichh...	99

BB. Elytral pubescence more scanty, the hairs on the declivity not appreciably longer; the declivity very faintly impressed next to the suture; more slender.
minutissimus Zimm. 100

AA. Elytral punctures not very numerous, arranged to form definite strial rows; pubescence scanty; smaller and more slender.
gracilus Blackm. 100

Pseudopityophthorus pruinosus Eichh.

Dark ferrugineous-brown; 1.4 mm. to 2 mm. long, 2 2-3 times as long as wide. The front of the female is rather sparsely clothed with grey hairs of moderate length, that of the male densely bordered with very long, incurved, yellow hairs; the pronotum is longer than wide, the anterior region densely asperate, the posterior region shining, finely punctulate; the elytra are finely punctulate with numerous short grey hairs, which are longer on the declivity, especially on the first and third interspaces.

P. **pruinosus** has been recorded from Carolina, New York, New Jersey and Florida and probably occurs throughout the entire eastern section of the country. This species has been recorded especially from red oak and probably will breed in any species of oak in its range. In Mississippi the writer collected specimens at Mississippi City, Gulfport, Laurel, Newton, Meridian, Agricultural College and Corinth and at Shiloh Park, Tenn. The hosts were red oak and live-oak and the dates of collection November 14, 15, 19, December 12, 18, 1919, January 8, 14, February 10, April 3, 10, 11, 19, May 12, 23, 1920. The specimens from Gulfport and Mississippi City were taken December 18 and 20 in their newly started burrows in recently cut limbs of live-oak. The beetles were active, some of them just entering the bark while others had begun to deposit their eggs. This indicates that on the Gulf coast there is very little interruption in the activities of the beetles during the winter months.

The brood-burrows of this species show some peculiarities not hitherto met with. The entrance gallery extends through the bark to the surface of the sapwood. From this point two short galleries extend longitudinally in opposite directions. These vary from 2 mm. to 10 mm. in length and are doubtless used as turning niches by the parent adults and apparently never as egg-galleries. The true egg-galleries are transverse and extend in opposite directions from the entrance tunnel. In length the combined egg-galleries vary from less than an inch to more than two inches. Both the egg-galleries and the turning niches lie at the juncture of the bark and sapwood and groove both. The eggs are laid in niches in the sides of the egg-galleries and the larvæ bore at the juncture of the wood and bark in a longitudinal direction, following the grain of the wood more closely than any other form known to the writer.

The beetles prefer the comparatively smooth bark of limbs or of the upper portions of the trunk for the construction of their breeding quarters. Recently cut or broken limbs are preferably attacked, but dying limbs often harbor numerous broods and occasionally limbs which were apparently entirely healthy are attacked and are killed by the combined efforts of adults and larvæ.

In the northern half of the state there are apparently two broods—possibly three broods per year. Along the Gulf coast the beetles continue breeding with but little interruption throughout the year and probably produce from three to five broods each season.

Usually the damage done by this and the other species of the genus is so small as not to warrant control measures but if they should ever become numerous enough to be distinctly injurious they can be readily controlled by burning infested slash and by cutting and burning infested trees. If the

slash is burned within a month after cutting, the brood will be destroyed in immense numbers and undue multiplication will be prevented.

P. pruinosus often occurred in the some material along with P. minutissimus Zimm., Pterocyclon mali Fitch., P. fasciatum Say., Platypus compositus Say., Xylobiops basilaris Say., Rhizophagus bipunctatus Say. and Bitoma quadricollis Horn.

Pseudopityophthorus minutissimus Zimm.

Similar in color to pruinosus, slightly smaller in size and slightly more slender (about 1.7 mm. long, 2.8 times as long as wide). The structure and sexual differences in the frons is similar; the thorax usually less shining on the posterior region; the elytra not so densely punctulate and with fewer, shorter and finer hairs, which are not longer nor more numerous on the declivity, which is not at all or only very faintly impressed at each side of the suture.

This species occurs throughout the eastern part of the country from Quebec to Florida. It has been reported as breeding in several species of oak, beech, hazel and dogwood. In Mississippi the writer collected specimens at Meridian and Agricultural College, all from red oak. The dates of collection are November 14 and 15, 1919 and February 21 and May 23, 1920. In all but one case the brood burrows ocurred in the same material as those of P. pruinosus. The habits and burrows of these two species are very similar. The burrows being apparently identical except that the turning niches are usually shorter in minutissimus. This species does not appear to be so numerous in Mississippi as pruinosus.

Pseudopityophthorus gracilus Blackm.

Dark brown to black in color; 1.1 to 1.3 mm. long, 3 times as long as wide. Prothorax over 1¼ times as long as wide, with the front margin extended, finely and regularly serrate, the anterior area finely, densely asperate, the posterior area shining, rather sparsely and finely punctured; elytra with surface shining, striæ indicated by fairly regular rows of very fine punctures, each bearing a very fine, short hair, interspaces not visibly punctured; declivity sloping, convex, with scarcely perceptible impression at each side of suture, hairs coarser and longer on the declivity This species seems to be even more closely allied to the genus Pityophthorus than are the others.

The only locality at which this new species was found is Natchez. Here it was abundant in the dead limbs of the water oak and of another unidentified oak. The limbs found infested varied from ⅜ to ¾ of an inch in diameter and the insects were found breeding only in broken limbs and in dying or dead limbs. The burrows are very similar to those of P. pruinosus but of course are smaller in all respects and especially in the bore of the parent galleries. So far as is known at present this bark-beetle is of little or no economic importance.

THE GENUS *PITYOPHTHORUS* EICHHOFF.

The body in this genus varies from slender to moderately stout; the pronotum is as long as wide (often considerably longer), with the anterior portion asperate, with the disc more or less strongly impressed behind the summit, the posterior portion moderately or sparsely punctured and pubescent and the base bordered by a fine marginal line; the elytra is variously punctured, with the striæ usually indicated by rows of punctures; the de-

clivity usually retuse and not strikingly unlike in the two sexes; the antennal funicle is 5-jointed, the club with distinct sutures, with the first segment subequal in width to the others; the prosternal process is short and wide. The front of the head in the female is often ornamented with longer or more numerous hairs.

Eleven species of this genus were taken by the writer in Mississippi and doubtless several others occur there. The following key serves to separate the species actually taken.

Key to the Mississippi Species of *Pityophthorus*

FF. Declivity in female without hairs and granules, in the male with smaller granules and shorter hairs.....**nudus** Sw... 108

EE. Apex of elytra less strongly acuminate or subacuminate, front of head in female with moderately long or very long hairs.

F. Prothorax as wide as long, moderately rounded in front, summit high; front of head in female rather densely pubescent with moderately long hairs.....**bisulcatus** Eichh... 108

FF. Prothorax distinctly longer than wide, broadly rounded in front, summit low; front of head in female with very short fine hairs surrounded by a border of very long, coarse, incurved light yellow hairs.....**annectens** Lec... 109

Pityophthorus pulicarius Zimm.

This species is readily separated from all others of the genus in Mississippi by the coarse, closely and irregularly arranged elytral punctures combined with the broadly rounded posterior margin of the elytra. The color varies from brown to piceous; the size from 1.3 mm. to 2 mm. long; 2.6 times as long as wide. The front of the head of the male is convex, rather closely, deeply, moderately coarsely punctured, sparsely pubescent, with short fine hair, with a distinct median carina; that of the female is slightly flattened, with longer hairs still rather sparse; the pronotum is moderately rounded in front, the anterior area moderately asperate, the summit very low, the posterior area strongly punctured; the elytra are very coarsely, deeply, irregularly punctured; the declivity fairly steep, convex, with the first and second striæ regularly punctured, and impressed to form a rather shallow sulcus at each side of the wide, moderately elevated suture.

P. pulicarius is quite widely distributed throughout the eastern portion of the country from Quebec to Florida and has been found as far west as Illinois. In Mississippi it is quite common in all parts of the state, having been taken by the writer at Iuka, Agricultural College, Gulfport, Long Beach and Ocean Springs. The host trees are loblolly, short-leaf, long-leaf and swamp pines. The dates of collections were November 2, December 16, 17, 19, 23, 30, 1919, March 30, April 16 and May 10, 1920. The beetles were especially numerous in the long-leaf and swamp pines along the Gulf coast.

This bark-beetle apparently breeds exclusively in the twigs, attacking either injured ones or ones which are apparently perfectly normal. They differ from most others of the genus in that the brood burrows are most commonly constructed not under the bark but in the pith. The lateral terminals of small and medium sized saplings are most commonly chosen as breeding places. The adult beetles bore through the bark and sapwood of the twig most often within a few inches of the terminal bud. The entrance gallery extends through to the pith, a nuptial chamber is constructed either in the pith or in the sapwood adjacent to it. The egg-galleries extend through the pith in both directions from the nuptial chamber. In the long-leaf pine twig in which the pith is of considerable diameter two or more egg-galleries may be side by side parallel to each other. The eggs are deposited in niches in the sides of the galleries and the larvæ burrow either in the pith or bore through the sapwood and live between the bark and sapwood. In the long-leaf pine the greater number of the larvæ burrow through the pith and in the inner part of the sapwood next to it. The pith and wood immediately adjacent to the terminal bud seem to be espe-

cially favored as food for the larvæ and young adults and often a number are found there or within the bud itself.

As has already been stated the beetles attack not only broken or dying lateral terminals but also perfectly normal ones. The work of the adults and larvæ, however, soon causes the leaves to wilt and turn brown and results in the death of all of the twig beyond the point of attack. Where only a few of the lower lateral twigs of a young tree are killed the damage perhaps is not great, as these lower limbs must be lost later if the tree is to produce clear timber. However, if any considerable number of the branches are thus killed or distorted the vitality of the tree is materially affected and its normal rate of growth decreased. The insects can be readily controlled by collecting and burning the infested twigs. This should be done as soon after they begin to wilt as is practicable.

It was associated with **P. nudus** Sw., **P. granulatus** Sw., **Pityoborus comatus** Zimm., **Ips grandicollis** Eichh., and **Carphoborus bicristatus** Chap.

Pityophthorus lautus Eichh.

The adult beetle is yellowish brown to reddish brown in color; 1.3 to 1.5 mm. long, 2.6 times as long as wide. The front of the head in the male is convex, transversely impressed below, densely punctured and with fine short greyish pubescence, longer on the epistoma; the club of the antenna is broadly oval with arcuate sutures; the pronotum is 1.12 times as long as wide, with the sides arcuate, the anterior outline rather narrowly rounded, the anterior area with the asperities in fairly regular concentric lines but not fused at the base to form ridges, the posterior area deeply, moderately punctured; the elytra are slightly narrower at the base than the thorax but wider farther back, the sides weakly arcuate, the posterior end very broadly, subtruncately rounded, the strial punctures of the disc coarser than on pronotum, deep, in regular rows, interspaces rugulose and impunctate or nearly so; the declivity is rather steep, distinctly sulcate at each side of the elevated suture, the first striæ more deeply impressed above than the second, suture and lateral convexities devoid of granules or with a few, very fine ones. The front of the head in the female is more flattened, shining, sparsely punctured and glabrous except for a surrounding fringe of moderately long yellowish grey hairs.

This species has been reported from Texas by LeConte (1876 p. 354) and from West Virginia on pine by Hopkins (1893 p. 131). In Mississippi the writer obtained but four specimens the localities being Corinth and Agricultural College and the dates of collection April 25, May 8, 10, 1920. All were taken from loblolly pine, three from burrows under the bark of twigs and one creeping over the surface of a pine twig. Nothing is known of the habits except that the beetles apparently breed in the smaller branches and twigs of pine. On account of their apparent small numbers they probably do little if any damage in Mississippi.

It was associated with **P. pullus** Zimm., **P. nudus** Sw., **Ips avulsus** Eichh., **Carphoborus bicristatus** Chap. and **Stephanoderes quadridentatus** Hopk.

Pityophthorus rhois Sw., var. *swainei* n. var.

The adult beetle is reddish brown in color; distinctly smaller than the typical northern specimen of **rhois**, 1.3 mm. to 1.4 mm. long, 2.7 times as long as wide. The front of the head is flattened below, shining, rather coarsely punctured, with a few rather fine and short hairs; the antennal club is 1½ times as long as wide, the first two sutures nearly straight and nearly completely chitinized, the third arcuate; the pronotum is slightly

longer than wide, broadly rounded on the posterior margin, sides slightly arcuate, feebly constricted before the middle, broadly rounded in front, asperities in nearly regular concentric rows, the first distant from the serrate margin, posterior area moderately punctured (not so closely and coarsely as in typical **rhois**); the elytra are similar to those of the typical form, but more finely punctured.

The chief difference in the southern variety here described is in the distinctly smaller size and finer sculpture. This variety is probably the form mentioned by Swaine (1918 p. 26) and recorded from Biscayne, Key West and Haw Creek, Fla., and left by him as a "smaller race of **rhois.**" The specimens studied by the writer were obtained from dying and dead sumach at Agricultural College and Wallerville, Miss., November 6, 1919, February 14, 20 and April 23, 1920.

The beetles are polygamous in their breeding habits, the burrows being constructed in the inner bark and outer sapwood. The parent burrows are of the radiate type consisting of from two to five or more egg-galleries extending out from a central nuptial chamber. The first two of these female galleries are likely to be transverse or only slightly diagonal in direction while the latter ones may have any relation to the grain of the wood. The egg-galleries are usually comparatively short, seldom being more than 1½ inches in length and often less. They engrave the wood rather deeply and often form very pretty patterns upon its surface. The egg-niches are arranged more or less regularly at each side of the female galleries. The larval mines are usually very tortuous and are for the most part in the inner bark, never grooving the surface of the wood but lightly.

Injured or dying sumach is usually chosen by the beetles as breeding quarters and the brood was found especially in small scrubby growth in pastures, which had been more or less injured by ground fires. As the sumach is of little value the insects attacking it cannot be considered injurious. Associated insects include **P. scriptor** Blackm. and **Stephanoderes interstitialis** Hopk.

Pityophthorus natalis Blackm.

The adult beetle is light reddish brown in color; **1.4 mm. to 1.5 mm.** long, 2.6 times as long as wide. The front of the head is flattened below, densely and deeply punctured with a faintly raised carina extending backward from a distinct notch at the middle of the epistomal margin; the pronotum is very slightly longer than wide, with the sides weakly arcuate behind, faintly constricted before the middle and rather broadly rounded in front, anterior area with asperities fused at the base to form nearly regular concentric lines, posterior area deeply, moderately coarsely punctured with a median longitudinal impunctate area; the elytra are widest behind the middle, with the sides weakly arcuate, broadly, subtruncately rounded behind, the strial punctures deep, moderately coarse, in regular rows, the interspaces narrow; faintly rugulose, impunctate in front of the middle; the declivity is abrupt, sulcate at each side of the wide, elevated, finely granulate suture, with the first striæ more deeply impressed than the second and the punctures reduced, the lateral elevations moderately high.

This species was taken by the author only at Agricultural College, Miss. It breeds in the dead limbs of redbud where it is associated with **Hypothenemus** sp. (near **nigricollis** Hopk.) and **H. nigripennis** Hopk. The burrows are similar to those of **rhois** and of other similar species. It is probably of little economic importance and apparently is not numerous.

Pityophthorus liquidambarus Blackm.

The adult is yellowish brown or light reddish brown in color; 1.3 mm.

to 1.4 mm. long; 2.87 times as long as wide. The front of the head in the female is broadly flattened, finely sparsely punctured, shining, with sparse, fine, rather short hairs, bordered by a fringe of longer, coarser hairs; the pronotum is longer than wide, more finely sculptured than in natalis; the elytra more slender than in the latter, sides subparallel, broadly, subtruncately rounded behind, with the strial punctures deep, moderately coarse, interspaces rather narrow, rugulose, nearly entirely impunctate on the disc except on sutural interspace; the declivity is only moderately abrupt, suture fairly wide, elevated with a distinct row of granules, lateral elevations fairly prominent, weakly granulate, second interspace sulcate, not widened behind. The male is slightly stouter; with the frons flattened only below, moderately punctured, with sparse, fine, short hairs; the pronotum is but little longer than wide; the declivital granules are slightly coarser.

It is possible that this is the same species referred to by Schwarz (1888, 1891) and by him identified as P. consimilis Lec. My specimens were, however, compared with LeConte's type and are very distinct. The specimens studied were taken by the writer at Hattiesburg, Meridian, Agricultural College, Ripley and Corinth, Miss., and at Mound, La., the dates of collection being November 2, 4, 21, 26, 1919 and February 21, March 2, April 25, 26, 1920.

P. liquidambarus is very common in Mississippi. It breeds in the bark of injured, recently cut and dying branches of sweet gum. The beetles were taken from their brood-burrows in the trunk of saplings three inches or more in diameter and in broken or dying branches and twigs down to a diameter of one-fourth of an inch. The beetles are polygamous in habit, the burrows being of the radiate type with from two to five egg-galleries which may bear any relation to the grain of the wood. The egg-galleries are short, usually less than an inch and a half long, and the egg-niches are rather numerous and closely placed. Those egg-galleries which start longitudinally are usually soon curved and are continued transversely. The larval mines are rather long and winding and in the larger limbs scarcely groove the surface of the sapwood, while in the thinner-barked twigs the sapwood is more strongly etched. There are two or three generations a year. No cases were observed where this beetle was really injurious.

It was associated with Hypothenemus hispidulus Lec., H. punctifrons Hopk., and two separate unidentified species of hymenopterous parasites.

Pityophthorus pullus Zimm.

The adult beetle is dark reddish-brown in color; 1.8 mm. to 2.33 mm. long, 3.1 times as long as wide. The front of the head in the female is convex above, slightly concave below, roughly punctured, coarsely above, more finely below and with longer more numerous hairs; antennal club about 1¼ times as long as wide, the first two sutures weakly, the third strongly arcuate; the prothorax is 1.1 times as long as wide, the sides subparallel, slightly constricted in front of the middle and rather broadly rounded in front, front margin strongly serrate, anterior area strongly asperate, summit moderate with the impression posterior to it divided by the raised median line, posterior area moderately coarsely punctured; the elytra are twice as long as wide, slightly narrower than the thorax, the sides subparallel to a point behind the origin of the declivity, then narrowed to the moderately acuminate point, the surface rather feebly shining, coarsely, deeply and irregularly punctured on the disc, the sides punctured in fairly regular rows with the interstrial punctures sparse; the declivity is deeply and widely sulcate, the suture wide, strongly elevated and granulate, the first and second striæ rather finely but regularly punctured, the second interspace widened behind, smooth, shining, impunctate, the lateral elevations fairly prominent, sparsely granulate, hairs short and moder-

ately sparse on the disc, longer and more numerous on the declivity. The male is smaller, with the hairs on the frons sparser and shorter.

This species has been reported from various localities in the eastern states. It probably occurs from New York and Michigan in the north to South Carolina and Mississippi in the south. In Mississippi the writer found it very numerous in the extreme northern part, taking numerous specimens at Iuka, Corinth and Ripley but obtaining none as far south as Agricultural College. The dates of collection were April 13, 14, 21, 24, 25 and 27, 1920. The beetles were taken only in short-leaf pine but doubtless breed in all species of pine within their range.

At the time when these beetles were first observed by the writer (April 13 and 14, 1920) they were well along in the construction of their brood burrows, some of which contained a male and as many as ten females. Many of the eggs had been laid and in a few of the egg-galleries more than half had hatched. The female burrows are more than usually long and there is a decided tendency toward their extending in a longitudinal direction (Figs. 59, 60, 61). Where such a large number originate from a single nuptial chamber, however, some of them must necessarily start transversely to the grain of the wood, but these soon turn and proceed in a general longitudinal direction. The eggs are laid at considerably greater intervals than is usual in bark-beetles, this doubtless being correlated with the unusual number of egg-galleries in each brood-burrow, the beetles instinctively placing them farther apart in order to assure sufficient food for the larvæ. The egg-galleries show another peculiarity, doubtless associated with the length of the galleries and usually found in those more than usually long. This is the frequent turning niches, often spoken of as "ventilation openings" which extend toward the surface of the bark. They are primarily intended to allow the female to turn without backing out into the nuptial chamber each time. Occasionally they penetrate through the bark to a space under one of the loose scales and in such case doubtless act as ventilation openings, although probably not intended for such. The number and closeness of these turning niches in burrows of **P. pullus** is quite unusual as will be seen from Fig. 60. The writer had no opportunity to make observations as to the number of generations per year, but there are probably two in the latitude of northern Mississippi.

The beetles breed by preference in recently cut pine trees but also will attack injured or weakend limbs or even young trees and often hasten the death of these. They can be controlled by cutting and burning infested material, and their occurrence in excessive numbers can be prevented by promptly utilizing the felled trees, by peeling timber to be used as poles and by the prompt burning of the slash. Slash should never be allowed to remain unburned for more than a month or six weeks.

Beetles associated in the same portions of infested trees include **P. lautus** Eichh., **P. bisulcatus** Eichh., **Ips avulsus** Eichh., **I. grandicollis** Eichh. and **Stephanoderes quadridentatus** Hopk.

Pityophthorus scriptor Blackm.

The adult beetle is dark reddish-brown in color; 1.54 mm. long, 2.8 times as long as wide. The front of the head is somewhat flattened, finely and densely punctured and pubescent with fine, moderately long hairs; the pronotum is very slightly longer than wide, with the asperities of the anterior area more or less fused at the base to form continuous or broken concentric ridges, the first row separated from the serrate margin by a distinctly punctured area, the posterior area deeply and strongly punctured, with an indefinite median impunctate region; the elytra are slightly wider, with the sides faintly arcuate and the apex subacuminate; the strial punctures are deep, moderately coarse, in regular rows, the interspaces are nar-

row, rugulose and nearly impunctate; the declivity is moderately steep, the suture moderately elevated, weakly granulate, punctures of first striæ reduced or lacking behind, second interspace widened, sulcate, shining, impunctate, lateral elevations not prominent, weakly and sparsely granulate. The male has the body form slightly stouter, the frons not so much flattened, with the punctures sparser and the hairs much shorter, finer and sparser.

This species is of the same size and is similar in sculpture to the form here treated as P. bisulcatus Eichh. but differs in certain characters mentioned in the key and in the descriptions. It also differs in the host plant P bisulcatus breeding in pine limbs while P. scriptor breeds in sumach. The latter was obtained in considerable numbers at Corinth, New Albany and Agricultural College, the dates of collection being November 6, 1919, February 14, April 11, 22 and May 19, 1920.

This species often is found breeding in the same shrubs as P. rhois. Their burrows can usually be distinguished by the longer, slightly coarser egg-galleries and by their less symmetrical arrangement. They are of little or no economic importance as they attack and complete the destruction of sumach injured by ground fires and otherwise. As these shrubs are at best of no value in pastures, the beetles might under such circumstances be considered mildly beneficial.

Pityophthorus granulatus Sw.

The adult female is reddish-brown in color; 1.5 mm. to 1.7 mm. long, 3 times as long as wide. The front of the head is convex, coarsely punctured above, flattened below, closely more finely punctured, divided by a faint carina ending below in a granule, densely pubescent with very fine, moderately short hairs; the eyes are rather coarsely granulate, with the inner margin deeply emarginate; the antennæ are lighter in color with the first two sutures of the club nearly straight, recurved at the sides; the pronotum is 1.1 times as long as wide, with the sides feebly arcuate behind, rather broadly rounded in front, the front margin regularly serrate, the anterior area regularly asperate, the first row rather widely separated from the margin, summit high, posterior area shining, moderately punctured, with a median and two lateral impunctate areas; the elytra are very slightly wider than the thorax, widest behind the middle, the sides subparallel and the apex strongly acuminate, the strial punctures are moderately coarse, deep, closely placed, in regular rows, the interspaces narrow, faintly rugulose, impunctate or nearly so; the declivity is moderately steep, the suture elevated, strongly granulate-setose, the punctures of first and second striæ reduced, the second interspace widened, sulcate, shining, the lateral elevations moderately high, granulate and setose. The male is shorter and wider, with the frons more uniformly, coarsely and roughly punctured, with very scanty fine pubescence.

This species was described by Swaine (1917) from a series of specimens from Manitoba, Quebec and Nova Scotia. It also has been reported from New York (Blackman 1919) and doubtless occurs throughout eastern Canada and United States. In Mississippi the writer obtained specimens from Agricultural College, Electric Mills, Meridian, Hattiesburg and Long Beach. The host plants are short-leaf, loblolly and swamp pine and the dates of collection were November 2, 12, 14, 21 and December 17, 1919.

In the southern pines the beetles breed principally in the twigs or smaller limbs a half inch or less in diameter, the bark on the larger limbs being unsuitable for their purposes. For this reason they do not exhibit the polygamous habit to such a degree as do the northern members of the species which when breeding in the thin bark of the upper trunk or limbs of white pine occur in the proportion of from three to nine females for each

male. In the smaller limbs there is not room for so many egg-galleries for each brood-burrow and here the proportion is one male to each two to five females. Otherwise the engravings are quite similar to those of the same species in white pine (Blackman, 1919) the chief characteristics being the small nuptial chamber, the long egg-galleries and the rather widely spaced egg-niches. Branches which are dying slowly either from mechanical injury or from overshading most commonly are infested, while slash or limbs entirely broken from the trees are apparently less attractive to the beetles. No cases of real injury by this species were observed and it is believed that even when numerous this insect acts only as an unimportant secondary enemy to pines.

This species has been found associated with **P. nudus** Sw., **P. pulicarius** Zimm., and **Pityogenes meridianus** Blackm.

Pityophthorus nudus Sw.

The adult beetles are reddish-brown in color, nearly glabrous, shining; 1.4 mm. to 1.7 mm. long, 2.9 times as long as wide. The front of the head is similar to that of **granulatus**; the pronotum is similar in shape but noticeably more finely asperate on the anterior area, more finely punctured on the posterior area; the elytra are similar in shape and sculpture, but with the punctures finer, the granules on the declivity of the female very much reduced on the sutures and the lateral elevations and the hairs lacking or very minute. The males are usually shorter with the front of the head convex, slightly flattened below, closely, roughly and coarsely punctured, with very fine, short, sparse pubescence, the declivity with the suture and lateral elevations distinctly granulate and with numerous moderately short hairs.

It will be seen that the male's characteristics given above do not entirely agree with the original description. Indeed, as regards the declivital characteristics they approach rather near to the **granulatus** type. As a matter of fact early specimens collected were at first referred to **granulatus**. However, in later lots of material, the contents of individual newly started brood-burrows were kept separate and in all of these both the glabrous and the slightly hairy types were found. An examination of the frontal characteristics immediately showed that the glabrous forms are female while the granulate-setose forms are males.

This small bark-beetle has been reported from Ontario, Quebec and New York, breeding in the twigs of white spruce and white pine. In Mississippi the writer obtained numerous specimens at Agricultural College, November 2, 1919, May 8, 10, 1920. None were taken at any other locality in the state. The beetles breed in the smaller limbs and twigs of short-leaf and loblolly pine and their habits are very similar to those of **P. granulatus** mentioned above.

P. nudus was found associated in the same limbs with **P. granulatus** Sw., **P. pulicarius** Zimm., and **Carphoborus bicristatus** Chap.

Pityophthorus bisulcatus Eichh.

The adult female is dark reddish-brown in color; 1.5 mm. long, 2.73 times as long as wide, with the posterior end subacuminate. The front of the head is plano-convex, transversely impressed below, finely punctured and pubescent with fine hairs, longer and more abundant at the sides and above, shorter and sparser at the center; the antennal club has the side margins strongly crenulate, the first two sutures nearly straight, strongly chitinized, the third strongly arcuate and not septate; the prothorax very slightly longer than wide, with the sides weakly arcuate behind, feebly con-

stricted in front of the middle, rather broadly rounded and serrate in front, anterior area with the asperities in fairly regular concentric rows, the bases not fused, the first row separated from the margin, posterior area deeply, rather finely punctured, with a narrow impunctate median line; the elytra have the sides very weakly arcuate, broadest behind the middle, subacuminate behind, the surface feebly shining, the striæ finely, deeply punctured, the interspaces narrow, weakly rugulose; the declivity is rather oblique, the suture moderately elevated, feebly granulate, second interspace moderately sulcate, the lateral elevations higher than the suture, with a few small granules. The male is similar in color and form, with the front plano-convex, deeply and rather coarsely punctured, and the sculpture of both thorax and elytra coarser.

This species is identified as **P. bisulcatus** Eichh. only provisionally as it seems to fit Eichhoff's rather brief and general description fairly closely. It is very closely related to **P. scriptor** Blackm. This differs from **bisulcatus** in that the pronotal asperities are more completely fused at their bases to form continuous or somewhat broken concentric ridges. In **bisulcatus** this is not true in the first row of asperities at least. Another striking difference is in the host—**scriptor** breeding in sumach while **bisulcatus** was taken from pine twigs.

The habitat of **P. sulcatus** was given by Eichhoff as North America. The specimens here treated were obtained by the writer from the twigs and small limbs of pine at Corinth, Miss., April 25, 1920. They were associated in the same limbs with **P. pullus** Zimm., **P. lautus** Eichh. and **Stephanoderes quadridentatus** Hopk., from the former of which they are readily distinguished by their smaller size, finer sculpture and different frontal characteristics. Nothing is known of their economic importance.

Pityophthorus annectens Lec.

The adult beetle is very dark reddish-brown; 1.3 to 1.7 mm. long, 3 times as long as wide. The front of the head in the female plano-concave on a nearly circular area extending from eye to eye very finely, very densely punctured, the central area with very fine, short hairs, bordered by a dense fringe of very long, coarse, yellow hairs with the ends incurved, often meeting at the center and veiling the entire frons; antennæ concolorous, the club broadly oval, the sides crenulate, first and second sutures nearly straight; the pronotum is distinctly longer than wide, the anterior area with the asperities not in regular rows, posterior area with moderate punctures; the elytra have the sides subparallel and the apex acuminate, the strial punctures are of moderate size, in fairly definite rows, the interspaces finely rugulose, very sparsely punctured; the declivity is rather widely and deeply sulcate at each side of the elevated, weakly granulate suture, lateral elevations moderately high. The male is similar in size and proportions, the front of the head is convex above, flattened below, coarsely and roughly punctured with very short, fine hairs; the sculpture of both thorax and elytra is coarser.

P. annectens was described from Florida and has been reported from District of Columbia, breeding in pines. In Mississippi the writer obtained specimens only near Meridian, November 17, 1919, in the smaller limbs of a recently felled loblolly pine. Infested limbs were confined in a breeding jar and the adults began to emerge in March.

The burrows (Fig. 82) are of the polygamous type, with a central nuptial chamber from which from two to five egg-galleries originate. These latter extend in a general longitudinal direction and may continue for a distance of 2½ inches or more. The larval burrows are transverse and are quite short, seldom extending for more than a half inch, but are relatively

broad. The beetles were found breeding only in the branches of recently felled trees but doubtless will also attack weakened or injured branches. In no cases observed were they numerous enough to be injurious. They were associated with **Ips avulsus** Eichh.

THE GENUS *PITYOGENES* BEDEL.

The body form in **Pityogenes** is usually moderately stout; the pubescence is rather scanty; the prothorax is strongly asperate in front, punctured behind, not margined; the elytra are punctate-striate, with the declivity more or less excavated and with that of the male much more strongly toothed; the antennal club is flattened, with sutures on both sides; the prosternum is short with the intercoxal process wide and short. The front of the female is often excavated.

But one species, an undescribed form, was found in Mississippi but another may occur. These may be readily separated by the following key:

		Page
A.	Smaller broader form (2 mm. long, 2.55 times as long as wide), front of female with triangular pubescent area; male declivital teeth very stout; declivital excavation in both sexes weakly rather finely punctured.....**plagiatus** Lec...	110
AA.	Larger and more slender (2.8 mm. long, 2.7 times as long as wide), front of female shining with sparse, fine hairs; male declivital teeth long and slender; declivital excavation roughly and coarsely punctured.....**meridianus** Blackm...	110

Pityogenes plagiatus Lec.

The only specimens of this species studied by the writer are LeConte's types consisting of a female and a male, both from Maryland, and two specimens in the Deitz collection at Cambridge. The female is 1.85 mm. long, the male 2.09 mm. long. The female has the front flattened with a triangular patch of pubescence and the rest of frons shining, punctured, with short sparse pubescence; the thorax is very little longer than wide, with the sides parallel behind, constricted before the middle and moderately rounded in front, anterior area moderately asperate, posterior area finely, deeply punctured, rugulose; the elytra have the sides subparallel, the apex broadly subtruncately rounded, the disc strongly not densely punctured, not in regular rows; the declivity is steep and abrupt, moderately excavated, with the suture elevated, the lateral elevations high, with a pair of teeth above near the suture and a second pair of larger ones near the apex in the third interspace, the excavation sparsely, obsoletely punctured. The male declivity is deeply concave with a distinct elevated margin; the teeth much larger, the first stout, hooked at end, the posterior outline emarginate-truncate, the declivital excavation evidently punctured.

This species has been taken in the Atlantic states from New York to West Virginia. It is especially common in the latter region showing a probably more southern distribution. No specimens were taken in Mississippi but it may occur there. The host trees are the Southern yellow pine, scrub pine, red pine and jack pine. Hopkins (1893) states that this species is very common in West Virginia where it hastens the death of injured trees.

Pityogenes meridianus Blackm.

The adult beetles vary from reddish-brown to black in color; 2.7 to 2.9 mm. long, 2.7 times as long as wide. The female has the front of the head broad, convex, shining, with fine, sparse hairs, granulate-punctate except in

the median line; the pronotum is longer than wide, widest behind the middle, arcuate, slightly constricted, rather broadly rounded in front, anterior area densely covered with short, blunt asperities, posterior area rather sparsely, coarsely punctured, with a broad, elevated, median impunctate line and a large, oval, impunctate area at each side; the elytra are subparallel at the sides, broadly, subtruncately rounded behind, the disc shining, with the first striæ impressed, strial punctures deep, coarse, somewhat irregularly spaced, in fairly regular rows, interspaces wide, with equally coarse but sparser punctures; the declivity is rather steep, sulcate, the suture slightly elevated, broadly not deeply excavated, with the first striæ regularly coarsely punctured, the rest irregularly coarsely punctured, with two distinct teeth at each side, one in the second interspace near the summit, and another opposite the third interspace near the apex, with granules variably arranged upon the ridge bordering the sides of the excavation. The male is of about the same size, with the front more coarsely sculptured, the pronotum scarcely or not at all longer than wide; elytral declivity more deeply concave, deeply and coarsely punctured, with the lateral margins more elevated and sharper, with a long, slender, hooked tooth at each side near the summit, the lateral margin tuberculate, and two conical teeth on the margin at each side near the apex.

This species was described from a series of 26 specimens collected by the writer November 3, 4, 14, 21, 1919 and March 22, 1920, at Agricultural College, Meridian and Hattiesburg, Miss. The host trees are loblolly and short-leaf pine. In one case it was associated with **Pityophthorus granulatus** Sw.

The burrows are of the polygamous radiate type with from two to five egg-galleries originating from each nuptial chamber. The first two egg-galleries are always transverse or slightly diagonal while the later ones are diagonal. They vary in length from 1 to 2½ inches. The egg-niches are not closely placed and are never as numerous as in many species of bark-beetles, as none of the egg-galleries studied contained more than thirty niches.

P. meridianus was found breeding only in the dead or dying lower branches of pines which had been weakened by excessive shading or injured by ground fires. In no observed case were they really injurious but rather were instrumental in completing the death of the lower shaded out limbs and therefore an aid in the limb-pruning necessary for the production of good timber. However, that under certain circumstances they might cause damage, is indicated by their ability to maintain themselves and breed in living pitchy bark. If injurious they may be controlled by cutting and burning the trees containing living brood. Their occurrence in excessive numbers may be prevented by the proper disposal of the slash from cuttings, and by the prompt utilization or destruction of dying or badly injured trees.

THE GENUS *IPS* DeGEER

The body form of Ips varies from moderately slender to rather stout, cylindrical, 2 mm. to 8 mm. long (Mississippi forms 2 mm. to 6.5 mm.); the color varies from brown to black; the sculpture is usually rather strong; the pronotum strongly asperate in front, punctured behind, the elytra concave on the declivity with the concavity separated from the apical margin by a definite horizontal plate-like extension distinct from the elytral margin; the antennal club is flattened, with definite sutures on the outer face; the front of the head not deeply excavated in either sex; the intercoxal process of the pronotum long and acute.

Three species of Ips were taken by the writer in Mississippi, all of

them breeding in the trunks or limbs of the various species of pines. The following key serves to separate these:

		Page
A.	The declivital margin with four teeth at each side, the second and third connected at the base; the interspaces on the disc impunctate except near the declivity; a small species, less than 2.8 mm. long; the antennal club with the first suture bisinuate. **avulsus** Lec.--	112
AA.	The declivital margin with five or six teeth at each side, elytral interspaces of the disc more or less punctured; the antennal club with the first suture angulate at the middle.	
B.	The declivital margin on each side with five teeth; interspaces 2, 3 and 4 usually impunctate on the basal two-thirds; less than 4 mm. long.-------**grandicollis** Eichh.--	113
BB.	The declivital margin on each side with six teeth; elytral interspaces all sparsely punctured; more than 4 mm. long. **calligraphus** Germ.--	114

Ips avulusus Eichh.

The adult beetles are reddish brown to nearly black in color, often with the elytra lighter; 2.1 to 2.6 mm. long, 2.6 times as long as wide. The front of the head is convex, transversely impressed below, roughly and deeply punctured and more or less granulate, with evidences of a median elevation ending in a definite tubercle just above the epistomal impression, with the hairs moderately numerous and longer toward the epistomal margin; the antennal club has the first suture bisinuate, the second widely angulate at the center; the pronotum is longer than wide, the asperate region extending well behind the middle at the sides, the posterior area rather finely and sparsely punctured, with a median impunctate line, the elytra are deeply punctate-striate with the interspaces slightly convex, impunctate except near the declivity; the declivity is moderately excavated, strongly punctured, with the apical margin moderately elevated, with the sides each having four teeth, less strongly developed than usual in this genus, the first minute, near the suture in the second interspace, the remaining three larger, conical, nearly equal in size.

Ips avulsus rears its brood in the various species of pine within its range. It has been reported from Pennsylvania, District of Columbia, Georgia and Florida. The writer took specimens at Corinth, Iuka, Agricultural College, Trimcane Swamp and Meridian, the dates of collection being November 5, 17, 1919; January 8, March 22, 27, April 14, 25 and May 19, 1920. The hosts were loblolly and short-leaf pine.

The beetles are polygamous forms which rear their brood in limbs from 1 inch to 6 inches in diameter, the burrows lying mostly in the inner bark and often only slightly etching the outer sapwood. There are from two to five egg-galleries in each burrow. These have in general a longitudinal direction and are rather long and tortuous. The larval mines are transverse, short and rather broad and except for the pupal chamber scarcely groove the surface of the wood.

Ips avulsus prefers to breed in the branches of recently felled trees and most of the lots of material were found under such conditions. However, it also occurs as a secondary enemy in trees attacked by other insects or rapidly dying from other causes. It was found associated in the same limbs with **Ips calligraphus, Ips grandicollis, Pityogenes meridianus, Pityophthorus annectens, P. pullus, P. lautus** and **P. bisulcatus.**

Ips grandicollis Eichh.

This species is usually readily separated from other southern species by the five teeth at each side on the declivital margin. It is dark reddish-brown in color; 3 mm. to 3.8 mm. long, 2.67 times as long as wide. The front of the head is granulate with several larger granules or tubercles just above the widely emarginate epistomal border; the antennal club with the first and second sutures strongly angulate; the pronotum is nearly one-fourth longer than wide, closely asperate in front, shining behind, moderately finely punctured, with an impunctate median line; the elytra are strongly punctate-striate, with the striæ impressed, interspaces 2, 3 and 4 usually impunctate except near the declivity, the declivity oblique, strongly excavated, coarsely punctured, with the lateral margin prominent, ornamented with five teeth, the third largest, the apical margin strongly elevated and typically entire. In some specimens the apical margin is slightly notched near the lateral angle—in this character approaching the 6-dentate condition in Ips calligraphus—but such specimens are still distinguishable by other characters.

This bark-beetle is a well-known and common species breeding in the pines of the eastern portion of the United States from Florida to Massachusetts. In Mississippi specimens were taken at Corinth, Iuka, Ripley, Agricultural College, Laurel, Newton, Gulfport and Long Beach. The host trees are loblolly pine, short-leaf pine, swamp pine and long-leaf pine and the dates of collection were November 4, 18, December 12, 16, 17, 1919; April 2, 13, 14, 16, 21 and May 8, 19, 1920.

The beetles are polygamous and breed in the inner bark of the trunk or limbs of all of the southern pines. As a host they seem to prefer the trunks of saplings or the upper trunk and limbs of larger trees but they have been found constructing their brood burrows in limbs less than an inch in diameter and in the stumps of recently cut trees nearly a foot thick. They appear to prefer recently cut material as they are nearly always found in pine felled at certain seasons of the year, but also breed in dying trees and even in the lower branches slowly dying by suppression. They will often attack weakened trees in concert with other bark-beetles—the combined attack soon killing such trees. However, the greatest damage is doubtless done to recently cut logs and poles. This may in a measure be obviated by cutting at seasons when the beetle is not active or by the rapid drying of the recently cut timber. It may be prevented by floating the logs in water or by sawing them immediately. If all slash is destroyed within a month or six weeks and dying trees are promptly utilized or destroyed the beetles will not occur in excessive numbers. However, it should be recognized that dying trees may still have nearly a full crop of green needles, even though the inner bark of the trunk and larger branches is entirely destroyed and the new generation of beetles ready to emerge.

The burrows of Ips grandicollis consist of several egg-galleries—usually from three to five—originating from a central nuptial chamber. They are several inches in length and most usually extend longitudinally, grooving both the bark and sapwood. In limbs the egg-galleries are mostly excavated from the sapwood while in the thicker-barked portions of the tree the inner bark is more deeply grooved. The larval burrows extend in a general transverse direction and are of only moderate length. There are at least two generations per year in northern Mississippi and doubtless more in the southern portion of the state.

Associates of Ips grandicollis include the bark-beetles Ips calligraphus Germ., I. avulsus Eichh., Pityophthorus pullus Zimm., Orthotomicus caelatus Eichh., Pityoborus comatus Zimm., and Carphoborus bicristatus Chap. In one case in the bark of a newly felled pine which I. grandicollis was attacking were found numerous specimens of Thanisimus dubius Fabr. and several

Temnochila virescens Fabr., which were doubtless preying on the entering bark-beetles; and several specimens of **Rhagium lineatum** Oliv. and **Asemum moestum** Hald. were probably preparing to deposit their eggs.

Ips calligraphus Germ.

This species is very readily recognized by having six teeth on the declivital margin at each side. The Mississippi specimens vary in color from rather light reddish-brown to black and in size from 4 mm. to 6 mm. long. The front of the head is sparsely and coarsely granulate, with a large median epistomal granule; the pronotum is densely asperate in front, rather sparsely and finely punctured and shining behind; the elytra have the striæ slightly impressed, coarsely punctured, the interspaces convex, shining, sparsely, finely uniserially punctured on the disc, more closely on the side, confusedly and densely near the declivity; the declivity is deeply excavated, strongly punctured, with the lateral margin strongly toothed and hairy and the apical margin acutely elevated. There is considerable variation in the development of the six teeth especially in the last one which typically is well set off from the apical margin, but in some specimens is separated only by a shallow notch. The males are distinguished by their coarser sculpture and by the greater development of the third declivital tooth.

Ips calligraphus occurs throughout eastern Canada and eastern United States. It breeds in the various species of pine in its range. In Mississippi this species is common in all regions of the state where the various species of pine occur. It was taken by the writer at Corinth, Iuka, Agricultural College, Meridian and Mississippi City, the hosts being loblolly, short-leaf, swamp and long-leaf pines, and the dates of collection being November 2, 4, 5, 15, December 2, 18, 1919; March 30, April 2, 13, 14 and May 8, 1920.

This species was found only in the trunk region of the tree. It breeds equally well in either felled or dying trees and prefers to enter bark which is still sappy as it has the ability to live in burrows flooded with pitch. This material when excessive in amount, as it often is in the bark chosen for breeding purposes, is pushed out of the burrow and built up into a sort of "chimney" or "pitch tube" surrounding the entrance. Several instances were found where the beetles had entered living trees apparently only slightly weakened and had insured their death. These trees would probably have survived except for the work of this and other insects. The trunks of such trees are often attacked simultaneously by this species and **Dendroctonus terebrans**, while at the same time or shortly after the tops and limbs are attacked by a host of such other forms as **Ips grandicollis, Ips avulsus**, and by several species of **Pityophthorus, Carphoborus**, etc., and the lower trunk by such ambrosia beetles as **Platypus flavicornis, Gnathotrichus materiarius**, etc.

The burrows of **Ips calligraphus** are essentially similar to those of **I. grandicollis** but are coarser in bore and longer. The longitudinal egg-galleries are marked at intervals of every inch or two by a turning niche extending toward the surface of the bark. In some cases these extend through the bark and serve also as ventilation-openings but in most cases end blindly. The larval mines are rather broad, more or less tortuous and often 2½ to 3 inches or more long. As the egg-galleries proceeding in opposite directions from the central nuptial chamber often reach a combined length of a foot or more it will be seen that the amount of bark destroyed by a single polygamous family is considerable.

The same preventive measures recommended for **Ips grandicollis** apply to this species also. While it is usually not a primary enemy of forest trees it has the power to breed in living trees and to kill them and if its numbers are sufficiently great it is a dangerous enemy to all species of pine within its range.

THE GENUS *ORTHOTOMICUS* FERRARI

This genus is very closely related to the genus Ips and indeed the American species have usually been included in the latter genus. However, it is readily separated by the following characters: the antennal club is longer than wide, considerably thicker at the base, obliquely truncate on the outer distal face; the front of the head is without long hair in the female; the declivity not deeply concave, with the concavity bordered posteriorly by an acute distinct apical margin which, however, is not so strongly produced as in Ips.

But one species of Orthotomicus was found by the writer in Mississippi and it was not common.

Orthotomicus caelatus Eichh.

The adult beetle is reddish-brown to black in color; 2.3 mm. to 3.3 mm. long, 2.8 times as long as wide. The front of the head is convex above, transversely depressed below, strongly granulate and with a rather faint longitudinal carina; the pronotum is densely asperate on more than the anterior half, strongly, deeply and rather closely punctured posteriorly; the elytral striæ are impressed, deeply, coarsely and closely punctured, the interspaces deeply, uniserially punctured, with those near the declivity nearly as coarse and numerous as on the striæ; the declivity is concave, coarsely punctured, with three teeth at each side, the second and third coarser and not on the lateral margin which is more or less coarsely granulate or tuberculate and is not sharply elevated. The declivity of the male is more concave and the armature is coarser.

This species is known to occur throughout the eastern portion of Canada and the United States as far south as Florida. It breeds in the eastern pines, spruces and larch. In Mississippi it was taken at Iuka, Agricultural College and Laurel in the bark of loblolly and long-leaf pine, the dates of collection being November 18, 1919; March 30 and April 14, 1920. The beetles were found in greatest numbers at Iuka, in loblolly pine, but even there they were by no means as common as in New York and the New England states.

O. caelatus breeds principally in the thicker bark at the base of the trunk of the southern pines. It is never found far from the ground and is therefore most common in the stumps of cut trees and in the lowermost portion of the trunks of standing trees. It may occur at any region of the thicker-barked portion of the trunk of felled trees lying on the ground. The beetles are polygamous and the general character of the burrows is similar to those of the various species of Ips and other allied genera. They, however, differ in several important particulars. The egg-galleries are short, the egg-niches fewer in number and usually from two to six eggs are deposited in each niche instead of only one as is most usually the case in bark-beetles. The engravings made by a single brood are therefore smaller in extent but, because of the larger number of larvæ within a more limited area, the destruction of the bark by the larval mines is more complete.

This beetle is not usually an important primary enemy of trees although it is able to breed successfully in sappy bark such as that on the stumps of recently cut trees and to resist the flooding of its burrows with pitch. It should be, however, classed as a rather important secondary enemy in that it often attacks weakened trees and completes their destruction, and in concert with other bark-beetles attacks and kills apparently healthy trees. However, in Mississippi the species is probably not numerous enough to do material damage except possibly in the extreme northern portion of the state. Where it does occur in excessive numbers, these may be much reduced

by a prompt utilization of the felled timber, the destruction of the slabs, and by the destruction of the brood in stumps by piling the slash closely about them and burning within six weeks after cutting.

O. caelatus was associated with Ips calligraphus Germ. and I. grandicollis Eichh. in thick-barked stumps and bases of pines.

THE GENUS *XYLEBORUS* EICHHOFF

In this genus the antennal funicle is 5-jointed, with the distal segments wider, the club broad, obliquely truncate on the outer face, with the distal segments completely telescoped, none of the sutures visible on the inner face; the body is rather slender, the pronotum is longer than wide, with the anterior area asperate but without serrations on the front margin; the elytral declivity more or less ornamented with teeth. The males are usually considerably smaller and in many cases at least their wings are so lacking in development that they are useless in flight.

The members of this genus are ambrosia beetles which breed for the most part in the more or less sappy wood of a variety of injured and living trees, green stumps and cut timber. Their burrows are usually mainly in the sapwood but by some species are often extended well into the heartwood. Broad-leaf trees are principally attacked, but a few of the species are found in pines and other conifers. The burrows are blackened by the ambrosial fungi and very often seriously affect the commercial value of lumber from logs left too long unsawed during the active season of the insect. The species of this genus are therefore very important enemies to the lumber industry of the south, their activities, together with those of other ambrosia beetles, making necessary the prompt manufacture of timber cut during the warmer months. They are especially injurious to the various species of oak, hickory and gumwood, but also attack the wood of other deciduous trees and a few are found in conifers.

All of the Mississippi specimens of this genus as well as all others in my collection have been studied by Dr. Swaine, who is engaged on a revision of the genus. The identifications of the species here treated are his.

Key to the Females of *Xyleborus*

DD. Thorax very broadly rounded in front, subquadrate, minutely and sparsely punctured behind; elytral striæ very shallowly punctured, interspaces scarcely punctured on the disc; widest through thorax, 2.7 times as long as wide._____ **confusus** Eichh.__ 119

CC. Elytral declivity less oblique (more nearly perpendicular), the second interspace armed with two large subequal teeth, the third unarmed; larger._____ **celsus** Eichh.__ 119

Xyleborus pecanis Hopk.

The adult females in the series taken in Mississippi are dark reddish-brown, varying in length from 2 mm. to 2.3 mm.; 3.3 times as long as wide. The front of the head is wide, reticulate, opaque, distinctly punctured, with a slightly elevated median line. The pronotum is widest in front of the middle with the sides subparallel, slightly converging posteriorly, anterior area finely and closely asperate, posterior area smooth, dully shining, minutely punctured. The elytra are brightly shining, widest at the middle with the sides parallel in front and rather strongly narrowed behind; striæ marked by definite lines of rather fine shallow punctures, interspaces smooth, finely, uniserially punctured; declivity opaque or subopaque, with first and third interspaces slightly elevated, and ornamented with rows of acute granules, the second flat, slightly narrowed, without punctures or granules; the posterior margin with a few small acute granules the largest of which is opposite the third interspace.

The males are smaller (1.6 mm. long) and lighter in color; with the pronotum wider than elytra, anterior area hairy, very finely asperate; elytra feebly shining, finely punctate striate, rugulose; dorsal outline curved from the base; declivity very finely granulate. As a usual thing this species shows apparent though slight differences from **saxeseni**, but in the large series from peach some of the individuals approach the latter very closely in many characters, leaving the status of **pecanis** somewhat in doubt. The type of **pecanis** was taken at Waynesboro, Miss., in **Hicoria pecan**.

The series taken by the writer in Mississippi includes 97 specimens. These were collected at Iuka, Agricultural College, Meridian and Woodville from yellow birch, sweetgum, peach and pecan, the dates of collection being November 6, 1919, February 13, April 8, 14, 15, May 10, 14, 19 and 23, 1920. The greater number of specimens were obtained from a dying limb from a peach tree sent in from Meridian to Prof. Beal of the Agricultural College, April 8, 1920. On examination by the writer this was found to contain a number of burrows, each containing several adult females and a considerable number of recently laid eggs. After removing a few of the females the material was placed in a breeding jar. The new generation of adults began to emerge about May 20 and continued throughout the rest of the month. In all 55 specimens of this generation were taken, including 7 males. In these parent burrows then it would appear that the males were in the proportion of one to seven. It is also apparent that the life history is completed in slightly less than two months.

The insects are true ambrosia beetles, both the larvæ and adults feeding upon fungi grown in their burrows. The burrows are of the simple unbranched type. The adults extend the entrance gallery directly through the bark for some distance into the sapwood. Here it is widened slightly in a direction parallel to the grain of the wood and the eggs are deposited free in the burrow. On hatching the larvæ continue to live in this cave-like chamber feeding upon the fungi grown upon its walls. As they grow they

enlarge their quarters more and more, probably being assisted in this operation by the parent beetles. The beetles breed not only in the trunks of trees but also in limbs down to a size of but little more than an inch in diameter. The injuries are of such character as to make the timber of little or no value for furniture or finishing or any of the better uses to which it might be put. To prevent such injuries it is only necessary to saw up the timber within a week or two of the time it is cut.

A single specimen either of this species or one closely allied to it was taken by the writer from a pine limb at Agricultural College, March 30, 1920. It may possibly be an undescribed species as **pecanis** has never been reported from soft woods. It shows some minor differences from the series derived from other sources.

Xyleborus saxeseni Ratz.

This beetle is about the same size as **pecanis** and is very similar in general appearance. It is distinguished by the interspaces of the elytra being faintly rugose and less shining (subopaque), and by small differences in the structure of the declivital interspaces.

Only a single specimen assigned provisionally to this species was taken in Mississippi. This was obtained from apple at Belzoni. The habits are very similar to those of **pecanis**.

Xyleborus affinus Eichh.

The female is light reddish-brown, about 2.5 mm. long; the pronotum longer than wide, with the posterior area smooth, shining, sparsely and finely punctured; elytral striæ weakly punctured in fairly regular rows, declivity oblique, subopaque, first and third interspaces armed, second unarmed, flat or faintly impressed.

The male is smaller, 2.25 mm. long, lighter in color, with the anterior area of pronotum excavated and the apex produced; strial punctures somewhat confused.

Two lots of this species were obtained by the writer from dying hickory trees at Agricultural College, Miss., May 8 and May 10, 1920. The college collection also contains several specimens from pecan, obtained at Gulfport and Hattiesburg during April and May, 1917.

Xyleborus fuscatus Eichh.

The female is reddish-brown in color, 2.6 to 3.2 mm. long; 2.9 times as long as wide. The front of the head is reticulate, subopaque, coarsely punctured with a short shining median longitudinal elevation. The pronotum is 1.18 times as long as wide with the sides subparallel, broadly rounded in front, the posterior area shining, rather finely punctured. The elytra are shining, with the striæ weakly impressed, coarsely and closely punctured; the interspaces sparsely punctured; declivity sloping, first interspace with one small tooth at apex, otherwise unarmed, second flat, unarmed, third with several granules at summit, and with one large tooth midway of the descent.

This species was described from Carolina and Columbia. It has been reported from New Jersey, District of Columbia, North Carolina, Florida, Indiana and Texas in the United States and from Guatemala and Columbia. The food plants include **Quercus, Hicoria, Castania, Juglans** and **Pinus** (wine and vinegar casks). In Mississippi the writer obtained specimens at Meridian, November 14, 1919, and Iuka, April 13, 15, 27 and May 19, 1920, the host trees being willow oak, yellow birch and red maple.

The burrows are of the Compound Ambrosial type. On April 15, at Iuka, the writer found a large red maple tree, down but still green and sappy. Some of the bark was entirely dead while some was apparently normal. The ambrosia beetles had attacked the tree the previous year when it was probably still standing and the remains of the dead beetles were found in the old burrows in the dead portion of the tree. In the part still covered by living bark the burrows were still occupied by living beetles. These burrows were very complicated, consisting of branching and rebranching galleries at several levels in the wood. The entrance galleries extend through the bark to the sapwood where, on the surface of the wood, they give rise to an elaborate system of galleries, grooving both bark and sapwood (Fig. 65). The primary galleries are mainly longitudinal but from these arise a number of transverse or diagonal mines, many of which are rebranched. From these surface galleries a number of mines lead down into the sapwood and even through this into the heartwood. Some of these deeplying galleries were apparently ambrosial galleries while others were used as nurseries for the young. No larvæ were found in the superficial galleries but some of these were stained with fungi and were doubtless used as ambrosia gardens while others—especially those in the healthy green bark —were unstained. It seems probable that the beetles used the sap from them to vary their diet.

Xyleborus confusus Eichh.

The females are reddish-brown in color; about 2.5 mm. long, 2.7 times as long as wide. The front of the head is broad, subopaque, reticulate, moderately punctured, with a distinct elevated median line extending from the epistomal margin to above the level of the eyes. The pronotum is subquadrate, very broadly rounded in front, shining behind, minutely and sparsely punctured. The elytra are narrower than the pronotum, brightly shining, with the striæ very shallowly punctured, interspaces very sparsely punctured on the disc, the declivity of the same type as fuscatus.

This species has been previously reported from Chili and Venezuela. In Mississippi only four specimens were obtained at Laurel, November 19, 1919. These were removed from their burrows in the base of a dead longleaf pine tree about 16 inches in diameter, where they were associated with Orthotomicus caelatus.

Xyleborus celsus Eichh.

The female is reddish-brown, 4 mm. to 4.5 mm. long, 2.9 times as long as wide. The front is broad, convex, subopaque, reticulate, coarsely, rugosely punctured. The pronotum is oblong, very broadly rounded in front, finely punctured behind. The elytra are slightly wider than the thorax, with the sides subparallel, the surface shining, the striæ impressed, with moderate punctures; interspaces broad, finely uniseriately punctured except the fourth; declivity abrupt, flat, obliquely truncate, with numerous coarse acute granules about the margin, the second interspace with two large subequal teeth, those of the two sides forming an approximate square.

The male is lighter in color, 2.3 to 2.7 mm. long, 2.6 times as long as wide; the pronotum is flattened anteriorly with the margin produced to form a subacuminate apex; elytra with striæ not impressed and strial punctures often irregular; declivity more gently sloping, flat, with from one to three teeth in each of the second and third interspaces.

The females are large and readily distinguished from other species of the genus. The species probably occurs in the entire eastern portion of the

country following the distribution of its host plants, the various species of **Hicoria.** In Mississippi the writer obtained numerous specimens at and near Agricultural College, the dates of collection being November 7, 1919; March 30 and May 10,1920. It is probably more or less common throughout the state. The burrows typically extend well into the sapwood where the entrance gallery is widened to form a small common chamber from which lead off a variable number of galleries. These latter are usually unbranched, but may branch and even anastomose with other galleries. The beetles breed either in dying or recently dead hickories and are especially numerous in those dying from the attack of the hickory bark-beetle. They also breed in the stumps and to a less extent in the trunk of felled trees. In the latter material they apparently do not as a rule find sufficient moisture.

THE GENUS *DRYOCOETES* EICHHOFF

This genus, the characters of which are sufficiently given in the key to the genera, includes a number of species which for the most part are northern in their distribution. They are all true bark-beetles, some breeding in coniferous trees, others in broad-leaf trees. Most of the species are secondary enemies, but a few are primary and serious enemies to the health or even the life of trees. Many of the species are very closely related and as they are also quite variable they are often difficult to determine. Only a single species has been taken in Mississippi and the specimens of this were taken by Dr. C. J. Drake, from the bark of sweetgum (**Liquidambar styraciflua**).

Dryocoetes betulae Hopk.
(*D. liquidambarus* Hopk.)

The female is dark reddish-brown, about 3.8 mm. long, 2.64 times as long as wide. The front of the head is broad, somewhat flattened, densely punctured, granulate punctate above and at the sides, with numerous rather long yellow hairs. The pronotum is asperate to the base at the sides, posterior median area coarsely punctate. The elytra have the striæ coarsely and closely punctured, the first two scarcely impressed; the punctures of the interspaces finer and fewer in number. The declivity is flattened with the first and second striæ distinctly impressed, first and third interspaces slightly elevated, second flat, each with a row of moderately coarse granules. The male is similar in color and size, with the front broad, with much fewer hairs and with a more apparent shining median line; the declivity is similar but with the granules smaller.

Several specimens of this species were taken by Dr. C. J. Drake at Leland, Miss., September 15, 1921, in the bark of the trunk of sweetgum. They were compared by him to the type of **D. liquidambarus** Hopk. in the National Museum and found to be identical. However, on comparing them with specimens of **D. betulae** taken from **Betula lutea, Betula papyrifera** and **Fagus Americana** in New York the conclusion was reached that they belong to this same species. The variations in **betulae,** as also in other species of **Dryocoetes,** are so considerable that it is difficult to assign specific boundaries, but the writer believes that **D. liquidambarus** Hopk. is at best a variety of **D. betulae** Hopk. In fact the differences between the specimens from sweet gum and the northern specimens showing the extreme **betulae** characteristics are no greater than those between southern and northern species of **Pityophthorus pulicarius** Zimm., **Xyloterinus politus** Say., and others. It is very likely that this species also attacks the birch and beech in Mississippi just as it does farther north.

D. betulae has been reported from white, black and yellow birch and wild cherry. The writer has taken numerous specimens from **Betula lutea, B. papyrifera** and **Fagus Americana** in New York and several undoubted specimens from pine and spruce taken at Cranberry Lake, N. Y. Drake and Fivaz also obtained a number of specimens, apparently of this species, from wild cherry at Cranberry Lake, N. Y.

The burrows are of the irregular radiate type with a variable number of egg-galleries which may extend longitudinally, diagonally or transversely to the grain of the bark. In birch and beech it breeds in weakened or diseased trees and in stumps of recently felled trees. The specimens from sweetgum were taken from a recently felled log.

THE GENUS *LYMANTOR* LOEVENDAL

This genus is sufficiently characterized by the characters given in the key. The genus contains but one known species in the eastern United States.

Lymantor decipiens Lec.

The adult beetle is reddish-brown in color; about 1.7 mm. long, 2.3 times as long as wide. The front of the head is rather deeply, roughly punctured, convex above, transversely impressed below; the antennæ are much lighter, the funicle 4-jointed, the club but little longer than wide, with the two sutures on the outer face arising from near the base and nearly circular; the pronotum is longer than wide, widest just in front of the middle, rounded behind, the summit low, the anterior portion weakly asperate, the posterior area rather coarsely, deeply and sparsely punctured, with a slightly elevated, impunctate, median line; the elytra are rather coarsely, deeply, not densely punctured, the punctures not arranged in striæ and rather irregular in size; the declivity is moderately rounded, the suture slightly elevated, slightly impressed at each side; the vestiture consists of rather sparse, fine, erect, yellow hairs, slightly longer on the declivity.

This species has been reported from various parts of the eastern portion of Canada and the United States as far west as Michigan and as far south as Virginia. The recorded host plants are **Hicoria, Pyrus** and **Acer.** Swaine (1918) states that he has taken it only in dry maple limbs. In Mississippi the writer found the beetles at Iuka and Trimcane Swamp, in both localities in the small dead limbs of red maple sprouts and seedlings.

The burrows are entirely in the wood, usually very near or at the surface but sometimes extending farther in. The entrance burrow extends through the thin bark and well below the surface of the sapwood. There is usually little or no indication of an enlargement to form a nuptial chamber; but the egg-galleries—usually two or three in number—extend in a general longitudinal direction just beneath the surface of the sapwood and parallel to it. Sometimes a larger part of the galleries is open to the surface of the sapwood. The egg-galleries often have a number of short branches, which may lie parallel to the surface or which may extend obliquely into the wood. The eggs are laid in niches and the larvæ bore through the wood in a more or less transverse direction. It is not known for certain whether these beetles are monogamous or polygamous but there is some evidence for believing them to be the latter. Dr. Swaine (1918) has stated that "Both adults and larvæ find an important food in certain black wood fungi, which are always abundant in the limbs they frequent." While the writer has never observed the insects feeding, this seems very likely, for the wood in which they live is dead and very dry and the fungus is abundant both in the wood and in the bark. This beetle is of little or no economic importance as it breeds only in the dead dry limbs.

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