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SYSTEMATICS

Hybosorids of the United States and Expanding Distribution of the Introduced Species *Hybosorus illigeri* (Coleoptera: Scarabaeoidea: Hybosoridae)

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ABSTRACT Two species of Hybosoridae, *Hybosorus illigeri* Reiche and *Pachyplectrus laevis* LeConte, are distributed in the United States. For the introduced species *H. illigeri*, three new country records are reported (Dominican Republic, Nicaragua, and Venezuela); six new state records are recorded in the United States (Arkansas, Arizona, Kansas, Missouri, New Mexico, and Virginia); and 10 new state records are reported in Mexico (Baja California Sur, Chiapas, Michoacán, Nuevo León, Sinaloa, Sonora, Tamaulipas, Veracruz, Querétaro, and Yucatán). Information on the predatory habits of *H. illigeri* and a report as a turfgrass pest in the state of Arizona are provided. *Pachyplectrus laevis* is redescribed, and information on its biology and distribution is provided. A key to the species is provided along with diagnostic illustrations.

RESUMEN Dos especies de Hybosoridae, *Hybosorus illigeri* Reiche y *Pachyplectrus laevis* LeConte se distribuyen en los Estados Unidos. Se reporta para la especie introducida, *Hybosorus illigeri*, nuevos registros en tres paises (República Dominicana, Nicaragua y Venezuela); seis nuevos registros en estados de los Estados Unidos (Arkansas, Arizona, Kansas, Missouri, New Mexico, y Virginia); y diez nuevos registros en estados de Mexico (Baja California Sur, Chiapas, Michoacán, Nuevo León, Sinaloa, Sonora, Tamaulipas, Veracruz, Querétaro y Yucatán). Se provee información sobre los hábitos predadores de *Hybosorus illigeri*. *Pachyplectrus laevis* es redescripta y se provee información sobre su biología y distribución. Se provee una clave para las especies junto con ilustraciones para su diagnosis.

KEY WORDS Scarabaeoidea, Hybosoridae, *Hybosorus*, *Pachyplectrus*, New World, introduced species

THE HYBOSORIDAE IS a small family within Scarabaeoidea, that includes 32 genera and ≈210 species (Ocampo 2000). It is a cosmopolitan family that is best represented in the tropics. In adults, diagnostic characters are the prominent mandibles and labrum and the 9- or 10-segmented antennae with the first segment of the club usually hollowed to receive segments 2 and 3 (Fig. 1). Little is known about the biology of members of this family. Larvae of hybosorids are distinguished from other scarabs by the presence of stridulatory structures on both prothoracic and mesothoracic legs, and the presence of three truncate lobes on the anterior margin of the labrum (Ritcher 1966, Woodruff 1973). Larvae stridulate by rubbing the front legs against the anterior margin of the epipharynx, a trait unique to the Hybosoridae (Paulian 1939). Two genera and two species of hybosorids occur in the United States and Northern Mexico: *Hybosorus illigeri* Reiche and *Pachyplectrus laevis* LeConte.

Pachyplectrus is a monotypic genus endemic to the southwest United States. *Pachyplectrus laevis* is redescribed because the original description, as with many old descriptions, lacks the necessary details for correct identification of the species. *Hybosorus illigeri* was introduced on the East Coast of the United States about 200 yr ago. In this article I report the expanding distribution of *H. illigeri* in the New World and discuss its predatory habits.

Materials and Methods

The results of this study were based on specimens from the following institutions, curators, and collections. The collections and their acronyms are as follows: AMNH, American Museum of Natural History, New York, NY (Lee Herman, Jr.); CASC, California Academy of Sciences, San Francisco, CA (D. Kavanaugh, R. Brett); CMNC: Canadian Museum of Nature, Ottawa, Canada (R. S. Anderson, F. Génier); CMNH; Carnegie Museum of Natural History, Pittsburgh, PA (J. Rawlins, R. Davidson); EMEC, Essig

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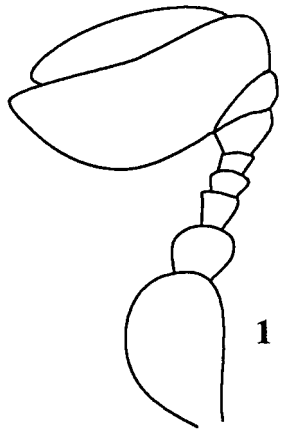


Fig. 1. Hybosorid typical antennal shape.

Museum of Entomology, University of California, Berkeley, CA (C. Barr); FMNH, Field Museum of Natural History, Chicago, IL (A. Newton); FSCA, Florida State Collection of Arthropods, Gainesville, FL (B. Beck, M. Thomas); HAHC, Henry and Anne Howden Collection, Ottawa, Canada (H. Howden); SEMC, Snow Entomological Museum, Lawrence, KS (S. Ashe, R. Brooks); TAMU, Texas A & M University, College Station, TX (e.g., Riley); UMRM, W. R. Enns Entomology Museum, University of Missouri, Columbia, MO (R. Sites); CNCI, Canadian National Collection of Insects, Ottawa, Canada (A. Davies); UNSM, University of Nebraska State Museum, Lincoln, NE (B. Ratcliffe); USNM, United States National Museum, Washington, DC (at University of Nebraska).

Key to Genera and Species of Hybosoridae from North America and Northern Mexico

1. Antenna 10-segmented with 3-segmented club, first segment hollowed to receive segments 2 and 3 (Fig. 1). Mandibles and labrum prominent . . . . . Hybosoridae, 2

1′. Antenna not as above. Mandibles and labrum not prominent . . . . . Other Scarabaeoids

2. Frontoclypeal suture with medial, pyramidal tubercle (Fig. 3). Labrum without teeth. . . . . *Pachyplectrus laevis* LeConte

2′. Frontoclypeal suture without medial tubercle (Fig. 2). Labrum with 7–11 teeth . . . . . *Hybosorus illigeri* Reiche

Hybosorus MacLeay 1819

Type Species. *Hybosorus illigeri* Reiche 1853.

Hybosorus illigeri Reiche 1853
(Figs. 2, 4–6, 9)

Scarabaeus arator Illiger 1803: 210 (junior primary homonym).

Hybosorus oblongus Dahlbom (nomen oblitum).

Hybosorus pinguis Westwood 1845: 159 (nomen oblitum).

Hybosorus roei Westwood 1845: 159 (nomen oblitum).

Hybosorus thoracicus Westwood 1845: 159 (nomen oblitum).

Hybosorus carolinus LeConte 1847: 84 (nomen oblitum).

Hybosorus illigeri Reiche 1853: 87.

Hybosorus nitidus Lansberge1882: 21.

Hybosorus illigeri variety *nossibianus* Fairmaire 1895: 17.

Hybosorus illigeri Reiche subsp. *palearcticus* Endrödi 1957: 46.

Diagnosis. This species is distinguished from other species of Hybosoridae from the New World by the following combination of characters: color dark reddish-brown; length 7.0–9.0 mm; antenna 10-segmented with 3-segmented club, first segment hollowed to receive segments 2 and 3; frontoclypeal suture not visible; labrum protruding beyond clypeus, anterior margin with 7–11 teeth; meso- and metatibiae with well-developed transverse ridge; parameres as in Figs. 4–6. An extensive redescription of the species was provided by Kuijten (1983).

Distribution (Fig. 9). *Hybosorus illigeri* was probably introduced to the east coast of the United States during the early 19th century (LeConte 1847). There are two prevailing hypotheses regarding the introduction of *H. illigeri* to the United States. Paulian (1944) suggested that the species probably arrived via slave ships from Africa. Howden (1970) stated that it is a

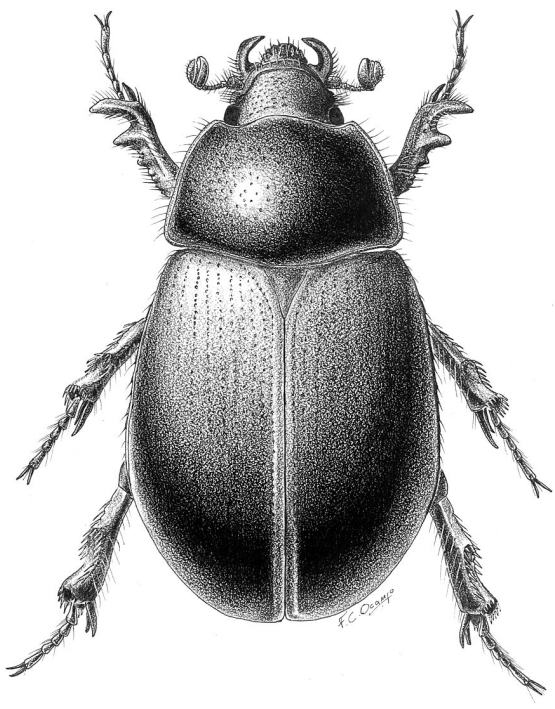


Fig. 2. Habitus of *Hybosorus illigeri* Reiche.

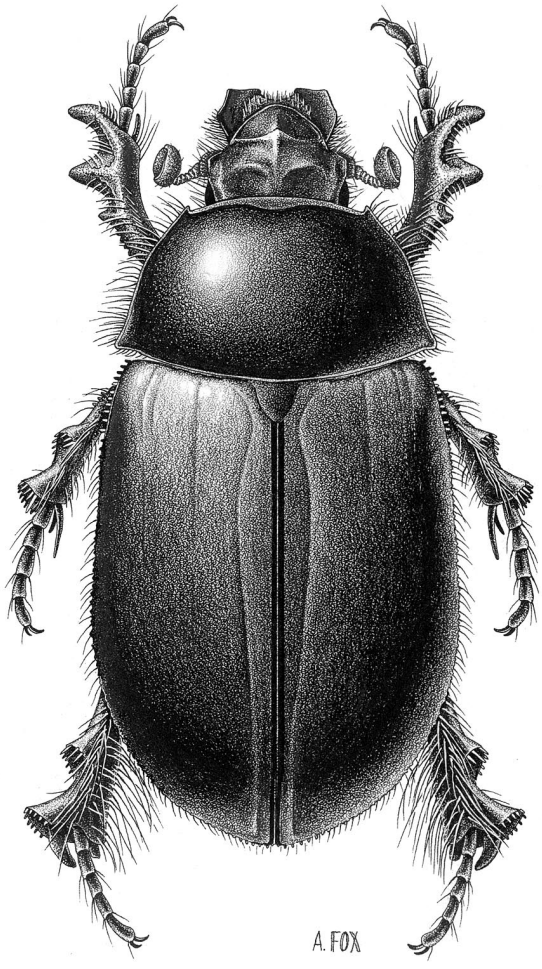


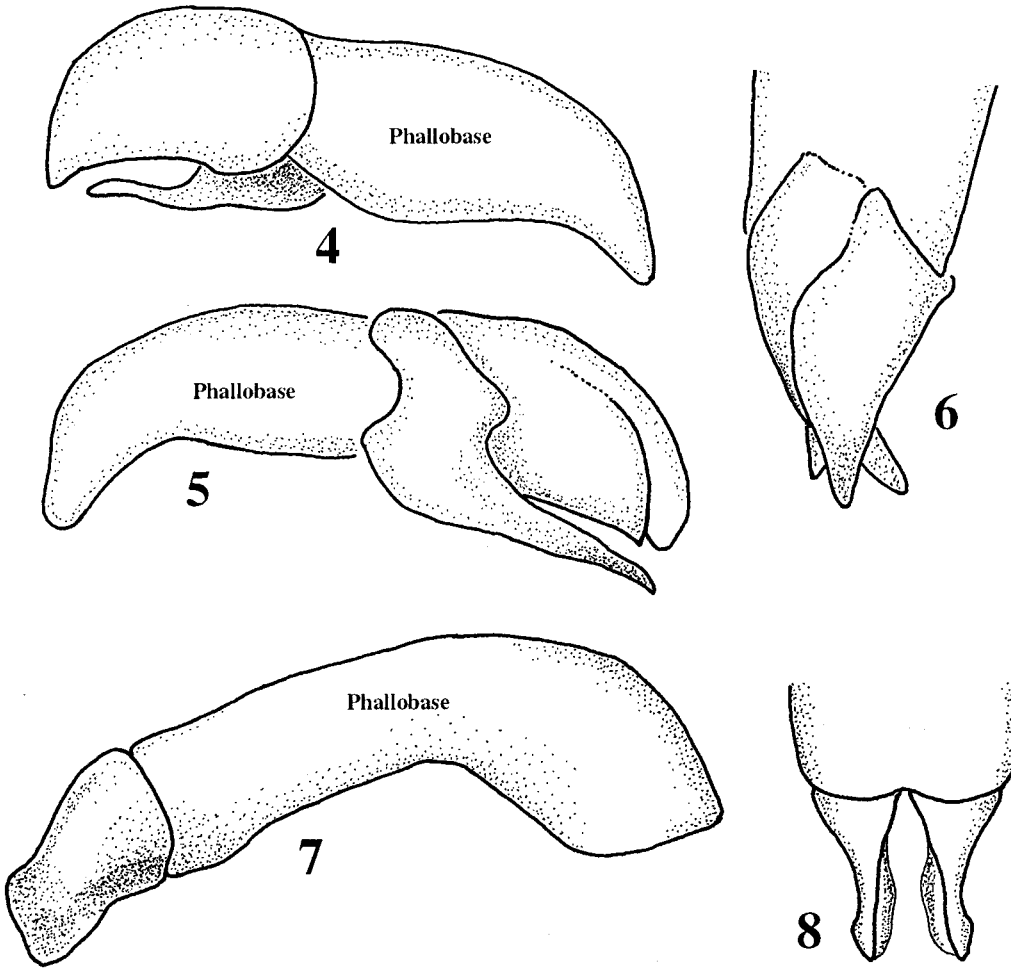
Fig. 3. Habitus of *Pachyplectrus laevis* LeConte.

recent European import to the United States. Woodruff (1973) recorded *H. illigeri* in the states of Georgia, Kentucky, and Texas. Arnold (1992) reported *H. illigeri* as far west as Oklahoma. I found six new state records in the United States: Arkansas, Arizona, Kansas, Missouri, New Mexico, and Virginia, which suggests that *H. illigeri* is still expanding its range. In summary, in the United States *H. illigeri* occurs in the states of Alabama, Arizona, Florida, Georgia, Kansas, Kentucky, Louisiana, Missouri, New Mexico, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia. It also occurs in Mexico in the states of Coahuila, Durango, Hidalgo, Jalisco (Morón et al. 1988, Navarrete-Heredia et al. 2001), Morelos, Oaxaca (Deloya 2000), Baja California Sur, Chiapas, Michoacán, Nuevo León, Sinaloa, Sonora, Tamaulipas, Veracruz, Querétaro, and Yucatán (new state records). The new records in Mexico and the United States extend the range *of H. illigeri* 350 km north and 690 km west from last reports in the literature (Arnold 1992, Deloya 2000). In the West Indies it occurs in Jamaica (Howden 1970, Ivie 1998), Bahamas, Cuba (Kuijten 1983), and the Dominican Republic (new country record). I also found a specimen of *H. illigeri* from Venezuela collected in 1984. Four specimens were collected in Nicaragua in 1999–2000. Both constitute new country records.

In the Old World, *H. illigeri* has a broad distribution. It occurs in temperate areas of Europe, all of Africa except the Sahara desert, and from the Middle East to Vietnam and China. Label data indicate localities at altitudes from sea level to nearly 2,000 m. Kuijten (1983) reported a specimen from the Spanish Sierra Nevada (2,600 m), an area covered by snow and ice during much of the year. The distribution of *H. illigeri* in the Old World shows the high adaptability of the species to a broad range of habitats and climatological conditions. In the New World, *H. illigeri* potentially could expand its range as far as California, Oregon, eastern Nebraska, and southern Illinois and Indiana in the United States, and throughout South America including the temperate areas of Argentina and Chile.

Locality Records. 1,219 specimens examined.

CUBA (10): Antilla Oriente, Playa Inglés, Playa Larga. DOMINICAN REPUBLIC (25): Los Hidalgos, Monte Cristo, San Cristóbal, San Pedro de Macoris, Santo Domingo. BAHAMAS (29): GRAND BAHAMA ISLAND (17): Freeport. NEW PROVIDENCE ISLAND (4): Nassau. ANDROS ISLAND (8): San Andros. MEXICO (67): BAJA CALIFORNIA SUR (2): Miraflores. CHIAPAS (2): Cintalapa (4 miles E). DURANGO (4): San Ignacio. JALISCO (23): Chamela, Estación Chamela, Tucxacuesco. MICHOACÁN (5): Aquila. NUEVO LEÓN (11): Monterrey. SINALOA (1): Vado Hondo. SONORA (2): Rosario de Tezopaco. TAMAULIPAS (15): Ciudad Victoria, San Fernando. VERACRUZ (1): La Tinaja (13 km E). QUERÉTARO (1): Jalpán de Serra. YUCATÁN (2): Chichen Itza, Xcalacoop. NICARAGUA (4): LEÓN (1): Los Lechecuagos. MASAYA (3): Las Flores. U.S.A. (1100): ALABAMA (32): Chewacla State Park (4 miles SW), Decatur, Gulf State Park, Houston County, Mobile, Mobile-Dog River, West Blocton. ARIZONA (10): Amado, Douglas (8 km E). ARKANSAS (49): Brinkley. FLORIDA (327): Alachua, Ana Marie Is., Archbold Biological Station, Bahia Honda State Park, Boca Raton, Boynton Beach, Broward Co., Clermont, Daytona Beach, Dickinson State Park, Everglade City, Everglades National Park, Florence, FL, City (11 km SW), Hummock State Park, Holly Hill, Homestead (6 miles N), Jacksonville, Key Largo, Miami, Ocala, Old Town (3 miles N), Palmdale, Palm Bach, Panacea (10 miles S), Polk Co., Quincy, Quincy (15 miles SW), Tallahassee (17 miles N). GEORGIA (220): Albany, Athens, Beachton, Clark Co., Heards Pond, Moultrie, Prattsburg, Tomasville, Smithville, Wheeler County, KANSAS (5): Greenburg (5 miles S). LOUISIANA (83): Monroe, New Iberia, Shreveport, St. Landry Park, Vermilion County, MISSISSIPPI (32): Copiah County, Gulfport, Moss Point, Oxford, Purvis (3 miles NW), Rolling Fork, Scott Bol County, Stone County, Van Cleave (11 miles NW), Washington County, Yazoo County, No data. MISSOURI (19): Greenwood, Ironton, Lanton, Pilar Bluff, Steelville,



Figs. 4–8. Male genitalia, lateral and caudal views. 4–6: *Hybosorus illigeri.* 7–8: *Pachyplectrus laevis.*

Sikeston, Vernon County, No data. NEW MEXICO (4): Carlsbad, Eddy County, Mescalero Dunes. NORTH CAROLINA (2): Cherokee, Kill Devil Hill. OKLAHOMA (52): Clinton, E. Wagoner (14 miles E), Foss, Lake Texoma, Oklahoma City, Texoma State Park, Thackerville. SOUTH CAROLINA (80): Allendale, Blackville, Clemson, Florence, Meredith, St. George. TENNESSEE (6): Pulaski, Springhill. TEXAS (178): Austin, Bedford, Big Bend, Brewster County, Brazos County, Bulverde, Canyon Lake (5 miles E), Cold Spring, Comanche, Dryden, Duval, Duval County, Elkhart (10 miles SW), Flynn (5 miles N), Ft. Stockton, Greenville, Guadalupe Mts. National Park, Hidalgo, Houston, Kermit, Kiote (3 km E), Lake Brownwood State Park, Lampasas, Laguna Park, Laredo, Loma Alta (3 miles W), Lubbock, Luling (8 km S), Medina County, New Braunfels, Nueces County, Oakville, Pleasanton, Presidio, Sinton, Stephenville, The Woodlands, Three Rivers, Town Bluff. VIRGINIA (1): No data. VENEZUELA (1): ZULIA: Distrito Perija, Tacuco.

Temporal Distribution. February (2), April (17), May (238), June (575), July (90), August (40), September (3), and October (4).

Remarks. In his revision of the genus *Hybosorus,* Kuijten (1983) provided a summary of the nomenclatorial history *H. illigeri.* The intricate nomenclatorial problems of the type-species were partially solved by Landin (1964) and finally by Allsopp (1982) when he proposed the conservation of the combination *Hybosorus illigeri* Reiche. Here I summarize the nomenclatorial history of *H. illigeri.*

In 1803, Illiger (1803) described *Scarabaeus arator.* MacLeay (1819) subsequently erected the generic name *Hybosorus* for *H. illigeri.* Reiche (1853) realized that *Scarabaeus arator* Illiger is a junior primary homonym of *Scarabaeus arator* Fabricius 1775, and he proposed the new name *H. illigeri.* At the same time, Reiche synonymized *H. laportei* Westwood 1845 and *Hybosorus thoracicus* Westwood 1845 with *H. illigeri. Hybosorus roei* Westwood 1845 was synonymized by Arrow (1912); *H. pinguis* Westwood 1845 was synonymized by Endrödi (1957); and *H. carolinus* LeConte

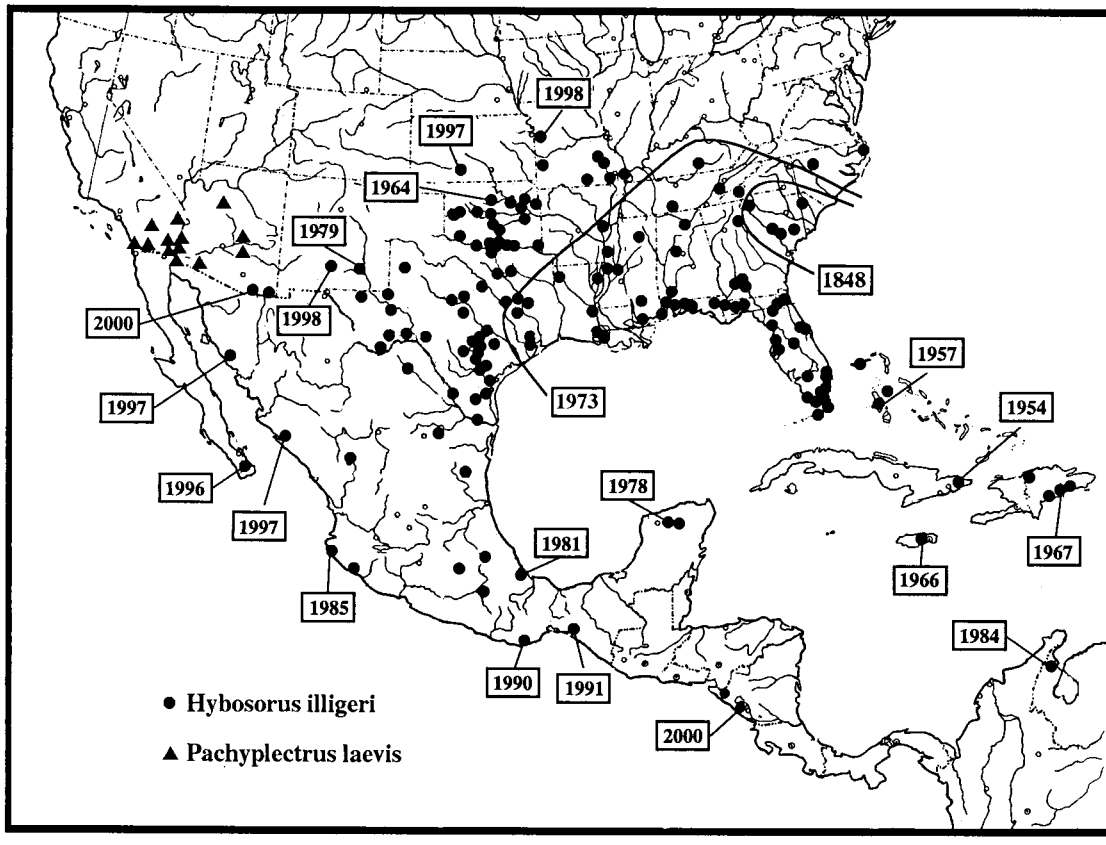


Fig. 9. Distribution of *Hybosorus illigeri* and *Pachyplectrus laevis* in the New World. Dates represent when specimens of *Hybosorus illigeri* were collected.

1847 was synonymized by LeConte (1862). All these names predate *H. illigeri* Reiche and so they should seemingly have priority over it. Kuijten (1983) reestablished *H. laportei* Westwood 1845 as a valid species within the genus *Hybosorus* and synonymized *H. nitidus* Lansberge 1882, *H. illigeri* variety *nossibianus* Fairmaire 1895, and *H. illigeri* subs. *palearticus* Endrödi 1957 with *H. illigeri.* Allsopp (1982) (restated by Kuijten 1983) proposed the conservation of *H. illigeri* in accordance with Article 79 (b) of the International Code of Zoological Nomenclature because the species has been known as "*illigeri*" or "*arator*" for nearly 150 yr (*Scarabaeus arator* must be rejected because it is a junior primary homonym of *S. arator* F. (Scarabaeidae: Dynastinae). The name *Hybosorus oblongus* Dahlbom was used by Gemminger and Harold (1869), is probably a nomen nudum (Woodruff 1973, Kuijten 1983), and has since disappeared from the literature; it is also a nomen oblitum (Kuijten 1983).

Biology. Specimens of *H. illigeri* were collected at light, in carrion, and in dung (Paulian 1941, Paulian and Baraud 1982, Kuijten 1983, Rozas et al. 1991). Rozas et al. (1991) observed *H. illigeri* feeding on other scarabaeoids (*Aphodius, Euoniticellus,* and *Onthophagus* species) and on other *H. illigeri.* The same predatory habits were observed by Rozas et al. (1991) at lights where adults fed on the hydrophilid *Helochares lividus* (Forster).

The presence of *H. illigeri* on dung may be a strategy for its predatory habits. Apparently *H. illigeri* comes to dung to feed on other insects, but it does not feed on dung. Like other hybosorids (*Coilodes castaneus* Westwood, *Hybosorus laportei* Westwood, *Phaeochrous emarginatus* Castelnau, and several species of *Phaeochroops* Candèze), *H. illigeri* is also attracted to carrion. *Hybosorus illigeri* is sometimes very abundant (Woodruff 1973) and I have seen long series collected at light.

Adults of *H. illigeri* were recently observed in the state of Florida in golf courses emerging from subterranean shelters (Paul Skelley, personal communication). The use of subterranean shelters by adult hybosorids was also observed in *Phaeochrous* species (Kuijten 1978).

The larvae of *H. illigeri* are undescribed. The larvae of other hybosorids were found associated with roots (*Chaetodus* sp.) or in decomposing plant material (*Cryptogenius fryi* Arrow) (Costa et al. 1988), but very little is known about their biology.

Pachyplectrus LeConte 1874

Type Species. *Pachyplectrus laevis* LeConte 1874.

Pachyplectrus laevis LeConte 1874
(Figs. 3, 7–9)

Pachyplectrus laevis LeConte 1874: 54.

Diagnosis. This species is distinguished from other species of Hybosoridae by the following combination of characters: Color testaceous or brown; length 4.8–6.9 mm; antenna 10-segmented with 3-segmented club, first segment hollowed to receive segments 2 and 3; fronto-clypeal suture complete, with median pyramidal tubercle; meso- and metatibiae with well-developed, transverse ridge; parameres as in Figs. 7–8.

Redescription. Length 4.8–6.9 mm. Width 2.5–3.5 mm. Color dorsally and ventrally testaceous or brown. *Head.* Dorsal surface glabrous and smooth. Frons with broad, sinuate, transverse impression. Frontoclypeal suture complete, with median pyramidal tubercle. Clypeus with apex rounded, margin slightly reflexed and setose. Labrum rounded; lateral margins rounded, apex at middle with emargination and with apical fringe of fine, dense setae. Mandible large (1.2 times clypeal length), external edge broadly rounded, dorsal surface smooth, slightly concave, with dorsally projecting sub-apical tooth. Labial surface smooth, with long, slender setae arising from margins. Antenna 10-segmented; scape subequal in length to segments 2–7, strongly notched, with 10–20 long setae on dorsal surface; segment 2 globose, with 5–7 long setae on dorsal surface; segments 3–7 wider than long; club 3-segmented, rounded, basal segment cupuliform, completely receiving penultimate and ultimate segments. *Pronotum.* Surface smooth, glabrous, convex, wider at base; weak bead present on all margins; basal and lateral margins rounded, lateral margins convergent toward apex; posterior angle sharp. *Scutellum.* Surface smooth, glabrous, subtriangular. *Elytra.* Surface smooth, glabrous, at middle slightly wider than pronotum. Sutural margin with stria; lateral margin with two striae; marginal striae abbreviated at base, inner marginal stria shorter than outer stria. Epipleuron with ventral surface flat and tapering from humeral angle toward sternite 1, finally serrulate. *Venter.* Prosternal surface smooth, biconcave; anterior margin bisinuate, anterior angle acute. Prosternal shield with medial process poorly developed, pointed. Mesosternal surface rugose. Metasternal surface smooth, posteriorly concave to partially receive metafemur. Proespisternal surface smooth, anteriorly and laterally with long, slender setae. Mesepisternum triangular. *Legs.* Coxae, trochanters, and femora with moderate to dense pilosity. Metatrochanter with posterior tooth at apex. Femora robust; profemur 2.0 times longer than wide; mesofemur 2.2 times longer than wide; metafemur 1.8 times longer than wide. Protibia with three large, apical teeth, apical tooth larger than medial and basal teeth, medial tooth larger than basal; 3–4 denticles on basal third. Meso- and metatibiae with well-developed, transverse ridge; median surface flattened, with long, slender setae; apical margin well-developed, semicircular; transverse ridge and apical margin with series of short, thick, round-tipped setae arising from medial surface. Mesotibial spurs semicircular in cross section, apices acuminate; medial spur longer than tarsomeres one and two together; external spur slightly longer than tarsomere 1. Metatibial spur broad, shovel-like, ventrally flattened; external spur 0.3–0.5 longer than medial. *Parameres.* Figs. 7–8.

Distribution (Fig. 9). *Pachyplectrus laevis* is found in the southwestern United States.

Locality Records. Fifty specimens examined.

U.S.A.: ARIZONA (7): Theodore Roosevelt Lake; Superior (3 miles W), Verde River, Tacna. CALIFORNIA (43): Glamis, Glamis (1 mile W, 1.3 miles W, 3.5 miles NW, 2 miles N), Ogilby (3.5 miles W), Blythe (18 miles W), Hopkins Well, Long Canyon, Mojave River, Yermo, Borego, San Diego.

Temporal Distribution. January (1), March (7), April (30), May (7).

Remarks. *Pachyplectrus laevis* is an uncommon species. It occurs in dry, sandy areas of Arizona, southern California, and probably northwest Mexico. Some specimens were collected under carrion and owl pellets. Most of the specimens were collected at night on the soil surface. Adults are not attracted to lights (William Warner, personal communication). Larvae of *P. laevis* are unknown.

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