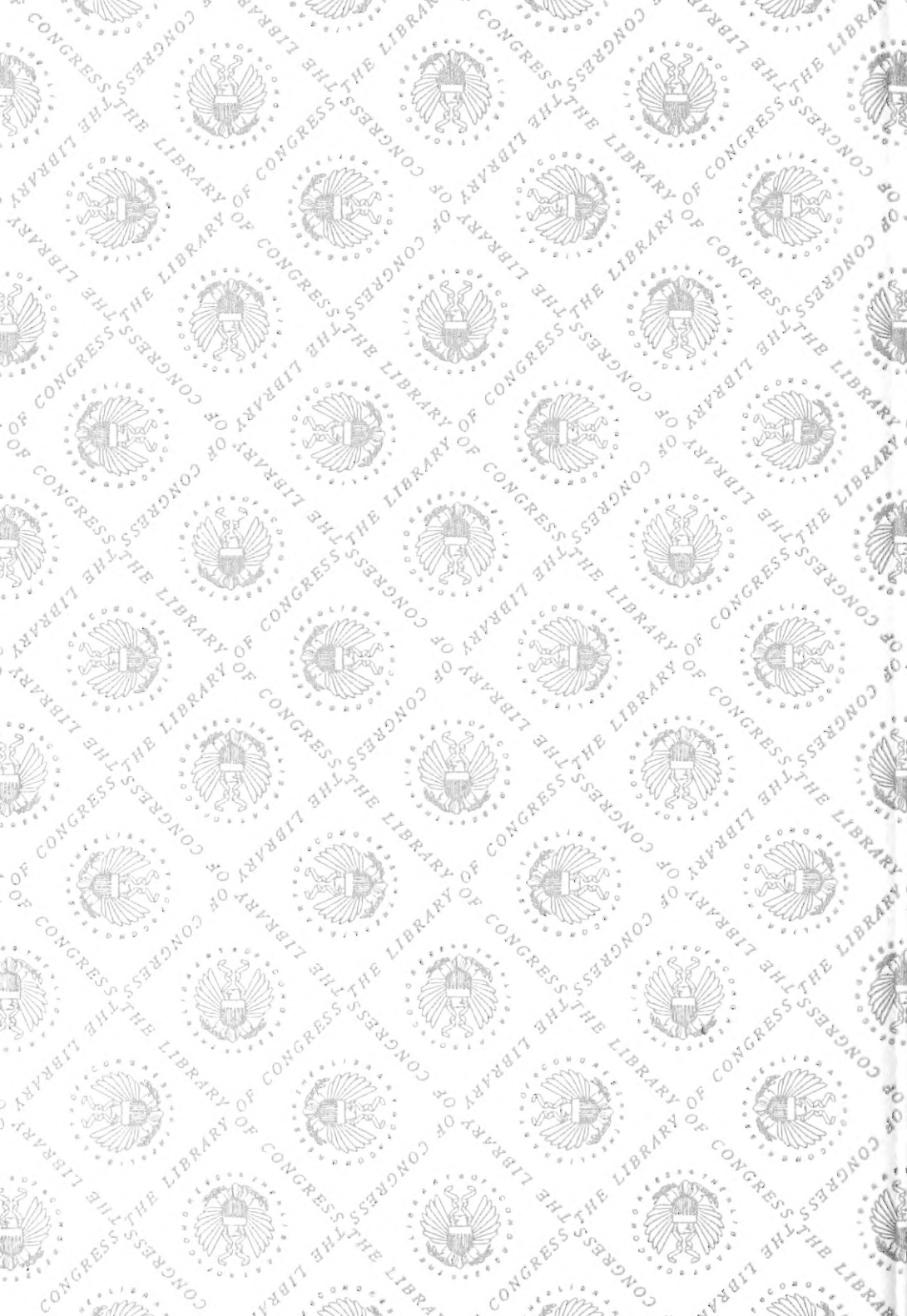
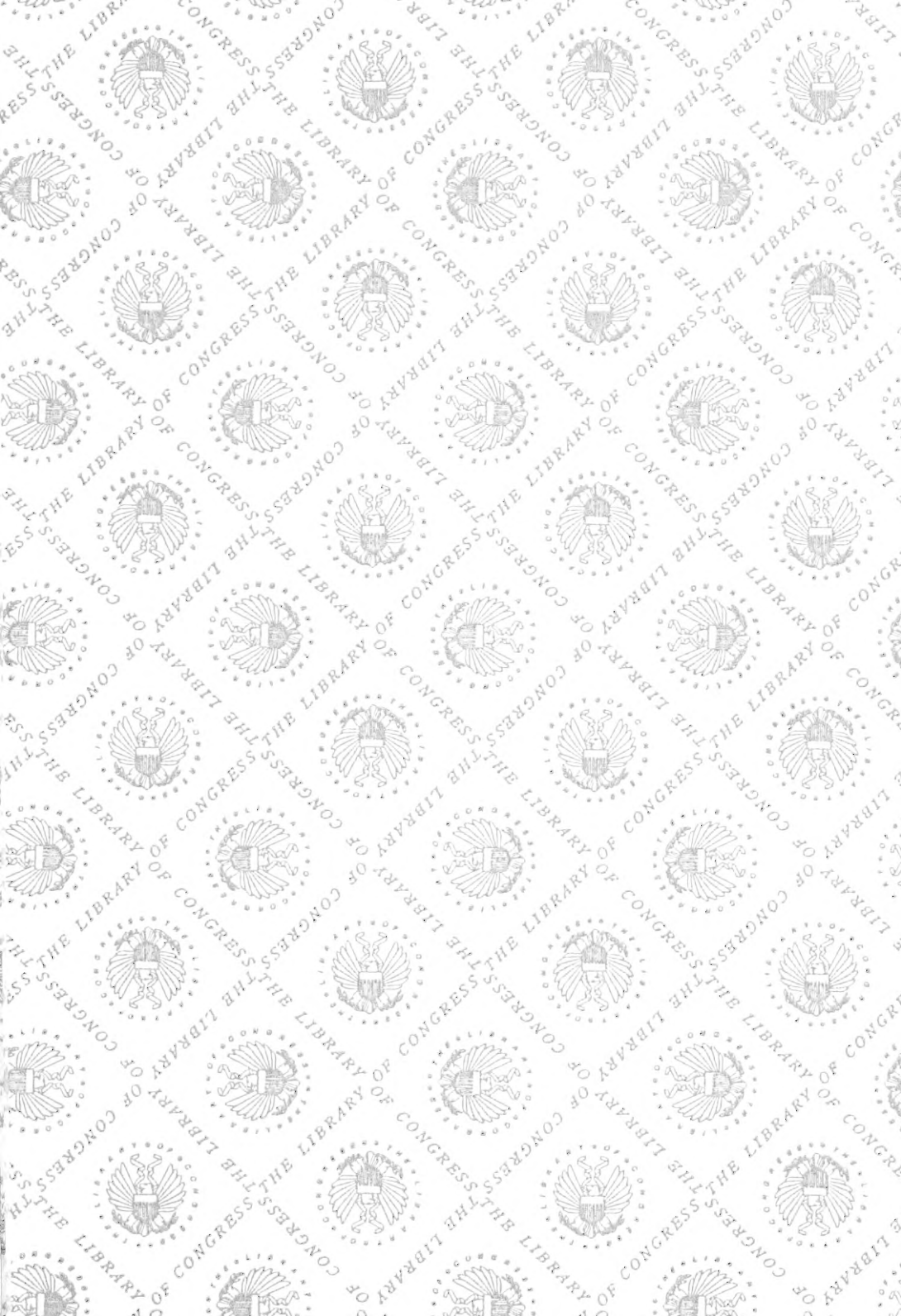
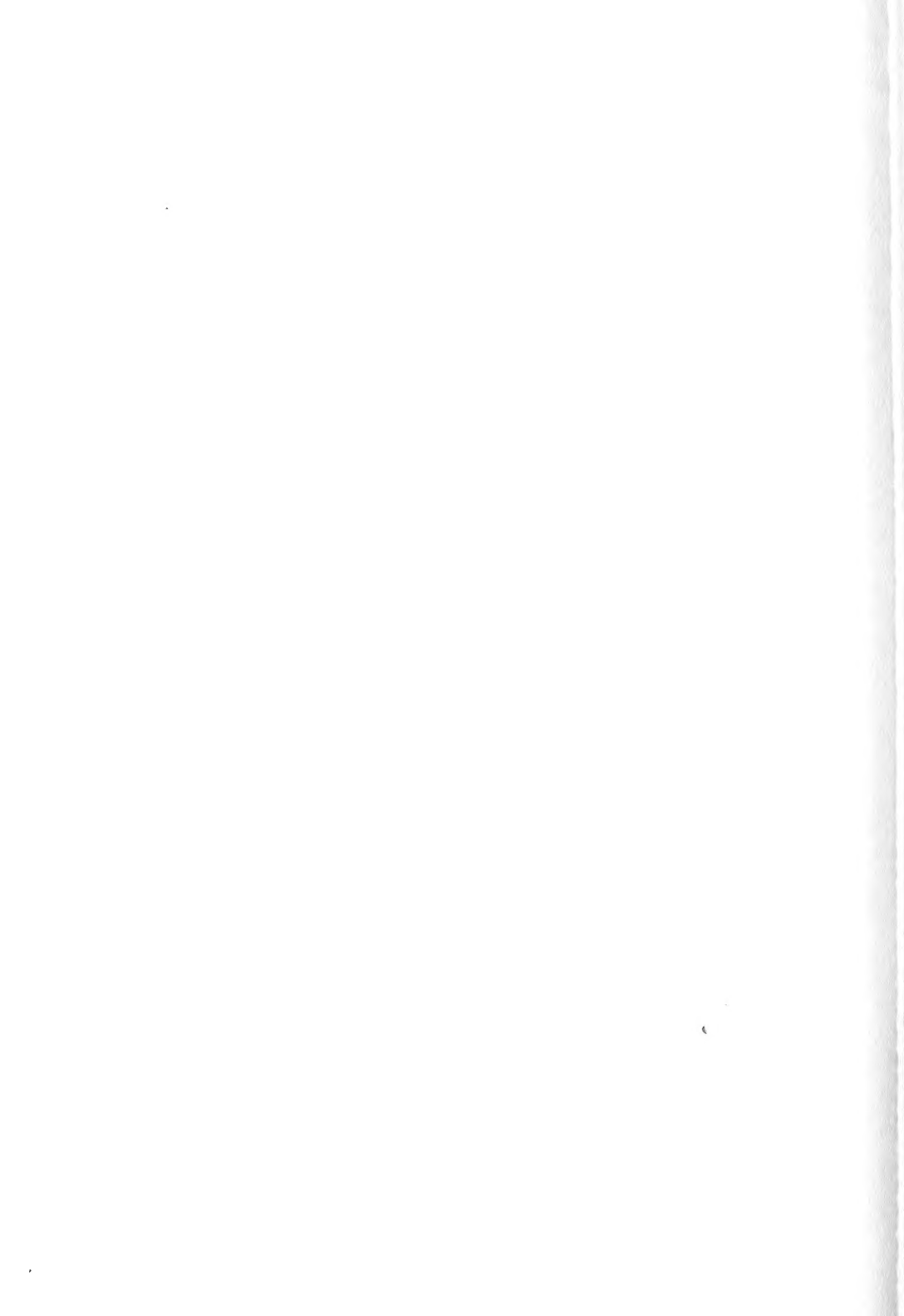


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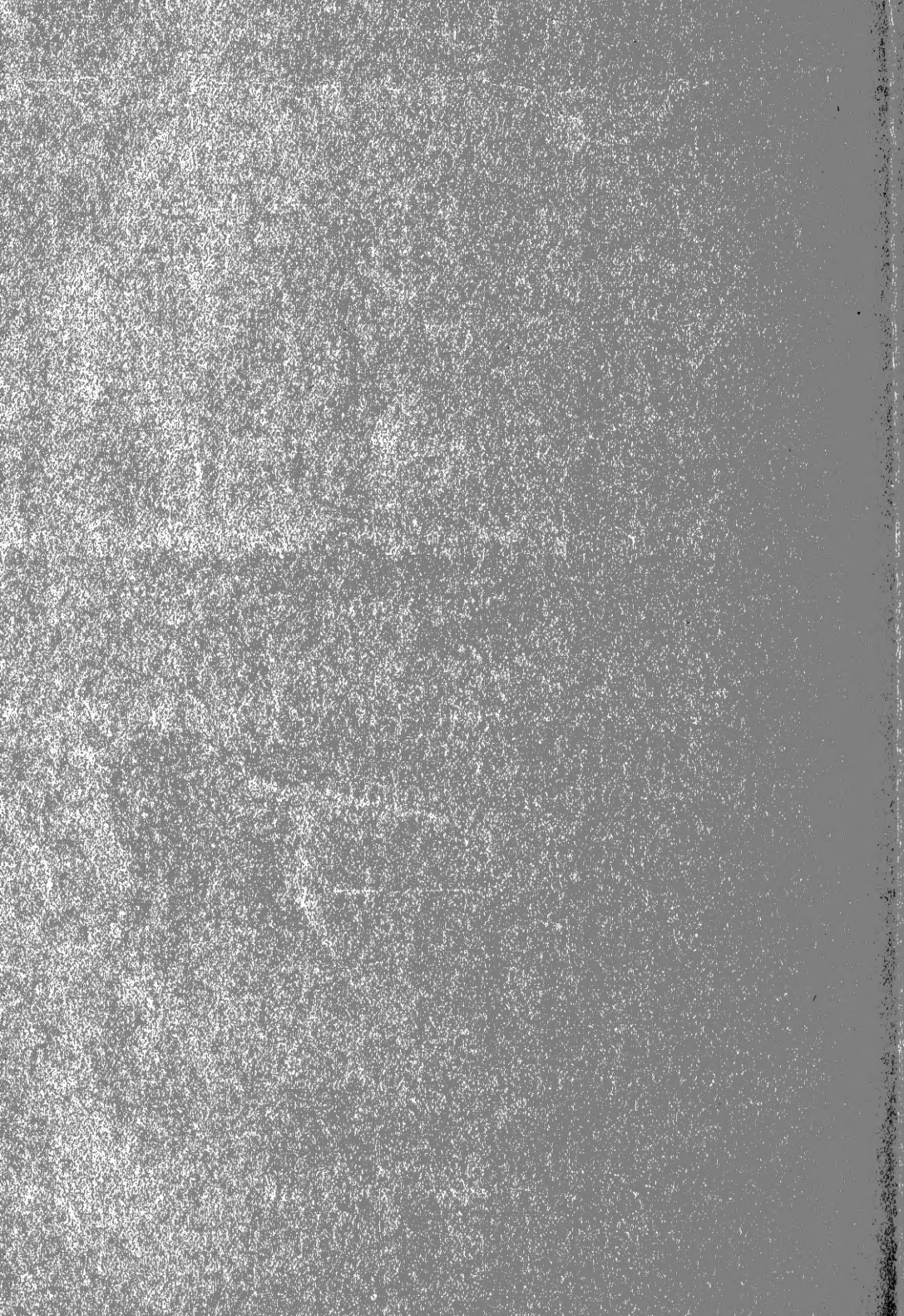
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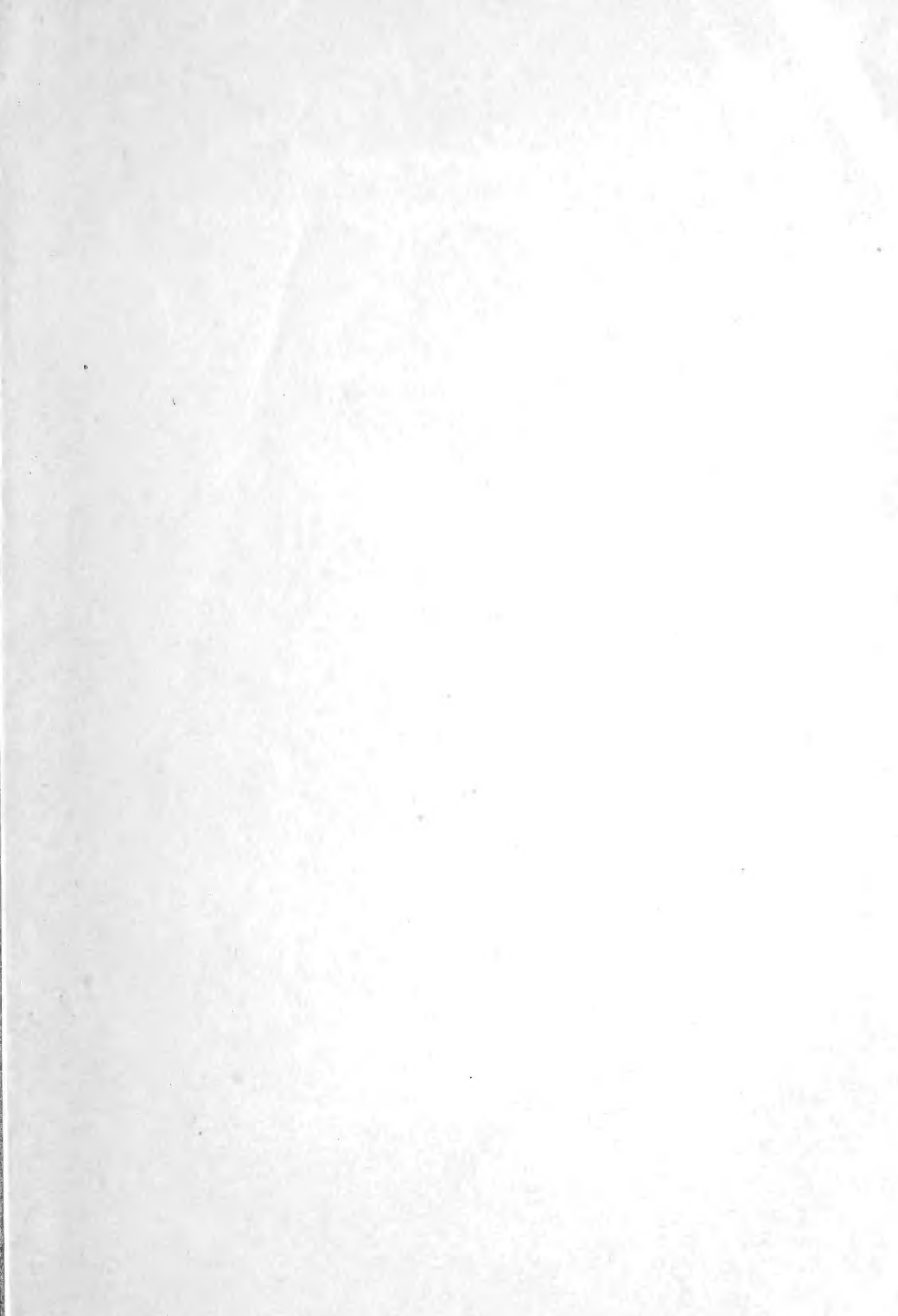
THE RIBBED PINE-BORER

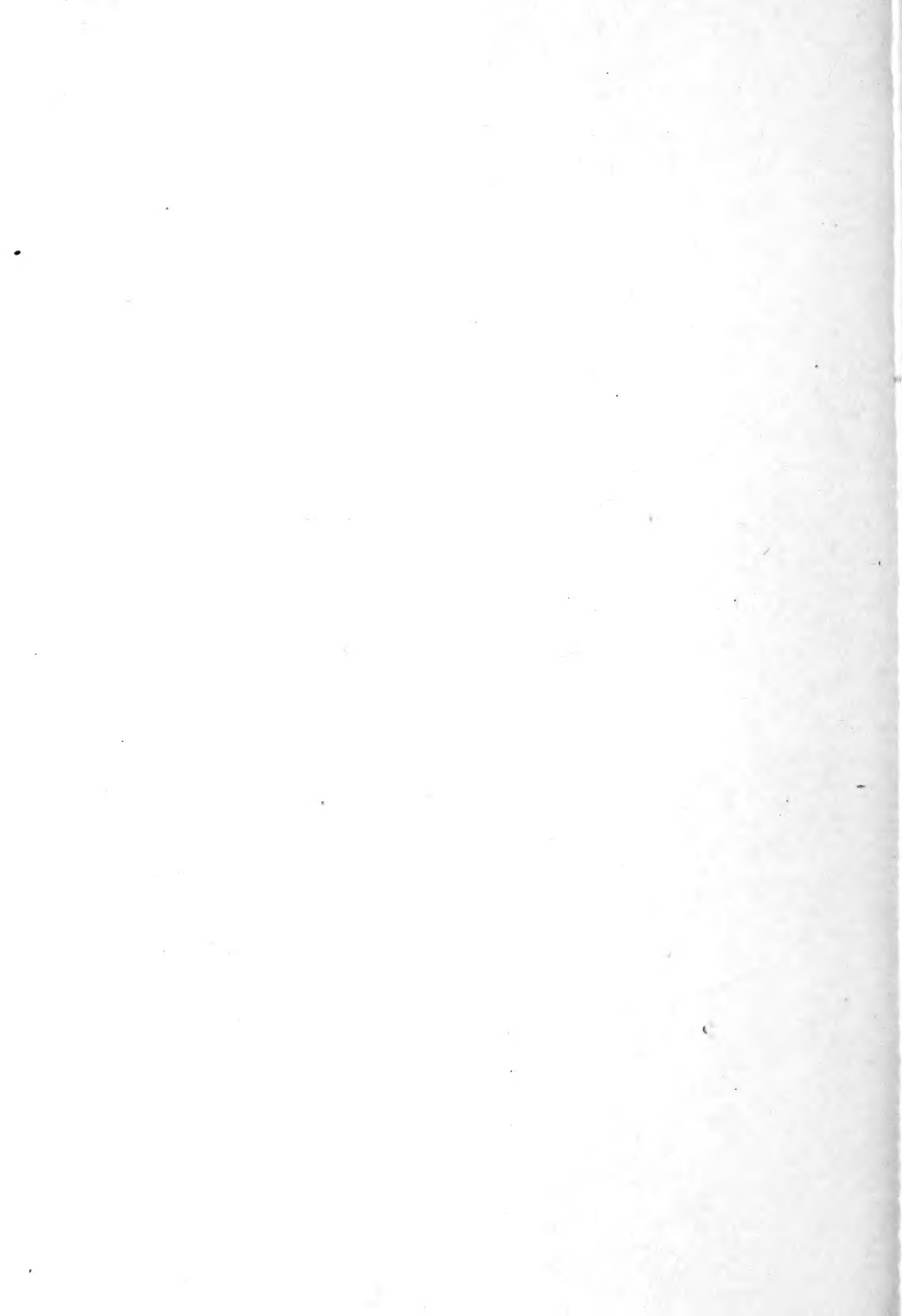
WALTER N. HESS

Wisconsin

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THE RIBBED PINE-BORER



THE RIBBED PINE-BORER¹

Rhagium lineatum Oliv.

WALTER N. HESS

Order, *Coleoptera*

Family, *Cerambycidae*

The ribbed pine-borer (*Rhagium lineatum* Oliv.) is one of the commonest and most widely distributed species of cerambycids in North America. It is especially abundant in the vicinity of central Pennsylvania and about Ithaca, New York, where this study was conducted. Since these insects are very abundant and the limited literature concerning them contains little information regarding their life history, it has seemed advisable to make a more careful study of their habits.

A number of authors have briefly discussed the economic importance of the insect. Their reports, however, are conflicting and indefinite.

HISTORY OF THE SPECIES

The ribbed pine-borer, originally described by Olivier in 1795, has subsequently been briefly referred to by many authors. Kirby (1837) reports the insect from latitude 54°, and also from Massachusetts. Harris (1842) found the larvae of the species living between the bark and the wood of pitch pine. He states that they attack living trees, often extensively loosening the bark, which falls off in large flakes as a result and the trees die. LeConte (1850) states that the insects are found from Maine to Chihuahua, Mexico.

Rathvon (1862) describes the larva as a whitish grub about an inch long. He found larvae in large numbers just underneath the bark of trees, which they caused to fall off in large pieces, frequently resulting in the death of the trees. Packard (1883) reports the larvae as very common under the bark of pines that have been cut down for a year or more. He found the chief injury to consist in the loosening of the bark, which forwards the decay of dead timber. Hopkins (1899) found the insects to be very common bark borers, mining under the bark

¹ The author is indebted to Professor Glenn W. Herrick and Dr. Robert Matheson, of the Department of Entomology at Cornell University, under whose direction this study was made.

of dying and dead pine trees. He records the presence of larvae on July 14; pupae in October, and adults on April 8, May 5 and 9, October 17, and December 19.

Felt (1906) thinks these insects should not be considered injurious to living trees, as they live in rotten wood. Their operations, together with those of associated insects, soon loosen the bark so that it falls off in large sheets. Felt found the grubs transforming to adults during the latter part of the summer, in specially constructed pupal cells underneath the bark.

SYNONYMY

The ribbed pine-borer belongs to the order Coleoptera, family Cerambycidae, subfamily Cerambycinae, genus *Rhagium*, species *lineatum*. This species was first described by Olivier (1795) as *Stenocorus lineatus*, but was later placed in the genus *Rhagium*. Several workers, chiefly European, consider this insect the American form of the European species *inquisitor*, and hence give it varietal rank under this species as *Rhagium inquisitor lineatum* Oliv. There seems to be good reason for considering this species the same as the European *inquisitor*; however, since American workers list the American form as a distinct species, it is so considered in this discussion.

DISTRIBUTION

The ribbed pine-borer is commonly and widely distributed throughout the greater part of North America. It has been reported from twelve States in this country, in addition to Chihuahua (Mexico), Vancouver, and the Mackenzie River region of Canada. The States from which it has been reported are Maine, Massachusetts, New York, Pennsylvania, Virginia, North Carolina, Maryland, Louisiana, Michigan, New Mexico, Idaho, and Oregon. From these data it seems probable that the beetle ranges in distribution from northern Mexico to central Canada, extending across the continent from coast to coast wherever pine is found.

The species *inquisitor*, with which this species is often grouped, is widely distributed in the Old World. It has been reported from Europe, Siberia, Syria, and Japan.

HOSTS

All of the common species of pine in New York and Pennsylvania are attacked by the ribbed pine-borer. The species most commonly found

infested are the white pine (*Pinus strobus* L.), the pitch pine (*Pinus rigida* Mill.), and the red pine (*Pinus resinosa* Ait.).

These insects are usually reported as pine insects, and it seems probable that they attack all or nearly all species of pines throughout the United States and southern Canada. The writer has never found them infesting other conifers, such as larch and spruce, though it is possible that they may attack these at times.

METHODS OF BREEDING

Numerous attempts were made by the writer to determine the molts of this insect, but with little success. For this purpose pieces of bark were taken to the college insectary, cavities were made on the inner side of the bark, and larvae were placed in these cavities and covered with strips of celluloid as shown on Plate VIII, 5 and 6. The bark was kept in dark, moist jars, where it was easily accessible for examination. Though these larvae lived for many months in an apparently normal condition, they never reached maturity. For making shorter observations, such as that of the pupal stage, this process was very satisfactory.

LIFE HISTORY AND DESCRIPTIONS

The adult

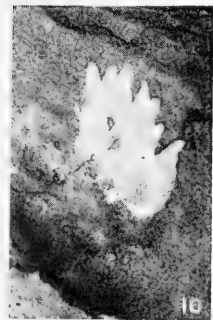
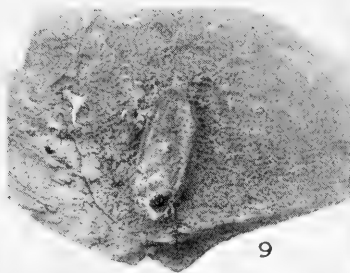
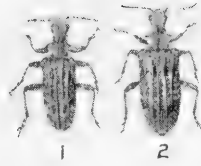
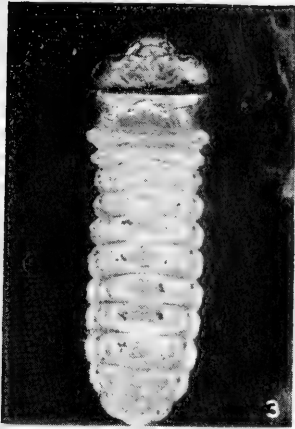
This species, *Rhagium lineatum* Oliv., no doubt owes its specific name to the three smooth, rather strongly elevated, lines or ribs extending lengthwise along each elytron. The beetle is elongate, rather robust, and black mottled with reddish brown and gray. The greater part of its surface is covered with grayish hairs, giving it a grayish pubescent appearance.

The head, which is slightly narrowed behind the eyes, is attached to the thorax by a short neck. The antennae are short, scarcely reaching the bases of the elytra; they are not enveloped by the eyes but are inserted in front of and between them. The maxillary palpus is longer than the labial palpus; the last segment of each is bluntly pointed. The labrum is free. The eyes are oblong and slightly emarginate. The mandibles are flat, acute, and fringed on the inner margin.

The thorax is cylindrical, not margined, and much narrower than the elytra. It is armed on each side with an acute tubercle.

PLATE VIII

1. *Rhagium lineatum*, male
2. *Rhagium lineatum*, female
3. Larva of *Rhagium lineatum*
4. Pupa of *Rhagium lineatum*
5. Inner view of pine bark, showing celluloid strip underneath which are various stages of *Rhagium lineatum* larvae
6. Inner view of pine bark, showing the arrangement of celluloid strips used in rearing larvae and pupae
7. Inner view of pine bark, showing four pupal cells. Photograph taken on April 8. The strips of wood woven into the frass in constructing the cells can be distinctly seen. The depressions at the sides of the pupal chambers were made by the adults in preparation for emergence. The lower cell shows a hole made by a woodpecker
8. Inner view of pine bark, showing in the pupal cell a larva of *Rhagium lineatum* which has been killed by a fungus
9. Pupal cell of an *Atanycolus simplex* which has parasitized a *Rhagium lineatum* larva. The exit hole of the parasite can be seen at the lower end of the pupal cell. The head of the parasitized larva is lying at the upper left side of the pupal cell
10. Egg mass on pine bark, exposed by removing a strip of the loose outer bark



8

9

10

3

1

2

5

4

6

The front coxae are conical and prominent; their cavities are open and are angulated externally. The front tibia has no oblique groove on the inner margin. The hind tibial spurs are terminal. The prosternum projects prominently between the coxae.

The elytra are gradually narrowed from about the middle to the apex. The intervals between the longitudinal ridges are coarsely and sparsely punctate.

The chief character that usually distinguishes this beetle is the extensive projection of the prosternum between the prominent fore coxae. Its general pubescence mottled with grayish brown and black, together with the short antennae, usually readily identifies this species.

The sexes are of the same general uniform coloration, but usually differ in two distinguishing characters: (1) the female (Plate VIII, 2) is about 3 millimeters longer and proportionally larger than the male (Plate VIII, 1); and (2) the tip of the abdomen is exposed in the female, while in the male it is entirely concealed by the elytra. The insects vary in length from 12 to 18 millimeters. Those found in small trees with thin bark, and hence scanty food, are usually smaller than those found in larger trees.

During the warm days of early spring the beetles become active in their pupal cells, and gradually begin gnawing through the bark to the exterior. The time of emergence is usually during the last week in April, but this may vary a week or more, depending on weather conditions. The beetles are active as soon as they emerge, and fly readily if disturbed.

Since these insects winter as adults the reproductive organs have had sufficient time to mature. In the spring the female's ovaries are full of large eggs. Copulation occurs as soon as the adults emerge. It occurs frequently, and a pair may remain in copula for several hours. In fact, during the first few days after emergence, this process may be repeated again and again at different times. One pair was taken in copula as late as the last week in June.

Although this beetle is a pine insect, and although it feeds on the bark after becoming an adult, it ceases to feed on pines after emerging. It then becomes a pollen feeder, feeding on such flowers as the dogwood — a habit which it has in common with many of its near relatives among the cerambycids.

The egg

When laid, the egg is pure white in color and is somewhat viscous, with a thin, fragile shell. It is ovoid in shape, being widest near the anterior end and tapering slightly toward the posterior. The shape, however, varies considerably, since owing to the softness of the shell it is easily modified by the shape of the crevice in which the egg is deposited. The entire surface is marked with very irregular elongate areas (fig. 61). The egg measures 1.9 millimeters long by 0.7 millimeter wide.

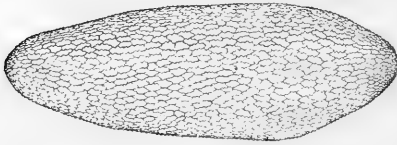


FIG. 61. EGG OF RHAGIUM LINEATUM, SHOWING MARKINGS

The egg stage lasts from eight to ten days, varying with weather conditions. In emerging, the young larva ruptures the egg in the lateral anterior region, usually on the right side. This it does by rubbing the sides of its head against the sides of the chorion, finally slitting the latter longitudinally. On each side of the head is a group of coarse setae which probably function in this process.

The larva

The newly hatched larva (fig. 62) is whitish in color and is slightly flattened. It is more rounded, however, than the mature larva, resembling rather the typical cerambycid type. The head and the thorax are slightly wider than the abdomen. The head is light brown in color, as are also the mouth parts except for the mandibles, which are dark brown toward the tips. At each side of the head is a group of coarse setae with dark brown chitinized basal parts, while scattered over the entire larva are a number of slender, elongate setae.

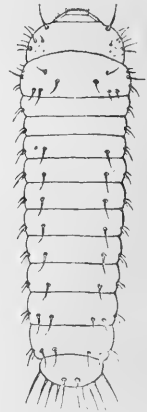


FIG. 62. FIRST INSTAR OF LARVA, DORSAL VIEW

Very soon after emergence, the newly hatched larva works its way through the outer bark into the cambium layer, where the larval life is spent. The larva at this stage is very delicate and soon perishes unless it reaches the cambium layer, where it begins at once to feed.

The mature larva (Plate VIII, 3) is long and is very much flattened, as a result of which it has been incorrectly called a flat-headed borer

(Kellogg, 1905). The head is very large and is slightly wider than the prothoracic segments. It has a triangular incision behind, the apex of which is met by a curved line passing back from the outside of the antennae and dividing the epicranium into two areas. The clypeus is short and wide. The labrum is about twice as wide as it is long, and is moderately rounded in front. The antennae are small and two-segmented, the second joint being blunt at the tip. The mandibles are large, with three cutting teeth. The maxillae are composed of only two segments besides the three-segmented palpus. The labium is large, with a prominent ligula which is slightly rounded at the front edge. The labial palpi are two-segmented.

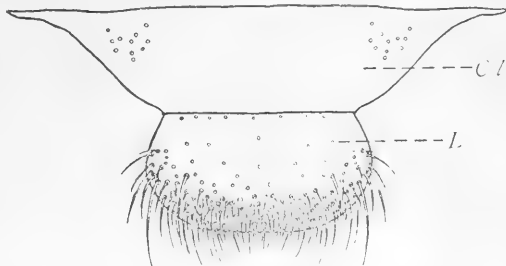


FIG. 63. CLYPEUS AND LABRUM, DORSAL VIEW

The prothorax is of about the same width as the other thoracic segments, but is more than twice as long. It has a flat, chitinized surface. The thoracic legs are slender and are composed of four segments.

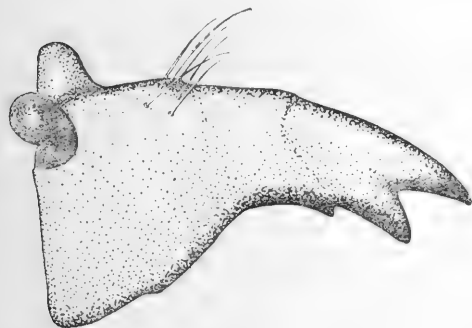


FIG. 64. LEFT MANDIBLE, DORSAL VIEW

The abdominal segments increase slightly in length posteriorly to the eighth, which is longer but narrower than the preceding ones. The ninth segment is of about the same length but is narrower than the eighth. The tenth is scarcely visible from above, being only about one-fourth as wide as the ninth; it is deeply cleft posteriorly.

The mature larva measures from 25 to 30 millimeters in length, with a maximum width of 6 millimeters in the region of the head and the prothorax. The width of the first abdominal segment is 5 millimeters.

This larva may undoubtedly be recognized by its habitat in the cambium of recently killed pine trees, by its relatively large size when mature, and by its broad, flattened head and body.

The mouth parts of the larva

Since these larvae closely resemble in appearance the flat-headed borers, the prothorax and the head are very wide and flat, resulting in a rather broad, short clypeus and labrum (fig. 63). The clypeus (C1) is very wide at its basal part but tapers anteriorly to join the labrum. The labrum is about twice as wide as it is long, and bears on its dorsal side many long bristles and sense pits.



FIG. 65. MAXILLA, VENTRAL VIEW
C, cardo; S, stipes region; LG, undifferentiated lacinia and galea; P, palpus

The mandibles (fig. 64) are broad and heavily chitinized, and bear near the apices three rather sharp cutting teeth which fit them for both cutting and chewing.

The maxillae of the larva (fig. 65) are of a much simpler type than those of the adult. The cardo (C) is a distinct sclerite, triangular in shape. The stipes (S) and the lacinia and galea (LG) are not differentiated but are represented by one segment; near the apex on the inner margin are many long bristles, which probably represent the region of the future lacinia.

The palpus (P) is three-segmented.

The labium (fig. 66) is large and covers the greater part of the lower side of the head. The submentum (SM) is broad and short. The mentum (M), while narrower than the submentum, is broad and flat. It bears the ligula (L), from which arise the two-segmented labial palpi (P). The greater part of the surface of the labium, but more especially the anterior edge of the ligula, bears numerous long bristles and sense pits.

The pupa

Pupation begins in the latter part of August and continues until late in October. Because of the varying temperature at that time of the year, the pupal period varies considerably. The individuals that pupated in August were found to emerge in from sixteen to twenty days, while those that pupated later took a month or even more to complete their pupal period. Some were found that wintered as pupae, but in every case observed these died before spring. When the adults emerge they are nearly white, and they require from two to five days to become fully colored.

The pupa (Plate VIII, 4) measures from 12 to 18 millimeters in length. It is white in color and rather convex in shape, and is without any special distinguishing markings. Scattered over its surface are many small setae, or spines.

HABITS

Of all the insects infesting the pine, few are commoner than, or as interesting to observe as, this species of cerambycid. Where the insects were studied in New York and Pennsylvania, they have been found during the winter months in large numbers, both as larvae and as adults, underneath the bark of white, red, and pitch pine. Here the larvae feed on the decaying tissues of the cambium layer.

The adults, which emerge in early spring, can be found during the last of May and in June on pines that have recently died. These insects always prefer the larger trees, and in this region the pitch pine is preferred to the other species, due possibly to the heavier bark which offers the insect more food and better protection. Trees less than six inches in diameter seldom, if ever, are infested with this insect; in fact, efforts have been made, by using cages, to have females oviposit on logs of this

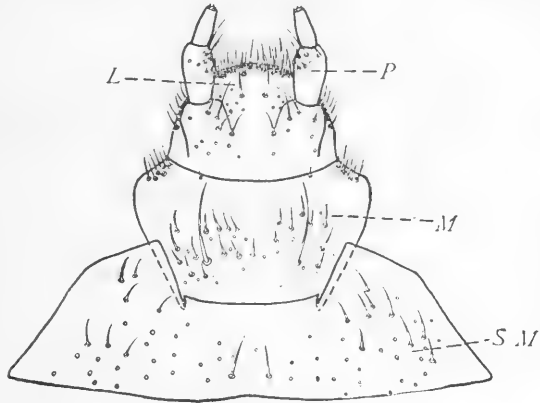


FIG. 66. LABIUM, VENTRAL VIEW
SM, submentum; M, mentum; L, ligula; P, palpus

size, with negative results. Where the insects have been found in trees of about this size, they frequently die before maturing, due probably to scanty food and to too little protection from cold and diseases. So far as is known, they never infest either trees that have been dead for more than three years or healthy living trees. They have been found in trees that had been injured by fire or other agencies on one side but were alive and healthy on the other side. The insects no doubt do material damage to such trees in hastening their death, not only by eating into the tissues that may be alive but also in opening and exposing the injured side to water and fungus attacks.

The normal time for these insects to oviposit on pine is in the spring following the death of the trees. The insects will oviposit on the trees again the second year, but only in rare instances will they do so the third year; and never the fourth year in so far as could be determined. In fact, by the third year the cambium layer is so nearly decayed that little is left for the larvae to feed upon.

The insects have been found from the very base of the stumps of the infested tree to near the top, where the trees were about six inches in diameter. They seldom are seen above this, and never in the limbs unless these happen to be very large. An idea of the number of individuals that may be found in an infested tree is given by notes made in regard to a tree cut on March 10, 1916. The tree was 16 inches in diameter at the base and was infested to a height of about 30 feet. It had been dead for two years, and so two broods were present. There were found 195 adults representing the first year's brood, and 155 larvae representing the second year's brood. These insects were rather uniformly distributed throughout the tree. In some cases they were as close together as two or three inches, while in other cases they were as much as a foot apart.

In badly infested trees the mines of these insects are more or less continuous by the end of the second or the third year, often separating the bark from the trees and not infrequently causing it to fall off. It is probable, however, that the burrows of other insects aid in this process.

Differing from most other cerambycid larvae, the larvae of this species move about comparatively little, but feed in all directions from a rather stationary point until all food within reach is consumed. They then move to one side or the other, leaving a large amount of frass behind them. Until the larvae are about three months old they make no special effort

to protect themselves from enemies. Toward fall, however, they construct about themselves a wall from débris, somewhat resembling that of the pupal cell. In the spring the larvae leave their winter cells for food, but during this second summer they usually keep themselves more or less protected by such a barrier. This they tear down and rebuild as they move about for food. As a result of this moving about, a rather extensive area, in the form of a blotch mine, is finally excavated.

During the early part of August of the second year the larvae prepare to pupate. This they do by enlarging and strengthening the chambers in which they have recently been feeding, forming what are called pupal cells (Plate VIII, 7). These cells are oval in shape, are about $\frac{1}{2}$ by $\frac{3}{4}$ inch in size, and lie just underneath the bark. They are constructed of frass which these or other insects have discarded, and are lined with strips of wood which the larvae tear from the bottom of the cells and push firmly into their walls. The excavation of the wood insures the insects plenty of room as well as a better protection against their enemies.

During late summer and early fall the second-year larvae transform to pupae, which in a period of from four to six weeks change to adults. They remain in the pupal cells over winter, emerging as adults the following spring.

SEASONAL HISTORY

Shortly after copulation, the female can be found on the bark of pine trees that have recently died. She walks over the bark, constantly searching with her ovipositor for crevices between the layers of the corky outer bark, in which she deposits her eggs in masses of from one to twenty-five or more, depending on the suitability of the cavity (Plate VIII, 10). The writer found masses of eggs that hatched at different intervals, indicating that the insects may oviposit in the same cavity more than once.

Egg laying continues from about the middle of May until the last of June or the first of July. Since the eggs all mature at about the same time, the number laid by a single female can be easily ascertained. This number was found to vary from 120 to 165, indicating that the number is comparatively constant.

The eggs hatch into young larvae in from eight to ten days. As soon as they are hatched, they work their way through the bark, where they feed during their larval life on the tissues of the cambium layer.

Since this insect requires two years to complete its life cycle, the first winter is spent in the larval stage. From the time of hatching until late summer, the larva feeds freely in the cambium, but toward fall it constructs about itself a defensive wall of frass. In this condition it spends the winter. During the second summer the larvae usually keep themselves protected by such a defense, moving about only as they need a fresh supply of food. Unlike most larvae, they do not feed in definite channels, but move about irregularly, excavating a blotch-like mine which is often rather extensive.

Toward fall (about September) of the second year the larvae transform to pupae. About three weeks later they transform to adults. In this condition the insects pass the second winter. Toward spring the adults gradually gnaw their way through the bark, and emerge about the first of May. Though they feed very little before emerging, they eat a part of the bark as they bore their way to the exterior. They now no longer feed on the pine, but become pollen feeders like many other cerambycids. After emerging they soon copulate, and about the middle of May begin oviposition.

ECONOMIC IMPORTANCE

Rhagium lineatum, in the strict sense, can hardly be considered as an insect of economic importance in so far as any damage to living pines is concerned. Though its attack is limited to the region of the inner bark and the outer sapwood, it no doubt causes considerable damage to recently dead timber. Its excavations are usually extensive, and as a result the bark is frequently loosened, allowing moisture to enter. When water has once gained access, it is held by the large masses of frass. This is favorable for fungous growth, and hence the decay of the tree is hastened.

During the second and third years after the trees die, the exit holes made by the emerging adults admit large quantities of water, other insects, and fungi, by means of which the log is soon rendered useless for commercial purposes.

Natural control

In the control of the ribbed pine-borer, as in that of many other injurious species, nature has provided enemies which, under favorable conditions, are very effective in reducing their numbers. A wet season not only

makes it difficult for this insect to work, but develops fungi which attack all stages of the insect, especially the larvae (Plate VIII, 8). This is especially true in the case of trees with thin bark, for such trees are less resistant to moisture and the insects may become wet. Under such conditions the larvae, the pupae, and even the adults often die from fungus attacks. Those that survive until winter are often killed by frosts, which under such conditions are destructive to them.

The newly hatched larvae, while searching for an easy access to the inner bark, often expose themselves to predatory enemies which help in reducing their numbers. Birds, chiefly the woodpeckers, are probably the most important of these predatory enemies (Plate VIII, 7). It is not uncommon to find infested trees where these birds have removed from one-half to two-thirds of the larvae and adults during a single winter. Ants are usually common on the trees where the adult beetles are ovipositing. Though the insect tries to place her eggs in a secluded crevice, the newly emerged larvae often expose themselves. Ants have been observed carrying off both eggs and young larvae, chiefly the latter, as food.

Numerous centipedes, and larvae of staphylinids and carabids, are frequently found under the bark with the larvae of this insect, and may feed on them.

Though the insect constructs about itself a defensive wall, it seems probable that this wall is often ineffective against these enemies, especially in trees on which the bark has become loosened. Large carpenter ants have been found in the pupal cells of the ribbed pine-borer, but whether or not they are definitely harmful is not known.

A larval parasite, *Atanycolus simplex* Cresson,² which was reared from certain larvae, seemed fairly effective in reducing the numbers of this insect, especially farther south in Pennsylvania. In no case, however, were more than about five per cent of the larvae found infested. In New York this parasite is exceptionally rare, infesting only about one per cent of the larvae. When this parasite is mature it emerges from the larva and constructs a pupal cell underneath the bark (Plate VIII, 9). This occurs during the early fall. The adult emerges the following June. The remnants of the old *Rhagium* larva can often be seen attached to the pupal case of this parasite.

² Identified by S. A. Rohwer, of the Bureau of Entomology, Washington, D. C.

Artificial control

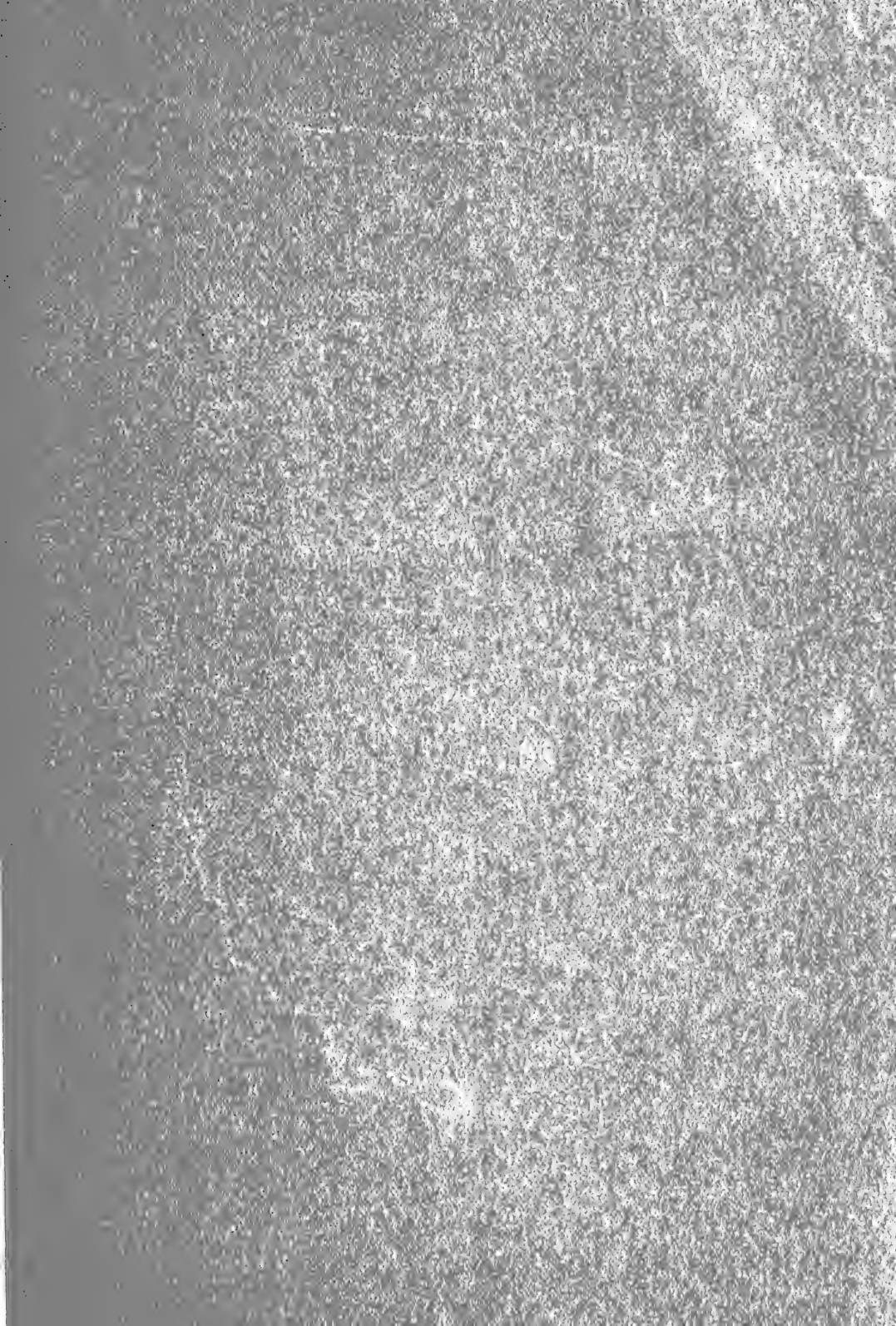
The insect can be artificially controlled by cutting all recently killed pines and removing the bark before the first of March. This will kill the larvae and the adults, and will do much to lessen attacks the following season. Where possible, the placing of newly felled logs in water will prevent attack. Putting logs in wet places will greatly reduce infestation, though it may hasten the decay of the timber. Repellents such as carbolineum, applied in May, will usually prevent oviposition.

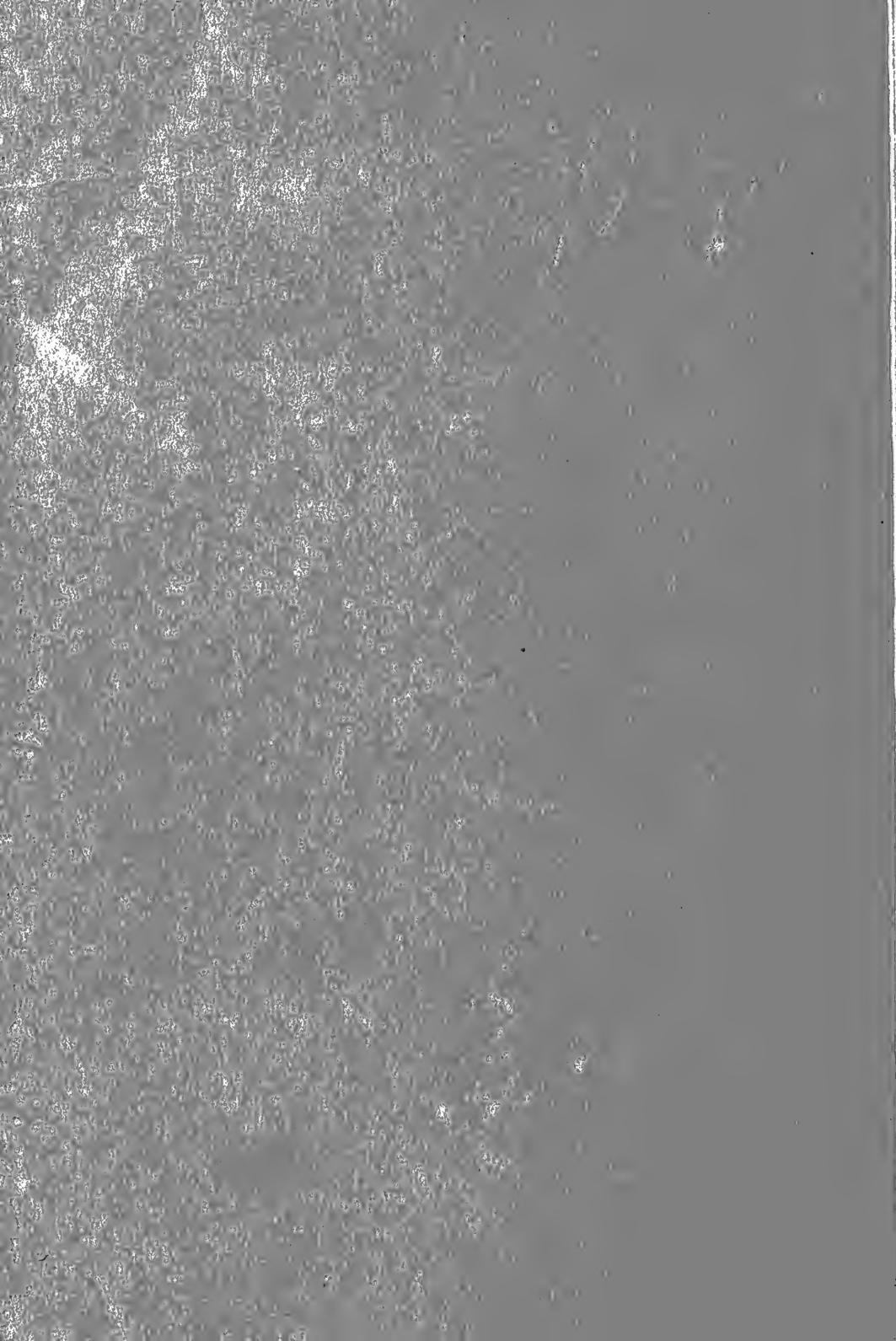
A few years ago the ribbed pine-borer was exceptionally abundant about Ithaca; but during the past few years, due to the improved methods employed in this region by the Department of Forestry, at Cornell University, these insects, together with many of the more injurious forest insects, have nearly disappeared. This has been largely due to the practice of cutting and removing all trees as soon as they die or are found to be dying.

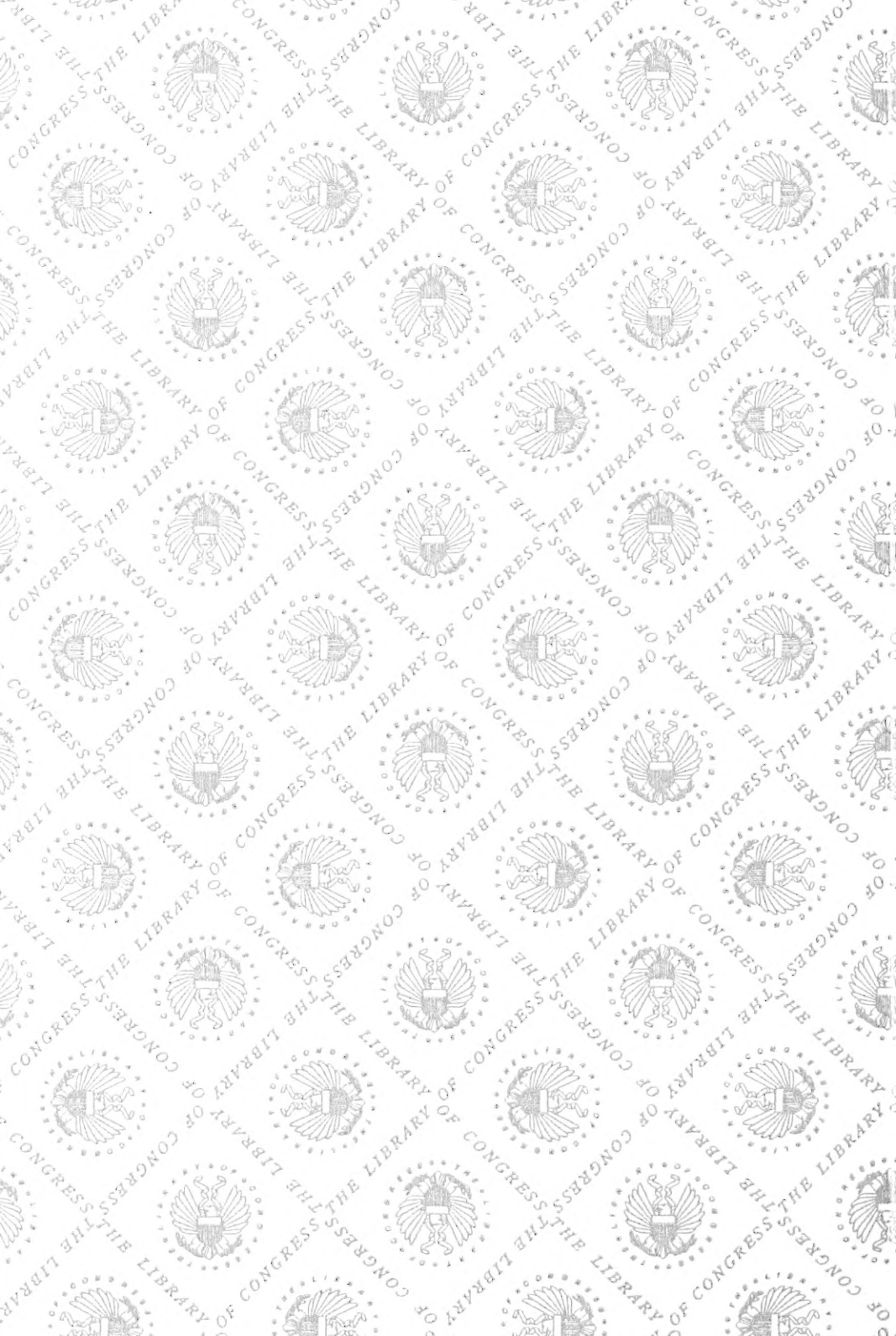
BIBLIOGRAPHY

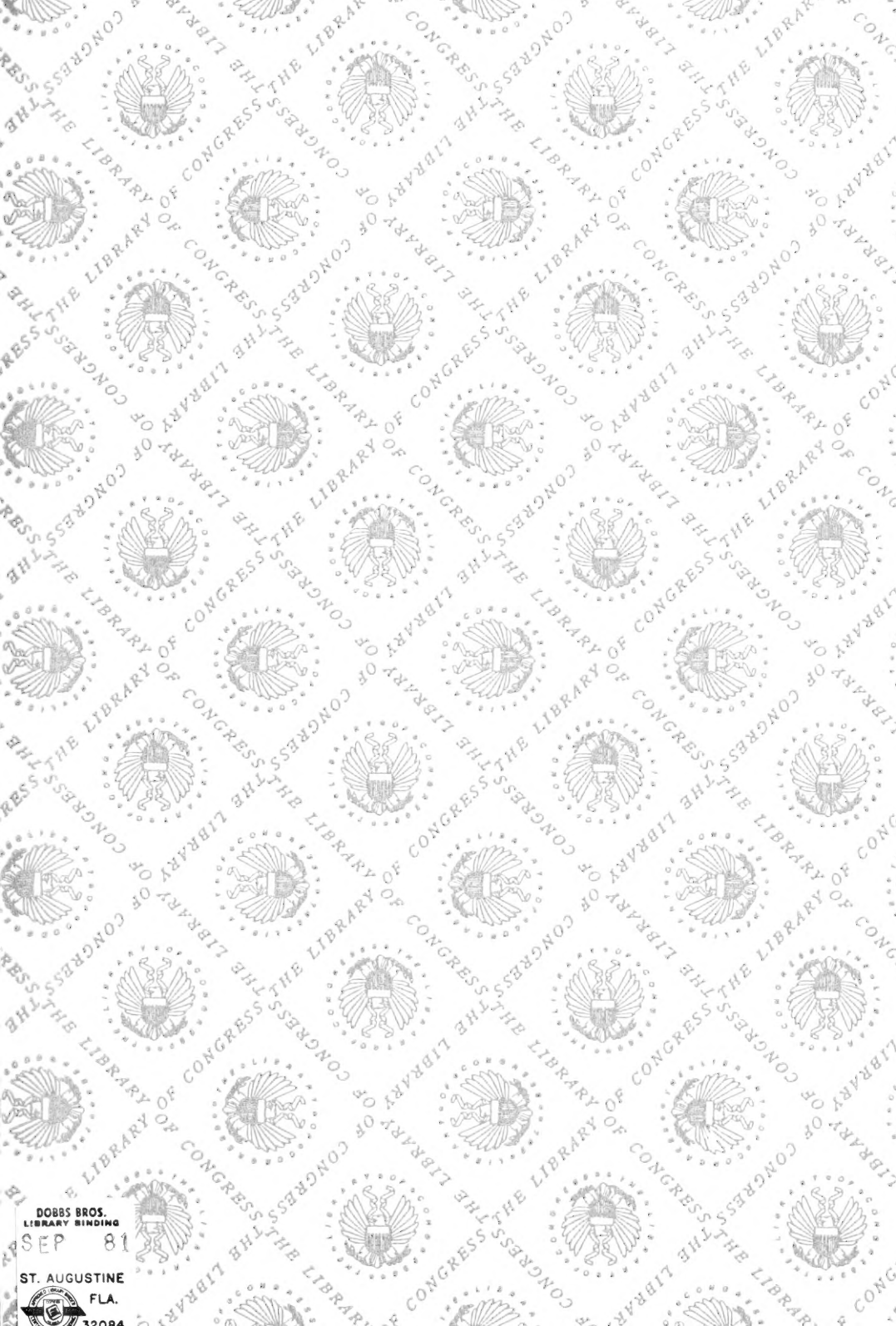
- FELT, E. P. Ribbed pine-borer. *In* Insects affecting park and woodland trees. New York State Mus. Mem. 8²:366-368. 1906.
- FITCH, ASA. Ribbed rhagium, *Rhagium lineatum*, Olivier. *In* Fourth report on the noxious and other insects of the State of New York, p. 715-716. 1858.
- HARRIS, THADDEUS WILLIAM. A treatise on some of the insects of New England which are injurious to vegetation, p. 1-459. (Reference on p. 92-93.) 1842.
- HOPKINS, A. D. Report on investigations to determine the cause of unhealthy conditions of the spruce and pine from 1880-1893. West Virginia Agr. Exp. Sta. Bul. 56:195-461. (Reference on p. 439.) 1899.
- KELLOGG, VERNON L. Coleoptera. *In* The development and homologies of the mouth parts of insects. Am. nat. 36:690-691. 1902.
- American insects, p. 1-674. (Reference on p. 266.) 1905.
- KIRBY, WILLIAM. *Rhagium lineatum*. *In* Fauna Boreali-Americana 4:178. 1837.
- LECONTE, JOHN L. *Rhagium*. *In* An attempt to classify the longicorn Coleoptera of the part of America north of Mexico. Acad. Nat. Sci. Philadelphia. Journ. ser. 2:1:319. 1850.
- LENG, CHARLES W. Synopses of Cerambycidae. Ent. Amer. 6:65-69. 1890.
- OLIVIER, A. G. *Stenocorus lineatus*. *In* Entomologie, ou Histoire naturelle des insectes. Coléoptères 4, no. 69. Stencore. Espèces no. 6:13-14. 1795.
- PACKARD, ALPHEUS S. The ribbed rhagium. *In* Descriptions of larvae of injurious forest insects. U. S. Ent. Comm. Rept. 3:259-260. 1883.
- The ribbed rhagium. *In* Insects injurious to forest and shade trees. U. S. Ent. Comm. Rept. 5:704-706. 1890.
- A text-book of entomology, p. 1-729. (Reference on p. 67.) 1898.
- RATHVON, S. S. Entomology and its relations to the vegetable productions of the soil, with reference to both destructive and beneficial insects. U. S. Comm. Patents. Rept. 1861:585-620. 1862.











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