**Systematics**

**Taxonomic Status of Scolytus opacus and Scolytus abietis (Coleoptera: Curculionidae: Scolytinae): A Comparative Study**

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**ABSTRACT** Anatomical features of male and female *Scolytus opacus* Blackman, infesting *Abies lasiocarpa* (Hook.), and *Scolytus abietis* Blackman (Coleoptera: Curculionidae: Scolytinae), infesting *Abies grandis* (Douglas) and *Abies concolor* (Gord. & Glend.), were compared by light and scanning electron microscopy. Diagnostic features involve body size; striations on the underside of the head, which have a stridulatory function; shape of the submentum; and several characters on abdominal sternites 1 and 2. Because of differences in these features of the two taxa, and because the two populations infest different tree species and are sympatric in Idaho, we reinstate *S. abietis* as a valid species.

**KEY WORDS** Scolytinae, *Scolytus opacus*, *Scolytus abietis*, synonymy

*Scolytus opacus* Blackman was described from six specimens collected from subalpine fir, *Abies lasiocarpa* (Hook.), at Ouray, CO (2), Glacier National Park, MT (3), and Brightons, UT (1) (Blackman 1934). *Scolytus abietis* Blackman was also described in that publication from 34 specimens collected from grand fir, *Abies grandis* (Douglas), at Sandpoint (27) and Coeur d’Alene (7), ID. Edson (1967) redescribed *S. opacus* and *S. abietis* and added *Abies concolor* (Gord. & Glend.) as a host of *S. abietis*. He also extended the distribution of *S. opacus* to include California, Oregon, and Washington; and that of *S. opacus* to include Arizona, Idaho, and Wyoming. The two taxa are sympatric in northern Idaho. Bright (1976) treated these two taxa as subspecies. Wood (1977) placed *S. opacus* in synonymy under *S. opacus* (see Discussion). We studied the variation in anatomical features of these two host-isolated populations, including specimens from the same locality (Priest River Experimental Forest, Idaho), for the purpose of clarifying their taxonomic status.

**Materials and Methods**

We examined 211 (101 male, 110 female) *S. opacus* from infested *A. lasiocarpa* at 12 localities in Colorado, Idaho, Montana, Utah, and Washington and 432 (227 male, 205 female) *S. abietis* from *A. grandis* and *A. concolor* at 23 localities in Idaho, Washington, and Oregon. Most the *S. opacus* and *S. abietis* were collected by us; we obtained and examined additional specimens that had host labels, including the types, from several museums (see Acknowledgments). Specimens were examined at 15–90× to determine their sex and to evaluate features in the descriptions by Blackman (1934) and the revision by Edson (1967). Sex of male specimens was determined by the presence of a spine on abdominal sternite 2 (ventrite 2); females have only an obtuse carina, or callus, on abdominal sternite 2. Also, the head of males is flat in front; the head of females is convex. Other features that were examined included body color, body length, underside of the head, and structures of the abdominal sternites including surface luster, punctures, setation, and the male spine. Eight adult specimens, divided equally between the taxa and sexes, were cleaned in an ultrasonic bath and examined by scanning electron microscopy (SEM) at Washington State University. The four *S. opacus* came from *A. lasiocarpa* collected at Priest River Experimental Forest (PREF), Bonner Co., and Cassia Co., ID. The four *Scolytus abietis* came from *A. grandis* collected at PREF and Hidden Campground, Wallowa Co., OR. Distinctive features of the underside of the head and of the abdominal sternites were photographed (Figs. 1 and 2). Specimens collected by us and other specimens that were not obtained on loan are deposited in the W. F. Barr Entomological Museum (WFBM), University of Idaho, Moscow, ID.

**Specimens Examined.** *S. opacus*. USA. Colorado: Ouray Co., Ouray, VII-1-15-1897, H. F. Wickham (Holoype USNM no. 43836). Mesa Co., Jumbo (Campground), VIII-25-1968, L. A. Kelton (1). Idaho: Idaho Co., Salmon Mt., VII-18-1985, M. M. Furniss and J. B. Johnson (3). Cassia Co., 6 miles E of Bostelt G. S., VII-26-1985, M. M. Furniss and J. B. Johnson (24). Cassia Co., 3 miles NE of Bostelt, VII-26-1985, M. M. Furniss and J. B. Johnson (3). Boundary Co., Ruby Pass, VI-7-1986, M. M. Furniss and J. B. Johnson (3).

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Fig. 1. Striations (str) and submentum (sm) on underside of head of S. opacus male (A) and female (B) and S. abietis male (C) and female (D).

Latah Co., Flat Cr., VI-26-1991, A. Equihua (22). Bonner Co., Priest River Experimental Forest, IX-14-1994, M. M. Furniss (10). Oregon: Deschutes Co., Paulina Lake., VI-12-1940, Schuh & Scott (7). Klamath Co., Klamath Falls, Geary Ranch, X-4-1962, J. Schuh (1). Douglas Co., Diamond Lake., VII-9-1964, D. E. Bright (6). Montana: Glacier National Park, VII-8-1931, E. W. Mank (2). Glacier Natl. Park, VIII-24-1923, J. C. Evenden (3). Utah: Utah Co., Hobble Creek Canyon, VI-4-1960 and VI-14-1960, D. E. Bright (38). Cache Co., Logan Canyon, IX-9-1934, T. O. Thatcher (2). Washington: Garfield Co., S of Pomeroy, VII-19-1991,
Abdominal sterna 2–5. *S. opacus* male (A) and female (B). *S. abietis* male (C) and female (D). sp, spine of male; sc, subcarina of female; st 2, sternite 2; st 5, sternite 5.

M. M. Furniss (80). Lewis Co., Walupt Lake, VII-16-1991, M. M. Furniss and J. B. Johnson (1). Wyoming: Carbon Co., Saratoga, VIII-31-1938 (3). CANADA: British Columbia: Lorna, VI-30-1926, H. Richmond (1).

S. abietis. USA: Idaho: Bonner Co., Sandpoint, VI-20-1899, A. D. Hopkins (Holotype USNM no. 43837). Bonner Co., Sandpoint, (Idaho) VI-2-1899 and VI-20-1899, A. D. Hopkins, Paratypes CNC no. 10575 (2) and Paratype USNM no. 43837 (1). Kootenai Co., Coeur
d’Alene, VI-16-1922, H. J. Rust, Paratypes USNM no. 43837 (9). Kootenai Co., Coeur d’Alene, V-15--1951, W. F. Barr (75). Bonner Co., Priest River Experimental Forest, VI-29-1967, M. M. Furniss (4). Kootenai Co., Hayden Lake, 1986, Jorge Macias (8). Bonner Co., Priest River Experimental Forest, VIII-5-1985, M. M. Furniss (2). Bonner Co., Priest River Experimental Forest, VIII-6-1985, M. M. Furniss (207). Bonner Co., Priest Lake, VIII-5-1985, M. M. Furniss (8). Bonner Co., Priest Lake, VIII-6-1985, M. M. Furniss and J. B. Johnson (8). Bonner Co., Idaho County, Priest Lake, VI-16-1966, M. M. Furniss and J. B. Johnson (2). Clearwater Co., Elk River, XI-1984, M. M. Furniss (50). Latah Co., 6 miles N of Pothlatch, IV-17-1922, H. L. Osborne (4). Latah Co., Flat Creek, VI-18-1991, A. Equihua (8). Latah Co., Beals Butte, VIII-21-1965, M. M. Furniss (1). Latah Co., Moscow Mtn., VII-18-1967, M. M. Furniss (4). Valley Co., Lick Creek, IX-29-1984, M. M. Furniss (18). Oregon: Jackson Co., Pinehurst, VI-28-1928, F. F. Keen, Paratypes (2). Crater Lake, V-9-1930, W. J. Buckhorn. Paratype (1). Hood River Co., Hood River, III-21-1931, W. J. Buckhorn (2). Deschutes Co., Bend, VII-8-1958, W. J. Buckhorn and P. W. Orr (1). Lake Co., Lakeview, VI-25-1962, K. H. Wright (1). Linn Co., Cascadia, VIII-8-1966, (1). Union Co., 9 miles N of Palmer Jen., VIII-17-1969, M. M. Furniss and J. B. Johnson (3). Washington: Pend Orielle Co., Metlaine Falls, VI-16-1930, D. DeLeon (3). Asotin Co., 10 miles S of Anatone, XI-4-1990, M. M. Furniss (5).

Results

Color. Blackman described S. opacus as “shining black, with elytra dark reddish brown” and S. abietis as “dark reddish brown, nearly black with elytra lighter in color.” We found color to be variable and of little value in separating these taxa. Likewise, they did not differ markedly in their general shininess.

Body Length. Published body lengths of S. opacus are: 2.77 mm, excluding head (Blackman 1934): 2.0–2.6 mm, including S. abietis as a synonym (Wood 1982); and 2.5–3.4 mm (Edson 1967). Published body lengths for S. abietis are as follows: 2.0–2.4 mm, excluding head (Blackman 1934) and 2.2–2.8 (Edson 1967). We measured specimens of six series spanning the smallest and largest of the specimens collected by us. The average and range for S. opacus were 3.3 (2.7–4.1) mm (n = 34); these values for S. abietis were 2.4 (1.7–3.0) mm (n = 34). Additionally, we measured the smallest and largest specimens of each series in the loans obtained from museums. All were within the values of our specimens. For example, the USNM specimens were S. opacus (2.5–3.4 mm) and S. abietis (2.1–2.9 mm).

Front of Head. Blackman (1934) described the front of the head of male S. opacus as being flattened to well behind the eyes whereas that of male S. abietis extends just back of the eyes. In practice, this difference was rather subjective and we noted that some pinned specimens had the head retracted and obscured beyond the eye.

Underside of Head. The submentum is more rounded posteriorly in S. opacus and more acute in S. abietis (Fig. 1). Both species have striations running horizontally across the gular suture, obscuring it (Fig. 1). The striations are relatively broader in S. abietis. In exploratory SEM, we observed 57–60 striations running horizontally across the gular suture, obscuring it (Fig. 1). The striations are not counted by ordinary microscopy, we did not examine a sufficient number of specimens to determine if the observed difference between males and females is significant. These features of the head involving the submentum and striations have not been described previously.

Abdominal Stermites and Venter. Characters on the venter (abdominal sternites 2–5) that are species specific according to Blackman (1934) and Edson (1967) involve the surface reflectance and color, impression of the punctures, and proportional length of the male spine. Those authors described abdominal sternite 2 of S. opacus as being subopaque in luster and brownish black, whereas that of S. abietis is shiny and dark black. Such distinction was less clear to us although abdominal sternite 2 of S. abietis generally had a bit more luster than that of S. opacus. The punctures of S. abietis are more impressed and each puncture has a branched seta that seems whitish under magnification (Fig. 2). The punctures of S. opacus are less impressed and their setae seem not to be branched and are less conspicuous. In S. opacus, the setae on abdominal sternite 1 are short and extend one-half or less of the length of this sternite behind the metacoxae; the setae of S. abietis are longer, sometimes spanning the sternite at that location. These differences involving the setae have not been described previously.

According to Edson (1967), the spine of S. opacus extends across three-fourths of the length of abdominal sternite 2, whereas that of S. abietis rarely extends beyond one-half the length of abdominal sternite 2. We found that the spine of the type of S. opacus generally exceeded that of S. abietis but that the latter also consistently extended beyond one-half of the length of abdominal sternite 2. For example, S. opacus (selected randomly from six localities), average = 0.70 (range, 0.59–0.79), n = 20 and S. abietis (10 localities): average = 0.62 (range, 0.54–0.69), n = 20. Similarly, we found that the spine of the type of S. opacus extends 0.82 of abdominal sternite 2, whereas the spine of the type of S. abietis extends 0.68 of abdominal sternite 2. As shown in Fig. 2, the pits on the summit of the male spine of S. opacus are more dense than are those of S. abietis. In side profile, the posterior slope of the spine of S. opacus is usually interrupted (notched), whereas the posterior slope of the spine of S. abietis is invariably straight (keel-like). Also, the spine of S. opacus is more broadly joined to the posterior edge of abdominal sternite 2 than is the spine of S. abietis (Fig. 2A and C). These last three features of the spine have not been described previously.
In females of both species, the spine is reduced to form a median obtuse carina or callus (Fig. 2B and D) and the posterior lip of abdominal sternite 1 of females is less produced than that of males. Additionally, the front of the head of females is rounded in side profile; that of males is flattened. Otherwise, females share the male features.

### Gallery System

The gallery systems of these taxa are rather similar. Egg galleries of both taxa are biramous with a central nuptial chamber as exemplified by Fig. 3. The branches may be straight or gull-wing-like and are oriented more-or-less across the wood grain. According to Edson (1967), the larger *S. opacus* has slightly longer egg galleries (1.8–5.1 cm [1.0–2.5 inches]) than *S. abietis* (2.5–6.3 cm [0.7–2.0 inches]), and the gallery system components (egg gallery, egg niches, larval mines, pupal chambers) of *S. opacus* etch the sapwood more deeply.

### Discussion and Conclusions

Wood (1977) erred in placing *S. abietis* in synonymy by failing to segregate specimens by their host. Thus, he compared specimens (only the spine and vertex of the head of males) from “Pacific Coast states and northern Idaho” (including *S. opacus* and *S. abietis*) to specimens “from the southern Rocky Mountain area” (where only *S. opacus* occurs). He concluded that “because the types of *opacus* and *abietis* represent the extremes (emphasis added) in these characters and because both characters intergrade in series from intermediate localities, it is necessary to place one of the names in synonymy.” Our study has discovered or confirmed several anatomical features that separate these two beetle populations (Table 1). A new character consists of horizontal striations (ridges) running across the length of the gular suture on the underside of the head. These striations (pars stridens or file) are part of a stridulatory apparatus by which sound is created when the head is rubbed against the plectum (scraper) on the adjacent ventral-anterior edge of the prothorax. In *Scolytus ventralis* LeConte, the resulting sound is audible and seems to stimulate courtship behavior and mating (Macías-Sámano et al. 1998). The number of striations is similar in *S. opacus* and *S. abietis*; however, the striations are relatively narrower in *S. opacus*. Other useful characters discovered are the shape of the submentum, length of setae behind the metacoxae on abdominal sternite 1, setae on abdominal sternite 2 (branched or not), lateral outline of the male spine, and the broadness of its attachment to the posterior edge of abdominal sternite 2.

*S. opacus* and *S. abietis* are separated by host as shown by our collections at Priest River Experimental Forest, ID, where *A. lasiocarpa* and *A. grandis* are sympatric. Elsewhere, *S. abietis* also infests *A. concolor*, a tree species closely related to *A. grandis* (Edwards 2008). Edwards notes that *A. lasiocarpa* is classified in the section Balsameae, whereas *A. grandis* and *A. concolor* are in the section Grandes. Further evidence of the close relationship of *A. concolor* and *A. grandis* is their hybridization and introgression in a broad zone extending from the Klamath Mountains of northern

### Table 1. Differentiating features of *S. opacus* and *S. abietis*

| Feature                                      | *S. opacus*                          | *S. abietis*                          |
|----------------------------------------------|--------------------------------------|---------------------------------------|
| Striations (pars stridens) on underside of head (Fig. 1) | Relatively narrower                   | Relatively wider                       |
| Submentum (Fig. 1)                           | More broadly rounded                 | More narrowly rounded                 |
| Setae posterior of meta coxae                | Shorter, generally less than one-half length of segment | Longer, generally exceeding one half of segment |
| Surface of abdominal sternite 2 (Fig. 2)     | Punctures fine, setae not branched   | Punctures more prominent, setae branched |
| Spine on abdominal sternite 2 (Fig. 2)       | Generally longer, joined to posterior edge of sternite 2 more broadly, posterior slope often notched in side profile | Generally shorter, joined to posterior edge of sternite 2 more narrowly; posterior slope straight in side profile |

Fig. 3. Biramous egg galleries and associated larval mines of *S. abietis* on sapwood of grand fir. The female beetle chews a branch on each side of her entrance hole and lays eggs in niches chewed along each side. The galleries of the usually larger *S. opacus* are similar but may etch the sapwood slightly deeper.

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Equihua-Martinez and Furniss: *S. opacus* and *S. abietis*
California through southwestern Oregon and through the Oregon Cascade Range into northeastern Oregon and west-central Idaho (Steinhoff 1978).

We conclude that the described differences in anatomical characters of S. opacus and S. abietis, taken together with their host specificity and their sympatric occurrence in Idaho, confirm that S. abietis is a distinct species, and it is hereby removed from synonymy.

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