

## Bark Beetles of the Genus *Carphoborus* Eichhoff (Coleoptera: Scolytidae) in North America<sup>1</sup>

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The genus *Carphoborus* is widely distributed in the Holarctic realm. It occurs from the northern limits of tree growth south in the Old World to India and northern Africa and in the New World to Baja California, New Mexico, Mississippi, and Florida.

All of the North American species breed in the inner bark of coniferous trees of the genera *Pinus*, *Picea*, and *Pseudotsuga*. Branches that are being shaded out or are broken, but still hanging in the tree, are generally preferred for the construction of galleries. A few species have been reported from slash; however, they are usually not aggressive or abundant enough to survive in competition with other bark beetles normally found in slash. The economic importance of the genus is not great; the habit of breeding in the unthrifty lower branches of coniferous trees contributes slightly toward accelerating the natural pruning of the trees and consequently aids in the production of a higher quality of timber.

The breeding habits of *Carphoborus* spp. do not differ greatly from those of many other polygamous scolytid beetles. The burrows are constructed partly in the inner bark and partly in the sapwood. The burrow consists of a short entrance tunnel that leads to a rather large nuptial chamber and several egg galleries. The entrance tunnel is usually on the lower side of the branch and slopes upward as it enters the bark. The nuptial chamber is engraved in the sapwood rather deeply; it is rather large, at least four millimeters in width and six millimeters in length. About five to eight egg galleries radiate from the nuptial chamber; each egg gallery is usually lined on both sides by large, deep, closely spaced egg niches. An egg is deposited in each niche and is carefully packed in with boring dust that evidently is mixed with a secretion from the female parent. The larval mines extend out from the egg galleries; they are ordinarily rather short and without a definite pattern, often doubling back and crossing one another. The egg galleries are engraved in the sapwood rather deeply, usually to a depth equivalent to at least two-thirds of their diameters. The larval mines are almost entirely in the inner bark and often do not touch the sapwood.

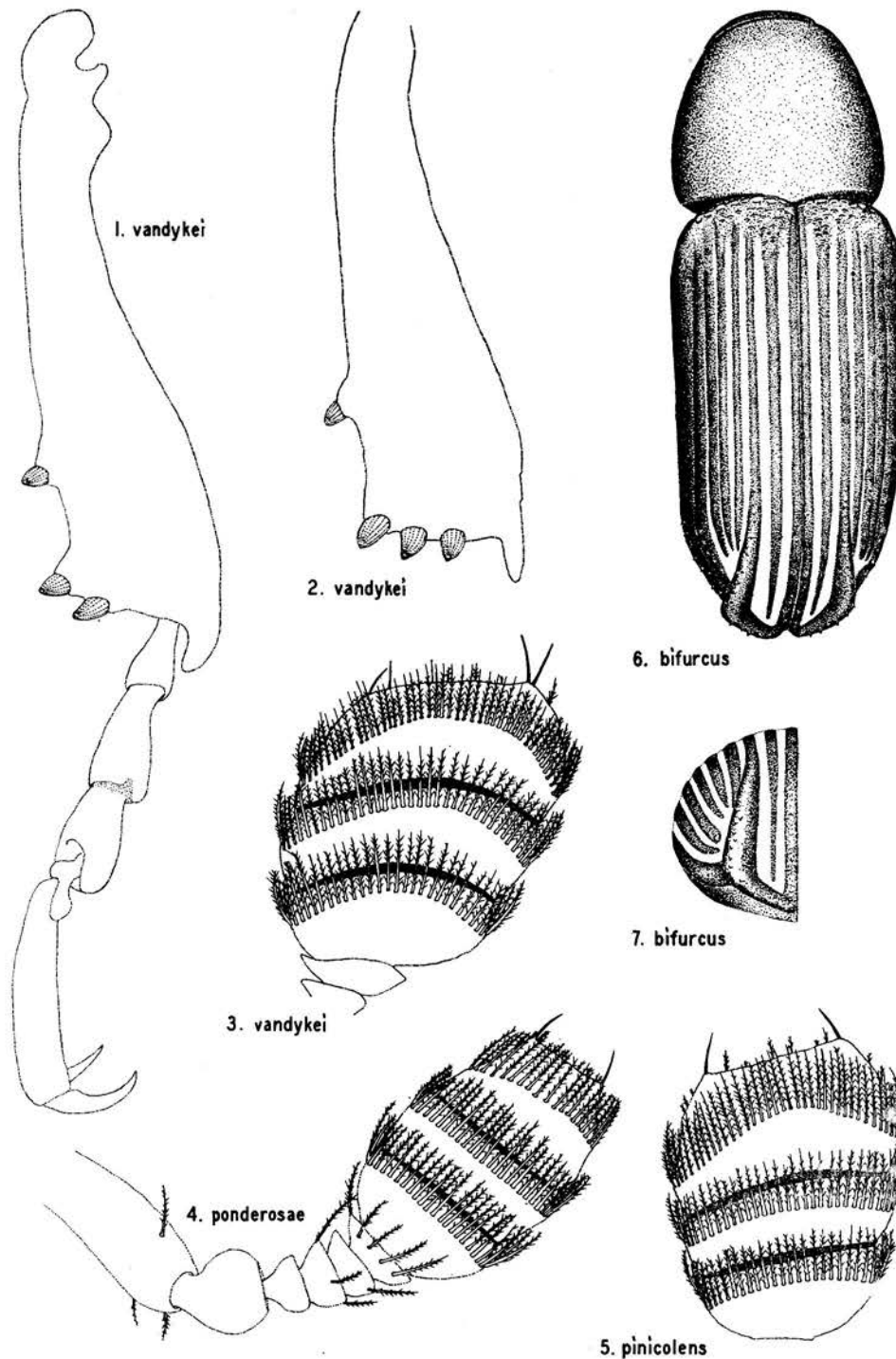
The winter is passed as mature larvae and young adults. These become sexually mature in the spring or early summer, when the males emerge to seek a new host. Several days, or weeks later the females emerge to join the males. Normally about five females are associated with each male, although as many as nine have been observed. As with other polygamous species, the male is ordinarily found in the nuptial chamber and the females in the egg galleries; they commonly remain in these positions until death. Mating generally occurs at the junction of an egg gallery and the nuptial chamber; it evidently occurs repeatedly.

### Intraspecific Variation

Secondary sexual characters of the frons are conspicuous in all species of *Carphoborus*. The frons of the female is flattened, rarely concave or convex, whereas that of the male is usually rather strongly impressed on the lower half and bears a transverse, bituberculate, median elevation at the upper margin of

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Figs. 1-7.—*Carphoborus* spp.: 1, *vandykei*, outline of posterior aspect of fore tibia and tarsus; 2, *vandykei*, outline of anterior aspect of hind tibia; 3, *vandykei*, anterior face of antennal club; 4, *ponderosae*, anterior face of antennal club; 5, *pinicolens*, anterior face of antennal club; 6, *bifurcus*, subdorsal aspect (vestiture and punctures of striae and interstriae omitted); and 7, *bifurcus* caudal aspect of left elytron (vestiture and punctures of striae and interstriae omitted).

the impression. The frontal vestiture of the female is usually much longer and more abundant than that of the male. In most species of the genus, the scales on the pronotum are more slender in the female; and in some species the elytral scales appear to be more abundant in the male.

Individual variation is usually not conspicuous, except the sculpturing of the elytral declivity. In certain individuals of some of the more primitive species, particularly *blaisdelli* and *vandykei*, the declivital serrations of the alternate interspaces are entirely absent. In other species, the number and spacing of the serrations vary slightly. The width of the second declivital interspace is used several times in the systematic section to separate species; unfortunately, occasional individuals vary sufficiently that they could be assigned to the wrong species unless it is possible to associate them with long series of specimens. In those species with rather weakly elevated declivital interspaces, the slight variation in the height of the elevations may be greater between certain specimens of a series than between certain individuals of different species, and yet the average difference between the two species is sufficient to separate them when used in combination with other differences.

#### Geographic Variation

Geographic variation was found in three species. Specimens of *ponderosae* from British Columbia have the frontal elevation of the male greatly reduced or absent, and the female frons usually has a narrow median groove; specimens from Utah and Wyoming always have a well developed frontal elevation in the male and lack a median groove in the female. Females of this species from series collected in Oregon have the frons slightly impressed and the declivity less coarsely sculptured, suggesting the beginning of a cline between typical *ponderosae* and *radiatae*; at present, it is interrupted by a gap in their known distributions.

The declivital sculpture of *pinicolens* is not as coarse in specimens from Oregon and northern California as in those from other parts of its range. Specimens of *vandykei* from British Columbia are more finely sculptured than those from California. The *pinicolens* specimens from Oregon are almost indistinguishable from California specimens of *vandykei*, but at any given locality the slight differences between the species are maintained. In addition to variation in the declivital sculpture, the frontal pubescence of females of *pinicolens* gradually decreases in length (about 20 per cent) toward the northeastern part of its range.

#### Discussion of Characters

Interspecific variation in structures on the frons of the female is extremely useful in classification of the genus. It varies from concave in *radiatae* to rather strongly convex in *convexifrons* and *pseudotsugae*; the surface may be shining, with the punctures either uniformly distributed or peripheral, or densely granulate. In the male, variations are less obvious, but the transverse impression of the frons varies in depth, and the median elevation above the impression may be tuberculate or not, or entirely absent.

The antennal club is of considerable importance in determining phylogenetic relationships. It may be large and broad with arcuate sutures as in *blaisdelli* and *vandykei* (Fig. 3), or small and rather slender with straight sutures as in *ponderosae* (Fig. 4) and *bifurcus*.

In outline the pronotum may have the sides subparallel on the basal two-thirds with one or two lateral constrictions, or the sides may be evenly arcuate (Fig. 6). The median line is usually narrowly elevated and conspicuous in the species with a large antennal club; it is inconspicuous in other species. The

punctures of the pronotum are rather coarse in one or two species and rather fine in a few others, but in general this variation is useful only when specimens are compared directly. The scales of the pronotum are almost hairlike in *frontalis*; usually they are small and rather slender, except in *carri* and *bifurcus*, where they are larger and broad.

The discal striae and interspaces are about equal in width in all of the North American species except *carri* and *bifurcus*, in which the striae are much wider than the interspaces. The sculpture of the declivity (Figs. 6 to 31) provides the most useful characters for separating species. The declivital interspaces are equally convex and serrate in some species; specialized elevations and serrations occur in others. The crenulations at the elytral bases and the tibial armature vary slightly, but characters provided by these structures are not reliable enough to be useful in separating species.

#### Phylogeny

The genus *Carphoborus* is very closely allied to *Polygraphus*, and in some respects the two genera intergrade. These genera differ from all other Holarctic scolytid genera in lacking pronotal asperities, and having a bituberculate frontal elevation in the male (occasionally absent in *Carphoborus*), a deeply emarginate or completely divided eye, the basal margins of the elytra crenulate, and a particular type of tibial armature (Figs. 1, 2). They form a distinct group in the Holarctic Scolytidae but appear to be allied to several of the hylesinine genera of tropical Asia.

*Carphoborus* and *Polygraphus* undoubtedly descended directly from a common ancestral stock. The principal specializations that have occurred in *Carphoborus* appear to be the partial fusion of the frontal tubercles of the male, complete loss of a segment in the antennal funicle, enlargement of the striae punctures, and modifications of the declivity by the addition of elevations and teeth; those of *Polygraphus* appear to be complete division of the eye into two parts by emargination, only partial loss of the sixth segment in the antennal funicle (Swaine, 1918, p. 55), and the complete loss of sutures in the antennal club.

In an effort to determine the probable characteristics of the ancestral stock, 11 species of *Polygraphus* and 24 of *Carphoborus* were examined. Surprisingly, the characteristics of one of these species, *Carphoborus boswelliae* (Stebbing) (from India), meet the requirements of the author's conception of the hypothetical ancestor almost as completely as did the original product of his imagination. In this species the female frons is similar to that of *carri*; the eye is more shallowly emarginate than is usual for *Carphoborus*; the antennae resemble those of *pinicolens*; the pronotum resembles that of *Polygraphus* more closely than that of *Carphoborus*; the elytral bases are coarsely crenulate as in *Carphoborus*; the striae punctures are very small and shallow as in *Polygraphus*; the interstriae are rather coarsely punctured as in *Carphoborus*; the declivity is broadly, evenly rounded, with minute interstitial tubercles resembling those of many *Polygraphus*; the tibiae are similar to those of *Carphoborus* but resemble more closely those of certain hylesinine genera of southeastern Asia. The body is very stout, much more so than in any of the known species of *Carphoborus* or in the species of *Polygraphus* examined, and the small median frontal elevation of the male is undivided.

The summary of primitive and specialized characters (Table 1) which evidently indicates evolutionary trends within the genus was based on the comparison of characters found in *Carphoborus* spp. with the primitive and specialized characters found in other genera of bark beetles, and on the association

of primitive or specialized characters known to be primitive or specialized in other genera.

TABLE 1

A summary of primitive and specialized characters found in the genus *Carphoborus*

| <i>Primitive</i>   | <i>Specialized</i>  |
|--|---|
| Frontal impression of male rather deep, with a transverse bituberculate elevation above the impression | Frontal impression of male shallow, the median elevation small or absent  |
| Female frons flat, impunctate at centre, pubescence moderately long                                    | Female frons convex or concave, punctate or granulate over entire surface, pubescence very long or short        |
| Antennal club large, broad, the sutures arcuate  | Antennal club small, narrow, the sutures straight   |
| Pronotum finely punctured  | Pronotum coarsely punctured   |
| Strial punctures small   | Strial punctures large  |
| Declivital interspaces equal in width, not elevated, the serrations fine, sparse, uniserate            | Some declivital interspaces elevated, others constricted or obsolete, the serrations coarse, abundant, confused |
| Scales small, narrow   | Scales large, broad, appearing multi-lamellate  |

Until more is known of the Palearctic species, as well as some Nearctic ones, a discussion of the evolution of species within the genus is unwarranted. Some of the North American species appear to be more closely related to Eurasian species than to other American species. For the present, the phylogenetic relationships are considered to be essentially as presented in the key to the species below, the most outstanding exception being that *simplex* should be placed nearer the end of the first major subdivision rather than near the beginning.

#### Methods

During this investigation more than 2,000 specimens of *Carphoborus* spp. were examined, including the types of all of Swaine's species and the type of *simplex* Leconte. Bruck's types of *crestatyi*, *vandykei*, and *swainei* were not seen, but paratypes of both sexes of these species were examined. Type material of *bifurcus* Eichhoff and *bicristatus* Chapuis was not available.

Illustrations were prepared with the aid of an ocular grid; those of antennae and tibiae were made from Canada balsam slide preparations, and those of elytra from pinned specimens. The striae punctures and pubescence were omitted from illustrations of the elytral declivity (Figs. 6-31) in an attempt to reduce the confusion of these structures with those considered more important in the classification of the group. Figs. 1-5 were drawn to one scale, Figs. 6 and 7 to another and slightly smaller scale than those in Figs. 8 to 31. Drawings of the antennae were made with the aid of a phase contrast microscope.

#### *Carphoborus* Eichhoff

*Carphoborus* Eichhoff, 1864, Berlin. Ent. Zeit. 8: 27; Leconte, 1868, Trans. Amer. Ent. Soc. 2: 172; Leconte, 1876, Proc. Amer. Philos. Soc. 15: 383; Chapuis, 1869, Synopsis des Scolytides, p. 40 (1873, Mem. soc. roy. sci. Liège, ser. 2, 3: 248); Eichhoff, 1880 (1881), Die europäischen Borkenkäfer, p. 129; Reitter, 1895, Verh. Ver. Brunn 33: 56; Hagedorn, 1910, Ipidae, in Wytsman, Genera Insectorum, fasc. 111. 62; Reitter, 1913, Wien. Ent. Zeit. 32: 56; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 660; Swaine, 1918, Canada Dept. Agr. Ent. Br. Bull. 14: 56; Blackman, 1922, Mississippi Agr. Expt. Sta. Tech. Bull. 11: 48; Bruck, 1936, Bull. Southern California Acad. Sci. 35: 111; Chamberlin, 1939, The Bark and Timber Beetles of North America, p. 126; Pfeffer, 1941, Sborn. Ent. Odd. Zemsk. Mus. Praha 19: 169; Balachowsky, 1949, Faune de France 50: 147.

#### History

The genus *Carphoborus* was described by Eichhoff (1864, p. 27) to contain a single species, *Hylesinus minimus* Fabricius. Since that time 24 species, 14 from



Eurasia and north Africa and ten from North America, have been added to the genus. Seven more North American species are described as new in this paper. The unique combination of characters has made recognition of the genus easy; consequently it has not been confused with other genera in the literature. Reitter (1913, p. 56) divided the genus, erecting the subgenus *Estenoborus* for *C. perrisi* Chapuis; however, this division has not been accepted generally by subsequent authors.

Original keys to the North American species have been given by Leconte (1876, p. 383), Swaine (1918, p. 56), and Bruck (1933, p. 105; 1936, p. 111). Leconte's key contained only three species and Swaine's only five. Bruck's keys contained names of all the species known at that time; however, about half of them were known to him only through descriptions or misidentifications.

#### Description of the Genus

Length 1.4-3.0 mm., about 2.3 times as long as wide; body colour yellowish or brownish-black to black, mouth-parts and tarsi yellow; mouth-parts ornamented with abundant, long yellow hair.

Frons of female usually flattened, rarely concave or convex, coarsely punctured at least at sides and above; pubescence usually consisting of rather long yellow hair; frons transversely impressed in male, usually with a pair of subcarinate, basally fused tubercles at upper margin of the impression. Eye reniform, about 2.3 times as long as wide; narrowly, deeply emarginate on inner line; rather coarsely granulate. Antennal funicle five-segmented, slightly longer than scape; club flattened, with three straight or slightly arcuate, transverse sutures conspicuously marked by rows of setae, the first two sutures septate.

Pronotum about 1.2 times as wide as long, widest near base; sides arcuately convergent, usually with a prominent lateral constriction behind the broadly rounded anterior margin; side and basal margins rounded, not marked by an elevated line; surface closely, rather coarsely punctured, densely clothed with small erect scales.

Elytra about 1.7 times as long as wide; sides subparallel on basal two-thirds, moderately rounded behind; basal margins slightly elevated and armed with about nine coarse, overlapping crenulations, a few submarginal crenulations present, especially on second interspaces; striae slightly impressed, coarsely, closely, rather deeply punctured; interspaces closely punctured, often subgranulate. Declivity moderately steep, usually with alternate interspaces elevated and serrate. Pubescence consisting of small, abundant, erect interstitial scales, and small, inconspicuous, fine strial hair. Scutellum not visible from above. Anterior coxae contiguous; tibiae armed on outer margins with three or four teeth; third tarsal segments cylindrical, not dilated or emarginate.

*Type species: Hylesinus minimus* Fabricius, monobasic.

#### Key to the North American Species of *Carphoborus*

1. Antennal club (Fig. 3) large, broad, less than 1.2 times as long as wide; female frons impunctate and glabrous on a rather large median area; transverse impression of male frons more conspicuous and extensive, the median elevation rather large and prominent ..... 2
- Antennal club (Fig. 4) small, narrow, 1.3 or more times as long as wide; female frons punctate or granulate, and pubescent over entire surface; male frons usually less strongly impressed below, the median elevation smaller, often absent ..... 8
2. Female frons flattened and with pubescence long ..... 3
- Female frons convex and with rather short pubescence ..... 6
3. Declivital interspace two as wide as one and three (Figs. 8, 9), usually convex; declivital interspaces one, three, five, seven and nine less strongly elevated, more finely or not at all serrate; California, in *Pseudotsuga macrocarpa* (p. 509) ..... *blaisdelli*

- Declivital interspace two distinctly narrower than one or three (Figs. 10-15), flat; alternate declivital interspaces usually more strongly elevated, the serrations usually larger ..... 4
4. Antennal club smaller, narrower; second interspace becoming obsolete on upper half of declivity (Figs. 14-15); third declivital interspaces more strongly elevated; California, in *Pinus* spp. (p. 513) ..... *simplex*
- Antennal club larger, broad; second declivital interspaces narrow, but continuing to near apex; third declivital interspaces only slightly elevated ..... 5
5. Sutures of antennal club suboblique, rather strongly arcuate (Fig. 3); third and ninth declivital interspaces usually less strongly elevated, the serrations smaller, less abundant; in *Pseudotsuga taxifolia* (p. 510) ..... *vandykei*
- Sutures of antennal club subtransverse, nearly straight (Fig. 5); third and ninth declivital interspaces usually more strongly elevated, the serrations larger, more abundant; in *Pinus* spp. (p. 512) ..... *pinicolens*
6. Impunctate area of female frons smaller, not more than one-third as wide as distance between eyes; pronotum more finely punctured; declivity more finely sculptured; in *Picea pungens* (p. 514) ..... *brevisetosus*
- Impunctate frontal area of female one-half as wide as distance between eyes; pronotum more coarsely punctured; declivity more coarsely sculptured; in *Pinus* spp. .... 7
7. Second declivital interspaces continuing to apex; female frons less strongly convex, with rather long pubescence; southern California (p. 515) ..... *frontalis*
- Second interspaces becoming obsolete on upper half of declivity (Fig. 16); female frons more strongly convex, with pubescence very short; southern Arizona and New Mexico (p. 516) ..... *convexifrons*
8. Ninth declivital interspaces not elevated or serrate behind declivital base (Figs. 26-31); declivital elevation ending at junction of interspaces three and nine ..... 9
- Ninth declivital interspaces regularly serrate and usually elevated from declivital base to junction with interspace three, the elevation usually continuing from this junction to interspace one (Figs. 18-23) ..... 11
9. Third declivital interspaces more strongly, broadly elevated, the serrations small, confused, more abundant on sides of the elevation than on its summit (Figs. 30, 31); Eastern Canada (p. 518) ..... *dunni*
- Third declivital interspaces less strongly elevated, narrower, the serrations larger, confined to summit; western ..... 10
10. First declivital interspaces more strongly elevated, rather coarsely serrate (Figs. 26, 27); elevation of third interspaces highest near middle of declivity; Alberta to Utah (p. 517) ..... *sansoni*
- First declivital interspaces slightly elevated, finely serrate (Figs. 28, 29); elevation of third declivital interspaces highest near apex; Northwest Territories to Alaska (p. 518) ..... *andersoni*
11. Female frons flattened or concave, rather coarsely punctured; declivital teeth on third interspaces very coarse, longer than height of the interspace (Figs. 20-23); declivital interspaces two, four, six, and eight never serrate ..... 12
- Female frons flattened or convex, punctate or granulate; declivital teeth fine, those on third interspace much shorter than height of the elevation; even-numbered declivital interspaces sometimes serrate ..... 13
12. Frons of female broadly concave, very coarsely punctured; male frons with a prominent median tuberculate elevation; declivital interspaces one, three, and nine less strongly elevated, the teeth less numerous and smaller (Figs. 20, 21); California (p. 520) ..... *radiatae*
- Frons of female flattened, often with a small, very narrow, deep median groove, punctures not as coarse; male frons usually without a tuberculate elevation; declivital teeth more numerous and larger (Figs. 22, 23); British Columbia to Utah (p. 521) ..... *ponderosae*
13. Declivital interspaces four, six and eight finely serrate; female frons at least weakly convex, finely granulate, never shining and punctured; western ..... 14
- Declivital interspaces four, six, and eight not serrate; female frons flattened and punctured, or convex and granulate ..... 15
14. Second declivital interspaces rather broad, serrate (Fig. 17); female frons evenly, weakly convex (p. 522) ..... *declivis*
- Second declivital interspaces very narrow, not serrate (Fig. 18); female frons rather strongly produced above the transverse epistomal impression (p. 522) ..... *pseudotsugae*
15. Discal striae about as wide as interspaces; declivital interspaces four, six, and eight subtuberculate (Fig. 19); female frons rather coarsely punctured; frontal pubescence longer and more abundant (p. 523) ..... *intermedius*

- Discal striae much wider than interspaces; even-numbered declivital interspaces not subtuberculate; female frons with shorter pubescence..... 16
16. Female frons flattened, shining, rather finely, closely punctured, the pubescence longer, fine, less abundant; third declivital interspaces moderately elevated (Figs. 24, 25); interspaces five and seven fusing apically; Alberta to New Brunswick (p. 524).....*carri*
- Female frons convex, opaque, finely granulate, the pubescence short, abundant; third declivital interspaces very strongly elevated, the elevation curving after converging with interspace nine and continuing to sutural apex (Fig. 6, 7); interspaces five and seven ending separately; southeastern U.S. (p. 525).....*bifurcus*

***Carphoborus blaisdelli* Swaine**

Figs. 8, 9

*Carphoborus blaisdelli* Swaine, 1924, Can. Ent. 56: 234; Chamberlin, 1939, The Bark and Timber Beetles of North America, p. 131.

*Carphoborus cressatyi* Bruck (new synonymy), 1936, Bull. Southern California Acad. Sci. 35: 36, 113; Chamberlin, 1939, The Bark and Timber Beetles of North America, p. 129.

This species is very closely allied to *vandykei* and *pinicolens* but has declivital interspace two broad, as wide or wider than one or three, and usually convex; and has declivital interspace three usually less strongly elevated. Also, the declivital teeth are smaller than in *pinicolens*.

*Female*.—Length 1.9-2.2 mm., 2.25 times as long as wide.

Frons flattened, with epistomal region transversely elevated, epistomal margin medially produced (variable) in front of mandibles; surface reticulate, impunctate on a subcircular median area the diameter of which equals about one-fourth the distance between eyes, punctures deep and close surrounding this area; pubescence arising from punctured area fine, rather long. Antennal club 1.04 times as long as wide; sutures suboblique and arcuate as in *vandykei*.

Pronotum 1.2 times as wide as long; sides almost subparallel on basal half, converging slightly anteriorly, laterally constricted just behind the broadly rounded anterior margin; surface reticulate, punctures of moderate size, rather close, deep; median line usually distinctly elevated on middle third; vestiture consisting of abundant small, slender, erect scales.

Elytra 1.7 times as long as wide; sides subparallel on basal two-thirds, rather broadly rounded behind, basal margins elevated and armed with about nine large overlapping crenulations; striae slightly impressed, the punctures rather large, deep, close; interstriae as wide as striae, weakly convex, the punctures close, deep, rather coarse, confused. Declivital interspaces (Figs. 8, 9) convex, three slightly higher; one, three, five, seven, and nine usually finely serrate, but serrations entirely absent in some specimens, usually coarser on three; interspaces two and three subequal in width, one narrower; on left elytron two occasionally narrower than one and flat. Vestiture consisting of small, abundant, erect interstitial scales, each scale slightly longer than wide.

*Male*.—Similar to female except: frons coarsely punctured, transversely impressed (longitudinally concave), with the median, bituberculate, transverse elevation characteristic of genus; vestiture evidently somewhat more abundant and scales slightly wider.

*Type Locality*.—Camp Baldy, San Bernardino County, California.

*Host*.—*Pseudotsuga macrocarpa*.

*Distribution*.—Southern California; evidently limited to the range of the host tree. Specimens from the following California localities were examined: Los Angeles County (Arroyo Seco, Mount Wilson and Pasadena), San Bernardino County (Camp Baldy), Ventura County (Santa Paula).

The above description of the female was prepared from the allotype, except measurements (which are composite) and obvious departures where "usually"



or "variable" is used. The holotype was one of the specimens used in determining the male characters. In addition to these specimens, two paratypes, and 106 other specimens (two of them paratypes of *cressatyi*) were studied before preparation of the description. The type of *blaisdelli* is in the Canadian National Collection; that of *cressatyi* (described from *Pseudotsuga macrocarpa* at Arroyo Seco in Los Angeles County, California) is in the collection of Ohio State University. Bruck erroneously recognized the common species *pinicolens* as *blaisdelli*, and as a result renamed this comparatively rare species *cressatyi*.

### *Carphoborus vandykei* Bruck

Figs. 1, 2, 3, 10, 11

*Carphoborus vandykei* Bruck, 1933, Can. Ent. 65: 104; Bruck, 1936, Bull. Southern California Acad. Sci. 35: 114; Chamberlin, 1939, The Bark and Timber Beetles of North America, p. 130.

This species is closely allied to, and somewhat intermediate between, *blaisdelli* and *pinicolens*. From the former species it is distinguished by the second declivital interspace being much narrower than the third and flat, and the third interspace usually more strongly elevated. From *pinicolens* it is distinguished only with difficulty when individuals are examined; series have a more distinctly brown (often reddish) colour, less strongly elevated third and ninth declivital interspaces, smaller and less numerous declivital teeth, and *more strongly arched sutures* of the antennal club (compare Figs. 3 and 5).

*Female*.—Length 1.8-2.6 mm., 2.3 times as long as wide; colour almost black, but always with a brownish cast, particularly on posterior half.

Frons flattened, with epistomal region marginally elevated and medially produced (variable) in front of mandibles; surface reticulate, impunctate on a subcircular median area the diameter of which equals about one-third the distance between the eyes, punctures deep and close surrounding this area; pubescence arising from punctured and epistomal areas fine, rather long. Antennal club 1.17 times as long as wide; sutures suboblique, arcuate (Fig. 3).

Pronotum 1.2 times as wide as long; sides almost straight on basal half, slightly converging anteriorly, laterally constricted just behind the very broadly rounded anterior margin; surface finely, indistinctly reticulate, punctures of moderate size, rather close, deep; median line usually distinct on middle third; vestiture consisting of abundant small, erect scales, each scale distinctly longer than wide.

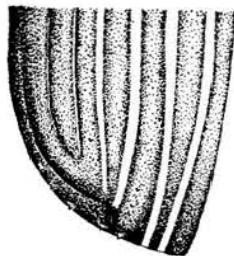
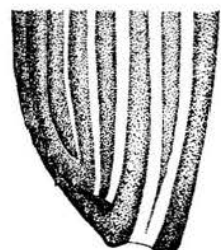
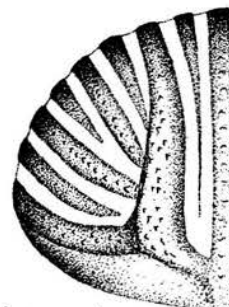
Elytra 1.7 times as long as wide; sides subparallel on basal two-thirds, rather broadly rounded behind, basal margins elevated and armed with about nine large, overlapping crenulations; striae slightly impressed, the punctures rather large, deep, close; interstriae about as wide as striae, weakly convex, the punctures confused, close, deep, rather coarse. Declivital interspaces (Figs. 10, 11) one and two subequal in width and narrower than three; one and three distinctly elevated; two flat (rarely slightly concave or convex); one, three, five, seven, and nine finely serrate, rarely the teeth entirely absent. Vestiture consisting of small, abundant, erect, interstitial scales, each scale indistinctly longer than wide.

*Male*.—Similar to female except: frons coarsely punctured, transversely impressed (longitudinally concave), with the median, bituberculate, transverse, elevation characteristic of genus; vestiture evidently somewhat more abundant and scales wider.

*Type Locality*.—Mount St. Helena, California.

*Host*.—*Pseudotsuga taxifolia*.

*Distribution*.—Central California to southern British Columbia. Specimens from the following localities were examined. *British Columbia*: Pender Harbor.

8. *blaisdelli*10. *vandykei*12. *pinicolens*9. *blaisdelli*11. *vandykei*13. *pinicolens*14. *simplex*16. *convexifrons*18. *pseudotsugae*15. *simplex*17. *declivis*19. *intermedius*

Figs. 8-19.—*Carphoborus* spp., declivity of left elytron: 8, dorsal, and 9, caudal aspect of *blaisdelli*; 10, dorsal, and 11, caudal aspect of *vandykei*; 12, dorsal, and 13, caudal aspect of *pinicolens*; 14, dorsal, and 15, caudal aspect of *simplex*; 16, caudal aspect of *convexifrons*; 17, caudal aspect of *declivis*; 18, caudal aspect of *pseudotsugae*; and 19, caudal aspect of *intermedius*

*California*: Del Norte County, French Hill, Mount St. Helena, Quincy, and Yosemite National Park. *Oregon*: Ashland, Oregon Caves, St. Helens, and Waldo.

The above description was prepared from the female paratype in the Canadian National Collection, except measurements and the statements that indicate obvious departures therefrom. Three additional paratypes and 219 other specimens were studied before preparation of the description. The type specimen of *vandykei* is in the collection of Ohio State University.

***Carphoborus pinicolens*, new species**

Figs. 5, 12, 13

*Carphoborus blaisdelli*, Bruck, 1936, Bull. Southern California Acad. Sci. 35: 116.  
*Carphoborus simplex*, Bruck, 1936, Bull. Southern California Acad. Sci. 35: 113.

This species is very closely related to *vandykei*, and less closely allied to the four following species. From *vandykei* it is distinguished with difficulty by the black colour, the more strongly elevated third and ninth declivital interspaces, the larger and more numerous declivital teeth, and the less strongly arched sutures of the antennal club; the characters of the antennal club provide the most reliable and useful means of separating these species. From *simplex* it is readily separated by the broad antennal club, the less strongly elevated third and ninth declivital interspaces, and the narrow second declivital interspaces, which continue to the apex. From *brevisetosus*, *frontalis*, and *convexifrons* it is distinguished by the flattened frons and the longer, incurved frontal hair of the female.

*Female*.—Length 2.4 mm. (paratypes 1.7-2.5 mm.), 2.3 times as long as wide; colour black.

Frons flattened, with epistomal region transversely elevated, and epistomal margin medially produced in front of mandibles (variable in a series); surface reticulate, impunctate on a subcircular median area the diameter of which equals about one-fourth the distance between the eyes; the punctures surrounding this area deep, close, coarser than in allied species; pubescence arising from punctured and epistomal areas fine, rather long, incurved. Antennal club about as long as wide; sutures transverse, the first straight, others slightly arcuate (Fig. 5).

Pronotum 1.2 times as wide as long; sides almost straight on basal half, converging slightly anteriorly, laterally constricted just in front of the very broadly rounded anterior margin; surface reticulate; punctures rather coarse and close, deep; median line usually elevated and impunctate; vestiture consisting of abundant small, erect scales; each scale distinctly longer than wide, somewhat more slender toward median and anterior areas in some specimens.

Elytra 1.7 times as long as wide; sides subparallel on basal two-thirds, rather broadly rounded behind; basal margins elevated and armed with about nine large, overlapping crenulations; striae slightly impressed, the punctures rather large, deep, close; interstriae about as wide as striae, weakly convex, the punctures confused, close, deep, rather coarse. Declivital interspaces (Figs. 12, 13) one and two subequal in width and distinctly narrower than three; one and three distinctly elevated; two flat; one, three, five, seven, and nine serrate. Vestiture consisting of small, abundant, erect, interstitial scales, each scale distinctly longer than wide.

*Male*.—Similar to female except: frons transversely impressed (longitudinally concave), coarsely punctured, with the median, bituberculate, transverse elevation characteristic of the genus above the impression; vestiture evidently somewhat more abundant and scales slightly wider.

*Type Locality*.—Logan Dry Canyon, Utah.

*Hosts*.—*Pinus edulis*, *P. flexilis*, *P. lambertiana*, *P. leiophylla*, *P. monophylla* (type), and *P. ponderosa*.

*Distribution*.—Colorado and New Mexico to the Pacific coast. The holotype, allotype, and 173 paratypes were collected at the type locality on July 1, 1947, from *Pinus monophylla* by the author. Several hundred additional specimens, not designated as paratypes, were examined from the following localities. *Arizona*: Chiricahua National Monument, Flagstaff, Santa Catalina Mountains, and Williams. *California*: Anderson Valley (Stanislaus National Forest, Mariposa County), General Grant National Park, Glenn County, Lava Ranger Station, Mount Hawkins, San Francisco, and Ventura. *Colorado*: Mancos, Mesa Verde National Park, Salida, Ute Pass, and Woodland Park. *Nevada*: Baker. *New Mexico*: Capitan, Cloudcroft, Las Vegas, and Manzano. *Oregon*: Ashland, Grants Pass, Pinehurst, and Portland. *Utah*: Bryce Canyon National Park, Logan Canyon, Panguitch, and Zion National Park. *Wyoming*: Saratoga.

The holotype, allotype, and several paratypes are in the U.S. National Museum; the other paratypes are in the Canadian National Collection and in the collections of the California Academy of Sciences, Cornell University, and Ohio State University.

This species appears to be the most widely distributed and abundant representative of the genus in North America. This evidently influenced Bruck (1933) and led him to assume that it was *simplex*; as a result he renamed the true *simplex* as a new species (*swainei*). Bruck evidently did not see specimens of the true *blaisdelli*, but used the original description, and possibly personal communications from Swaine and others, to diagnose his species. He placed *blaisdelli* in his key as would be done if the original description were followed; however, he recorded pine, not *Pseudotsuga macrocarpa*, as the host. Either he guessed that the host was pine, or the specimens at hand represented Leconte's *simplex* or the species described above as *pinicolens*. If he did not guess, and if it is assumed that he recognized *simplex* Leconte (which he called *swainei*), the specimens in question must have been of *pinicolens*. Another species occurring in pine in southern California is *frontalis*; however, specimens of this species did not become available to Bruck until after 1936.

### *Carphoborus simplex* Leconte

Figs. 14, 15

*Carphoborus simplex* Leconte, 1876, Proc. Amer. Philos. Soc. 15: 383; Swaine, 1918, Canada Dept. Agr. Ent. Br. Bull. 14(2): 56; Chamberlin, 1939, The Bark and Timber Beetles of North America, p. 129.

*Carphoborus swainei* Bruck (new synonymy), 1933, Can. Ent. 65: 105; Bruck, 1936, Bull. Southern California Acad. Sci. 35: 117; Chamberlin, 1939, The Bark and Timber Beetles of North America, p. 130.

This species is rather closely allied to *vandykei* and *pinicolens*, but is readily distinguished by the more strongly elevated first, third and ninth declivital interspaces, the much narrower second declivital interspaces which are usually eliminated on the upper half by convergence of striae one and two, and the more slender antennal club.

*Female*.—Length 1.8-2.4 mm., 2.3 times as long as wide.

Frons flattened, with epistomal region transversely elevated; epistomal margin usually without median area produced; surface reticulate, impunctate on a subcircular median area the diameter of which equals about one-third the distance between eyes, punctures surrounding this area rather fine, shallow; pubescence arising from the punctured area rather fine, moderately long. Antennal club 1.2 times as long as wide, the sutures slightly arcuate.

Pronotum 1.2 times as wide as long; sides almost straight on basal half, converging slightly anteriorly, laterally constricted just behind the broadly rounded anterior margin; surface reticulate, punctures of moderate size, not close; median line elevated and moderately distinct on middle third; vestiture consisting of abundant small, erect scales, each scale slightly longer than wide.

Elytra 1.7 times as long as wide; sides subparallel on basal two-thirds, rather broadly rounded behind; basal margins elevated and armed with about nine large, overlapping crenulations; striae slightly impressed, the punctures rather large, deep, close; interstriae about as wide as striae, weakly convex, the punctures confused, close, deep, rather coarse. Declivital interspace (Figs. 14, 15) two made obsolete on upper half by convergence of striae one and two; one, three, and nine moderately elevated and serrate; five and seven also with a few teeth near apex. Vestiture consisting of small, abundant, interstitial scales; each scale about as long as wide.

*Male*.—Similar to female except: frons transversely impressed (longitudinally concave), more coarsely punctured (less strongly impressed and more finely punctured than in males of *pinicolens*), the median bituberculate, transverse elevation above the impression present as in most other species of genus; body vestiture evidently somewhat more abundant and scales wider.

*Type Locality*.—Mojave Desert, California.

*Hosts*.—*Pinus lambertiana* and *P. sabiniana*.

*Distribution*.—California and Baja California. Specimens from the following localities were examined. *Baja California*: San Isidor. *California*: Anderson Valley (Stanislaus National Forest, Mariposa County), Chiquite Basin (Madera County), Cleveland National Forest, Hollister, Idyllwild, Los Angeles County, Mount Diablo, North Fork, Placerville, Red Bluff, Redding, and Ventura County.

Before preparation of the above description, Leconte's type was examined (comparisons with other species were also made by Mr. W. J. Brown) and 229 other specimens were studied, four of which were paratypes of *swainei*. The type of *simplex* is in the Museum of Comparative Zoology, Harvard College, that of *swainei* (described from *Pinus sabiniana*, Mount Diablo, California) is in the collection of Ohio State University.

#### ***Carphoborus brevisetosus*, new species**

This species is very closely allied to *pinicolens* but differs by having the frons more strongly convex, the frontal vestiture much shorter (about one-half as long), and the punctures of the frons and the pronotum finer.

*Female*.—Length 2.4 mm. (paratypes 2.0-2.4 mm.), 2.3 times as long as wide.

Frons weakly convex, transversely impressed just above the distinctly elevated epistomal margin; epistomal margin medially produced (variable in a series) in front of mandibles; surface indistinctly reticulate, impunctate on a subcircular median area the diameter of which equals about one-third the distance between eyes; punctures surrounding this area rather fine, shallow; pubescence arising from punctured area rather fine, short. Antennal club 1.2 times as long as wide; sutures transverse, almost straight.

Pronotum 1.2 times as wide as long; sides straight on basal half, converging slightly anteriorly, laterally constricted just behind the very broadly rounded anterior margin; surface reticulate, punctures of moderate size, rather close, and deep; median line usually distinct on middle third; vestiture consisting of abundant small, erect scales, each scale slightly longer than wide.

Elytra 1.7 times as long as wide; sides subparallel on basal two-thirds, rather broadly rounded behind, basal margin elevated and armed with about nine large, overlapping crenulations; striae slightly impressed, the punctures rather large.



deep, close; interstriae about as wide as striae, weakly convex, the punctures confused, close, rather fine. Declivity as in *pinicolens*; interspaces one and two subequal in width and distinctly narrower than three; one slightly, three distinctly elevated; three and nine finely serrate; one, five, and seven usually with a few teeth near apex. Vestiture consisting of small, abundant, erect, interstitial scales; each scale indistinctly longer than wide.

*Male*.—Unknown.

*Type Locality*.—Saratoga, Wyoming.

*Host*.—*Picea pungens*.

*Type Material*.—The female holotype and two paratypes were collected at the type locality on July 28 (lot 955-2) from *Picea pungens* by D. DeLeon, and three paratypes on July 17 (Hopk. U.S. 31529e) from the same host and locality. The holotype and two paratypes are in the collection of the U.S. National Museum; the other three paratypes are in the Canadian National Collection.

#### *Carphoborus frontalis*, new species

This species is closely allied to *pinicolens*, *brevisetosus*, and *convexifrons* but differs by having a broad, raised, median line on the lower half of the frons (both sexes), and by the predominantly hairlike pubescence on the pronotal disc. The female is also distinguished from the female of *pinicolens* by having a weakly convex frons with a larger median impunctate area; from *brevisetosus* by having longer frontal pubescence and a larger impunctate frontal area in the female, and by having a more coarsely punctured pronotum and more coarsely sculptured elytral declivity in both sexes; and from *convexifrons* by having a less strongly convex frons and longer frontal pubescence in the female, and by having a less coarsely punctured pronotum and the second declivital interspaces continuing to apex in both sexes.

*Female*.—Length 2.5 mm. (paratypes 1.8-2.5 mm.), 2.6 times as long as wide.

Frons weakly convex, the median line broadly, indistinctly raised from upper level of eyes to epistoma, transversely impressed above epistoma; epistomal area with median area produced in front of mandibles; surface finely reticulate, impunctate on subcircular median area the diameter of which equals about one-half the distance between the eyes, punctures surrounding this area rather fine, shallow; pubescence arising from punctured area rather coarse, moderately long. Antennal club about as long as wide, the sutures weakly arcuate.

Pronotum 1.2 times as wide as long; sides converging slightly anteriorly, a distinct lateral constriction one-third the distance from base, and another just behind the broadly rounded anterior margin; surface reticulate, punctures moderately coarse and close; median line usually elevated and impunctate; vestiture consisting of abundant small, erect, almost hairlike (often bifid) scales; a few shorter, stout scales intermixed in lateral areas.

Elytra 1.7 times as long as wide; sides subparallel on basal two-thirds, rather broadly rounded behind; basal margins elevated and armed with about nine large, overlapping crenulations; striae slightly impressed, the punctures rather large, deep, close; interstriae about as wide as striae, weakly convex, the punctures confused, close, deep, rather coarse. Declivity similar to that of *pinicolens*; interspaces one and three moderately elevated; one, three, five, seven, and nine rather coarsely serrate at least near apex; interspace two depressed, as narrow as one, narrower than three, continuing to apex. Vestiture consisting of abundant scales; each scale longer than wide, some of those on first and second declivital interspaces longer and hairlike.

*Male*.—Similar to the female except: frons transversely impressed on lower

half (longitudinally concave), with the median, bituberculate, transverse elevation at upper level of impression characteristic of the genus; the frontal impression with a broad, weak, median elevation; impunctate area of frons smaller, punctures coarser, and pubescence shorter.

*Type Locality*.—Ventura County, California.

*Hosts*.—*Pinus edulis* (type) and *P. monophylla*.

*Type Material*.—The female holotype, male allotype, and 16 paratypes were collected at the type locality on April 6, 1906 (lot 2781a), from *Pinus edulis* by A. D. Hopkins. Seventy-seven other paratypes were collected in California as follows: Frazier Mountain, Sept. 6, 1940; Valyermo, Jan. 17, 1936, and Jan. 26, 1937, by A. T. McClay; and Ventura County, Jan. 17, 1905 (lot 277g), by A. D. Hopkins.

The holotype, allotype, and several paratypes are in the collection of the U.S. National Museum; additional paratypes are in the Canadian National Collection and collections of the California Academy of Sciences and Ohio State University.

***Carphoborus convexifrons*, new species**

Fig. 16

This species is closely allied to *frontalis* but is readily separated by the rather strongly convex frons and very short (subglabrous) frontal pubescence of the female, the more coarsely punctured pronotum, the scalelike vestiture on the pronotal disc, and the second interspaces made extremely narrow or obsolete on the upper half of the declivity by convergence of striae one and two (usually narrower than illustrated in Fig. 16).

*Female*.—Length 2.5 mm. (paratypes 1.8-2.5 mm.), 2.3 times as long as wide.

Frons broadly, rather strongly convex, transversely impressed above epistoma; epistomal margin medially produced (variable in a series) in front of mandibles; surface indistinctly reticulate, impunctate on a subcircular area the diameter of which equals about one-half the distance between eyes, the punctures rather fine and shallow surrounding this area; pubescence arising from punctured area very short and inconspicuous except on epistomal margin (the epistomal brush), where setae are of normal length and about four times longer than on sides and above. Antennal club about as long as wide, the sutures arcuate.

Pronotum 1.2 times as wide as long; sides converging slightly anteriorly, with a distinct lateral constriction one-third the distance from base and another just behind the broadened rounded anterior marking; surface reticulate, punctures very coarse and close; median line raised near centre, largely obliterated by punctures; vestiture consisting of abundant small, erect scales, each scale indistinctly longer than wide.

Elytra 1.8 times as long as wide; sides subparallel on basal two-thirds, rather broadly rounded behind; basal margins elevated and armed with about nine large, overlapping crenulations; striae slightly impressed, the punctures rather large, deep, close; interstriae about as wide as striae, weakly convex, the punctures confused, close, deep, coarse. Declivital interspaces (Fig. 16) one and three moderately elevated, two depressed and made obsolete (or at least very narrow) on upper half by convergence of striae one and two; interspaces one, three, five, seven, and nine serrate at least near apex. Vestiture consisting of abundant scales, each scale indistinctly longer than wide.

*Male*.—Similar to the female except: frons transversely impressed on lower half (longitudinally concave), with the median, bituberculate, transverse elevation above the impression characteristic of the genus; surface of frons more coarsely

punctured, the pubescence more than twice as long, and the impunctate area much smaller.

*Type Locality*.—Chiricahua National Monument, Arizona.

*Hosts*.—*Pinus edulis* and *P. leiophylla* (type).

*Type Material*.—The female holotype, male allotype, and nine paratypes were collected at the type locality on Oct. 1, 1936 (lot 838-2), from *Pinus leiophylla* by D. DeLeon. Nine other paratypes were collected as follows: Santa Catalina Mountains, Arizona (lots 7703 and 7705), by M. Chrisman; and Peloncillo National Forest, New Mexico, Nov. 12, 1907 (bred Jan. 6, 1908) (Hopk. U.S. 5593), by J. L. Webb.

The holotype, allotype, and several paratypes are in the U.S. National Museum; additional paratypes are in the Canadian National Collection and collections of the California Academy of Sciences.

### *Carphoborus sansoni* Swaine

Figs. 26, 27

*Carphoborus sansoni* Swaine, 1924, Can. Ent. 56: 235; Chamberlin, 1939, The Bark and Timber Beetles of North America, p. 132.

*Carphoborus engelmanni* Wood (new synonymy), 1951, J. Ent. Soc. Kansas 24: 31.

This species is very closely allied to *andersoni*; it differs by the more strongly elevated and serrate first declivital interspaces, and less strongly elevated third declivital interspaces. Possibly the two forms are only subspecifically distinct.

*Female*.—Length 1.8-2.1 mm., 2.4 times as long as wide.

Frons flattened, weakly impressed above the elevated epistoma; epistomal margin medially produced in front of mandibles; surface rather coarsely punctured; vestiture rather long, coarse. Antennal club 1.3 times as long as wide, the sutures straight.

Pronotum 1.2 times as wide as long; sides slightly arcuate, indistinctly converging anteriorly, a weak lateral constriction just behind the broadly rounded anterior margin; surface reticulate, punctures of moderate size, deep, close; median line elevated only near middle; vestiture consisting of abundant small, erect scales, each scale distinctly longer than wide.

Elytra 1.7 times as long as wide; sides subparallel on basal two-thirds, rather broadly rounded behind, the posterior profile interrupted by the elevated declivital interspaces; basal margins elevated and armed with about nine large, overlapping crenulations; striae slightly impressed, the punctures rather large, deep, close; interstriae about as wide as striae, weakly convex, the punctures confused, close, deep, rather coarse. Declivital interspaces one and three moderately elevated; one highest just above apex; three highest near middle of declivity (Figs. 26, 27); interspace two very slender, flat; interspaces one, three, five, and seven serrate; nine usually with one or two teeth at or anterior to declivital base (not serrate as originally described by Swaine); declivital elevation ending at junction of interspaces three and nine, not continued across interspace two. Vestiture consisting of large, abundant, erect, interstitial scales, each scale longer than wide.

*Male*.—Similar to female except: frons convex above, strongly, transversely impressed below (longitudinally concave), the median bituberculate, transverse elevation as in other species of the genus; surface of frons more coarsely, deeply punctured, and vestiture shorter.

*Type Locality*.—Banff, Alberta.

*Hosts*.—*Picea engelmannii* and *P. glauca*.

*Distribution.*—Alberta to Utah. Specimens from the following localities were examined. *Alberta:* Banff. *Utah:* Beaver, Logan Canyon, and Monte Cristo. *Wyoming:* Yellowstone National Park.

Fifty-three specimens were studied before preparation of the above description. The description of the female is based on the type of *engelmanni*, that of the male on the type of *sansoni*. The type of *sansoni* is in the Canadian National Collection; that of *engelmanni* (described from *Picea engelmannii*, Logan Dry Canyon, Utah) is in the U.S. National Museum.

The ninth declivital interspace was originally described by Swaine as being serrate, and the species was compared to *carri*. This combination of factors led me to describe specimens collected in Utah as a distinct species; actually the Utah specimens are indistinguishable from Swaine's type.

#### ***Carphoborus andersoni* Swaine**

Figs. 28, 29

*Carphoborus andersoni* Swaine, 1919, Rept. Canadian Arctic Exped. 3: 6E; Bruck, 1936, Bull. Southern California Acad. Sci. 35: 115; Chamberlin, 1939, The Bark and Timber Beetles of North America, p. 130.

This species is very closely allied to *sansoni*; possibly it is only a northern subspecies. It is distinguished by the less strongly elevated, more finely serrate first declivital interspaces, and more strongly elevated third declivital interspaces (particularly at apical end of elevation).

*Female.*—The description of this species is exactly the same as that of *sansoni* except for the elytral declivity; for this reason only the posterior area of the type is described.

Declivital interspace one slightly elevated, finely serrate (Figs. 28, 29); interspace two very narrow, impressed; interspace three strongly, narrowly elevated, highest near apical end of elevation, teeth rather long and slender; interspaces five and seven serrate; nine almost flat, with one or two teeth at, or anterior to, declivital base.

*Type Locality.*—Sandstone Rapids, Coppermine River, Northwest Territories.

*Host.*—*Picea glauca*.

*Distribution.*—Northwest Territories to Alaska. Five female specimens were examined: three are from the type locality; two are from Fort Yukon, Salmon River, Alaska.

The type specimen is in the Canadian National Collection.

#### ***Carphoborus dumni* Swaine**

Figs. 30, 31

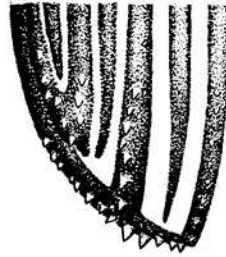
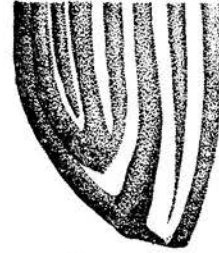
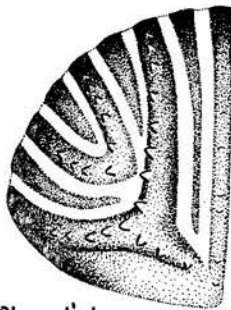
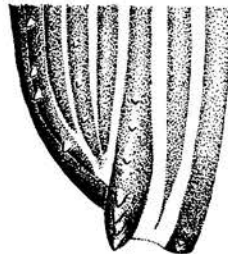
*Carphoborus dumni* Swaine, 1924, Can. Ent. 56: 235; Chamberlin, 1939, The Bark and Timber Beetles of North America, p. 132.

This species is allied to *andersoni* and *sansoni* but differs by the granulate surface and shorter pubescence of the female frons, by the higher, wider elevation of the third declivital interspaces, and by the serrations on the third declivital interspaces, which are small, confused, more abundant on the sides of the elevation than on its summit.

*Female.*—Length 1.6-1.9 mm., 2.4 times as long as wide.

Frons convex, transversely impressed above the slightly elevated epistoma; epistomal margin medially produced in front of mandibles; surface granulated-punctate; vestiture very short, scanty. Antennal club 1.4 times as long as wide, the sutures straight.

Pronotum 1.2 times as wide as long; sides convergently arcuate anteriorly, laterally constricted just behind the broadly rounded anterior margin; surface reticulate, the punctures deep, rather close, of moderate size; vestiture consisting of abundant small, semi-erect, very slender scales (almost hairlike).

20. *radiatae*22. *ponderosae*24. *carri*21. *radiatae*23. *ponderosae*25. *carri*26. *sansoni*28. *andersoni*30. *dunni*27. *sansoni*29. *andersoni*31. *dunni*

Figs. 20-31.—*Carphoborus* spp., declivity of left elytron; 20, dorsal and 21, caudal aspect of *radiatae*; 22, dorsal, and 23, caudal aspect of *ponderosae*; 24, dorsal, and 25, caudal aspect of *carri*; 26, dorsal and 27, caudal aspect of *sansoni*; 28, dorsal, and 29, caudal aspect of *andersoni*; 30, dorsal, and 31, caudal aspect of *dunni*.



Elytra 1.7 times as long as wide; sides subparallel on basal two-thirds, narrowly subtruncate behind, the posterior profile interrupted by the elevated third interspaces; basal margins elevated and armed with about nine large, overlapping crenulations; striae slightly impressed, the punctures rather large, deep, close; interstriae about as wide as striae, weakly convex, the punctures confused, close, deep, rather coarse. Declivital interspace (Figs. 30, 31) one weakly elevated, finely serrate; two very narrow, flat; three very strongly, rather broadly elevated, with the teeth confused, not confined to summit; five and seven serrate, slightly elevated, joining apically and this elevation usually continuing to interspace three; nine usually entirely devoid of teeth behind declivital base, weakly or not at all convex. Vestiture consisting of rather large, slender, abundant, semi-erect, interstitial scales.

*Male*.—Similar to female except: frons more strongly convex, the impression deeper, a median transverse elevation indicated; surface of frons more coarsely punctured.

*Type Locality*.—Nictor Lake, New Brunswick.

*Host*.—*Picea rubens*.

*Distribution*.—Known only from the type series of five specimens.

The above descriptions were prepared from the female holotype and male allotype, which are in the Canadian National Collection.

#### ***Carphoborus radiatae* Swaine**

Figs. 20, 21

*Carphoborus radiatae* Swaine, 1918, Canada Dept. Agr. Ent. Br. Bull. 14(2): 57; Bruck, 1936, Bull. Southern California Acad. Sci. 35: 112; Chamberlin, 1939, The Bark and Timber Beetles of North America, p. 129.

This species is allied to *ponderosae* but is readily distinguished by the concave frons of the female, the more strongly impressed frons of the male, and the much coarser frontal punctures and less strongly elevated, more finely, sparsely serrate third and ninth declivital interspaces of both sexes.

*Female*.—Length 1.8-2.4 mm., 2.4 times as long as wide.

Frons broadly, shallowly concave on an area the diameter of which equals about three-fourths of the distance between the eyes, and extending from just above epistoma to well above the upper level of the eyes; epistomal area elevated and medially produced (variable in a series) in front of mandibles, entire surface very coarsely punctured (finer below) and pubescent; vestiture rather long and moderately fine. Antennal club 1.5 times as long as wide, the sutures straight.

Pronotum 1.2 times as wide as long; sides almost straight on basal half, converging slightly anteriorly, indistinctly constricted just behind the very broadly rounded anterior margin; surface reticulate, punctures coarse, deep, close; median line elevated and distinct on middle half; vestiture consisting of abundant small, erect scales, each scale distinctly longer than wide.

Elytra 1.8 times as long as wide; sides subparallel on basal two-thirds, rather broadly rounded behind, basal margins elevated and armed with about nine large, overlapping crenulations; striae slightly impressed, the punctures rather large, deep, close; interstriae about as wide as striae, weakly convex, the punctures confused, close, deep, rather coarse. Declivital interspace (Figs. 20, 21) one wider than two, but distinctly narrower than three; one slightly, three and nine distinctly elevated, two flat; one, three, five, seven, and nine sparsely serrate at least apically. Vestiture consisting of small, abundant, semi-erect, interstitial scales, each scale distinctly longer than wide.

*Male*.—Similar to the female except: frons rather strongly, transversely

impressed (longitudinally concave) below the median bituberculate, transverse elevation; surface of frons coarsely, deeply punctured, vestiture shorter.

*Type Locality*.—Carmel, Monterey County, California.

*Host*.—*Pinus radiata*.

*Distribution*.—Known only from the type locality. Twenty-five specimens representing five series, collected between 1913 and 1919, were examined.

The above description of the female was based on the type, which is in the Canadian National Collection. In Swaine's original description the sexes were reversed; consequently, the type is a female, not a male.

### *Carphoborus ponderosae* Swaine

Figs. 4, 22, 23

*Carphoborus ponderosae* Swaine, 1924, Can. Ent. 56: 236; Bruck, 1936, Bull. Southern California Acad. Sci. 35: 118; Chamberlin, 1939, The Bark and Timber Beetles of North America, p. 131.

This species is allied to *radiatae* but is distinguished by the flattened, less coarsely punctured frons of the female, by the less strongly impressed frons of the male, and by the less strongly elevated, more coarsely, closely serrate third and ninth declivital interspaces of both sexes.

*Female*.—Length 1.8-2.1 mm., 2.3 times as long as wide.

Frons flattened, epistomal region moderately elevated; epistomal margin medially produced (variable in a series) in front of mandibles; surface shining, rather coarsely punctured over entire frontal area, punctures rather deep, moderately close; vestiture rather long, fine. Antennal club (Fig. 4) small, 1.5 times as long as wide, the sutures straight.

Pronotum 1.3 times as wide as long; sides arcuately converging anteriorly, laterally constricted just behind the broadly rounded anterior margin; surface reticulate, the punctures moderately coarse and close, rather deep; median line slightly elevated, impunctate; vestiture consisting of abundant small, erect scales, each scale slightly longer than wide.

Elytra 1.7 times as long as wide; sides subparallel on basal two-thirds, rather broadly rounded behind, basal margins elevated and armed with about nine large, overlapping crenulations; striae slightly impressed, the punctures rather large, deep, close; interstriae about as wide as striae, weakly convex, the punctures confused, close, deep, rather coarse. Declivital interspaces (Figs. 22, 23) one moderately, three and nine rather strongly elevated; two flat; one, three, five, seven, and nine very coarsely serrate; the elevation continuing from junction of three and nine to one, usually serrate. Vestiture consisting of small, abundant, erect, interstitial scales, each scale about as long as wide.

*Male*.—Similar to female except: frons moderately, transversely impressed below (longitudinally concave), the median elevation above the impression usually absent; surface of frons more coarsely punctured, vestiture shorter; pronotal scales stouter, at least as wide as long.

*Type Locality*.—Midday Valley, Merritt, British Columbia.

*Hosts*.—*Pinus contorta* and *P. ponderosa* (type).

*Distribution*.—British Columbia to Utah. Specimens from the following localities were examined. *British Columbia*: Midday Valley near Merritt. *Montana*: Bozeman and Clinton. *Oregon*: Fort Rock. *Utah*: La Sal Mountains and Logan Canyon.

The above descriptions were based on the female holotype and male allotype, which are in the Canadian National Collection. One hundred and sixty-two other specimens of this species were also studied.

***Carphoborus declivis*, new species**

Fig. 17

This species is not closely related to any known North American species, but is perhaps more closely allied to *pseudotsugae* than to other species of the genus. It differs from all others by the presence of small teeth on the comparatively broad second declivital interspaces. It resembles *pseudotsugae* in having declivital interspaces four, six, and eight serrate.

*Female*.—Length 2.0 mm. (paratypes 1.7-2.0 mm.), 2.3 times as long as wide.

Frons planoconvex, finely, densely granulate; epistomal margin raised and medially produced in front of mandibles (variable in a series); vestiture of moderate length, fine. Antennal club 1.4 times as long as wide; the sutures straight.

Pronotum 1.2 times as wide as long; sides arcuately converging anteriorly, indistinctly constricted just behind the broadly rounded anterior margin; surface subreticulate, punctures of moderate size, deep, close; median line not evident; vestiture consisting of abundant small, erect scales, each scale distinctly longer than wide.

Elytra 1.7 times as long as wide; sides subparallel on basal two-thirds, rather broadly rounded behind; basal margins elevated and armed with about nine large, overlapping crenulations; striae slightly impressed, the punctures rather large, deep, close; interstriae about as wide as striae, weakly convex, the punctures confused, close, deep, coarse. Declivital interspaces (Fig. 17) one and two of equal width, three wider; all interspaces convex, with one, five, seven, and nine slightly, three moderately elevated; all declivital interspaces serrate, finer on two and six, rather coarse on three. Vestiture consisting of small, abundant, semi-erect, interstitial scales, each scale about as long as wide.

*Male*.—Similar to female except: frons with moderate, transverse impression (longitudinally concave) below the rather low, median, bituberculate, transverse elevation; surface of frons very coarsely punctured, the vestiture shorter, rather coarse; scales on pronotum wider.

*Type Locality*.—Lake Tenaya, Yosemite National Park, California.

*Host*.—*Pinus contorta* (type series labeled *murrayana*).

*Type Material*.—The female holotype, male allotype, and four paratypes were collected on Aug. 11, 1918 (Hopk. U.S. 15740a and b), from *Pinus contorta* by J. E. Patterson.

The holotype, allotype, and one paratype are in the U.S. National Museum, and three paratypes are in the Canadian National Collection.

***Carphoborus pseudotsugae*, new species**

Fig. 18

This species is allied to *declivis* and *intermedius* but is distinguished by the rather strongly protruding frons of the female; from the former species it is also separated by the very narrow, non-tuberculate second declivital interspaces; from the latter species it also differs by the presence of serrations on interspaces four, six, and eight, the much less strongly elevated third declivital interspaces, and the granulate frons of the female.

*Male*.—Length 2.1 mm., 2.3 times as long as wide.

Frons moderately, transversely impressed, longitudinally concave below the median transverse elevation; epistomal margin elevated, produced medially in front of mandibles; surface coarsely, rather deeply punctured; vestiture rather short, coarse. Antennal club 1.3 times as long as wide, the sutures very slightly arcuate.

Pronotum 1.3 times as wide as long; sides straight and subparallel on basal half, abruptly converging anteriorly to the broadly rounder anterior margin; surface shining, subreticulate, punctures rather coarse, deep, close; median line evident only near centre; vestiture consisting of abundant small, erect scales, each scale indistinctly longer than wide.

Elytra 1.7 times as long as wide; sides subparallel on basal two-thirds, rather broadly rounded behind, basal margins elevated and armed with about nine large, overlapping crenulations; striae slightly impressed, the punctures rather large, deep, close; interstriae about as wide as striae, weakly convex, the punctures confused, close, deep, rather coarse. Declivital interspace (Fig. 18) two very narrow, almost obsolete; one narrower than three; one and nine slightly, three moderately elevated; one and three to nine serrate, the teeth on three larger and more numerous. Vestiture consisting of small, abundant, semi-erect, interspatial scales, each scale about as long as wide.

*Female*.—Similar to the male except: frons more strongly convex above; the transverse impression above epistoma more abrupt, narrower (longitudinally); frons more finely granulate-punctate than in male, but much coarser than in females of other North American species. Vestiture on frons largely abraded, evidently rather short and fine; more slender on pronotum than in male.

*Type Locality*.—Prescott National Forest, Arizona.

*Host*.—*Pseudotsuga taxifolia*.

*Type Material*.—The male holotype and female allotype were collected at the type locality on July 29, 1930 (Hopk. U.S. 20412E), from *Pseudotsuga taxifolia* by M. W. Blackman. The pronotum of the allotype is badly crushed.

The holotype and allotype are in the U.S. National Museum.

#### *Carphoborus intermedius*, new species

Fig. 19

This species is rather closely allied to *carri* but is readily distinguished by the subtuberculate fourth and eighth declivital interspaces, by the more strongly elevated third declivital interspaces, by the narrower discal striae, and by the larger average size. It may be separated from *pseudotsugae* by the absence of distinct teeth on declivital interspaces four, six, and eight, the more strongly elevated third declivital interspace, and the shining, punctured, flat female frons.

*Male*.—Length 2.1 mm. (paratypes 1.9-2.1 mm.), 2.3 times as long as wide.

Frons convex above, transversely impressed below, the median elevation absent; epistoma slightly elevated, the margin medially produced in front of mandibles (variable in a series); surface coarsely, shallowly, not closely punctured; vestiture very short, coarse. Antennal club 1.3 times as long as wide, the sutures straight.

Pronotum 1.3 times as wide as long; sides arcuately converging anteriorly, laterally constricted just behind the broadly rounded anterior margin; surface subtuberculate, punctures rather coarse, deep, very close; median line evident only near centre; vestiture consisting of abundant small, erect scales, each scale indistinctly longer than wide.

Elytra 1.7 times as long as wide; sides subparallel on basal two-thirds, appearing narrowly truncate behind, the posterior profile interrupted by the elevated declivital interspaces; basal margins elevated and armed with about ten large, overlapping crenulations; striae slightly impressed, the punctures rather large, deep, close; interstriae about as wide as striae, weakly convex, the punctures confused, close, rather deep and coarse. Declivital interspace (Fig. 19) two very narrow, almost obsolete; three wider than one; one and nine moderately, three strongly elevated; one, three, five, seven, and nine rather finely serrate, four

and eight subtuberculate behind (these form definite teeth in one paratype); five and seven ending separately on right elytron of type, fusing on the left side (evidently this is a variable character in this species). Vestiture consisting of abundant semi-erect, interstitial scales, each scale about as long as wide.

*Female*.—Similar to male except: frons flat, shining, rather coarsely punctured; epistoma gradually raised toward margin; vestiture of frons very long, fine, less abundant and shorter near centre.

*Type Locality*.—New Castle, Colorado.

*Hosts*.—*Picea engelmannii* (type) and *Pinus contorta*.

*Type Material*.—The male holotype was collected at the type locality (Hopk. U.S. 31408-2-4) from *Picea engelmannii* by C. L. Massey; the female allotype was collected at Grand Lake, Colorado, on Oct. 5, 1938 (Hopk. U.S. 31542-J2), from *Pinus contorta*; two male paratypes are labelled "Metaline Falls, Washington, July 15, 1932 (Hopk. U.S. 22366), T. T. Terrell collector, flight"; and fourteen paratypes were taken at Tollgate, Oregon, July 1-15, 1950, on an aluminum roof by E. S. McClusky. The posteroventral half of the head is missing from the allotype.

The holotype and allotype are in the U.S. National Museum; the paratypes are in the Canadian National Collection.

#### ***Carphoborus carri* Swaine**

Figs. 24, 25

*Carphoborus carri* Swaine, 1917, Canada Dept. Agr. Ent. Br. Bull. 14(1): 16; Swaine, 1918, Canada Dept. Agr. Ent. Br. Bull. 14(2): 57; Chamberlin, 1939, The Bark and Timber Beetles of North America, p. 131.

This species is allied to *intermedius* and *bifurcus* but is distinguished by the less strongly elevated third declivital interspaces. From *intermedius* it is also separated by the small average size, narrower discal interspaces, and much larger elytral scales. From *bifurcus* it also differs by the flat, shining, punctured female frons; by interspaces five and seven converging and joining posteriorly; and by the elevation between the junction of interspaces three and nine and interspace one not well developed or serrate.

*Female*.—Length 1.4-2.0 mm., 2.3 times as long as wide.

Frons flattened; epistomal region slightly elevated, medially produced in front of mandibles, transversely impressed above epistoma; surface shining, closely, deeply rather finely punctured; vestiture long, fine. Antennal club 1.3 times as long as wide; the sutures straight.

Pronotum 1.3 times as wide as long; sides arcuately converging anteriorly, laterally constricted just behind the broadly rounded anterior margin; surface reticulate, closely, rather coarsely punctured; median line evident near middle; vestiture consisting of abundant small, erect scales, each scale indistinctly longer than wide.

Elytra 1.7 times as long as wide; sides subparallel on basal two-thirds, appearing rather narrowly truncate behind, the posterior profile interrupted by the elevated declivital interspaces; striae slightly impressed, the punctures very large, close, deep; interstriae much narrower than striae, convex, the punctures confused, close, deep, coarse. Declivital interspaces (Figs. 24, 25) one and two rather narrow, three wider; one and nine slightly, three moderately elevated, the elevation continuing from junction of three and nine to one rather poorly developed, often incomplete; one, three, five, seven, and nine finely serrate. Vestiture consisting of rather large, abundant, semi-erect, interspaces scales, each scale about as long as wide and many of them appearing multilamellate.



*Male*.—Similar to female except: transverse frontal impression deeper, wider (longitudinally), median area not elevated above impression; surface of frons coarsely punctured, the vestiture short and rather coarse.

*Type Locality*.—Edmonton, Alberta.

*Hosts*.—*Picea glauca* and *P. rubens*.

*Distribution*.—Alberta to New Brunswick, and South Dakota. Specimens from the following localities were examined. *Alberta*: Banff and Edmonton. *Manitoba*: Aweme. *New Brunswick*: Nictor Lake. *South Dakota*: Black Hills.

One hundred and forty-two specimens were studied before preparation of the above description. In the original description Swaine designated a female as the type; however, a male was described and was labelled as the female type in the Canadian National Collection. The above description of the female is based on Swaine's allotype, which was described as the male; the description of the male is based on the type.

### *Carphoborus bifurcus* Eichhoff

Figs. 6, 7

*Carphoborus bifurcus* Eichhoff, 1868, Berlin. Ent. Zeit. 12: 147; Chapuis, 1869 Synopsis des Scolytides, p. 41 (1873, Mem. soc. roy. sci. Liège, ser. 2, 3: 249); Leconte, 1876, Proc. Amer. Philos. Soc. 15: 383; Schwarz, 1888, Proc. Ent. Soc. Washington 1: 80; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 660; Blackman, 1922, Mississippi Agr. Expt. Sta. Tech. Bull. 11: 49; Chamberlin, 1939, The Bark and Timber Beetles of North America, p. 128.

*Dendroctonus bifurcus*, Zimmerman, 1868, Trans. Amer. Ent. Soc. 2: 148.

*Carphoborus bicristatus* Chapuis (new synonymy), 1869, Synopsis des Scolytides, p. 41 (1873, Mem. soc. roy. sci. Liège, ser. 2, 3: 249); Leconte 1876, Proc. Amer. Philos. Soc. 15: 384; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 661; Blackman, 1922, Mississippi Agr. Expt. Sta. Tech. Bull. 11: 49; Chamberlin, 1939, The Bark and Timber Beetles of North America, p. 128.

This species is allied to *carri* but is really distinguished by the very strongly elevated interspace three on the declivity, which continues after joining interspace nine to interspace one; by interspaces five and seven, which end separately; and, in the female, by the slightly convex, granulate frons, which has shorter vestiture.

*Female*.—Length 1.4-1.8 mm., 2.5 times as long as wide.

Frons weakly convex, transversely impressed above epistoma, epistoma slightly elevated, the margin medially produced in front of mandibles; surface granulate; vestiture rather short, coarse. Antennal club 1.3 times as long as wide, the sutures straight.

Pronotum 1.2 times as wide as long; sides arcuately converging toward the rather broadly rounded anterior margin; surface coarsely, closely, rather shallowly punctured; median line not indicated; vestiture consisting of abundant small, erect, subcircular scales.

Elytra 1.9 times as long as wide; sides subparallel on basal two-thirds, appearing narrowly subtruncate behind; posterior profile altered conspicuously by the elevated declivital interspaces; basal margins elevated and armed with about nine large, overlapping crenulations; striae slightly impressed, the punctures very large, deep, close; interstriae much narrower than striae, weakly convex, the punctures confused, close, deep, rather coarse, often subgranulate. Declivital interspace (Figs. 6, 7) two very narrow, one slightly wider and feebly elevated; three wider than one, very strongly elevated; five indistinctly elevated and terminating separately from the more strongly elevated seventh; nine moderately elevated; one (very finely), three, five, seven, and nine serrate. Vestiture consisting of

rather large, abundant, semi-erect, interspacial scales, each scale slightly longer than wide, some appearing almost multilamellate.

*Male*.—Similar to female except: frons more strongly convex above, more broadly impressed below, the surface more coarsely punctured, often with a small median elevation.

*Type Locality*.—"Amer. bor." Evidently "Carolina" according to Chapuis (1869, p. 41).

*Hosts*.—*Pinus echinata*, *P. taeda* and *P. virginiana*.

*Distribution*.—Southeastern United States, north to New York and west to Missouri and Mississippi. Specimens from the following localities were examined. *District of Columbia*: Washington. *Florida*: Tallahassee. *Maryland*: "Md.". *Mississippi*: Agricultural College and Meridian. *Missouri*: Eminence. *New York*: Flatbush (Long Island) and Westpoint. *North Carolina*: Chadbourn, Raleigh, and Tryon. *Tennessee*: "Tenn.". *Virginia*: Arlington. *West Virginia*: Kanahwa Station.

Type material of *bifurcus* and *bicristatus* was not accessible. The type localities of both are in the southeastern United States (Chapuis, 1869, p. 41, gives "Carolina" for *bifurcus*; Leconte, 1876, p. 384, gives "Georgia" for *bicristatus*). Since the 182 specimens examined from that region represent only one species, it is presumed, after careful study of the original descriptions, that these names apply only to different sexes of the same species, as was originally suggested by Leconte.

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#### References

- Bruck, C. R. 1933. New species of *Carphoborus* Eich. with key to species north of Mexico (Coleoptera-Scolytidae). *Can. Ent.* 65: 103-106.
- Bruck, C. R. 1936. Synoptic revision of the subfamily Hylesiniinae (Scolytidae-Coleoptera) of western North America north of Mexico. Part 2. *Bull. Southern California Acad. Sci.* 35: 108-126.
- Chapuis, F. 1869. Synopsis des Scolytides. Liège. 61 pp. (1873. *Mem. soc. roy. sci. Liège*, ser. 2, 3: 213-269).
- Eichhoff, W. 1864. Ueber die Mundtheile und die Fühlerbildung der europäischen Xylophagi sens. strict. *Berliner Ent. Zeitschr.* 8: 17-46.
- Leconte, J. L. 1876. Family Scolytidae. In *The Rhynchophora of America north of Mexico* by J. L. Leconte and G. H. Horn. *Proc. Amer. Philos. Soc.* 15: 341-391.
- Reitter, E. 1913. Bestimmungstabelle der Borkenkäfer. *Wiener Ent. Zeit.* (Beiheft) 32: 116 pp.
- Swaine, J. M. 1918. Canadian bark beetles. Part 2. *Canada Dept. Agr. Ent. Br. Bull.* 14: 143 pp.

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