BIOLOGY AND TAXONOMY OF BARK BEETLE SPECIES IN THE GENUS PSEUDOHYLESINUS SWAINE*

(Coleoptera: Scolytidae)

BY

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ABSTRACT

TWELVE species and subspecies of *Pseudohylesinus* Swaine are recognized. The species and subspecies and their synonymy are (1) *P. nebulosus nebulosus* (Leconte) (=*P. nebulosus* Leconte); (2) *P. nebulosus serratus* Bruck (=*P. serratus* Bruck); (3) *P. dispar dispar* Blackman (=*P. dispar* Blackman); (4) *P. dispar pullatus* Blackman (=*P. pullatus* Blackman); (5) *P. variegatus* (Blandford) (=*P. maculosus* Blackman and *P. mexicanus* Blackman); (6) *P. tsugae* Swaine (=*P. obesus* Swaine, *P. keeni* Blackman and *P. similis* Blackman); (7) *P. nobilis* Swaine (=*P. furnissi* Blackman). *P. granulatus* (Leconte), *P. grandis* Swaine, *P. sitchensis* Swaine, *P. sericeus* (Mannerheim), and *P. magnus* Wood are also included in the genus. *P. humilis* (Blanchard) is transferred to *Xylechinus* Chapuis and *P. brasiliensis* Schedl is transferred to *Xylechinosoma* Schedl. *Pseudohylesinus* and *Xylechinus* are placed in the tribe Hylesinini in the subfamily Hylesininae.

Host plants, gallery pattern, geographical distribution, and other aspects of the biology are given for each species. All species are redescribed and a key to the adults is included.

INTRODUCTION

THE GENUS *Pseudohylesinus* Swaine includes twelve species and subspecies which occur within the forested regions of North America from southern Alaska through western United States to southern Mexico. Most of the species are associated in varying degrees of host specificity with species of true firs, *Abies;* hemlocks, *Tsuga;* or Douglas fir, *Pseudotsuga menziesii* (Mirb.) Franco. However, Sitka spruce, *Picea sitchensis* (Bong.) Carr.; bigcone Douglas fir, *Pseudotsuga macrocarpa* (Vasey) Mayr; and several species of *Pinus* each serve as hosts for a species or subspecies of this genus.

All members of the genus feed and reproduce in the phloem-cambial region of the bole and larger branches of standing, injured, or fallen trees. *P. grandis* and *P. granulatus* are capable of attacking and killing apparently healthy trees. These two species, in association with several fungi, destroyed more than 528 million board feet of silver fir, *Abies amabilis* (Dougl.) Fobes, distributed over a million acres in Oregon and Washington from 1947 to 1955 (Thomas and Wright, 1961).

The present study was undertaken with three primary objectives. First, to conduct a morphological study of the adults in order to answer some of the perplexing questions concerning their systematics. As an aid to identification, each species is redescribed and a key to the adults is presented. Second, since very little is known about the biology of the species of *Pseudohylesinus,* an attempt was made

* Revision of a dissertation submitted in partial fulfillment of the Ph.D. degree in Entomology at the University of California, Berkeley. Present address: Entomology Research Institute, Research Branch, Canada Department of Agriculture, Ottawa, Ontario, Canada.

to obtain at least the gallery pattern and host plants for each. More complete biological data are presented for some species. The third objective was to examine inter- and intra-generic relationships to determine evolutionary trends and possible phylogenetic affinities.

History of the genus.—The genus *Pseudohylesinus* as described by Swaine (1917) included *Hylesinus sericeus* Mannerheim, and five new species, *P. tsugae, P. sitchensis, P. nobilis, P. grandis,* and *P. obesus.* Later, Swaine (1918) presented a key to the species and added *Hylesinus nebulosus* Leconte and *Hylastes granulatus* Leconte to the genus.

Eggers (1929) placed *Hylesinus humilis* Blanchard, described from Chile, in *Pseudohylesinus.* One species, *P. serratus,* was described by Bruck (1936) from southern California.

The most complete treatment of *Pseudohylesinus* for North America was a revision by Blackman (1942). In this work he recognized *P. nebulosus* (Leconte), *P. serratus* Bruck, *P. granulatus* (Leconte), *P. tsugae* Swaine, *P. obesus* Swaine, *P. nobilis* Swaine, *P. grandis* Swaine, *P. sitchensis* Swaine, and *P. sericeus* (Mannerheim) and described seven new species: *P. pullatus, P. dispar, P. maculosus, P. mexicanus, P. keeni, P. similis,* and *P. furnissi.* Blackman gave detailed descriptions and a key for all species treated.

The most recently named species, *P. brasiliensis* from Brazil and *P. magnus* from Mexico, were described by Schedl (1951) and Wood (1956), respectively.

The biology of a species of *Pseudohylesinus* was first studied by Schwarz (1894). In this interesting paper he briefly described the life history and gallery system of *P. nebulosus* to which he erroneously applied the name *Hylesinus sericeus* Mannerheim. Burke (1905) stated that *Hylesinus granulatus* causes damage to lowland fir, *Abies grandis* (Dougl.) Lindl. Chamberlin (1918) gave the first accurate description of the biology of *P. grandis, P. granulatus,* and *P. nebulosus.* In the same year, Swaine (1918) published his work on the Canadian bark beetles which included a brief mention of hosts and distributions of the various species, a very excellent figure of the adult *P. grandis,* and photographs of the galleries of *P. nebulosus* and *P. granulatus.* Few studies (Keen, 1929; Chamberlin, 1939; Blackman, 1942) were made on this genus until 1952 when Keen presented biological data for eight species including descriptions of gallery systems, hosts, geographic distribution, and economic damage.

Detailed biological studies since that time include the life history and habits of *P. nebulosus* (Walters and McMullen, 1956), the biology of *P. grandis* and *P. granulatus* (Thomas and Wright, 1961), the flight habits of *P. nebulosus* and *P. grandis* (Daterman et al., 1965) and the feeding habits of *P. nebulosus* (Stoszek and Rudinsky, 1967) (see appendix).

ACKNOWLEDGMENTS

Appreciation is here expressed for the assistance, comments, and criticism of Professors E. G. Linsley and R. W. Stark of the University of California, Berkeley. This work was suggested by Dr. S. L. Wood, Brigham Young University, Provo, Utah, to whom I am grateful for the use of his collection and for his efforts in comparing several species to type specimens. Dr. D. L. Wood, University of California, Berkeley, offered helpful comments throughout the course of this study.

The mites were identified by Mr. D. N. Kinn, University of California, Berkeley.

Various institutions and individuals allowed me to examine their collections or sent specimens for my use. Sincere thanks are extended to: A. Descarpentries, National Museum of Natural History, Paris, France; F. S. Truxal and C. L. Hogue, Los Angeles County Museum, Los Angeles, California; J. D. Lattin, Oregon State University, Corvallis, Oregon; R. L. Furnis, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon; M. H. Hatch, University of Washington, Seattle, Washington; G. R. Struble and T. W. Koerber, Pacific Southwest Forest and Range Experiment Station, Berkeley, California; H. B. Leech, California Academy of Sciences, San Francisco, California; Patricia Vaurie, American Museum of Natural History, New York, New York; H. F. Howden, Canadian National Collection, Ottawa, Ontario; D. M. Anderson, United States National Museum, Washington, D.C.; Joe Schuh, Klamath Falls, Oregon; T. O. Thatcher, Colorado State University, Fort Collins, Colorado and C. W. O'Brien, University of California, Berkeley, California. Thanks are also extended to the National Park Service, Mount Rainier National Park, Washington, for allowing me the opportunity to collect in some critical type localities.

Partial support from the California State Division of Forestry, the T. B. Walker and Surdna Foundations, and various forest industries is gratefully acknowledged. Field work in Oregon and Washington was made possible by a travel grant generously supplied by the Committee on Research, University of California, Berkeley, California.

The research on this project was conducted under California Experiment Station Project, No. 1778, "The classification, bionomics, ecology, and control of bark beetles infesting California trees."

METHODS

The present study is based on approximately four thousand specimens, including holotypes or lectotypes of all species except *P. magnus* Wood, *P. sericeus* (Mannerheim), and *P. variegatus* (Blandford). My concept of *P. magnus* is based on paratypes in the United States National Museum and in Wood's personal collection. A "presumed cotype" of *P. sericeus,* bearing the labels "*Hylesinus sericeus* Mann. Sitka" and "Type 5450," in the Leconte Collection at Harvard University was examined. Two specimens of *Hylesinus variegatus* Blandford that had been compared to the type in the British Museum (Natural History) by Wood were also examined.

Measurements of length were made by using a calibrated ocular micrometer and measured from the anterior margin of the pronotum to the posterior edge of the elytra. Measurements of width were taken at the widest point. Drawings were prepared with the aid of an ocular grid.

Several male specimens of each species from various localities were dissected and the genitalia examined. Males of *P. magnus* were not available. The genitalia were prepared for examination and illustration by placing the dissected capsule in a solution of 10 percent potassium hydroxide for several hours or until the attached muscle fibers became clear. It was then placed in distilled water for three to four hours to stop the action of the clearing agent. The capsule was then re-

examined and, if adequately cleared, put through a series of alcohols of increasing concentration. For ease of examination it was carefully positioned on a glass slide and a permanent mount made in Hoyer's Mounting Media or in Canada balsam.

Almost all the species were observed in the field in Oregon, Washington, and California. When species of *Pseudohylesinus* were found attacking their host

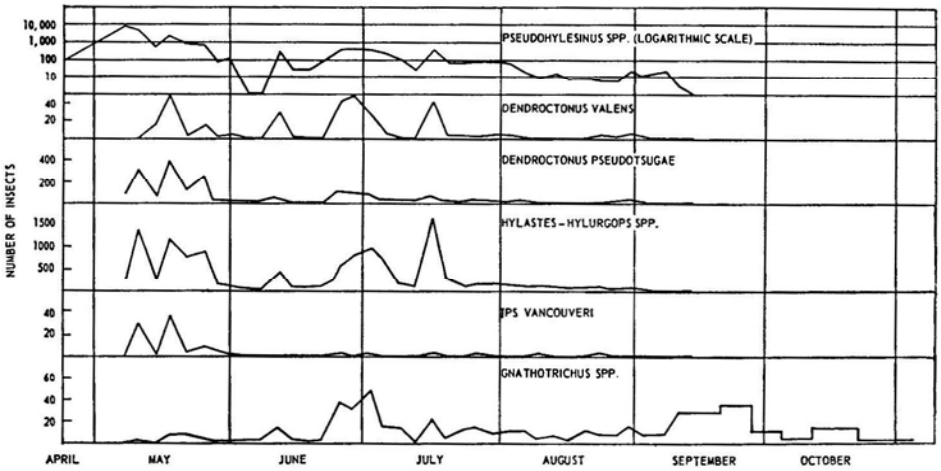

Fig. 1. Flight activity of various scolytids in British Columbia in 1954. Autumn *Gnathotrichus* records averaged to correspond to earlier collection periods. (After Chapman and Kinghorn, 1958.)

material, one of two courses was generally followed. When collecting in local areas, the adults and larvae were collected. Then a sample of the parent galleries was measured and either sketched or photographed. On the more extended trips or when the adults had not completed their galleries, several pieces of infested host material were taken into the laboratory and the beetles allowed to complete their galleries. Data on gallery length, shape, orientation, and larval mines were taken on the completed galleries and the associated insects were reared from the bolts.

Localities cited were taken from specimens I personally examined. These localities were checked in various atlases or postal guides. In the list of localities under "Specimens examined," quotation marks indicate localities that could not be found in any source.

The nomenclature of the host trees follows Little (1953).

COMPARATIVE BIOLOGY

Apparently all species of *Pseudohylesinus* winter either as larvae under the bark or as older adults in the moss on tree trunks, in bark crevices, in the forest litter (Chamberlin, 1939), or as young adults in specially constructed hibernating niches. These niches are most often constructed in the bark near the base of the host trees (Walters and McMullen, 1956; Cowlin, 1956; Thomas and Wright, 1961). They may be distinguished from the brood galleries by the absence of egg niches and by the large number of adults congregating in them. In some cases,

these overwintering sites may be extended into brood galleries in the spring (Walters and McMullen, 1956).

Activity begins early in the spring when temperatures are near 55° (Daterman et al., 1965). Peak activity is reached soon after the first appearance of the insects, then continues at a decreasing rate throughout the season. Chapman and Kinghorn (1958) found that the species of *Pseudohylesinus* and other scolytids

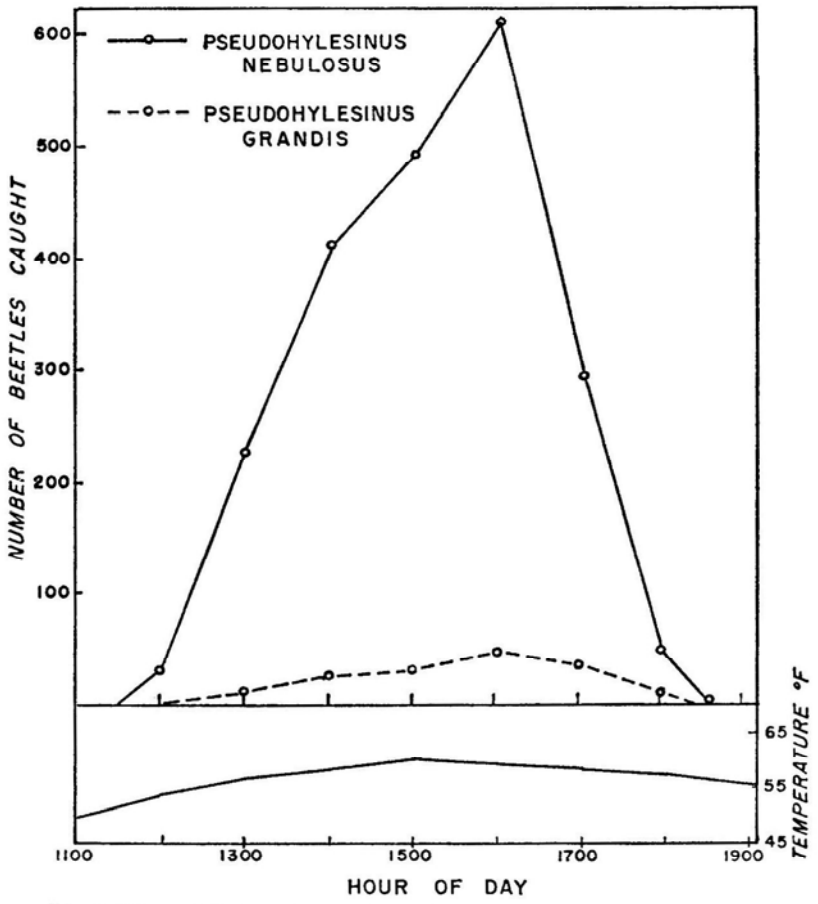

Fig. 2. Diurnal flight patterns of *Pseudohylesinus nebulosus* and *P. grandis*. (From Daterman et al., 1965.)

in different genera have characteristic flight periods in interior British Columbia (fig. 1), and their data were substantiated by Daterman et al. (1965) in Oregon. *P. nebulosus nebulosus* begins flight in April or early May, whereas the bark beetle species in other genera in the same area begin flight a short time later. The flight period of *P. nebulosus nebulosus* lasts well into September, whereas in species of the other genera it is nearly over by late July. A second peak of emergence and attack can be detected in early fall when the adults seek hibernation sites or begin a second attack. Walters and McMullen (1956) report that *P. nebulosus nebulosus* first appeared in British Columbia on May 5, 1955, with a peak occur-

ring on May 8; Daterman et al. (1965) report that the initial flight of this species in Oregon took place on March 20, 1963, with peak activity occurring through April 28, but in 1964 peak activity was over by the end of March. It has also been taken in flight as early as February 24, 1964, in Marin County, California. In Oregon, *P. grandis* has been observed flying between mid-March (Bright, unpublished data) and late April (Chamberlin, 1918; Daterman et al., 1965) and from late May or early June near Mount Baker, Washington (Cowlin, 1956). During the present study, *P. nobilis* was observed attacking new host trees in late June at Paradise, Mount Rainier National Park, Washington.

Temperature and light intensity are the most important factors influencing the diurnal activity of *Pseudohylesinus* (Daterman et al., 1965). The ambient air temperature required to initiate flight in *P. nebulosus nebulosus* was found to be 54° to 55° F; while in *P. grandis* it was slightly higher, 56° to 58° F. The flight of these species decreases sharply when the sun sets, even though the temperature remains favorable for several more hours (fig. 2). This pattern contrasts sharply with that exhibited by *Hylastes, Gnathotrichus,* and *Dryocoetes* which have crepuscular flight patterns (Daterman et al., 1965).

Under ordinary conditions, all species of *Pseudohylesinus* attack weakened, felled, or dying trees and branches. However, in 1947, *P. grandis* and *P. granulatus* were found killing mature Pacific silver fir, *Abies amabilis* (Dougl.) Forbes, in northwestern Washington. The outbreak reached a peak in 1954 and subsided abruptly in 1955, apparently due to natural causes.

Certain species exhibit preferences for locations on the tree in which to initiate their attacks. *P. nebulosus* attacks all parts of the tree including the small limbs but seems to show a preference for trees in the sapling or pole stage and limbs of larger trees (Keen, 1952). It is capable of killing suppressed or weakened trees of small diameter but occasionally attacks the boles of living trees where it competes with the Douglas fir beetle, *Dendroctonus pseudotsugae* Hopkins. *P. granulatus* usually attacks the lower fifteen feet of large trees, often extending its galleries into the roots for as much as two feet (Chamberlin, 1958). *P. dispar dispar* has been found in California only in the bole of large wind-thrown trees. The remaining members of the genus may be found breeding anywhere from the bole to the small limbs.

The initial attack is made by the female, usually in a crevice, under moss and lichens or under a bark scale. Branch crotches are also a preferred location. Since the host is generally in a weakened condition and oleoresin is not flowing, pitch tubes are not a common occurrence as with some other bark beetles. The first evidence of attack is the appearance of reddish boring dust under each entrance hole. As the number of attacks increase, entrance holes may be constructed wherever the insect can find a purchase. Attacks are often so dense that the cambium is completely destroyed. Walters and MacMullen (1956) report a maximum of 121.7 attacks with an average of 50.6 per square foot for *P. nebulosus nebulosus.* Bark thickness in the area attacked ranged from 0.1 to 1.4 inches. When attacks are abundant, the boring dust may form a conspicuous ring around the base of the tree (Thomas and Wright, 1961).

All members of the genus are monogamous. Occasional instances of polygamy

were noted but these were evidently accidental occurrences of temporary duration. It has not been established when the male joins the female in the gallery but it is assumed to be as soon as the entrance hole reaches the cambium. *P. tsugae* was observed mating in the entrance gallery in the bark. It is not known if mating occurs in the egg tunnel or not, or if it occurs more than once. Often the male remains in the entrance tunnel assisting the female by keeping the gallery free of boring dust. The female excavates the egg galleries.

Two types of parent galleries are characteristic of species of *Pseudohylesinus*. One type, illustrated by *P. nebulosus, P. sitchensis,* and *P. sericeus* (fig. 29, 32, 33), is longitudinal or follows the grain of the wood. The entrance hole may be in the middle of the gallery system as with *P. nebulosus* (fig. 29) or at the lower end as with *P. sericeus* and *P. sitchensis* (figs. 32, 33). An enlarged chamber is evident at the base of the entrance tunnel which probably serves as a nuptial chamber. The second, more common, form is transversely oriented and occurs in the remaining species (figs. 30, 31). The entrance tunnel is toward the middle, forming a biramous gallery. No enlarged chamber is evident in galleries of this type. Galleries of both types are kept free of frass by the beetles. All galleries are excavated in the phloem-cambium region and may or may not engrave the sapwood, depending mainly on the thickness of the phloem. Occasionally galleries are found which are curved, bent, or oriented at an angle. These deviations are caused by the resistance of knots, pitch globules, bark irregularities, or when attacks are numerous.

Eggs are laid singly in niches in the gallery wall. After each egg is laid, the female packs the niche with boring dust and frass, making the walls of the gallery smooth. There does not seem to be any definite order to the placement of egg niches, at least for the species examined. Chamberlin (1918) states that the eggs of *P. granulatus* are laid in an alternating sequence along the parent gallery. After laying one complement of eggs, the beetles frequently emerge, make a second attack usually on a new host plant, and lay a second batch of eggs. The

TABLE 1

NUMBER OF EGG NICHES FOR OBSERVED SPECIES OF PSEUDOHYLESINUS

Species	Number of galleries examined	X no. of egg niches/gallery	Maximum no. of egg niches/gallery
P. nebulosus nebulosus	102	18	43
P. dispar dispar	15	57	72
P. dispar pullatus	9	87	130
P. nobilis	13	41	51
P. grandis	30	51	101
P. sitchensis	12	28	39

average number of eggs laid (table 1) varies according to host condition, fecundity, degree of crowding, or other ecological factors.

The larval mines are mostly in the phloem but may score the wood slightly, especially in the later instars. In all species, the larvae tend to mine parallel to the grain of the wood. In those species with longitudinal parent galleries, the

larvae mine at right angles to the gallery for a short distance before turning with the grain (figs. 29, 32, 33). In transverse parent galleries, the larvae simply mine at right angles to the adult gallery (figs. 30, 31). At first the larval mines parallel each other, but as the larvae mature or become crowded their paths wander and the gallery pattern may become confused.

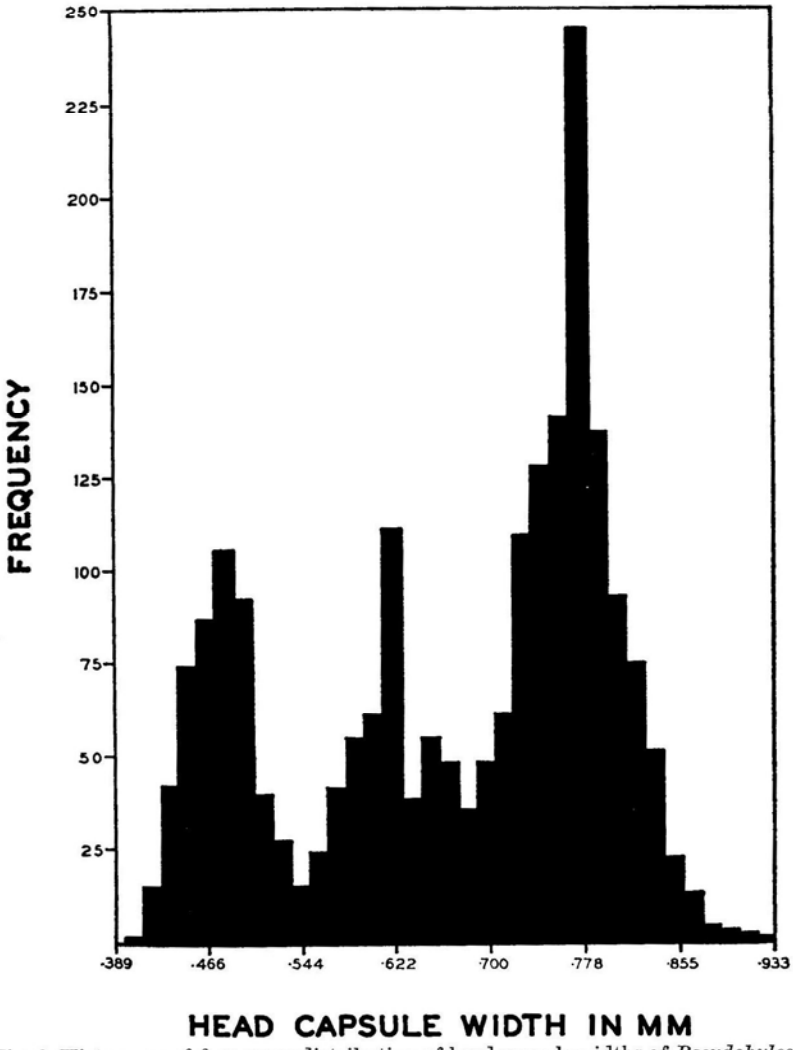

Fig. 3. Histogram of frequency distribution of head-capsule widths of *Pseudohylesinus nebulosus*. (From Walters and McMullen, 1956.)

Walters and McMullen (1956) found that *P. nebulosus* has three larval instars (fig. 3), which corresponds with the data obtained by me for *P. grandis* in Marin County, California.

Pupation in all species takes place in enlarged cells at the end of the larval mines in the inner bark. If the bark is thin, the cells may engrave the sapwood. Under normal conditions, Walters and McMullen (1956) found the pupal period

for *P. nebulosus nebulosus* to be about eight days. *P. grandis,* reared from material collected in Marin County, California, also had a pupal period of approximately eight days.

As would be expected for a group of insects distributed through a wide range of conditions, the number of generations each year varies considerably. *P. nebulosus nebulosus* may have two or more generations a year in California (Chamberlin, 1939), one and a partial second generation along the British Columbia coast, (Hopping, 1928), and one generation per year in interior British Columbia (Harris, 1954; Walters and McMullen, 1956). It is almost certain that *P. nebulosus serratus* in southern California completes several generations per year and the same is probably true for *P. variegatus* and *P. magnus* in Mexico, due to the more favorable conditions. *P. dispar dispar* in the central Sierras completes a generation in one year. There is considerable overlapping of generations because the females may reattack after laying the first batch of eggs and some young adults attack in the fall while others attack in the spring.

Host specificity.—The genus *Pseudohylesinus* does not exhibit a high degree of host specificity. Of the twelve species and subspecies recognized in this study, only two species and two subspecies (*P. sitchensis, P. magnus, P. dispar pullatus,* and *P. nebulosus serratus*) restrict their attacks to one species of host tree. Two more species and one subspecies (*P. variegatus, P. sericeus,* and *P. dispar dispar*) normally limit their attack to one genus of tree. The remaining species breed in trees of several genera, generally *Abies, Tsuga,* and *Pseudotsuga.*

In several instances in the literature, hosts such as *Pinus ponderosa* Laws., *P. monticolae* Dougl., *Picea engelmanni* Parry, and *Thuja plicata* Donn are cited. It is not known from the information given if broods were actually produced in

TABLE 2

HYMENOPTEROUS PARASITES RECORDED FROM VARIOUS SPECIES OF PSEUDOHYLESINUS
(from Bushing, 1965 and Bushing and Bright, 1965)

	Host
Braconidae	
Coeloides brunneri Viereck	*P. granulatus*
	P. sp.
Ecphylus sp.	*P.* sp.
Eubadizon strigitergum (Cushman)	*P.* sp.
Opius sp.	*P. nebulosus nebulosus*
Spathius brunneri Viereck	*P. nebulosus nebulosus*
Eurytomidae	
Eurytoma sp.	*P. nebulosus nebulosus*
	P. sericeus
Pteromalidae	
Cecidostiba acuta (Provancher)	*P. nebulosus nebulosus*
Cheiropachus arizonensis (Ashmead)	*P. nebulosus nebulosus*
C. brunneri Crawford	*P. nebulosus nebulosus*
Heydenia unica Cook and Davis	*P. nebulosus nebulosus*
Macromesus americanus Hedquist	*P. nebulosus nebulosus*
Rhopalicus pulchripennis (Crawford)	*P. nebulosus nebulosus*
Torymidae	
Roptrocerus xylophagorum (Ratzeburg)	*P. nebulosus nebulosus*

these hosts or if the insects were accidentally attracted to these non-host species, resting on the foliage or crawling on the bark. These hosts are infrequently listed and it is reasonable to assume that they were accidental occurrences or erroneous reports.

NATURAL ENEMIES

There are no data currently available on the natural mortality of any species of *Pseudohylesinus*. From my observations, the occurrence of mortality due to predators, parasites, or pathogens is generally low. Because of the color pattern of these beetles, which closely resembles lichen-covered bark, adults are extremely difficult to see when on the bark or in the entrance tunnels. This probably serves to reduce predation by birds but there are no data to support this assumption. No woodpecker work was observed on trees infested with species of *Pseudohylesinus,* but such predation probably occurs.

Bushing (1965) lists three species of Braconidae from species of *Pseudohylesinus*. Additional records obtained during this study increased the number of known parasites to thirteen (table 2).

Mites belonging to the families Acaridae, Pyemotidae, Schizogyniidae (*Choirarchus reginus* Kinn), Tarsonemidae (*Tarsonemoides* sp., and *Tarsonemus* sp.) and Uropodidae were collected from various species of *Pseudohylesinus* (mostly *P. grandis*). The Pyemotidae, *C. reginus* and *Tarsonemoides* sp., are known to have a parasitic or predaceous habit. The impact of the mites on the insect population was not determined.

No insect pathogens or nematodes were discovered or have been reported for the genus.

DISCUSSION OF TAXONOMIC CHARACTERS

The previous classification of *Pseudohylesinus* by Blackman (1942) was based mainly on the relative width of the segments of the antennal club, the relative length and width of the frons, the pubescence of the pronotum and elytra, color pattern, pronotal shape, and relative width of elytral striae and interspaces. He found it extremely difficult to separate species by utilizing more conventional characters previously used in the Scolytidae. This was because he only occasionally found a species that could be characterized by a single outstanding structure or by a combination of characters. This difficulty is further complicated by a very evident sexual dimorphism.

In the following discussion, the most useful taxonomic characters are described. However, a thorough analysis of all the characters useful in the classification of Scolytidae is not available nor have all possible characters been investigated. The term "*nebulosus* group" is used several times on the following pages and refers to those species closely related to *nebulosus,* i.e., *P. dispar* (two subspecies), *P. magnus,* and *P. variegatus.*

Form.—The species of *Pseudohylesinus* are generally stout and robust in general outline. This is most noticeable in those which appear in the last half of the key. The group of species related to *P. nebulosus* show a more elongate, slender body shape.

Head.—The head in all cases is convex with an arcuate impression reaching to about the mid-point of the frons. The area below this impression may be either

slightly convex or flat depending on the species. Extending through this region is generally a prominent median carina.

The sculpture of the frons frequently offers valuable characters. It may be distinctly granulate and roughly, deeply punctured as shown by *P. granulatus* or relatively smooth and punctuate as shown by *P. grandis*. Two species (*P. tsugae* and *P. nobilis*) have a few scattered granules on the frons formed by the upraised edges of close-set punctures.

The vestiture of the frons is formed of moderately stout, suberect setae. No useful distinctions can be made based on the vestiture except that in *P. tsugae*, the vestiture is much shorter and is less obvious than in the other species.

A character utilized extensively by Blackman (1942) was the ratio of the length to the width of the frons. While there does seem to be some basis for using this measurement, the variation observed in most species makes this character difficult to use. Very little difference can be detected in some of Blackman's species. In the *nebulosus* group the frons was found to be about equal in length and width. In the other species, the ratio varied from 1.39:1 (male of *P. sericeus*) to 1.14:1 (male of *P. grandis*) and from 1.17:1 (female of *P. sitchensis*) to 1.02:1 (female of *P. granulatus*).

A complicating factor in the above discussion is the sexual dimorphism. The male frons is always narrower between the eyes, making the length-width ratio longer, the median carina is often more strongly developed, the arcuate impression is deeper and more prominent, and the sculpture is almost always relatively rougher. Because of this variation, the length-width ratio is not used in the present treatment except to distinguish *P. sitchensis* and *P. sericeus*.

Pronotum.—The punctures and granules on the pronotal surface were found to vary so much among individuals that their usefulness was markedly reduced. Also, the pronotal vestiture in most species is so abundant that the pronotal surface is not visible except in older abraded specimens.

The vestiture of the pronotum is an extremely valuable character (figs. 34–49) and is of two types: erect hairlike setae and relatively broad recumbent scales. In *P. tsugae* the erect setae are not noticeable. The scales vary from a broad, almost circular outline as in male *P. grandis* (fig. 44) to nearly hairlike, as in female *P. tsugae* (fig. 41). In several species, the broad scales are divided nearly to the base forming a tufted structure (figs. 34–35).

Sexual dimorphism is evident in the shape of the pronotum, but the differences are less striking in the *nebulosus* group compared to the remaining species, but nevertheless they are present. The pronotum in all species is distinctly wider in the males with lateral margins more arcuate, and usually strongly constricted in front of the middle. The pronotal scales in the male are always wider and the sculpture of the pronotal surface is generally stronger than in the female.

Elytra.—The width and depth of the striae are of value if used with caution and accompanied by other characteristics. The striae vary from rather narrow in *P. grandis, P. sitchensis,* and *P. sericeus* to almost as wide as the interspaces as shown by *P. granulatus* (figs. 54, 55, 60–65). The surface of the punctures is smooth and shining except in *P. magnus* where it is distinctly reticulate.

The interstriae typically have a median row of tubercules which vary in char-

acter according to species but also vary within species so as to reduce their taxonomic value. In *P. tsugae* and *P. magnus,* the tubercules are somewhat confused on the anterior portion of the interspaces to about halfway toward the declivity.

The vestiture of the elytra is also valuable in separating species or species groups. Each interspace typically bears a median row of erect hairlike setae; each seta arises at the base of each tubercule. These setae may be shorter than a distance equal to the width of an interspace and inconspicuous as in the *nebulosus* group or as long or longer than a distance equal to the width of an interspace as in *P. grandis* and its relatives. The scales of the elytra also offer valuable characters. They vary from narrow and hairlike in female *P. tsugae* (fig. 57) to broad and circular as in both sexes of *P. grandis* (figs. 64–65).

Declivital characters are, as a rule, of no value. In all species the first and third interspaces are elevated to some degree and bear tubercules and setae. The coarseness of the setae and tubercules varies between specimens of the same species as well as between different species. The second interspace in the majority of species is narrowed at the elytral apex, depressed below the level of the first and third interspaces, and devoid of setae or tubercules. In *P. magnus* and *P. variegatus,* the second interspace always bears setae and small tubercules while in *P. grandis,* this character is occasionally apparent. The declivital scales are usually wider and more numerous than on the disc.

Sexual dimorphism is evident on the elytra in that the scales of the male are always broader and the setae are relatively coarser and longer than those of the female.

Male genitalia.—Fairly good characters were found on the seminal rod in the genitalic capsule (figs. 12–23). These characters, although not suitable for rapid or routine identification, were useful in this study by providing a key to the confusing array of variation encountered in the genus.

INTRASPECIFIC VARIATION

There is a considerable amount of intraspecific variation in the genus *Pseudohylesinus.* This evidently led Blackman (1942) to describe as distinct species variants of several widespread species. Because it is impossible to construct a key to the species that will account for all the variations that could be encountered, caution must be used in identifying specimens. A knowledge of the species of host tree, gallery pattern, and geographical distribution will help when combined with the morphological characters.

Individual variation.—Variation between individuals of the same sex and species was noted in all species and subspecies. When large numbers of specimens of a particular species are examined, a complete range of scale size, shape and amount, pronotal shape and surface punctuation can be seen which is characteristic for that species.

The color pattern consistently displayed excessive individual variation and consequently cannot reliably be used as a taxonomic character. The only consistent color pattern seems to occur in the subspecies of *P. nebulosus* and *P. dispar* where color alone can be used to differentiate these forms from their relatives.

Other characters which vary between individuals are the depth and placement

of pronotal and elytral punctures, the size of the interstrial granules, the length and placement of the erect interstrial setae, and the characters of the declivity.

DISTRIBUTION AND PHYLOGENY

All of the known species of *Pseudohylesinus* occur in western North America. Of the twelve species and subspecies recognized in this study, eight occur in the Pacific Northwest; the remainder occur either as scattered populations in southern California and Mexico or throughout the western United States.

Of the eight species and subspecies occurring in the Pacific Northwest, *P. dispar pullatus* (fig. 5) and *P. nobilis* (fig. 8) are restricted to that region. *P. tsugae* (fig. 7) occurs primarily in the Pacific Northwest but extends south into northern California along the coast and north into southeastern Alaska. *P. dispar dispar* (fig. 5), *P. granulatus* (fig. 6), and *P. grandis* (fig. 9) are more widely distributed, extending as far south as central California and, in the case of *P. grandis,* north to southern Alaska. *Pseudohylesinus sitchensis* (fig. 10) and *P. sericeus* (fig. 11) are strictly coastal, never being found more than a few miles inland. The most widely distributed species is *P. nebulosus* (fig. 4). One of its subspecies, *P. nebulosus nebulosus,* is found throughout the range of its host tree, Douglas fir, except in northern Mexico. Its absence there is no doubt due to lack of collecting. The other subspecies, *P. nebulosus serratus,* is endemic to southern California and is found only in bigcone Douglas fir.

Records are too incomplete for the two species known from Mexico to permit a general discussion of their distribution. However, *P. variegatus* (fig. 5) is the most widespread. It probably occurs throughout the range of its host tree, *Abies reliogosa,* in the high mountains. It extends into the United States as far north as northern Utah, in various species of *Abies. P. magnus* is possibly endemic to central Mexico.

Pseudohylesinus is in the subfamily Hylesininae and was placed in the tribe Hylurgini by Wood (1961). However, a critical examination of the species in the genus has shown that it fits more naturally in the tribe Hylesinini. This conclusion is based on the following combination of characters, which distinguish genera in the Hylesinini: the anterior coxae are separated by an intercoxal piece, the eye is elongate and entire and the antennal club is conical and slightly compressed. Further, by placing *Pseudohylesinus* in the tribe Hylesinini, its relationships to related genera is made clearer. For the same reasons, the closely related genus *Xylechinus* Chapuis also belongs in the Hylesinini.

Pseudohylesinus undoubtedly is related to *Xylechinosoma* Schedl and possible *Squamosinus* Nunberg of South America, the cosmopolitan genus *Xylechinus* Chapuis and the Old World genus *Kissophagus* Chapuis. *Pseudohylesinus* and *Xylechinosoma* possess a seven-segmented antennal funicle which immediately separates them from the other genera. *Pseudohylesinus* differs from *Xylechinosoma* by its narrower, more conical antennal club, by the more definite arcuate impression on the frons, by the more evident longitudinal carina on the frons, by the less widely separated anterior coxae and by the more convex elytral declivity.

Within the species of *Pseudohylesinus,* two species groups can be designated each with two subdivisions. The first group, containing *P. nebulosus* (two sub-

species), *P. dispar* (two subspecies), *P. variegatus* and *P. magnus,* is distinguished by the slender form, the short first segment of the antennal club and the scale pattern. Within this first division, further subdividing can be made on the basis of their gallery patterns. All the species construct transverse parent galleries except *P. nebulosus* which constructs longitudinal galleries. The species in this first major division are distributed from southern Mexico to the Pacific Northwest with the majority tending to have a more southerly distribution.

The second major species group contains *P. nobilis, P. tsugae, P. grandis, P. granulatus, P. sitchensis,* and *P. sericeus.* This group can be distinguished by the stouter body, the longer first segment of the antennal club, and the more pronounced sexual dimorphism. It also can be further subdivided on the basis of gallery pattern. Of this group, only *P. sitchensis* and *P. sericeus* construct longitudinal parent galleries, while the remaining species construct transverse galleries. This latter species group is distributed entirely from the Pacific Northwest to central California.

SYSTEMATIC SECTION

Genus *Pseudohylesinus* Swaine

Pseudohylesinus Swaine, 1917, Can. Dept. Agric., Ent. Branch, Tech. Bull. 14:11 (original description); Swaine, 1918, Can. Dept. Agric., Ent. Branch, Tech. Bull. 14(2):74–77; Bruck, 1936, Bull. So. Calif. Acad. Sci. 35(1):43; Keen, 1938, U.S. Dept. Agric. Misc. Publ. 273:161–162; Chamberlin, 1939, Bark and timber beetles of North America, pp. 196–204; Blackman, 1942, U.S. Dept. Agric. Misc. Publ. 461, 31 pp.; Chamberlin, 1958, Scolytidae of Northwest, pp. 102–114.

This genus is most closely related to *Xylechinus* Chapuis in North America and may be distinguished from *Xylechinus* by the seven-segmented antennal funicle and the lack of erect interstrial scales. It may be distinguished from other genera by the scale covering of the body, by the hairlike interstrial setae, by the arcuately impressed frons and by the nearly contiguous anterior coxae. It is the only genus in North America with a combination of recumbent scales and erect hairlike setae.

Description.—Body moderately elongate to stout; integument reddish-brown to black, shining; scale color variable but generally some shade of dark brown and white in various combinations; length, 2.4 to 6.0 mm.

Head with frons convex, punctate to granulate with an arcuate, transverse, impression; area below impression divided by a raised median carina; epistomal margin broad, smooth and shining, with a longitudinally impressed, bilobed, median process; epistoma broadly impressed, punctured; vestiture of stout, erect, hairlike setae. Antennal scape clavate, shorter than funicle; funicle seven-segmented, segments becoming wider and shorter distally. Eye entire, oval, about three times longer than wide, wider above.

Pronotum 0.7 to 1.3 times longer than wide; sides arcuate, sometimes very strongly constricted on anterior one-fourth, especially in males; surface shining, distinctly punctured, clothed with recumbent scales and erect setae; median line visible, extending from posterior margin to transverse impression in anterior third.

Scutellum longer than wide, slightly depressed.

Elytra 1.2 to 1.9 times longer than wide; sides parallel on anterior two-thirds, then rather narrowly rounded behind; bases arched, bearing sharp to blunt, overlapping crenulations; striae narrow to wide with distinct, impressed punctures; interspaces flat to slightly convex, confusedly tuberculate at base, but uniserially tuberculate and setose on posterior three-fourths. Declivity evenly convex; first, third, fifth, and seventh interspaces narrowed and elevated slightly, each with a row of tubercules and erect setae; second interspace depressed below level of first and third, usually devoid of granules or setae; ninth interspace variably raised and serrate; vestiture over elytra consists of elongate to wide scales and erect interstrial hairlike setae.

Ventral surface of body with numerous, tuftlike, yellowish scales.

Type species: Pseudohylesinus grandis Swaine, 1917, original designation.

KEY TO THE KNOWN SPECIES OF PSEUDOHYLESINUS SWAINE

1. Frons about as long as wide; antennal club with first segment equal to or slightly longer than second; body more slender, more than 2.2 times longer than wide 2
   Frons definitely longer than wide; antennal club with first segment distinctly longer than second, sometimes as long as second and third; body stout, usually less than 2.2 times longer than wide, except *P. granulatus* 7
2. Elytral bases with serrations high, sharp and prominent, more so at sides; ninth interspace strongly elevated and distinctly serrate; size smaller, averaging less than 3.5 mm; parent galleries longitudinal 3
   Elytral bases with serrations low, blunt; ninth interspace not strongly elevated or distinctly serrate; size larger, averaging more than 3.5 mm; parent galleries transverse 4
3. Elytral declivity with first and third interspaces slightly elevated and with small inconspicuous tubercules; second declivital interspace about as wide as on disc; serrations of ninth interspace less strongly developed; body size 2.3–2.9 mm; western United States in numerous hosts ..... *nebulosus nebulosus* (Leconte)
   Elytral declivity with first and third interspaces strongly elevated and with prominent, sharp tubercules; second declivital interspace strongly narrowed posteriorly; serrations of ninth interspace strongly developed; body size 3–3.5 mm; southern California in *Pseudotsuga macrocarpa* ..... *nebulosus serratus* Bruck
4. Second interspace on declivity completely devoid of setae or tubercules; elytral setae fine, length less than half the width of interspace 5
   Second interspace on declivity with setae and tubercules; elytral setae stout, at least as long as width of interspace 6
5. Color pattern consisting of very light brown and white scales, the white scales not arranged in patches ..... *dispar dispar* Blackman
   Color pattern of predominantly dark scales with small scattered patches of white scales ..... *dispar pullatus* Blackman
6. Surface within strial punctures smooth and shining, not reticulate; body size smaller, less than 5 mm ..... *variegatus* (Blandford)
   Surface within strial punctures reticulate; body size larger, 5.5–6.1 mm ..... *magnus* Wood
7. Size larger, up to 5.5 mm; body more elongate, 2.4 times longer than wide; pronotum and frons strongly granulate-punctuate; elytral striae about as wide as interspaces, punctures deep ..... *granulatus* (Leconte)
   Size smaller, less than 4.6 mm long; body stout, less than 2.2 times longer than wide; frons not strongly granulate-punctuate; elytral striae narrower than interspaces 8
8. Pronotal scales of female hairlike, those of male slender and broader (figs. 40–43); striae wider, interspaces appearing convex; interstrial setae in females shorter than width of interspace 9
   Pronotal scales of female elongate-oval, those of male broadly oval to nearly circular (figs. 44–49); elytral striae narrow and interspaces flat; interstrial setae coarser and longer than width of interspace in both sexes 10
9. Pronotal scales of male slender, some nearly hairlike (fig. 40); elytral scales of female narrow, hairlike on disc (fig. 57); elytral striae narrower than the interspaces; principally from *Tsuga* ..... *tsugae* Swaine
   Pronotal scales of male broad, none hairlike (fig. 42); elytral scales of both sexes broad (figs. 58, 59); elytral striae nearly as wide as interspaces; principally from *Abies* ..... *nobilis* Swaine
10. Frons with arcuate impression not distinct in either sex; frons of male broad (.51 mm–.57 mm, average .54 mm); elytral scales of female nearly circular on disc (fig. 61) ..... *grandis* Swaine
    Frons with arcuate impression deep and distinct in both sexes; frons of male narrower; elytral scales of female longer than wide on disc (figs. 63, 65) 11

11. Frons of male broader (.48 mm–.55 mm, average .49 mm); body size 2.4–3.4 mm; in Sitka spruce ..... *sitchensis* Swaine
Frons of male narrower (.32 mm–.43 mm, average .33 mm); body size 2.6–3.3 mm; in coastal pines ..... *sericeus* (Mannerheim)

Pseudohylesinus nebulosus nebulosus (Leconte), new status

(Figs. 2, 3, 4, 13, 24, 29, 34, 35, 50, 51)

Hylesinus nebulosus Leconte, 1859, Proc. Acad. Nat. Sci. Philadelphia, p. 285; Leconte, 1868, Trans. Amer. Ent. Soc. 2:170, 178; Leconte, 1876, Proc. Amer. Phil. Soc. 15:380; Hamilton, 1894, Trans. Amer. Ent. Soc. 21:35; Hopkins, 1904, U.S. Div. Ent. Bull. 48:20; Currie, 1905, U.S. Div. Ent. Bull. 53:75; Swaine, 1909, New York St. Mus. Bull. 134:113.

Pseudohylesinus nebulosus: Swaine, 1918, Can. Dept. Agric., Ent. Branch, Tech. Bull. 14(2):75; Bruck, 1936, Bull. So. Calif. Acad. Sci. 35:37; Keen, 1938, U.S. Dept. Agric. Misc. Publ. 273: 161; Chamberlin, 1939, Bark and timber beetles of North America, p. 198; Blackman, 1942, U.S. Dept. Agric. Misc. Publ. 461:7; Walters and McMullen, 1956, Can. Ent. 88(5):197–202; Chamberlin, 1958, Scolytoidea of Northwest, p. 106.

Male.—Length 2.3 to 2.9 mm, about 2.5 times longer than wide. Body clothed with pale hairs and many white to dark brown scales, these forming a variable color pattern.

Frons black, as long as wide; punctures close, moderately sized below the arcuate impression and rougher with denser punctures above. Antennal club with first segment slightly shorter than second.

Pronotum 1.3 times wider than long, widest about middle; sides slightly arcuate behind constriction; surface dark with reddish tinge on anterior portion, punctures close and shallow; vestiture on disc consisting of short, stout, erect hairs scattered over surface and many flat, recumbent scales which are finely divided.

Elytra 1.9 times longer than wide; crenulations on bases small, becoming larger and sharper on sides; striae narrow, punctures close, deep; interspaces weakly convex; surface (when visible) slightly roughened by small asperities, the larger asperities forming a median row; vestiture on disc consisting of numerous circular scales, these forming a variegated color pattern. Declivity sloping, unmodified except ninth interspace more strongly elevated and bearing prominent sharp teeth.

Male seminal rod as in figure 13.

Female.—Similar to male in general outlines; frons wider and with finer sculpture; pronotum narrower, not as strongly constricted in anterior portion; vestiture on pronotum of finely divided, elongate recumbent scales; elytra with elongate scales with acuminate apex; color markings less well defined.

Type locality.—Table Mountain, California. The holotype, in the Museum of Comparative Zoology, was examined.

Hosts.—Principally *Pseudotsuga menziesii* (Mirb.) Franco, but also recorded from *Abies concolor* (Gord. and Glend.) Lindl., *Picea engelmanni* Parry, *Tsuga mertensiana* (Bong.) Carr., *T. heterophylla* (Raf.) Sarg., *Thuja plicata* Donn, and *Pinus ponderosa* Laws.

Geographical range.—Widely distributed throughout the western United States and Canada wherever its principal host tree occurs (fig. 4). Specimens were examined from: UNITED STATES. ARIZONA. Cochise Co.: Chiricahua Mountains. Coconino Co.: Williams. Maricopa Co.: Phoenix. Yavapai Co.: Prescott National Forest. CALIFORNIA. Del Norte Co.: Crescent City and Gasquet. Humboldt Co.: Fort Seward and 11 miles SE of Orick. Marin Co.: Mt. Tamalpais and Woodacre. Mariposa Co.: Yosemite Valley. Monterey Co.: Monterey. Placer Co.: Dutch Flat. Plumas Co.: Big Spring. San Francisco Co.: San Francisco. Shasta Co.: Costella and Shingletown. Siskiyou Co.: 7 miles NW of Callahan, Happy Camp, and McCloud. Sonoma Co.: Plantation, "Triniti." Trinity Co.: Carrville. COLORADO. El Paso Co.: Colorado Springs. Jefferson Co.: Foxton. Larimer Co.: Rist Canyon. Montezuma Co.: Dolores. IDAHO. Blaine Co.: Hailey. Boise Co.: Centerville, Grimes Pass and Placerville. Bonner Co.: San Point. Kootenai Co.: Coeur d'Alene. Latah Co.: Cedar Mountain and Moscow Mountain. MONTANA. Blaine Co.: Bear Paw Mountain. Clark Co.: Helena. Flathead Co.: Columbia Falls. Lincoln Co.: Warland. NEW MEXICO. Lincoln

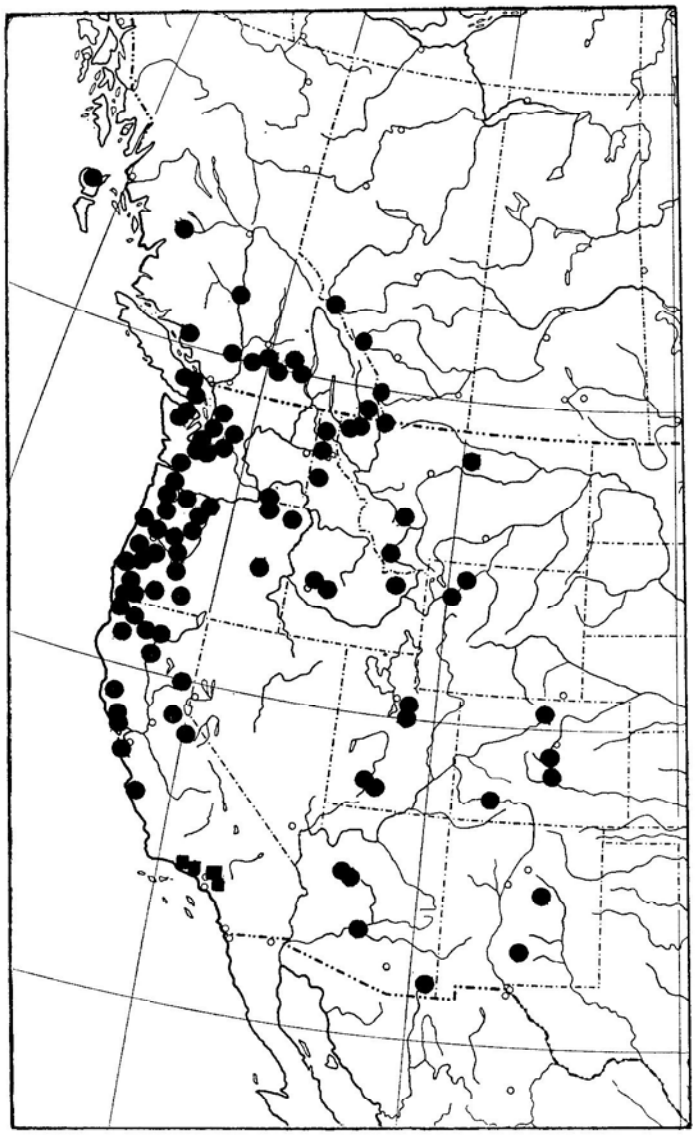

Fig. 4. Known geographical distribution of the subspecies of *P. nebulosus*. Squares in southern California represent *P. nebulosus serratus;* circles represent *P. nebulosus nebulosus.*

Co.: Capitan. Otero Co.: Clouderoft. San Miguel Co.: Las Vegas Hot Spring. OREGON. Santiam National Forest and Siskiyou Mountains. Baker Co.: Baker and Baker Creek. Benton Co.: Corvallis and Mary's Peak. Columbia Co.: Mist. Coos Co.: Coos Bay. Jackson Co.: Ashland. Josephine Co.: Elk Creek, Grants Pass, Oregon Caves and Waldo. Klamath Co.: Klamath Falls and Upper Klamath Lake. Lane Co.: Glenada, Junction City, McCredie Springs, Oak Ridge, and Springfield. Linn Co.: Albany, Berlin, Detroit and Upper Soda. Lincoln Co.: Otis. Multnomah Co.: Gresham and Portland. Polk Co.: Boyer and Independence. Umatilla Co.: Blue Mountains. Washington Co.: Forest Grove. Wasco Co.: Bear Springs. Yamhill Co.: McMinnville. UTAH. Bryce Canyon National Park. Salt Lake Co.: Alta. Utah Co.: Mt. Timpanogos. WASHINGTON. "Olympic National Forest." Clallam Co.: Port Angeles. Clark Co.: Vancouver. Grays Harbor Co.: Junction City.

King Co.: Kent and Seattle. Kittitus Co.: Easton. Pierce Co.: American Lake, Ashford, Fort Lewis, Longmire, Loveland, Puyallup, and Spanway. Pend Oreille Co.: Metaline Falls. Snohomish Co.: "Lee Forest." Thurston Co.: Tenino. Walla Walla Co.: Kooskooskie. WYOMING. Shoshone National Forest. Park Co.: Wapiti. CANADA. ALBERTA: Banff, Jasper, Maycroft and Waterton Lakes. BRITISH COLUMBIA: Aspen Grove, Chilcotin, Columbia Lake, Cowichan Lake, Duncan's, Pender Harbor, Kaslo, Massett, Merritt, Nelson, Peachland, Vancouver, Vernon, Wellington, and Williams Lake.

Remarks.—This subspecies is distinguished from *P. nebulosus serratus* by the absence of prominent granules on the slightly elevated first and third declivital interspace, by the smaller serrations of the ninth interspace, and by its hosts and distribution. From other members of the genus, it may be distinguished by its small size, by the elevated and strongly serrate ninth interspace, by the more convex and wider frons, and by the vestiture and color pattern.

Pseudohylesinus nebulosus nebulosus constructs longitudinal egg galleries in the phloem region of tops and limbs of recently dead and dying Douglas fir (fig. 29). The galleries range in length from 1.8 to 7.2 cm, the average being 4.1 cm.

Pseudohylesinus nebulosus serratus Bruck, new status

(Figs. 4, 14)

Pseudohylesinus serratus Bruck, 1936, Bull. So. Calif. Acad. Sci. 35:37; Keen, 1938, U.S. Dept. Agric. Misc. Publ. 273:162; Chamberlin, 1939, Bark and timber beetles of North America, p. 198, Blackman, 1942, U.S. Dept. Agric. Misc. Publ. 461:8.

Very similar in appearance to *P. nebulosus nebulosus* but may be distinguished by its larger size (3.0–3.5 mm), and by the prominent granules on the strongly elevated first and third declivital interspaces. With these exceptions, the description is identical to *P. nebulosus nebulosus*. The host and more southern distribution will also aid in its recognition.

Male seminal rod as in figure 14.

Type locality.—West Fork, San Gabriel Canyon, Los Angeles Co., California. The holotype, in the Ohio State University collection, Columbus, Ohio, was examined.

Host.—*Pseudotsuga macrocarpa* (Vasey) Mayr.

Geographical range.—Southern California, probably throughout the range of its host tree (fig. 4). Specimens were examined from: CALIFORNIA. Los Angeles Co.: West Fork, San Gabriel Canyon, Big Pines, and Switzers Camp. Santa Barbara Co.: "S. Madre." San Bernardino Co.: Lytle Creek.

Remarks.—This subspecies constructs galleries identical to those of *P. nebulosus nebulosus.*

The subspecific distinction of this and the preceding form is undertaken with some hesitation. When specimens of *P. nebulosus nebulosus* from southern California are compared with specimens of *P. nebulosus serratus* a slight amount of intergradation can sometimes be detected. Unfortunately, the amount of intergradation is so slight that the occurrence of gene flow cannot be definitely proved. However, in view of the nearly identical development of the morphological characters including the male genitalia, the slight indication of intergradation and the allopatric distribution of the two forms, it seems best to regard each population as a subspecies.

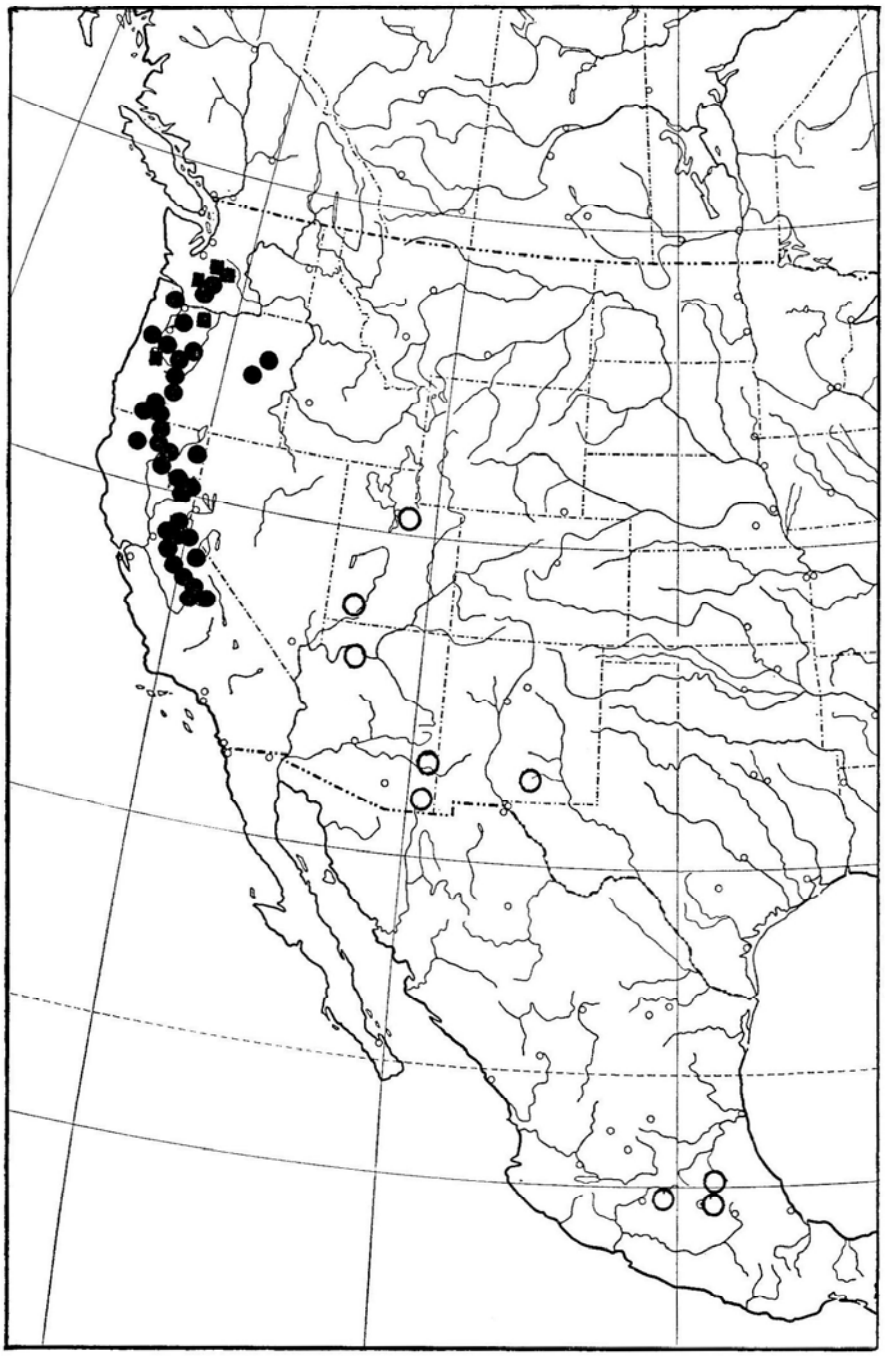

Fig. 5. Known geographic distribution of *P. variegatus* and the subspecies of *P. dispar*. Open circles represent *P. variegatus;* closed circles represent *P. dispar dispar* and squares represent *P. dispar pullatus.*

Pseudohylesinus dispar dispar Blackman, new status

(Figs. 5, 15, 36, 37, 52, 53)

Pseudohylesinus dispar Blackman, 1942, U.S. Dept. Agric. Misc. Publ. 461:11; Chamberlin, 1958, Scolytidae of the Northwest, p. 107.

Male.—Length 2.8 to 4.0 mm, about 2.3 times longer than wide. Color pattern composed of light brown and white scales in various patterns.

Frons black, as long as wide; punctures fine, close below arcuate impression, more coarse above. Antennal club with first segment only slightly longer than second.

Pronotum 1.3 times wider than long, widest on posterior half; sides subparallel on posterior half; surface (when visible) dark; punctures close, somewhat rough; vestiture on disc consisting of erect, hairlike setae scattered over surface and numerous circular to suboval, recumbent scales, these becoming elongate on sides.

Elytra 1.6 times longer than wide; crenulations on elytral bases blunt, overlapping, none larger than any others; striae narrow, punctures small, close; interspaces convex; surface (when visible) slightly roughened, the large asperities forming a median row; vestiture on disc consisting of broad, suboval scales, these forming a variegated color pattern. Declivity sloping, unmodified except scales more thickly placed than on disc and ninth interspace lower and less strongly serrate than in preceding species.

Male seminal rod as in figure 15.

Female.—Similar in general proportions to male; length up to 3.9 mm, 2.4 times longer than wide; pronotum more elongate with less constricted sides; frons wider; elytral scales elongated, fimbricate.

Type locality.—Vernonia, Oregon. The type, in the United States National Museum, was examined.

Hosts.—*Abies concolor* (Gord. and Glend.) Lindl., *A. grandis* (Dougl.) Lindl., *A. magnifica* A. Murr. and possibly other species of *Abies* in its range.

Geographical range.—Central California north to central Washington (fig. 5). Specimens were examined from: CALIFORNIA. Amador Co.: Dew Drop Camp and Jackson. Eldorado Co.: Blodgett Forest, Fallen Leaf Lake, and Vade. Fresno Co.: Huckleberry Meadows and Huntington Lake. Lassen Co.: Grassy Lake, Lassen National Forest, and Susanville. Madera Co.: Bass Lake. Mariposa Co.: Coulterville, "Hazel Green," and Miami Ranger Station. Modoc Co.: Warner Mountains. Placer Co.: Cisco. Plumas Co.: Chestor and Meadow Valley. Shasta Co.: Castella, Cayton, and Viola. Siskiyou Co.: Grass Lake, McCloud, and Mt. Shasta. Tuolumne Co.: Pinecrest and Yosemite. OREGON. Baker Co.: Baker. Benton Co.: Corvallis. Columbia Co.: Mist and Vernonia. Douglas Co.: Diamond Lake. Jackson Co.: Ashland, Fish Lake, and Pinehurst. Klamath Co.: Ash Lake, Crater Lake National Park, and Lake of the Woods. Lane Co.: Willamette Pass. Linn Co.: Marion Forks and Santiam Pass. WASHINGTON: Kittitas Co.: Easton. Skamania Co.: Spirit Lake.

Remarks.—From *P. dispar pullatus*, this subspecies may be distinguished by the light brown and white color pattern in which the white scales are not arranged in isolated patches. The hosts and distribution will further aid in separation. In the northern portion of its range, distinction may be somewhat more difficult since the color patterns of the two subspecies show an indication of intergradation. A fuller discussion of this problem follows in the treatment of *P. dispar pullatus*.

The galleries and site of attack of *P. dispar dispar* are identical to *P. dispar pullatus*. Gallery lengths of nearly eighty galleries ranged from 4.8 to 11.7 cm, with an average of 7.7 cm. In California and Oregon, the galleries are most frequently encountered in the bole and larger limbs. S. L. Wood (personal communication) stated that he had taken it occasionally in the roots.

Pseudohylesinus dispar pullatus Blackman, new status

(Figs. 5, 16)

Pseudohylesinus pullatus Blackman, 1942, U.S. Dept. Agric. Misc. Publ. 461:9; Chamberlin, 1958, Scolytidae of the Northwest, p. 113.

Shows tendency to intergrade with *P. dispar dispar* where the two forms occur together. It may be easily recognized by the distinctive color pattern. With this exception, the description is identical to *P. dispar dispar*. The host and altitudinal distribution will also aid in its recognition.

Male seminal rod as in figure 16.

Type locality.—Mount Rainier National Park, Washington. The holotype, in the United States National Museum, was examined.

Host.—*Abies procera* Rehd.

Geographical range.—This subspecies is probably distributed throughout the range of its host tree in Oregon and Washington but records from the Olympic Mountains and southern portions of the Cascade Mountains are lacking (fig. 5). It is not abundant. Specimens were examined from: OREGON. Benton Co.: Mary's Peak. Hood River Co.: Lost Lake. WASHINGTON. Pierce Co.: White River in Mt. Rainier National Park. Skamania Co.: Spirit Lake.

Remarks.—This distinctive subspecies may be easily recognized by the color pattern which is very different from any other form. The pattern on the elytra consists of dark brown to black scales interspersed with small isolated patches of white scales. The host and distribution will further characterize this subspecies.

The galleries are transverse and range in length from 4.7 to 11.7 cm, and average 7.3 cm. Most galleries are constructed in the bole and larger limbs of the host tree. All galleries observed were in large trees, but Blackman (1942) reported that small, four-inch trees were attacked.

When specimens from California and Washington are compared, the difference in color pattern between the two subspecies is very evident. However, in the northern parts of the range of *P. dispar dispar,* a trend to the color pattern of *P. dispar pullatus* can be seen. Even in series from California, an occasional specimen of *P. dispar dispar* will resemble *P. dispar pullatus.* These two subspecies overlap slightly in their geographical distribution in northern Oregon. However, each subspecies inhabits a different host, at different altitudes, which maintains the allopatric characteristic essential for the subspecies distinction. Noble fir (*Abies procera*), the host for *P. dispar pullatus,* is found in a belt through central Oregon and Washington at altitudes between 2,000 to 5,000 feet, while white fir (*A. concolor*), the principal host of *P. dispar dispar,* occurs from southern California to central Oregon at altitudes from 6,000 to 11,000 feet (Preston, 1948).

Since morphologically (except for color pattern) and biologically these two forms are nearly identical, occur as allopatric populations, and appear from genitalic investigations to be potentially capable of interbreeding, they are considered as well-marked populations within the species.

The name *P. pullatus* has page priority over *P. dispar,* however, according to article 24(A) of the International Code of Zoological Nomenclature, the first revisor may overlook page priority and use the name that seems best to preserve stability. Since *P. pullatus* is presently a rare form, known from only a few specimens and a few localities and *P. dispar* is common throughout California and Oregon, *P. dispar* is chosen as the specific name for these two subspecies.

Pseudohylesinus variegatus (Blandford), n. comb.

(Figs. 5, 17)

Hylastes variegatus Blandford, 1897, Biol. Centrali-Americana 4(6):145; Blandford, 1910, Genera Insectorum 111:46.

Pseudohylesinus maculosus Blackman, 1942, U.S. Dept. Agric. Misc. Publ. 461:12 (new synonymy).

Pseudohylesinus mexicanus Blackman, 1942, U.S. Dept. Agric. Misc. Publ. 461:13 (new synonymy).

Male.—Length 3.7 to 4.3 mm, 2.4 times longer than wide; color pattern of dark brown to black scales, with scattered patches of white scales in various patterns.

Frons black, about as long as wide; punctures fine and close below the arcuate impression, rougher above. Antennal club with first segment about as long as second.

Pronotum 1.2 times wider than long, widest about middle; sides nearly parallel on posterior third; surface reddish-brown; punctures close and deep on disc, becoming finely rugose on sides; vestiture on disc consisting of short, erect hairs and numerous short, broad, suboval scales.

Elytra 1.5 times longer than wide; crenulations on bases low, blunt; striae narrow, punctures deeply impressed; interspaces much wider, convex; surface (when visible) roughened by small asperities, the large asperities forming a median row; vestiture on disc consisting of short, nearly circular, recumbent scales, these forming patches of white and brown or black. Declivity sloping; second interspace with median row of tubercules and setae.

Male seminal rod as in figure 17.

Female.—Similar in general size and shape to male; length 4.0 to 4.7 mm, 2.4 times longer than wide; frons broader; pronotum with sides less strongly constricted; pronotal scales much narrower and finer.

Type locality.—Of *H. variegatus*, Panama; of *P. maculosus*, Chiricahua Mountains, Arizona; of *P. mexicanus*, Distrito Federal, Mexico. The types of *P. maculosus* and *P. mexicanus*, in the United States National Museum, were examined. The concept of *P. variegatus* is based on specimens compared to the type by S. L. Wood. The type of *P. variegatus* is in the British Museum (Natural History).

Hosts.—*Abies* species, probably *A. reliogosa* in Mexico and *A. concolor* (Gord. and Glend.) Lindl. and *A. lasiocarpa* (Hook) Nutt. in the United States.

Geographical range.—Presently known from scattered localities from central Utah to southern Mexico (fig. 5). The Panama locality cited in the original description of *H. variegatus* is probably an error, since no native representative of the Pinaceae occurs south of northern Nicaragua. Specimens were examined from: UNITED STATES. ARIZONA. Cochise Co.: Chiricahua Mountains. Coconino Co.: Grand Canyon. Pima Co.: Santa Catalina Mountains. NEW MEXICO. Lincoln National Forest. Otero Co.: Cloudcroft. UTAH. Beaver Co.: Beaver. Summit Co.: Kamas. MEXICO. DISTRITO FEDERAL. Hidalgo: Pachuca. Michoacan: 34 miles E of Morelia.

Remarks.—This species and *P. magnus* are the only species in the genus which consistently possess stout bristles on the second declivital interspaces. *P. variegatus* may be distinguished from *P. magnus* by its smaller size and the smooth surface within the strial punctures. It seems remotely relate to *P. dispar* and may be easily distinguished by the characters given above and in the key. The hosts and distribution will immediately characterize it.

The galleries of this species have not been observed; however, judging from the phylogenetic position of the species, they are transverse and occur in the bole and larger limbs (see appendix).

Specimens compared to the type of *P. variegatus* show no consistent, meaningful differences when compared to holotypes of *P. mexicanus* and *P. maculosus*. The differences which do show are of a magnitude one would expect in a widely

distributed species. Blandford's name must therefore take precedence over the two names proposed by Blackman.

Pseudohylesinus magnus Wood

Pseudohylesinus magnus Wood, 1956, Can. Ent. 88(6):247.

Male.—Unknown.

Female.—Length 5.5 to 6.1 mm, 2.4 times wider than long. Body clothed with numerous very small suboval, dark brown to white scales, the white scales in patches resembling *P. dispar pullatus.*

Frons about as long as wide; punctures close, deep, of moderate size below the arcuate impression, rougher above. Antennal club with first segment nearly as long as second.

Pronotum 1.2 times wider than long, widest about middle; sides slightly arcuate on posterior three-fourths; surface reddish-brown to black; punctures close, shallow; vestiture on disc consisting of erect, dark setae and slender, recumbent scales.

Elytra 1.7 times longer than wide; crenulations on bases low, blunt; striae narrow, punctures large, close, surface within each puncture reticulate-granulate; interspaces convex, about twice as wide as striae; surface (when visible) finely rugose, the larger asperities forming a median row on posterior portion; vestiture on disc consisting of numerous small, elongate to suboval scales and two-ranked interstrial setae. Declivity sloping; second interspace with median row of tubercules and setae.

Type locality.—Twenty-five miles west of Ciudad Hidalgo, Michoacan, Mexico. The type is in the Snow Collection, University of Kansas, Lawrence. Paratypes, in the collection of S. L. Wood, Brigham Young University, Provo, Utah, were examined.

Host.—Abies reliogosa (H.B.K.).

Geographical range.—Presently known only from central Mexico. Specimens were examined from: MEXICO. Michoacan: 25 miles W of Ciudad Hidalgo and 33 miles E of Morelia.

Remarks.—This large species appears to be related to *P. variegatus* and, in some respects, to *P. dispar dispar*. It may be easily distinguished from all known species since it is the largest species thus far known south of the United States. Other distinguishing characteristics are the peculiar reticulate-granulate surface within each strial puncture and the finer, somewhat shorter, setae on the elytra.

The galleries have not been observed by me during this study; however, S. L. Wood (personal communication) stated that they are transverse and in the main bole of the tree.

Pseudohylesinus granulatus (Leconte)

(Figs. 6, 12, 18, 38, 39, 54, 55)

Hylastes granulatus Leconte, 1868, Trans. Amer. Ent. Soc. 2:175; Hagedorn, 1910, Coleopterorum Catalogus 4:9; Hagedorn, 1910, Genera Insectorum 111:45.

Hylurgops granulatus: Leconte, 1876, Proc. Amer. Phil. Soc. 15:390.

Hylesinus granulatus: Hopkins, 1904, U. S. Div. Ent. Bull. 48:19; Currie, 1905, U. S. Div. Ent. Bull. 53:75; Burke, 1905, Proc. Washington Ent. Soc. 7:89; Swaine, 1909, New York State Mus. Bull. 134:112.

Pseudohylesinus granulatus: Swaine, 1918, Can. Dept. Agric., Ent. Branch, Tech. Bull. 14(2):74, 75; Keen, 1938, U. S. Dept. Agric. Misc. Publ. 273:162; Chamberlin, 1939, Bark and timber beetles of North America, p. 200; Blackman, 1942, U. S. Dept. Agric. Misc. Publ. 461:14; Chamberlin, 1958, Scolytidae of the Northwest, p. 108; Thomas and Wright, 1961, U. S. Dept. Agric. For. Serv., For. Pest Leaf. 60, 7 pp.

Male.—Length 4.1 to 5.5 mm, 2.4 times longer than wide. Body clothed with numerous, elongate, cinerous to brown scales, and erect, short, hairlike setae.

Frons slightly longer than wide; punctures close, deep, rough below the faint arcuate impression, only slightly more so above. Antennal club with first segment much longer than second.

Pronotum 1.2 times wider than long, widest behind middle; sides strongly arcuate behind constriction; surface reddish-brown, punctures large, dense, giving a very roughened appearance; vestiture on disc consisting of sparse, narrow, flat, recumbent scales and erect, short hairs.

Elytra 1.6 times longer than wide; crenulations on bases low, blunt; striae of moderate width, punctures close, deep; interspaces about twice as wide as striae, convex; surface (when visible)

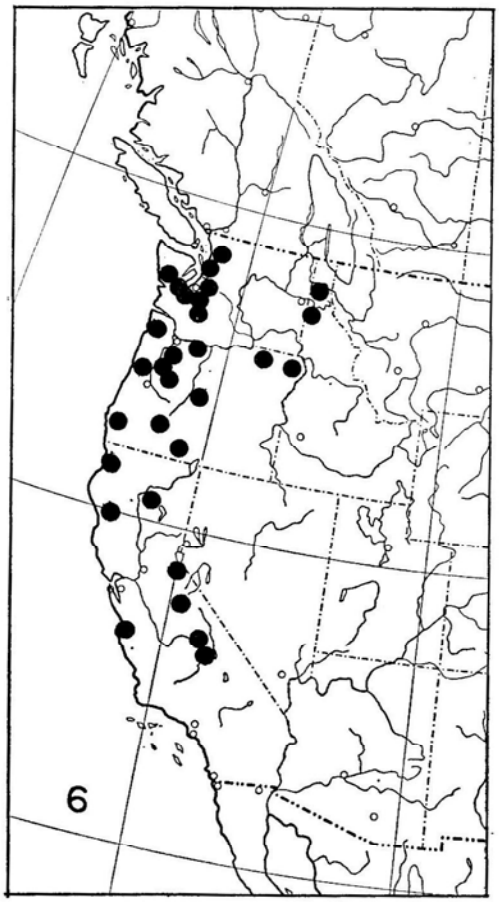

Fig. 6. Known geographic distribution of *Pseudohylesinus granulatus*.

more strongly roughened, the larger asperities forming a median row; vestiture on disc consisting of narrow, recumbent scales, these arranged in various color patterns. Declivity sloping; scales slightly broader than on disc.

Male seminal rod as in figure 18.

Female.—Similar in size and proportions to male; length up to 5.5 mm, about 2.4 times longer than wide; frons broader, more finely punctate and roughened; pronotum more evenly arcuate laterally; pronotal scales narrower, more hairlike; elytral scales less dense.

Type locality.—Oregon, exact locality not given. The type, in the Museum of Comparative Zoology, Cambridge, Massachusetts, was examined.

Hosts.—Various species of *Abies*.

Geographic range.—Throughout the forests of the Pacific Northwest, east to Montana and south to central California (fig. 6). Specimens were examined from: CALIFORNIA. Alpine Co.: Lake Alpine. Eldorado Co.: Fallen Leaf Lake. Fresno Co.: Paradise Valley and Kings River. Humboldt Co.: Eureka, Fieldbrook, and Trinidad. Lassen Co.: "Facht." Mendocino Co.: County

record only. Monterey Co.: Carmel. Placer Co.: Meadow Valley. Shasta Co.: Shingletown. Tulare Co.: Giant Forest, Kaweah, and Sequoia National Park. IDAHO. Kootenai Co.: Coeur d'Alene. Latah Co.: Moscow. OREGON. Benton Co.: Corvallis and Mary's Peak. Clatsop Co.: Cannon Beach. Coos Co.: Bandon. Crook Co.: Prineville. Hood River Co.: Hood River. Klamath Co.: Bly and Odell Lake. Linn Co.: Sweet Home. Marion Co.: Stayton. Umatilla Co.: Blue Mountains. WASHINGTON. Grays Harbor Co.: Moclips and Satsop. King Co.: Kanaskut and Seattle. Lewis Co.: Mineral. Pierce Co.: La Grande and Mt. Rainier. Skagit Co.: Clear Lake and Lyman. Thurston Co.: Carlyon Beach.

Remarks.—This is the largest species in the genus north of Mexico. It may be very easily distinguished from *P. magnus,* the only species approaching it in size, by the characters brought forth in the discussion of that species. From other species in North America, it may be separated by its large size, by the more roughly sculptured elytral interspaces, by the more strongly and deeply punctured frons, by the very faint arcuate impression on the frons, and by its biology.

The transverse galleries of this species are constructed in the lower part of the main bole, often extending below ground level as much as two feet. The galleries range in length from 2 cm to 18 cm.

Pseudohylesinus tsugae Swaine

(Figs. 7, 19, 40, 41, 56, 57)

Pseudohylesinus tsugae Swaine, 1917, Can. Dept. Agric. Ent. Branch, Tech. Bull. 14(1):11; Swaine, 1918, Can. Dept. Agric. Ent. Branch, Tech. Bull. 14(2):75; Keen, 1938, U. S. Dept. Agric. Misc. Publ. 273:166; Chamberlin, 1939, Bark and timber beetles of North America, p. 201; Blackman, 1942, U. S. Dept. Agric. Misc. Publ. 461:16; Chamberlin, 1958, Scolytidae of the Northwest, p. 110.

Pseudohylesinus obesus Swaine, 1917, Can. Dept. Agric. Ent. Branch, Tech. Bull. 14(1):15: Chamberlin, 1958, Scolytidae of the Northwest, p. 112 (new synonymy).

Pseudohylesinus keeni Blackman, 1942, U. S. Dept. Agric. Misc. Publ. 461:17; Chamberlin, 1958, Scolytidae of the Northwest, p. 114 (new synonymy).

Pseudohylesinus similis Blackman, 1942, U. S. Dept. Agric. Misc. Publ. 461:18; Chamberlin, 1958, Scolytidae of the Northwest, p. 113 (new synonymy)

Male.—Length 3.3 to 4.3 mm, 2.1 times longer than wide. Reddish-brown, covered with numerous light brown to black scales and hairs.

Frons reddish-brown, slightly longer than wide; punctures close, almost granulate below the arcuate impression, larger, coarser above; surface between punctures faintly granulate. Antennal club with first segment longer than second.

Pronotum 1.3 times wider than long, widest about middle; sides subparallel behind constriction; surface reddish-brown, minutely rugose; punctures somewhat coarse, close; vestiture on disc consisting of relatively short, hairlike, recumbent scales, these becoming broader at sides, devoid of erect hairs except at sides.

Elytra 1.5 times longer than wide; crenulations on bases low, blunt; striae rather wide, punctures large, deeply impressed; interspaces about twice as wide as striae, convex; surface (when visible) shining, slightly rugose, the larger asperities forming a median row except on third and fifth interspace where they are irregular to declivity; vestiture on disc consisting of numerous elongate scales, these about 2 times longer than wide and forming an irregular color pattern. Declivity sloping, unmodified except scales more dense than on disc.

Male seminal rod as in figure 19.

Female.—Similar in general proportions to male, 2.1 times longer than wide; frons about as long as wide, smoother, more finely punctured; pronotum less strongly constricted, finely punctured and rugose, clothed only by hairlike setae; elytral scales much more elongate, about 4 times longer than wide, only partially covering elytral surface.

Type locality.—Of *P. tsugae,* Stanley Park, Vancouver, British Columbia; of *P. obesus,* Inver-

ness, British Columbia; of *P. keeni*, Cannon Beach, Oregon; of *P. similis*, Paradise Valley, Washington. Types of all names were examined. The types of *P. tsugae* and *P. obesus* are in the Canadian National Collection and the types of *P. keeni* and *P. similis* are in the United States National Museum.

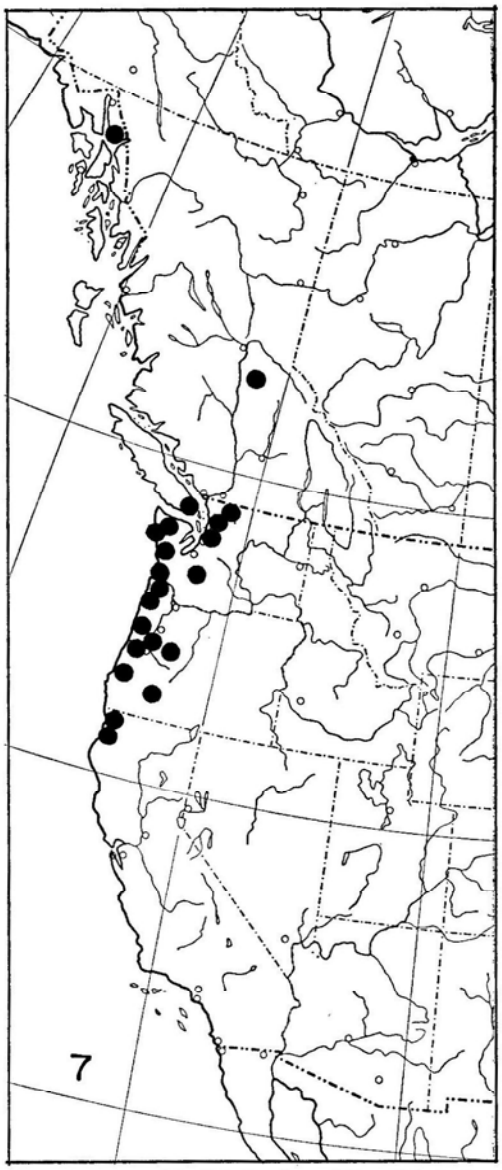

Fig. 7. Known geographic distribution of *Pseudohylesinus tsugae*.

Hosts.—Principally *Tsuga heterophylla* (Raf.) Sarg., also recorded from *T. mertensiana* (Bong.) Carr, *Abies amabilis* (Dougl.) Forbes, and *A. lasiocarpa* (Hook.) Nutt.

Geographical range.—From northwestern California north along the Coast and Cascade Ranges to southeast Alaska (fig. 7). Specimens were examined from: UNITED STATES. ALASKA. Juneau. CALIFORNIA. Del Norte Co.: Crescent City. Humboldt Co.: Fieldbrook. OREGON. Benton Co.: Corvallis and Waldport. Clatsop Co.: Astoria, Cannon Beach, "Clatsop" and 10 miles N

of Mohler. Coos Co.: Marchfield. Klamath Co.: Crater Lake National Park and "Mt. Pitt Trail." Lincoln Co.: Otis. Linn Co.: Marion Forks. Polk Co.: Boyer. Tillamook Co.: Batterson. WASHINGTON. Clallam Co.: Sappho. Grays Harbor Co.: Hoquiam. King Co.: Montlake Terrace. Pacific Co.: Naselle. Pierce Co.: Paradise Valley and White River. Skagit Co.: Concrete. Whatcum Co.: Glacier. CANADA. BRITISH COLUMBIA. Duncan, Inverness, "Mt. Mahleach," Stanley Park, and Vancouver.

Remarks.—Pseudohylesinus tsugae appears to be most closely related to *P. nobilis* but may be readily separated from that species by the following characteristics: the narrow to hairlike pronotal scales of both sexes, the lack of erect, stout pronotal setae, the very narrow elytral scales of the female and the host.

This species seems to show the most variation of any species in the genus, as evidenced by the amount of synonymy. The species that Blackman described seem to be distinct in themselves except when large series are examined. The most prominent variation occurs in the shape of the pronotal setae, especially in the males. They vary from almost completely hairlike to very slender, about 4 to 5 times longer than wide. In this respect, these forms approach the type of vestiture in *P. nobilis*. Some specimens also show a more granular pronotal surface with somewhat wider scales.

Since these variations can be seen in any large series of *P. tsugae* and no discernible variation can be observed in the genitalia or the gallery pattern, only one species can be recognized.

The galleries of this species may be constructed from the main bole to the smaller limbs and are transversely oriented. They range in length from 3.8 to 7.8 cm, the average being 5.5 cm.

Pseudohylesinus nobilis Swaine

(Figs. 8, 20, 30, 42, 43, 58, 59)

Pseudohylesinus nobilis Swaine, 1917, Can. Dept. Agric. Ent. Branch, Tech. Bull. 14(1):12; Swaine, 1918, Can. Dept. Agric. Ent. Branch, Tech. Bull. 14(2):74; Keen, 1938, U. S. Dept. Agric. Misc. Publ. 273:162; Chamberlin, 1939, Bark and timber beetles of North America, p. 202; Blackman, 1942, U. S. Dept. Agric. Misc. Publ. 461:19; Chamberlin, 1958, Scolytidae of the Northwest, p. 110.

Pseudohylesinus furnissi Blackman, 1942, U. S. Dept. Agric. Misc. Publ. 461:21 (new synonymy).

Male.—Length 2.7 to 3.7 mm, 2.2 times longer than wide. Body clothed with dark brown to white scales and hairs.

Frons black above arcuate impression, reddish below; punctures coarse, close below impression, rougher, deeper above; surface between punctures finely granulate. Antennal club with first segment longer than second.

Pronotum 1.3 times wider than long, widest at about middle; sides evenly arcuate behind constriction; surface reddish, roughly punctured and granulate over entire disc, becoming strongly asperate on sides; vestiture on disc consisting of erect hairs scattered over surface and numerous short, broad recumbent scales, these broader on sides.

Elytra 1.5 times longer than wide; crenulations on bases small, blunt; striae narrow, punctures large, deep, close; interspaces about twice as wide as striae, convex; surface (when visible) finely rugose, the larger asperities forming a median row; vestiture on disc consisting of numerous, oval, recumbent scales, these about twice as long as wide. Declivity sloping, unmodified except scales shorter and wider than on disc.

Male seminal rod as in figure 20.

Female.—Length up to 4.2 mm, 2.2 times longer than wide; frons broader, more finely punctate; pronotum much less strongly constricted at lateral margins, scales completely hairlike on

disc with no trace of wide scales except near lateral margin; elytral scales slightly smaller and interstrial setae finer and shorter.

Type locality.—Of *P. nobilis,* Santiam National Forest, Oregon; of *P. furnissi,* Mount Rainier National Park, Washington. The lectotype of *P. nobilis,* in the Canadian National Collection, and the holotype of *P. furnissi,* in the United States National Museum, were examined.

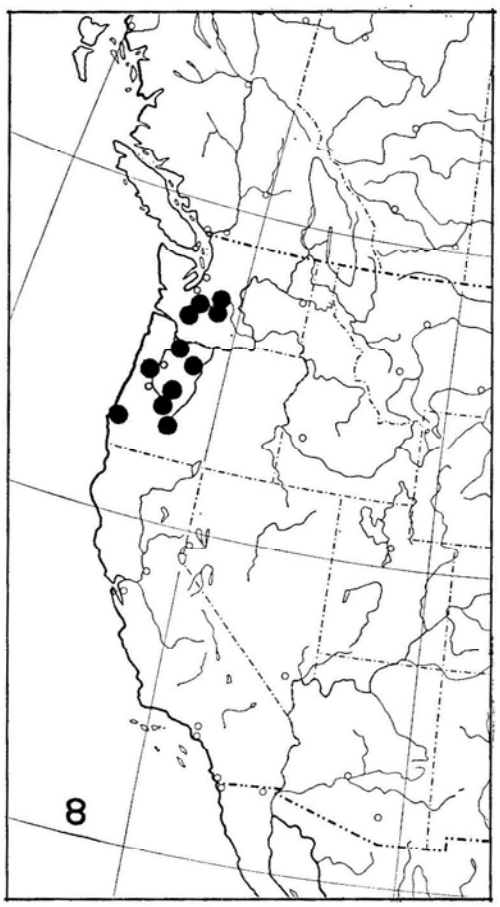

Fig. 8. Known geographic distribution of *Pseudohylesinus nobilis.*

Hosts.—Probably all species of *Abies* in the Pacific Northwest but definitely recorded from *Abies procera* Rehd., *A. amabilis* (Dougl.) Forbes, *A. grandis* (Dougl.) Lindl. and *Tsuga heterophylla* (Raf.) Sarg.

Geographical range.—The Pacific Northwest (fig. 8). Specimens were examined from: OREGON. Benton Co.: Mary's Peak. Coos Co.: Bandon. Hood River Co.: Lost Lake and Mt. Hood. Klamath Co.: Crater Lake National Park. Lane Co.: Gold Lake and Willamette Pass. Linn Co.: Santiam Junction. Multnomah Co.: Portland. WASHINGTON. Kittitas Co.: Easton. Pierce Co.: Longmire, Mt. Rainier National Park, Paradise, White River, and Yakima Park. Skaminia Co.: Spirit Lake. Yakima Co.: White Pass.

Remarks.—This species is most closely related to *P. tsugae* and *P. grandis.* From *P. grandis,* it may be distinguished by the hairlike pronotal scales of the female, by the narrow pronotal scales of the male, by the short, inconspicuous interstrial setae of the female and by the relatively wider striae of both sexes.

From *P. tsugae,* it may be distinguished by the lack of hairlike setae on the male pronotum, by the much wider elytral scales of the female and by the host.

The galleries of this species are the most irregular of any species observed. In all other species, the orientation of the gallery generally remains the same throughout the range. In *P. nobilis,* the galleries are most often transverse but many times either one arm or the entire gallery may be constructed at an angle to the grain (fig. 30). The galleries measure from 3.0 to 8.4 cm with the average about 5.1 cm, and may be found in the main bole and the larger limbs.

Pseudohylesinus grandis Swaine

(Figs. 2, 9, 21, 25, 26, 27, 28, 31, 44, 45, 60, 61)

Pseudohylesinus grandis Swaine, 1917, Can. Dept. Agric. Ent. Branch, Tech. Bull. 14(1):13; Swaine, 1918, Can. Dept. Agric. Ent. Branch, Tech. Bull. 14(2):75; Keen, 1938, U. S. Dept. Agric. Misc. Publ. 273:162; Chamberlin, 1939, Bark and timber beetles of North America, p. 200; Blackman, 1942, U.S. Dept. Agric. Misc. Publ. 461:22, Chamberlin, 1958, Scolytidae of the Northwest, p. 109; Thomas and Wright, 1961, U. S. Dept. Agric. For. Serv., For. Pest Leaf. 60, 7 pp.

Male.—Length 2.7 to 3.3 mm, 2.1 times longer than wide. Color pattern of brown and white scales in various combinations, many times the light scales form a V-shaped area about midway on elytra.

Frons black to reddish, slightly longer than wide; punctures rather coarse below arcuate impression, rougher, deeper above. Antennal club with first segment longer than second.

Pronotum 1.3 times wider than long, widest at about middle; sides strongly rounded behind constriction; surface reddish; punctures strong and rough; vestiture on disc consisting of erect hairs scattered over surface and numerous broad, recumbent scales, these about two to three times longer than wide.

Elytra 1.4 times longer than wide; crenulations on bases small, blunt; striae narrow, punctures close and deep; interspaces about 3 to 4 times wider than striae, weakly convex; surface (when visible) slightly rugose, the larger asperities forming a median row; vestiture on disc consisting of numerous flat, short, nearly circular scales. Declivity sloping, unmodified except second interspace frequently with a median row of erect setae and scales more nearly circular.

Male seminal rod as in figure 21.

Female.—Length 2.7 to 3.9 mm, 2.1 times longer than wide; frons broader with a more prominent arcuate transverse impression, surface more finely sculptured; pronotum with sides less arcuate and less strongly constricted; vestiture of broad, elongate scales; scales of elytra nearly circular on disc, less numerous.

Type locality.—Saanichton, British Columbia. The lectotype in the Canadian National Collection was examined.

Hosts.—Various species of *Abies,* also *Pseudotsuga menziesii* (Mirb.) Franco and *Tsuga heterophylla* (Rafinesque) Sargent.

Geographical range.—From southeast Alaska, south through the coniferous forests of the Pacific Northwest and along the coast to central California (fig. 9). Specimens were examined from: UNITED STATES. CALIFORNIA. Del Norte Co.: Crescent City and Gasquet. Humboldt Co.: Ferndale and 11 miles SW of Orick. Lassen Co.: "Facht." Marin Co.: Carson Creek, Inverness, Lagunitas, Mill Valley, and Mt. Tamalpais. Mendocino Co.: Fort Bragg and Noyo River. San Francisco Co.: San Francisco. San Mateo Co.: Lake Pilarcitas. Sonoma Co.: Duncan's Mill. OREGON. Benton Co.: Corvallis, Mary's Peak and Waldport. Clatsop Co.: Astoria and Cannon Beach. Coos Co.: Marshfield. Douglas Co.: Diamond Lake. Hood River Co.: Lost Lake. Jackson Co.: Pinehurst. Klamath Co.: Bly, Crater Lake National Park, and Lake of the Woods. Lane Co.: Florence, Junction City, and Willamette Pass. Lincoln Co.: Otis and Taft. Linn Co.: Santiam Junction and Scio. Polk Co.: Boyer. Washington Co.: Hillsboro. Yamhill Co.: McMinnville. WASHINGTON. Clallam Co.: Lake Crescent and Forks. King Co.: Seattle. Pacific Co.: Bruce Port

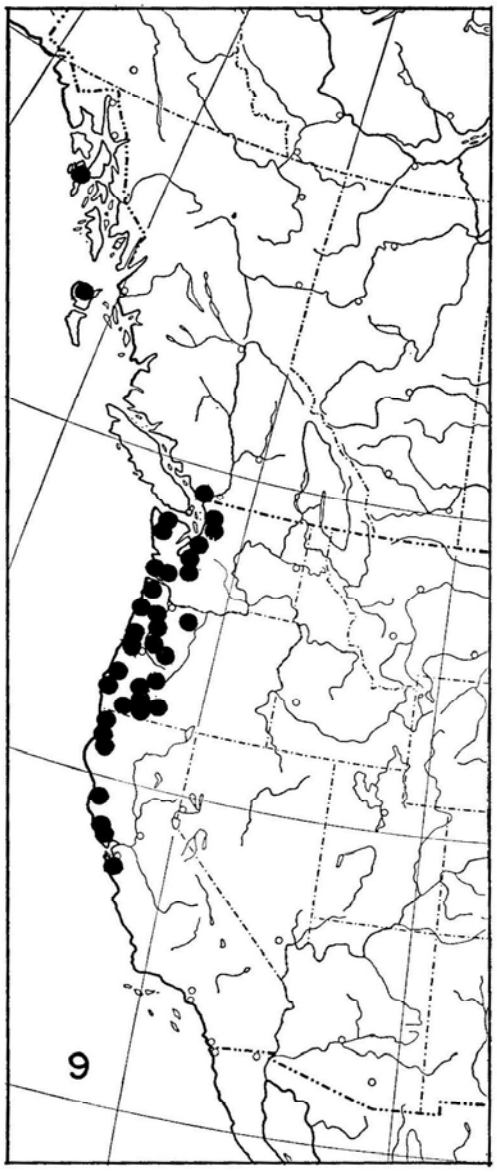

Fig. 9. Known geographic distribution of *Pseudohylesinus grandis.*

Park and Naselle. Pierce Co.: American Lake, Longmire, Loveland, and Mt. Rainier National Park. Skagit Co.: Clear Lake. Snohomish Co.: Chase Lake. CANADA. BRITISH COLUMBIA. Queen Charlotte Islands, Saanichton, and Vancouver.

Remarks.—This species seems to occupy an intermediate position between the *tsugae-nobilis* group and the *sericeus-sitchensis* group. It is difficult to present characters which will readily separate it from these other species. From *P. nobilis, P. grandis* may be most easily distinguished by the wide pronotal scales of both sexes (figs. 44, 45), the different pronotal shape and the long interstrial setae

of the female. It may be separated from *P. sericeus* and *P. sitchensis* by the shorter frons of both sexes, by the nearly circular elytral scales of the female (fig. 61), by its hosts and by its gallery pattern (fig. 31).

The galleries of this species are almost invariably transverse. They are constructed in almost any portion of the tree except the roots and very small limbs. The galleries range in length from 4 to 12 cm with the average being about 6.6 cm.

Pseudohylesinus sitchensis Swaine

(Figs. 10, 22, 32, 46, 47, 62, 63)

Pseudohylesinus sitchensis Swaine, 1917, Can. Dept. Agric. Ent. Branch, Tech. Bull. 14(1):12; Swaine, 1918, Can. Dept. Agric. Ent. Branch, Tech. Bull. 14(2):75; Keen, 1938, U. S. Dept. Agric. Misc. Publ. 273:165; Chamberlin, 1939, Bark and timber beetles of North America, p. 202; Blackman, 1942, U. S. Dept. Agric. Misc. Publ. 461:23; Chamberlin, 1958, Scolytidae of the Northwest, p. 111.

Male.—Length 2.9 to 3.2 mm, 2.1 times longer than wide. Color pattern closely resembles *P. grandis.*

Frons reddish, distinctly longer than wide; punctures coarse, deep below the arcuate impression, rougher above. Antennal club with first segment longer than second.

Pronotum 1.2 times wider than long, widest near middle; sides strongly arcuate behind constriction; surface reddish; punctures rough, closely placed; vestiture on disc consisting of short, erect hairs scattered over surface and numerous circular, recumbent scales about the size of pronotal punctures.

Elytra 1.4 times longer than wide; crenulations on bases blunt, separate; striae narrow, punctures deep and close; interpaces almost 4 times wider than striae, weakly convex; surface (when visible) shining, finely rugose, the larger asperities forming a median row; vestiture on disc consisting of elongate scales, about 1.5 to 2.0 times longer than wide, these arranged in various patterns. Declivity sloping, unmodified except scales more thickly placed.

Male seminal rod as in figure 22.

Female.—Length 2.9 to 3.5 mm, slightly more elongate than male, 2.2 times longer than wide. Frons broader, more finely punctured; pronotum much less strongly constricted anteriorly, punctures finer; scales of pronotum and elytra more elongate.

Type locality.—Menzies Bay, British Columbia. The type, in the Canadian National Collection, was examined.

Host.—Picea sitchensis (Bongard) Carriere.

Geographic range.—Throughout the Pacific coast region wherever its host occurs (fig. 10). Specimens were examined from: UNITED STATES. ALASKA. Afognak Island, Juneau, and Prince of Wales Island. CALIFORNIA. Del Norte Co.: Klamath. Humboldt Co.: Eureka, Ferndale, and Trinidad. OREGON. Clatsop Co.: Cannon Beach and Seaside. Coos Co.: Marshfield. Hood River Co.: Mt. Hood. Lincoln Co.: Otis. WASHINGTON. Grays Harbor Co.: Hoquiam. CANADA. BRITISH COLUMBIA. Menzies Bay.

Remarks.—This species is almost identical in appearance to *P. grandis.* The females may be separated by the narrower and more elongate elytral scales and the deeper, more distinct arcuate impression of the frons of *P. sitchensis* while in the males, the narrower, more elongate frons, the nearly circular pronotal scales and the narrow elytral scales will distinguish *P. sitchensis.* Since this species is the only species of *Pseudohylesinus* commonly found in Sitka spruce, this fact alone will identify it at once.

The longitudinal orientation of the galleries is completely different from *P. grandis* or related species, and can only be confused with *P. sericeus.* In this case, the absence of any enlarged nuptial chamber characterizes *P. sitchensis* (fig. 32). The galleries of *P. sitchensis* range from 1.8 to 3.0 cm, with an average of 2.0 cm.

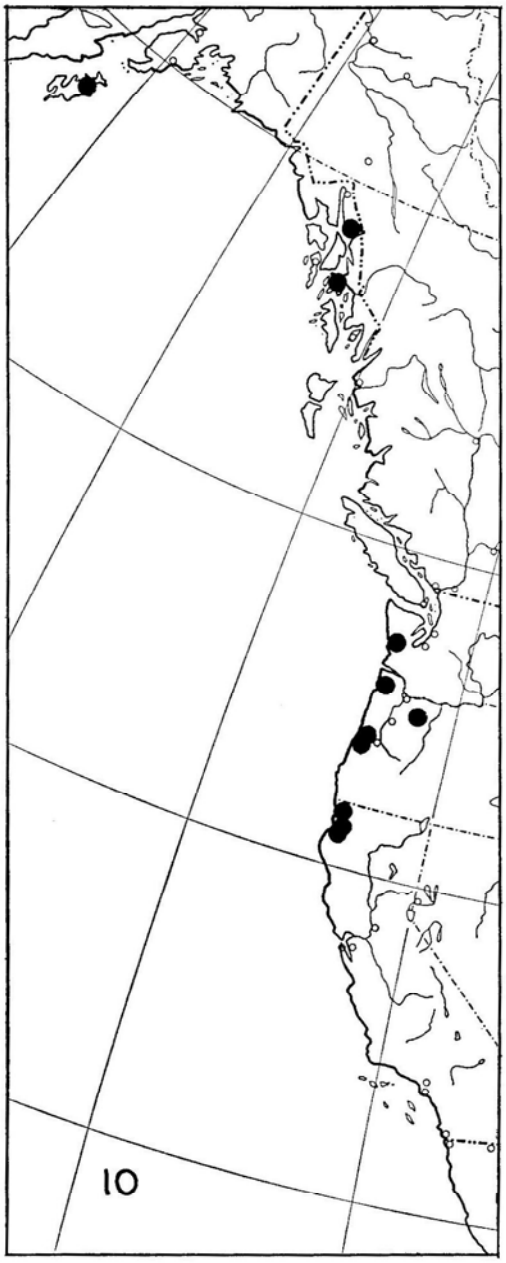

Fig. 10. Known geographic distribution of *Pseudohylesinus sitchensis.*

Pseudohylesinus sericeus (Mannerheim)

(Figs. 11, 23, 33, 48, 49, 64, 65)

Hylurgus sericeus Mannerheim, 1843, Moskov. Obshch. Isp. Prirody, Otd. Biol. Biul. (Soc. Nat. de Moscov. Sect. Biol. Bull.) 16:296; Mannerheim, 1852, Moskov. Obshch. Isp. Prirody, Otd. Biol. Biul. (Soc. Nat. de Moscov. Sect. Biol. Bull.) 25:356; Hagedorn, 1910, Genera Insectorum 111:46.

Hylesinus sericeus: Mannerheim, 1852, Moskov. Obshch. Isp. Prirody, Otd. Biol. Biul. (Soc. Nat. de Moscov. Sect. Biol. Bull.) 25:385; Leconte, 1868, Trans. Amer. Ent. Soc. 2:170; Leconte, 1876, Proc. Amer. Phil. Soc. 15:379; Schwarz, 1894, Insect Life 7:254–256; Hamilton, 1894, Trans. Amer. Ent. Soc. 21:35; Hopkins, 1904, U. S. Div. Ent. Bull. 48:20; Currie, 1905, U. S. Div. Ent. Bull. 53:75; Swaine, 1909, New York State Mus. Bull. 134:113.

Hylastes sericeus: Hagedorn, 1910, Coleoptorum Catalogue 4:12.

Pseudohylesinus sericeus: Swaine, 1917, Can. Dept. Agric., Ent. Branch, Tech. Bull. 14(1):14; Swaine, 1918, Can. Dept. Agric., Ent. Branch, Tech. Bull. 14(2):75; Keen, 1938, U. S. Dept. Agric. Misc. Publ. 273:155; Chamberlin, 1939, Bark and timber beetles of North America, p. 203; Blackman, 1942, U. S. Dept. Agric. Misc. Publ. 461:24; Chamberlin, 1958, Scolytidae of the Northwest, p. 112.

Male.—Length 2.4 to 2.9 mm, 2.1 times longer than wide. Color pattern of numerous dark brown to white scales and yellowish hairlike setae.

Frons black above arcuate impression, reddish below, distinctly longer than wide; punctures fine, close below impression, rougher and granulate above. Antennal club with first segment longer than second.

Pronotum 1.4 times wider than long, widest about middle; sides very strongly arcuate behind constriction; surface reddish-brown; punctures deep and somewhat granulate; vestiture on disc consisting of short, erect hairs and nearly circular scales.

Elytra 1.5 times longer than wide; crenulations on bases slightly elevated, overlapping; striae narrow, punctures small, close; interspaces 2 to 3 times wider than striae, weakly convex; surface (when visible) shining, finely rugose; the larger asperities forming a median row; vestiture on disc consisting of numerous, circular scales, the white ones forming a V-shaped pattern at mid-elytra. Declivity sloping, unmodified except scales more thickly placed.

Male seminal rod as in figure 23.

Female.—Slightly more elongate, 2.2 to 2.3 times longer than wide; frons much broader, arcuate impression more prominent and impressed; pronotal and elytral scales more elongate; interstrial setae shorter and finer.

Type locality.—Sitka, Alaska. The type should be in the Helsinki Museum, Finland. A "presumed cotype" in the Leconte Collection at Harvard University was examined.

Hosts.—*Pinus contorta* Loudan, *P. muricata* D. Don, and *P. radiata* D. Don.

Geographic range.—Along the Pacific Coast from Monterey, California to southeast Alaska (fig. 11). Specimens were examined from: UNITED STATES. ALASKA. Sitka. CALIFORNIA. Marin Co.: Carson Creek and Cypress Ridge. Mendocino Co.: Albion and Mendocino. Monterey Co.: Carmel and Monterey. San Francisco Co.: San Francisco. Santa Cruz Co.: Santa Cruz. OREGON. Clatsop Co.: Seaside. Lane Co.: Florence and Glenada. Lincoln Co.: Neport (Newport?). Tillamook Co.: Sandlake. WASHINGTON. Grays Harbor Co.: Westport. CANADA. BRITISH COLUMBIA. Massett (Queen Charlotte Islands) and Metlaktla.

Remarks.—*Pseudohylesinus sericeus* very closely resembles *P. sitchensis* in general shape and color pattern. It differs, however, in the narrower male frons (.32–.43 mm, average .33 mm for *P. sericeus* versus .48–.55 mm, average .49 mm for *P. sitchensis*), by the more strongly arcuate male pronotum, by the smaller body size for both sexes, by the broader elytral scales of the female (fig. 65), by the gallery pattern (fig. 33) and by the host.

The longitudinal galleries almost invariably show a pronounced curve or hook

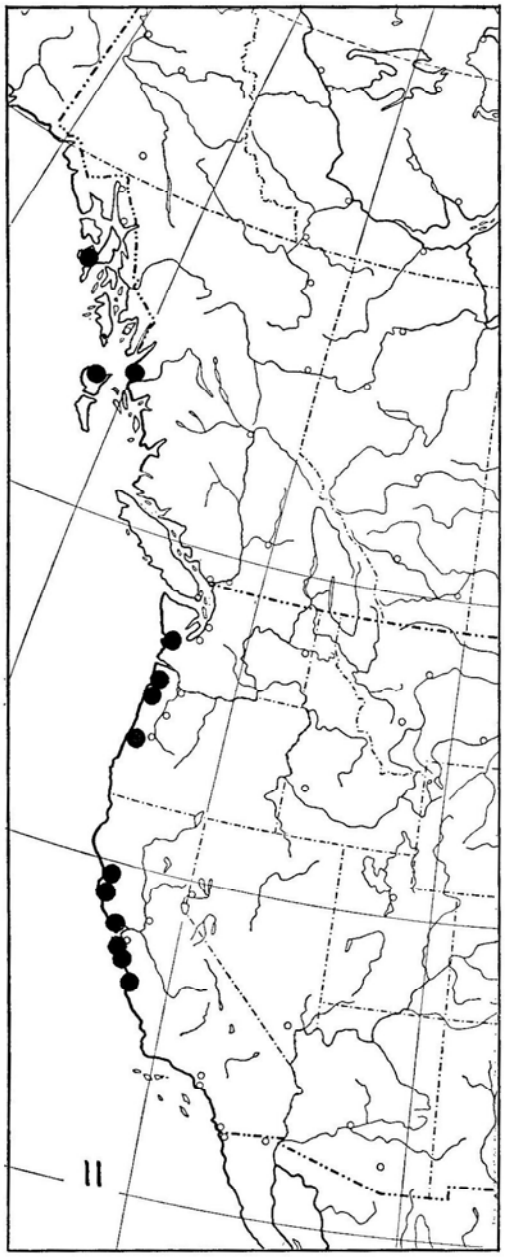

Fig. 11. Known geographic distribution of *Pseudohylesinus sericeus.*

at the entrance tunnel. In some cases, this may be enlarged to form a cavity which may serve as a nuptial chamber. This is in contrast to the gallery of *P. sitchensis* in which no curve, hook, or enlarged chamber is evident.

SPECIES OMITTED

Xylechinus humilis (Blanchard), n. comb.

Hylesinus humilis Blanchard, 1851, *in* Guy, Hist. fisica y politica Chile, p. 427.
Pseudohylesinus humilis: Eggers, 1929, Wein. Ent. Zeit. 46(2):53.

Remarks.—The type of this species, loaned by the Paris Museum, was examined. Although it is in poor condition, I was able to determine that it belongs in the genus *Xylechinus* Chapuis. The elytral interspaces bear erect, scalelike setae, which are not found on any species of *Pseudohylesinus*. The antennae are obscured by dirt and could not be seen. The frons is very similar to species of *Pseudohylesinus* but differs by lacking the epistomal lobes and by the more concave surface.

Xylechinosoma brasiliensis (Schedl), n. comb.

Pseudohylesinus brasiliensis Schedl, 1951, Dusenis 2(2):95.

Remarks.—A recent examination of a syntype of this species in the Canadian National Collection revealed that it belongs to the genus *Xylechinosoma* Schedl and is most closely related to *X. araucariae* Schedl.

SUMMARY

The present study of the species in the genus *Pseudohylesinus* Swaine was undertaken to solve some of the taxonomic problems existing in the group. After an examination of large numbers of specimens, the array of variations became less confusing. A large amount of variation occurs in this genus with the result that previous authors named several varieties as species. As a result of this investigation, the species are redefined and their relationships indicated.

No new species ae described. The species and subspecies recognized and their synonyms are: (1) *P. nebulosus nebulosus* (Leconte) (=*P. nebulosus* Leconte); (2) *P. nebulosus serratus* Bruck (=*P. serratus* Bruck); (3) *P. dispar dispar* (=*P. dispar* Blackman); (4) *P. dispar pullatus* (=*P. pullatus* Blackman); (5) *P. variegatus* (Blandford) (=*P. maculosus* Blackman, *P. mexicanus* Blackman; (6) *P. tsugae* Swaine (=*P. obesus* Swaine, *P. keeni* Blackman, *P. similis* Blackman); (7) *P. nobilis* Swaine (=*P. furnissi* Blackman). *Pseudohylesinus granulatus* (Leconte), *P. grandis* Swaine, *P. sitchensis* Swaine, *P. sericeus* (Mannerheim), and *P. magnus* Wood are also included in the genus. *P. humilis* (Blanchard) is transferred to *Xylechinus* Chapuis and *P. brasiliensis* Schedl is transferred to *Xylechinosoma* Schedl. *Pseudohylesinus* and *Xylechinus* are placed in the tribe Hylesinini in the subfamily Hylesininae.

All members of the genus feed and reproduce in the phloem-cambial region of various coniferous trees. Generally the species in this genus do little damage, but they are capable of attacking and killing apparently healthy trees.

The winter is passed as mature larvae or young adults under the bark of trees, sometimes in special hibernating niches. The species of *Pseudohylesinus* are usually the earliest bark beetles to emerge and attack in the spring. Initial attack is made by the female, usually under a bark scale or in a crevice. *Pseudohylesinus nebulosus, P. sitchensis,* and *P. sericeus* excavate longitudinal galleries, while the

other species construct transverse gallery systems. Eggs are laid singly in niches along the gallery wall and the larvae mine mostly in the inner bark at right angles to the main gallery but eventually turn to follow the grain of the wood. Pupation takes place in enlarged chambers excavated in the bark at the end of the larval mines.

All species occur in western North America, predominantly in the Pacific Northwest; two species occur in Mexico.

APPENDIX

1. After this study was completed, Schedl (Ent. Arb. Mus. Frey 17:75, 1966) stated that *Pseudohylesinus* Swaine, 1917, is a synonym of the European genus *Pteleobius* Bedel, 1888. Although the species of the two genera are similar in general appearance, there is enough distinctness in important characters to easily differentiate the genera. The prothoracic intercoxal piece of *Pseudohylesinus* is much narrower than in *Pteleobius;* the lateral margins of the pronotum of *Pteleobius* bears distinct asperities while the pronotum of *Pseudohylesinus* is smooth throughout; the frons of *Pteleobius* is evenly concave or convex while the frons of *Pseudohylesinus* is convex with an arcuate impression and the antennal club of *Pteleobius* has two distinct transverse sutures while the antennal club of *Pseudohylesinus* has three distinct transverse sutures. In view of these different characters, it seems best to regard the two genera as distinct.

2. Wood (personal communication) has detected biological differences between populations of *Pseudohylesinus variegatus* occurring in Mexico and Utah. He states "*variegatus* larval tunnels were in the cambium-phloem area through about the first half of their length, there abruptly move ¼ inch below the surface of the wood and continue at this level to the end; young adults emerge from the wood. In *P. maculosus* (= *variegatus*) . . . larval mines were in the cambium-phloem region throughout; young adults emerged from the outer bark." It is not known if these differences in larval habits are intrinsic factors in the populations or are caused by external factors. Until more observations are available, the populations will be considered as one species.

3. An important paper on the biology of *Pseudohylesinus tsugae* and *P. grandis* by J. H. McGhehey and W. P. Nagel (Can. Ent. 101(3):269–279, 1969) appeared too recently for its findings to be included herein. They present additional data on life history, gallery construction, attack pattern, and additional parasite records. Their data showed that there were four larval instars in contrast to previously published and unpublished data that showed three or roughly three instars. This point should be investigated.

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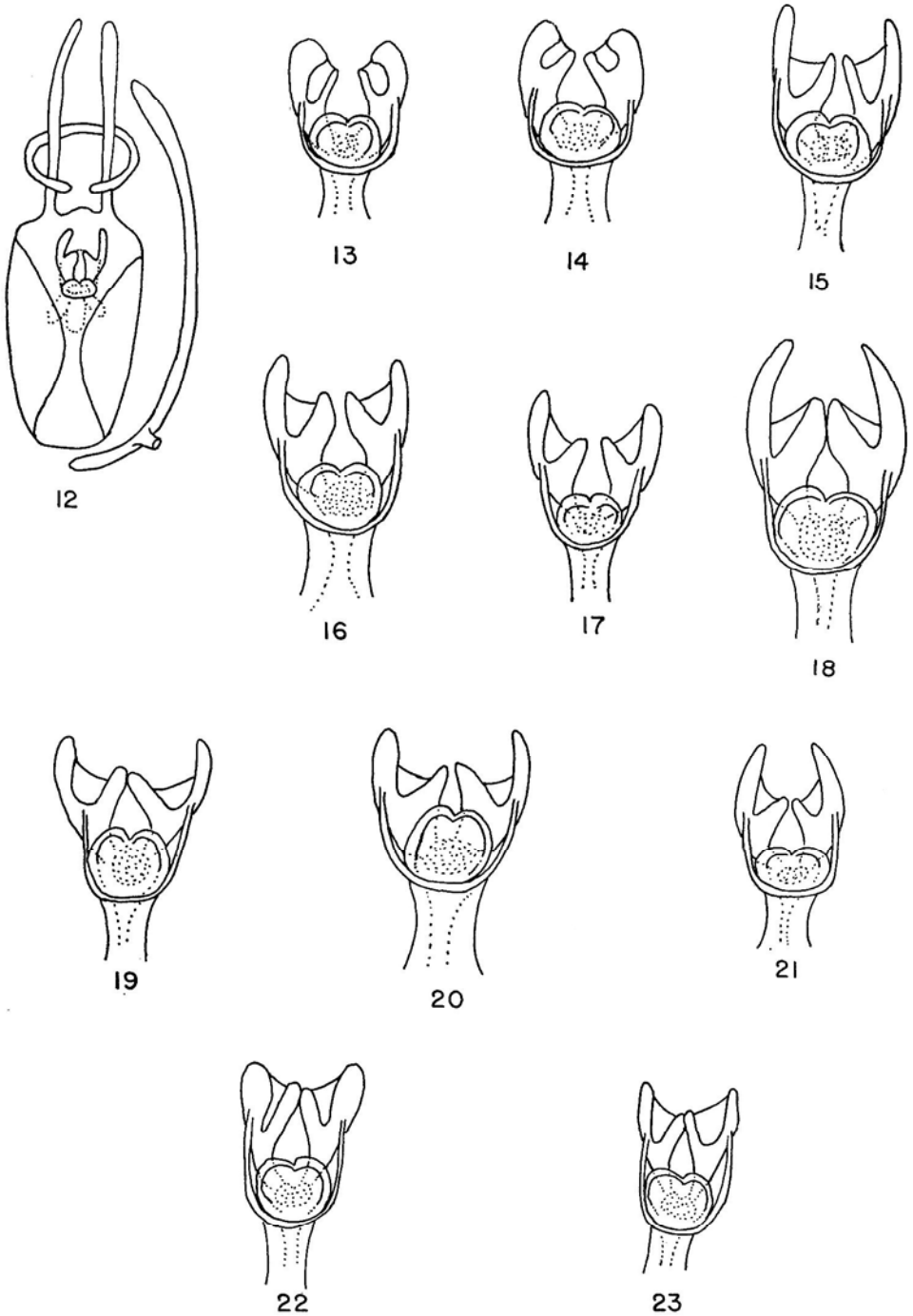
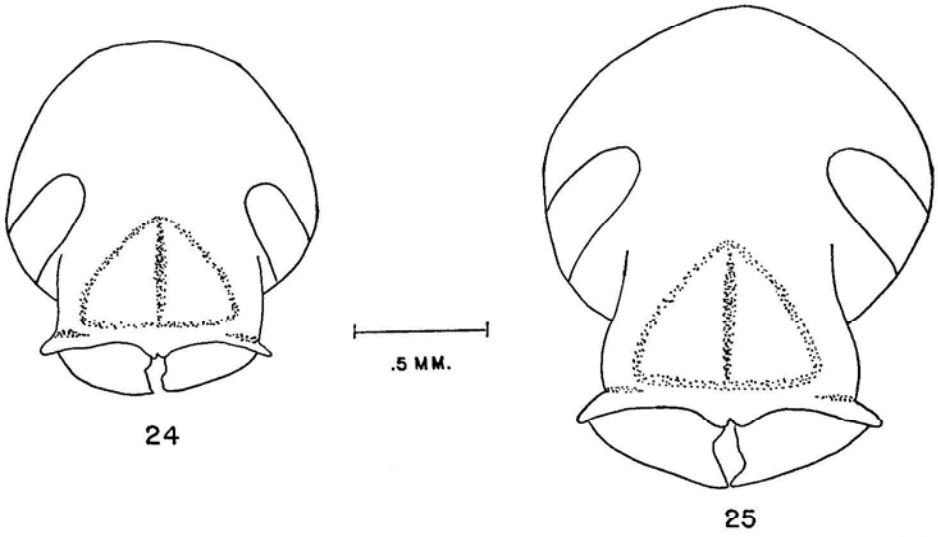
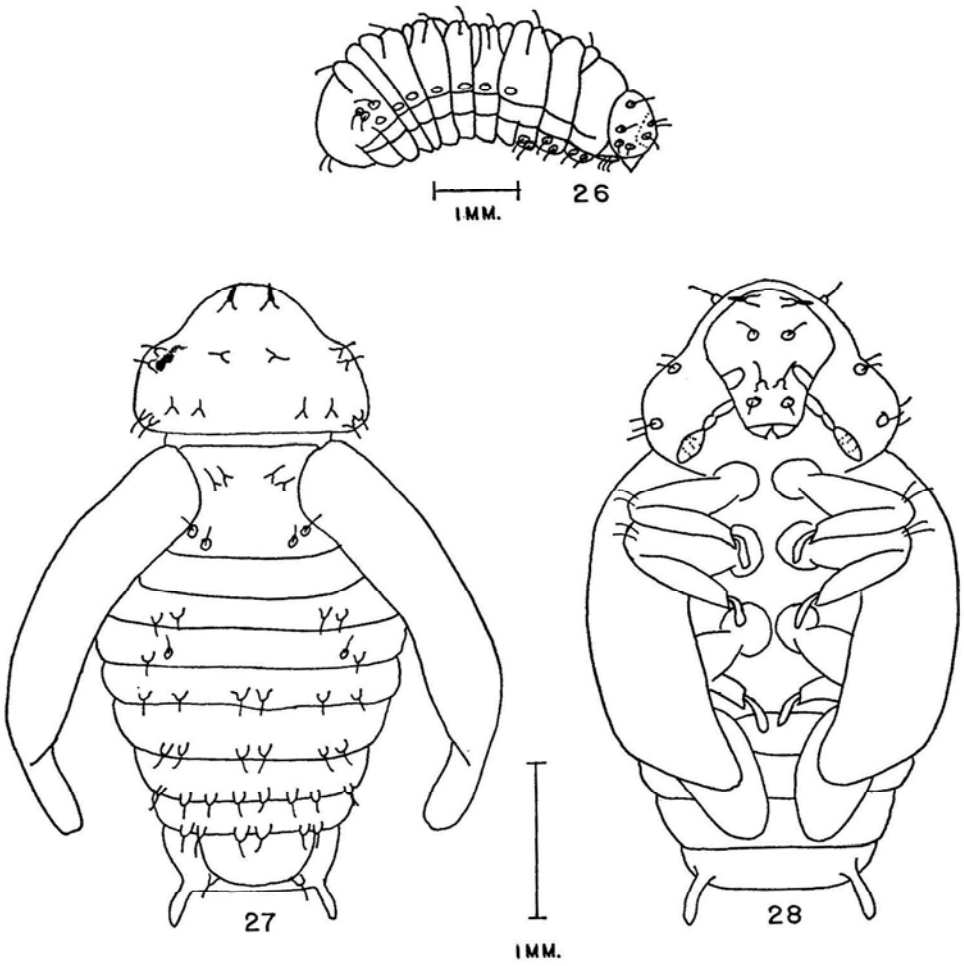
FIGURES 12–33



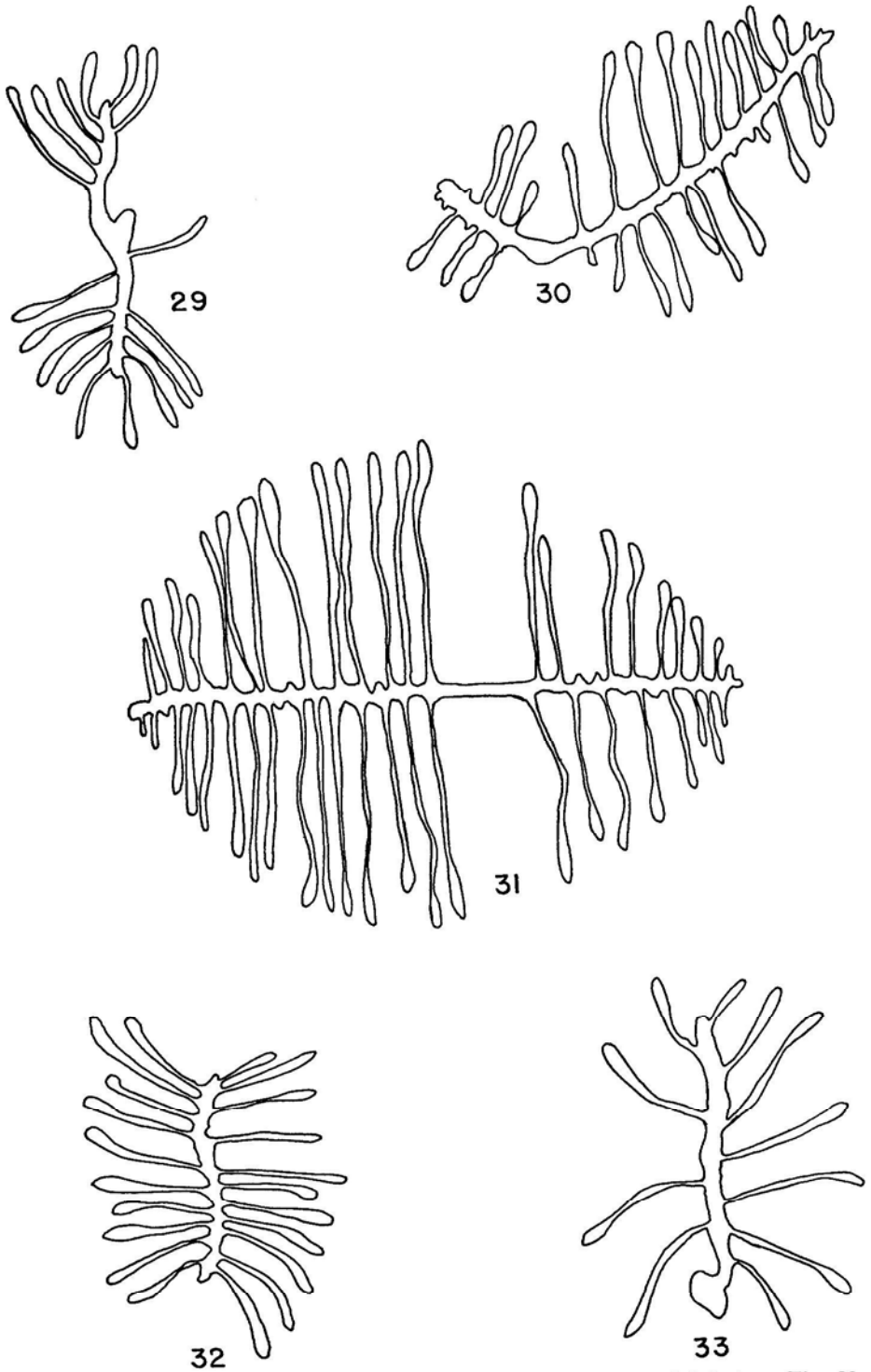
Figs. 12–23. Male seminal rods of species of *Pseudohylesinus*. Fig. 12. Overall genitalic capsule showing position of seminal rod. Fig. 13. *P. nebulosus nebulosus*. Fig. 14. *P. nebulosus serratus*. Fig. 15. *P. dispar dispar*. Fig. 16. *P. dispar pullatus*. Fig. 17. *P. variegatus*. Fig. 18. *P. granulatus*. Fig. 19. *P. tsugae*. Fig. 20. *P. nobilis*. Fig. 21. *P. grandis*. Fig. 22. *P. sitchensis*. Fig. 23. *P. sericeus*. Figs. 13–23 drawn to same scale.



Figs. 24–25. Outline of heads of species of *Pseudohylesinus* showing differences in length-width ratios. Fig. 24. *P. nebulosus nebulosus*. Fig. 25. *P. grandis*.

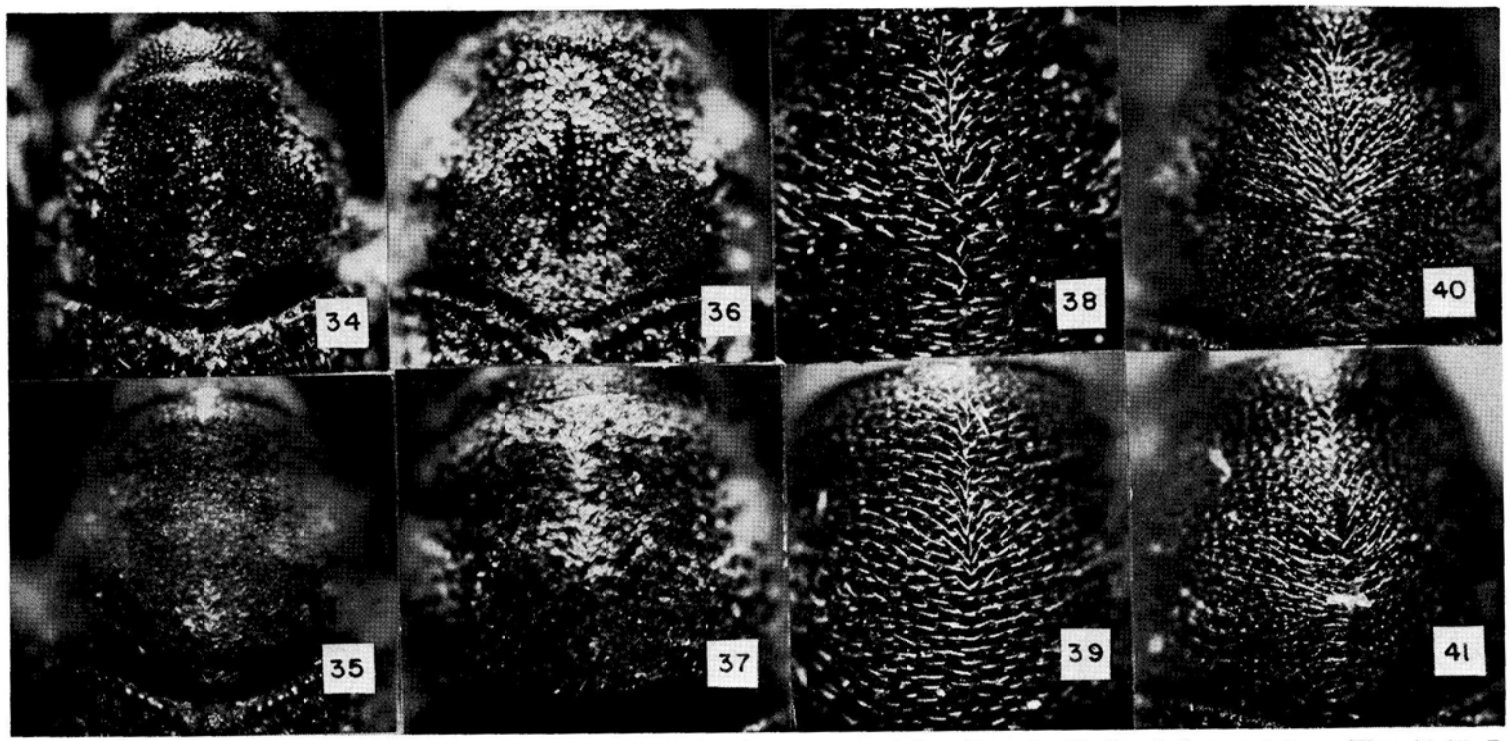


Figs. 26–28. Immature stages of *Pseudohylesinus grandis*. Fig. 26. Third instar larvae. Fig. 27. Dorsal aspect of pupae. Fig. 28. Ventral aspect of pupae.

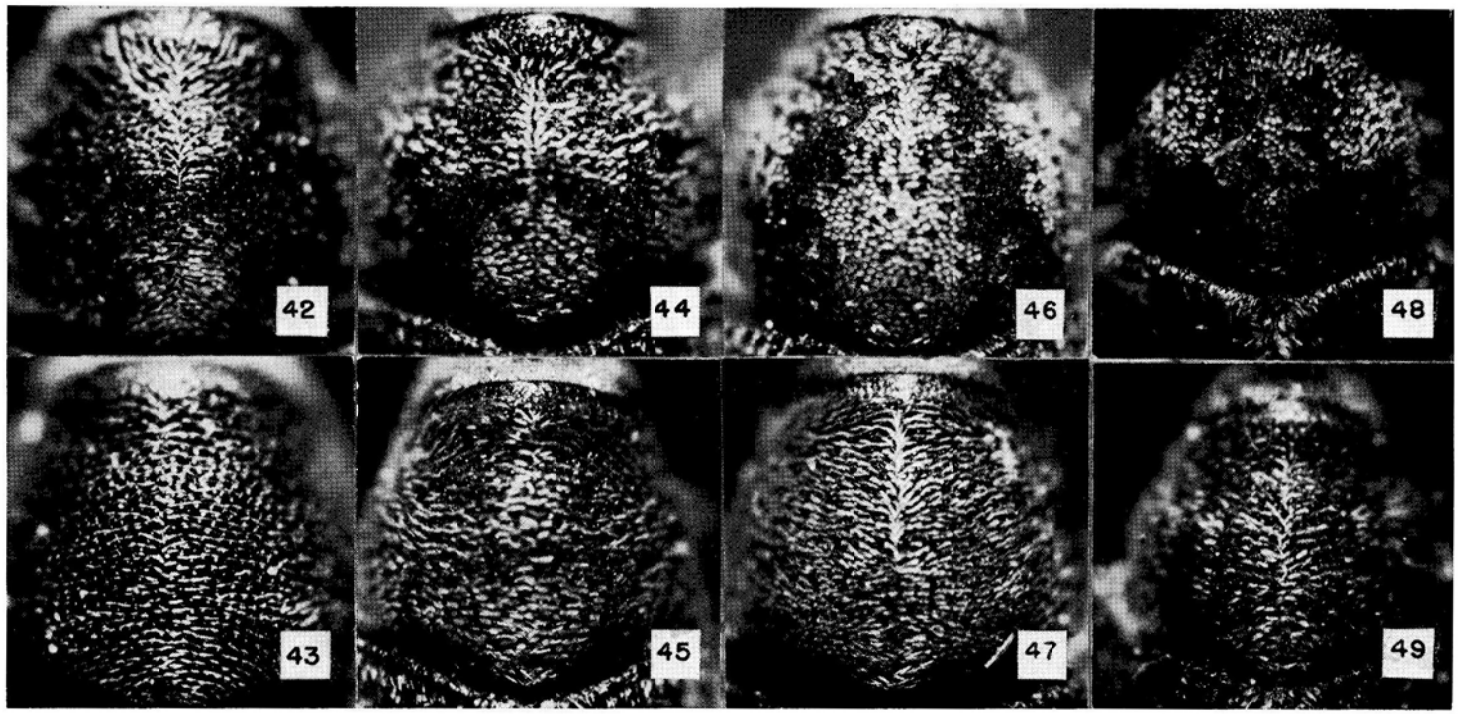


Figs. 29–33. Various types of gallery patterns of species of *Pseudohylesinus*. Fig. 29. *P. nebulosus nebulosus*. Fig. 30. *P. nobilis*. Fig. 31. *P. grandis*. Fig. 32. *P. sitchensis*. Fig. 33. *P. sericeus*.

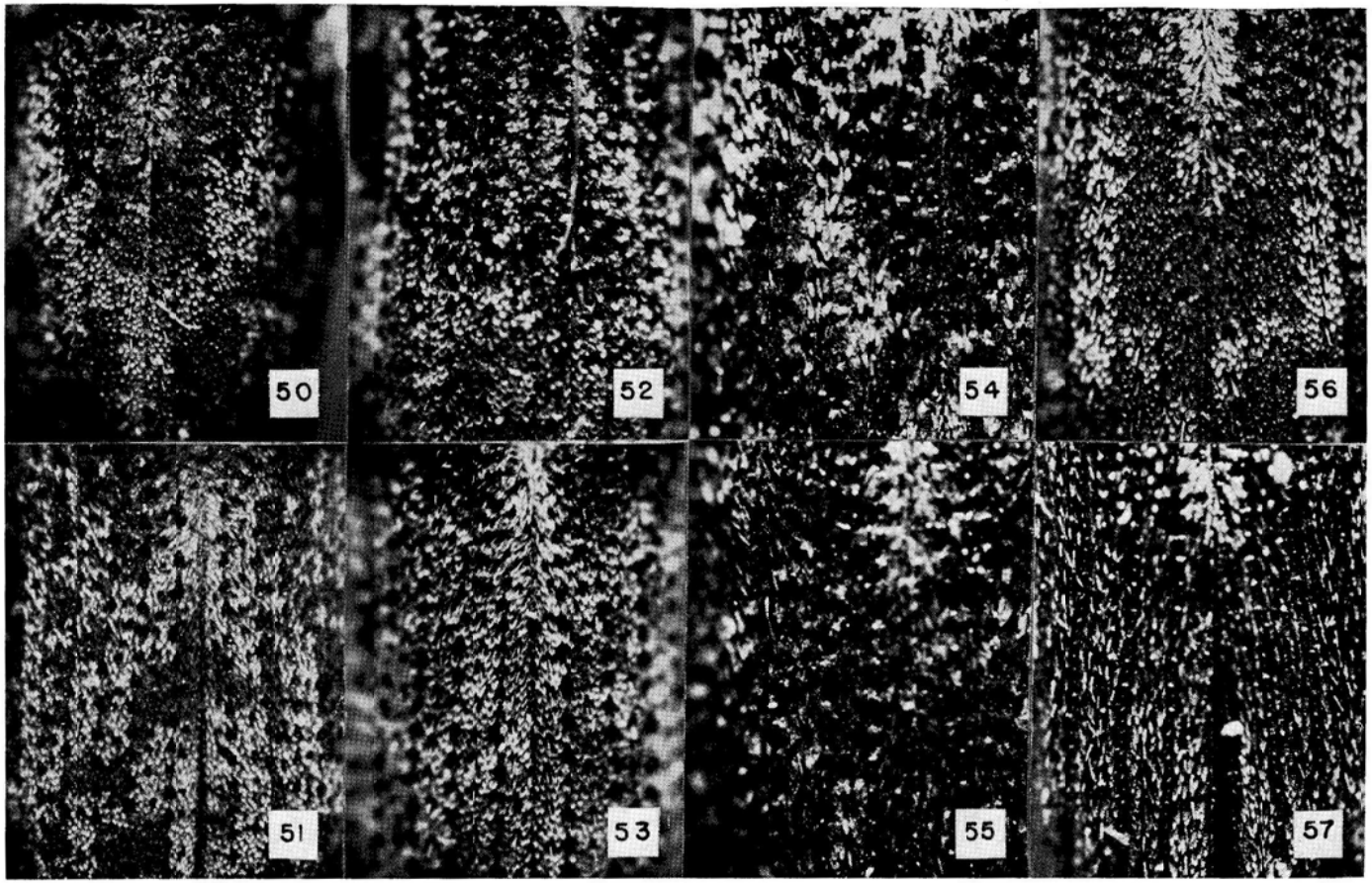
PLATES
(Figures 34–65)



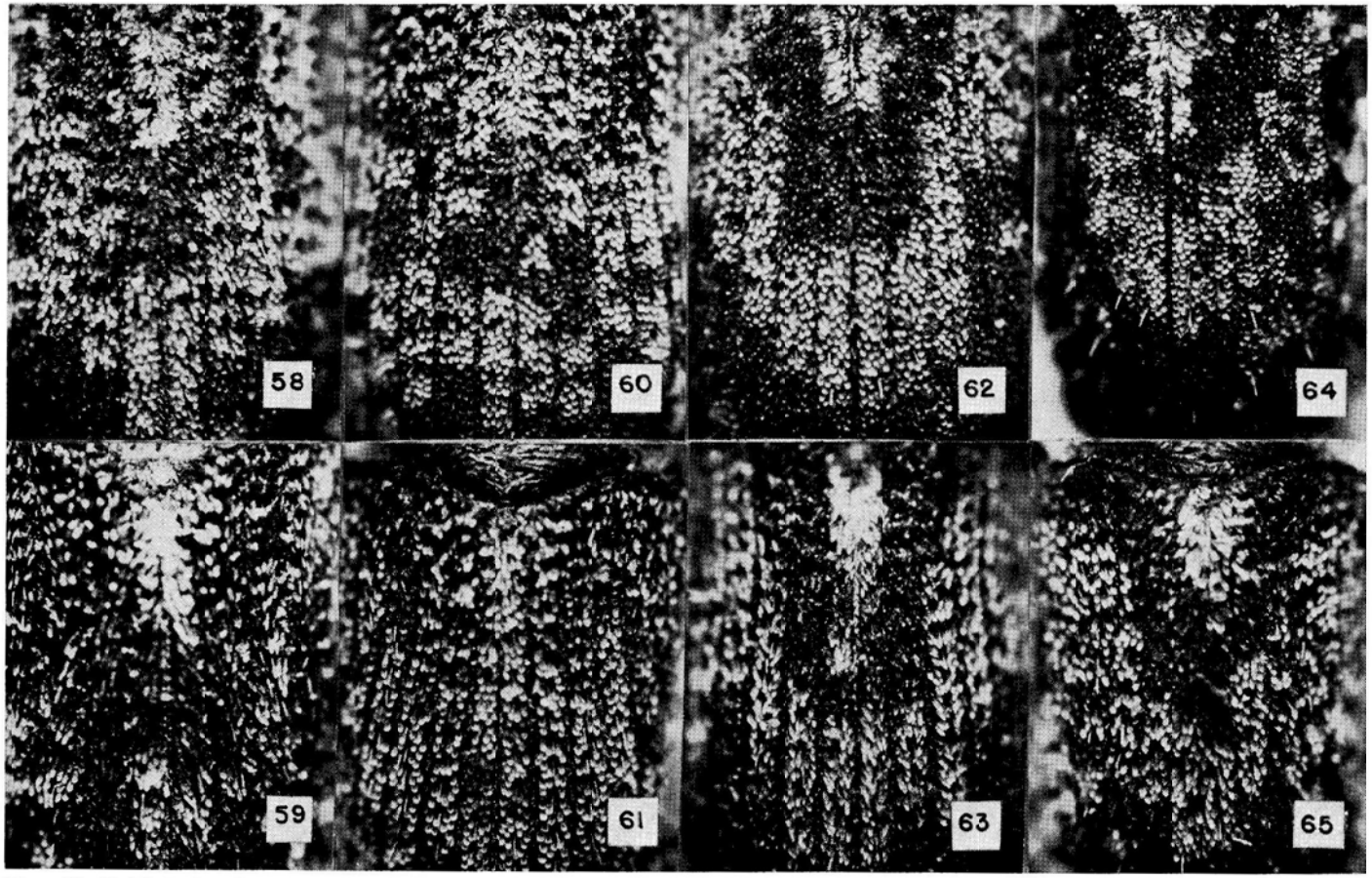
Figs. 34–41. Pronotal scales of species of *Pseudohylesinus*, 40×. Males above, females below. Figs. 34–35. *P. nebulosus nebulosus*. Figs. 36–37. *P dispar dispar*. Figs. 38–39. *P. granulatus*. Figs. 40–41. *P. tsugae*.



Figs. 42–49. Pronotal scales of species of *Pseudohylesinus*, 40×. Males above, females below. Figs. 42–43. *P. nobilis*. Figs. 44–45. *P. grandis*. Figs. 46–47. *P. sitchensis*. Figs. 48–49. *P. sericeus*.



Figs. 50–57. Elytral scales of species of *Pseudohylesinus,* 40×. Males above, females below. Figs. 50–51. *P. nebulosus nebulosus.* Figs. 52–53. *P. dispar dispar.* Figs. 54–55. *P. granulatus.* Figs. 56–57. *P. tsugae.*



Figs. 58–65. Elytral scales of species of *Pseudohylesinus,* 40×. Males above, females below. Figs. 58–59. *P. nobilis.* Figs. 60–61. *P. grandis.* Figs. 62–63. *P. sitchensis.* Figs. 64–65. *P. sericeus.*