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A new species of *Polyphylla* Harris from peninsular Florida (Coleoptera: Scarabaeidae: Melolonthinae) with a key to species of the pubescens species group

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A new species of *Polyphylla* Harris from peninsular Florida (Coleoptera: Scarabaeidae: Melolonthinae) with a key to species of the pubescens species group

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Abstract. *Polyphylla starkae* Skelley, **new species** (Coleoptera: Scarabaeidae: Melolonthinae: Melolonthini), is described from peninsular Florida, USA. Observations on its life history and a key to related species are provided.

Introduction

Polyphylla Harris is a Holarctic genus of large (>15 mm) scarab beetles with the greatest diversity in the southwestern United States. Many Nearctic species have restricted distributions and are frequently found only in specific sand dunes or in other isolated habitats (Young 1988, LaRue 1998). In the eastern United States, the pubescens species group inhabits isolated sand deposits: *P. donaldsoni* Skelley from the Ohoopee Dunes region of central Georgia, *P. pubescens* Cartwright from the inland sandy uplands of the Eglin Air Force Base region of the Florida Panhandle, and *P. woodruffi* Skelley from the coastal dunes of the Florida Panhandle (Skelley 2004). The discovery of a new species (Fig. 2-5) in this group in peninsular Florida was quite surprising and prompted this study.

Recent researchers have varied in their conclusions about the relationships of the *Polyphylla* - pubescens species group with other members of the genus. Hardy (1974) proposed the generic name *Polylamina* for *Polyphylla pubescens* Cartwright (1939). Young (1988) recognized all eastern United States species as belonging to a single complex within *Polyphylla* and called them the "occidentalis complex." However, he considered *Polylamina* a distinct genus and excluded it from further consideration. Coca-Abia (2000) synonymized *Polylamina* under *Polyphylla* after presenting a phylogeny based on a few characters of some aberrant taxa. Russell (2000) performed molecular analyses on all North American species of *Polyphylla* and included separate populations of "*Polylamina pubescens* (Cartwright)". His data suggest "*Polylamina*" belongs in *Polyphylla* and is part of Young's occidentalis complex. Russell (2000) confirmed that members of the occidentalis complex (including "*P. pubescens*") form a distinct clade well separated from the western species complexes. In addition, Russell (2000) presented data showing the various populations of "*P. pubescens*" have a greater genetic divergence than other *Polyphylla* species. Skelley (2004) reviewed the Melolonthini of the southeastern United States, described two new species of *Polyphylla* related to *P. pubescens*, and referred to this cluster of species as the pubescens species group within the occidentalis complex.

The new species described here is considered a member of the pubescens species group. This description makes a name available for ongoing survey and natural history work to establish this species' distribution and ascertain its conservation needs. Also included here are observations on the species' life history and adult activity. It is hoped that future research will provide additional data.

Polyphylla - pubescens species group

Diagnosis. Species of the pubescens group share some characters that distinguish them from all other *Polyphylla*. The most notable characters are the vestiture of setae (not scales), pronounced sexual dimorphism (Fig. 22-29), and male genitalic form.

Male. Length 15.3-25.0 mm, width 6.9-12.0 mm. As with all *Polyphylla*, males have seven lamellate antennomeres in the club (Fig. 6, 8). Males of the pubescens species group are unique in *Polyphylla* by having dense, short dorsal pubescence made of setae (devoid of scales), relatively narrowed protibiae with

2 lateral teeth (rarely a weak basal tooth is visible), and genitalia with apex laterally flattened and semicircular in lateral view.

Female. Length 15.0-25.0 mm, width 6.9-14.0. In addition to being distinctly more robust overall, females of the pubescens species group differ from males in having the apical clypeal ridge reduced, five weakly lamellate antennomeres in the club (Fig. 7, 9), greatly reduced dorsal pubescence, protibiae with two lateral teeth much more pronounced, metafemora much more robust, metatibiae greatly dilated at apex (Fig. 14-21), and more spatulate meso- and metatibial spurs. Although flight wings are present, female body and appendage morphologies indicate they do not fly, which is corroborated by all behavioral observations.

Key to species of the *Polyphylla* - pubescens species group

Skelley (2004) presented a key to Melolonthini of the southeastern United States in which identification of females in the *Polyphylla* - pubescens species group without associated males is impossible. In that key, all members of the pubescens species group, including the new species, will key to couplet 7, which leads to couplet 8 where problems begin. I take this opportunity to correct the oversight by presenting a key to both males and females of the pubescens species group.

1. Antennal club elongate of 7 antennomeres; dorsal elytral pubescence dense (Fig. 22, 24, 26, 28); metafemora not robust, only slightly larger than mesofemora [males] **2**
— Antennal club short of 5 antennomeres; dorsal elytral pubescence sparse and widely scattered or absent (Fig. 23,25,27,29); metafemora robust, distinctly larger than mesofemora [females] .. **5**

2(1). Pronotal punctation coarse and distinct (Fig. 6); elytra with setae in patches, giving a mottled pattern (Fig. 23); peninsular Florida ..... ***P. starkae* Skelley, n. sp.**
— Pronotal punctation fine and indistinct (Fig. 8); elytra evenly pubescent, silky, lacking mottled pattern (Fig. 24, 26, 28); continental US (Georgia and panhandle of Florida) **3**

3(2) Metatibiae parallel-sided for most of length (Fig. 11); Ohoopee Dunes region of central Georgia . ..... ***P. donaldsoni* Skelley**
— Metatibiae diverging toward apex for most of length (Fig. 12-13); Florida Panhandle **4**

4(3). Elytra with lateral marginal bead attaining base of pronotum; metatibiae usually black, same color as pronotum (Fig. 12, 26); inland Florida Panhandle, west of Choctawhatchee River, Eglin Air Force Base area ..... ***P. pubescens* Cartwright**
— Elytra with lateral marginal bead not attaining base of pronotum; metatibiae usually tan, contrasting in color with pronotum (Fig. 13, 28); primarily coastal Florida Panhandle east of Choctawhatchee Bay ..... ***P. woodruffi* Skelley**

5(1). Apical metatibial plates below tarsal junction distinctly larger than upper part (Fig. 18-19) ... **6**
— Apical metatibial plates below tarsal junction same size as upper part (Fig. 20-21) **7**

6(5). Pronotal punctation coarse and distinct on disc (Fig. 7, 23) ..... ***P. starkae* Skelley, n. sp.**
— Pronotal punctation fine and indistinct on disc (Fig. 25) ..... ***P. donaldsoni* Skelley**

7(6). Metatibiae abruptly widening near apex (Fig. 16); metatibiae usually black, same color as pronotum ..... ***P. pubescens* Cartwright**
— Metatibiae gradually widening from base to apex, somewhat triangular in appearance (Fig. 17); metatibiae usually tan, contrasting in color with pronotum ..... ***P. woodruffi* Skelley**

***Polyphylla starkae* Skelley, new species**
Figure 2-7, 10, 14, 18, 22-23, 30-32

Figure 1-5. *Polyphylla starkae*, new species. **1)** Clear cut type locality in April 2009. **2-5)** Adult beetles, male on left, female on right, courtesy D. Almquist, FNAI.

Diagnosis. *Polyphylla starkae* is a member of the pubescens species group and unique with males having elytral setae clustered into groups, some in vague stripes (Fig. 2, 4, 22). This species is the largest member of the pubescens group and is strongly sexually dimorphic. Females are more robust than the males (Fig. 3, 5, 23) with legs modified for burrowing (compare Fig. 10, 14) and elytral setae nearly absent. Although flight wings appear fully developed, female elytra are tightly connected at the base along the suture, suggesting females are flightless.

Description. Male Holotype. Length 23 mm; width 11 mm. Body reddish-brown to nearly black with overlying vestiture of golden setae generally dense all over. Head between eyes with moderately coarse punctures separated by about 1 x their diameter, punctures of frons with long erect setae. Clypeus transverse, 2 x wider than long, with broadly reflexed margin, anterior angles rounded; anterior margin broadly truncate in dorsal view, weakly sinuate in anterior view; surface punctures slightly larger than

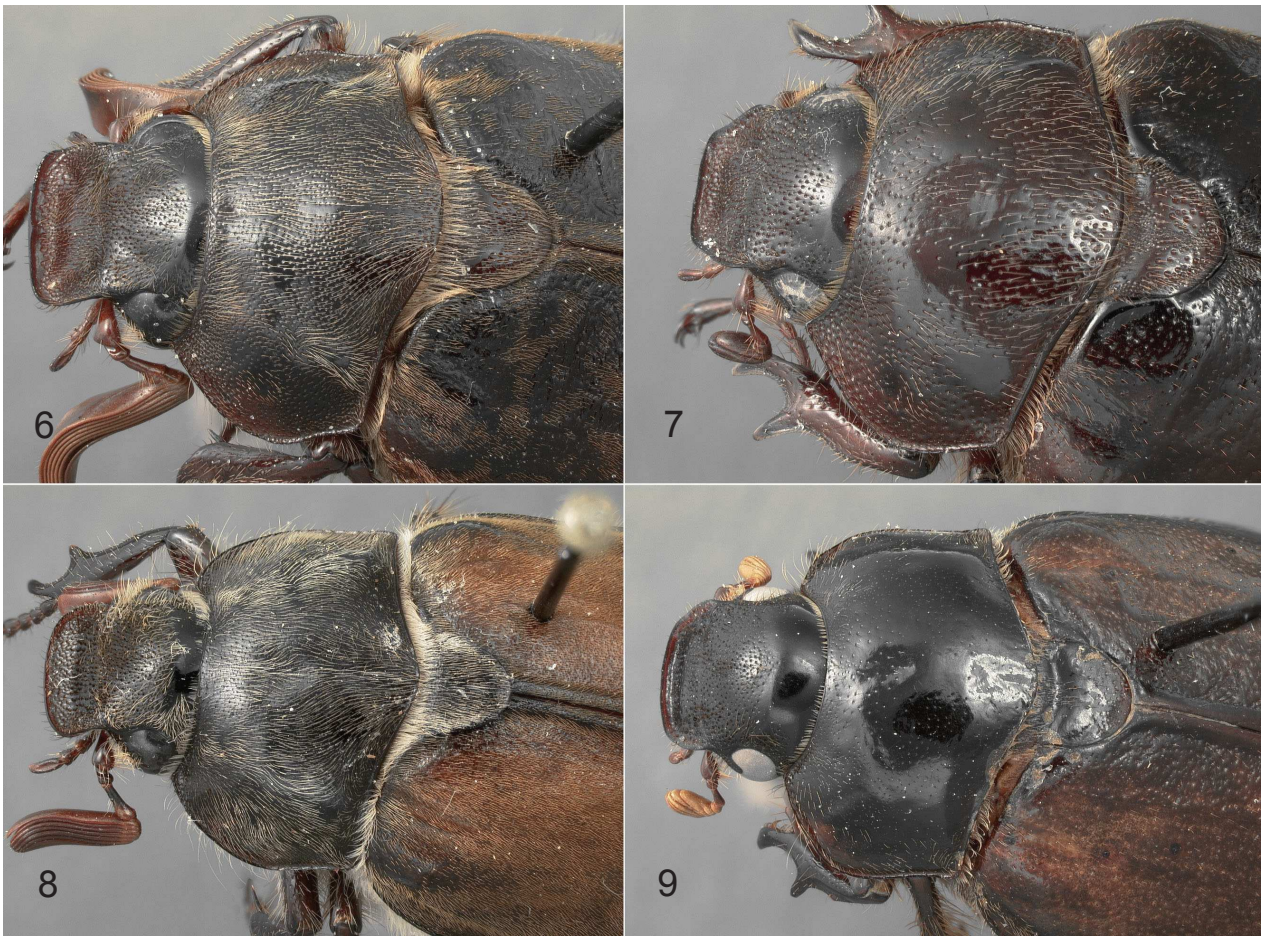


Figure 6-9. *Polyphylla* spp. head and pronotum, males on left, females on right. **6-7)** *Polyphylla starkae*. **8-9)** *Polyphylla pubescens*.

those on frons, separated by 0.5-1.0 x their diameter, setae moderately appressed, not erect. Antennae uniformly pale brown; antennal club large, length 1.5 x width of clypeus.

Pronotal width = 1.8 x length; lateral margin rounded, weakly serrate because of setae bearing punctures; surface glossy between punctures; punctures coarse, same size as on clypeus, separated by less than 0.5 x their diameter near anterior and posterior angles, less dense on disc where variably separated by 1.0-4.0 x their diameter; each puncture bearing an appressed seta, lateral setae distinctly shorter than those on disc. Pronotal hypomeron with scattered coarse punctures bearing long erect setae, except for completely glabrous apicolateral third near pronotal angle. Scutellum with coarse punctures and setae as on disc, setose punctures nearly coalescing along midline, much sparser laterally.

Elytral length 3.2 x length of pronotum; lateral margin moderately reflexed, reflexed lateral edge reaching middle of humerus, not attaining base; surface glossy with glabrous areas near base and coarsely punctate areas on apical two thirds between patches of dense fine punctures, all punctures bearing short appressed seta, setal patches vaguely linear in arrangement, setal covering along the sutural, apical and lateral margins complete although variable in width. Flight wings present, fully functional (specimen observed flying). Venter with metathorax densely covered with long erect golden setae. Each abdominal sternite with band of setae bearing punctures on apical half, band wide laterally, narrowed medially, setae appressed; punctures on first three visible sternites fine and dense, punctures on last two visible sternites 3 x diameter of those on basal sternites, all punctures separated by 1-2 x their diameters.

All femora somewhat flattened. Pro- and mesofemora narrowed, parallel-sided most of length. Metafemora weakly dilated, wider than mesofemora, margins arcuate, length 3.1 x maximal width. Protibia elongate, with apical tooth and second tooth at apical quarter. Mesotibia narrow entire length,

not expanded at apex; with weak external tooth at middle of outer edge small; tooth at basal fourth lacking. Metatibia slender, parallel-sided most of length, wider at apex; width at apex = midline length of third visible abdominal sternite; inner tibial margin slightly curved at apex. Metatibial spurs narrowed to acute point. Legs reddish-brown, contrasting with dark pronotum. All tarsi with tooth on posterior claw 0.75 x length of tooth on anterior claw. Genitalia with paramere length 2.5 x basal width in dorsal view, abruptly narrowed at middle; each paramere with dorsal-lateral groove from middle to apical quarter; apex laterally flattened and rounded in lateral view (Fig. 30-32).

Female Allotype. Length 25 mm; width 13 mm. Body reddish-brown, elytral and abdominal cuticle thin, structures underneath visible when alive, dorsal vestiture of thin setae sparse. Head between eyes with coarse punctures separated by about 1 x their diameter, punctures of frons with long erect setae. Clypeus trapezoidal, sides converging anteriorly, 2 x wider than long, with narrowly reflexed margin, anterior angles rounded; anterior margin broadly truncate in dorsal view, straight in anterior view; surface punctures same size and distribution as on frons, setae moderately appressed, not erect. Antenna unicolorous pale brown; antennal club short, length 0.25 x width of clypeus.

Pronotal width = 1.7 x length; lateral margin rounded; surface glossy between widely scattered coarse punctures, punctures size 1.0-1.5 x those on clypeus, separated by less than 0.5 x their diameter near anterior and posterior angles, less dense on disc where variably separated by 1.0-4.0 x their diameter; each puncture bearing a seta, which vary from somewhat appressed to erect, lateral setae shorter than those on disc. Pronotal hypomeron with scattered coarse punctures bearing long erect setae, except for completely glabrous apical-lateral third near pronotal angle. Scutellum with laterally with coarse punctures and setae as on disc, smaller punctures nearly coalescing along midline.

Elytral length 3.3 x length of pronotum; lateral margin weakly reflexed, sharp lateral edge reaching middle of humerus, not attaining base; surface glossy and mostly glabrous with widely scattered punctures bearing fine setae; setal covering visible along the sutural, apical and lateral margins complete although variable in width; elytra were tightly connected at basal quarter along suture and they were separated with some difficulty. Flight wings present. Venter with metathorax and abdomen similar to male holotype.

All femora with surface somewhat convex. Pro- and mesofemora weakly arcuate most of length. Metafemora distinctly dilated, 1.5 x wider than mesofemora, margins strongly arcuate, length 2.1 x maximal width. Protibia broad, distinctly tridentate, with elongate apical tooth, elongate middle tooth at apical third, triangular basal tooth at basal quarter. Mesotibia slender entire length, not expanded at apex, width 0.5 x mesofemoral width; with small external tooth at middle of outer edge; tooth at basal fourth lacking; apical spurs narrowed to acute apex spatulate, slightly curved downward, upper spur shorter than lower spur. Metatibia parallel-sided along middle half of length; tooth at middle of outer edge weak; abruptly widened near apex; apical spurs curve downward on lower edge; lower spur flattened, gradually narrowing to acute apex, upper spur somewhat spatulate, widest at middle; portion of apical tibial plate below tarsal junction same size as upper part. All tarsi with teeth equal in size.

Variation. **Male**. Length 21-25 mm; width 10-12 mm. Anterior clypeal margin on most is weakly sinuate in anterior view, is somewhat raised in the middle on a few. Lateral pronotal margin, evenly arcuate on most, is slightly angulate on a few. Patches of elytral setae vary in size in the specimens available. On some, their somewhat linear arrangement is clearer, but never prominent, on others it is imperceptible. The elytral pattern of radiating lines in reflected light is not visible in most specimens. Two specimens studied had patterning identical to the other members of this group. Body color also varied from light brown to dark brown, almost black.

Female. Length 23-25 mm; width 13-14 mm. Body color in life varied from the reddish-brown (Fig. 3, 5) to a chocolate brown, similar to the pinned specimen in Figure 23. All specimens darkened when preserved.

Type Locality. Auburndale, Florida, USA (Fig. 1), which is geographically part of the Winter Haven Ridge. For conservation purposes, and until more populations are discovered, the exact coordinates are not provided here.

Type Materials. Male holotype and female allotype label data as follows: FLORIDA: Polk Co., Auburndale, 15 April 2009, P. Skelley, R. Morris, T. Palmer, mating at dusk.

Paratypes (40) were all collected at the same locality by various collectors, here listed in alphabetical order: D. Almquist, R. Morris, T. Palmer, P. Skelley, D. Stark. Unless otherwise noted, paratypes were collected at light on the following dates: 10-IV-2007 (3M); 22-IV-2008 (8M); 8-V-2008 (1M); 4-IV-2009 (2M); 6-IV-2009 (1M); 6-IV-2009, flying at 4:56 pm (1M); 9-IV-2009 (10M); 11-IV-2009 (4M); 12-IV-2009 (1M); 14-IV-2009, under ground after dusk (1F); 15-IV-2009, mating at dusk (2F, 4M); 26-IV-2009 (2M).

The holotype, allotype and a series of paratypes are deposited in the Florida State Collection of Arthropods, Gainesville, FL (FSCA). At least one paratype will be deposited in each of the following collections: Archbold Biological Station, Lake Placid, FL (ABSC); A. V. Evans, Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA (AVRC); Natural History Museum, London (BMNH); Canadian Museum of Nature, Ottawa, Canada (CMNC); D. A. LaRue, Entomology Research Museum, University of California, Riverside, CA (DALC); D. Stark, Lakeland, FL (DSIC); D. E. Russell, Miami University, Oxford, OH (DERC); J. Zidek, Praha, Czech Republic (JZIC); M. J. Paulsen, Lincoln, NE (MJPC); National Museum of Natural History, Smithsonian Institution, Washington, DC (NMNH); R. F. Morris, Lakeland, FL (RFMC); University of Nebraska State Museum, Lincoln, NE (UNSM); and W. B. Warner, Chandler, AZ (WBWC).

Etymology. Named for Donna Stark, who first collected this beetle, attempted to identify it, and brought it to our attention (see Palmer 2009). Survey efforts such as hers are greatly needed to discover and document our indigenous invertebrate fauna.

Common Names. Woodruff and Deyrup (1994) called "*P. pubescens*" the "panhandle beach scarab." Unfortunately, this name refers to the species later recognized and named *P. woodruffi* Skelley (2004). True *P. pubescens* is not known to occur on beaches and is here named the "Eglin uplands scarab". Given the immediate interest *P. starkae* has raised among naturalists, conservation groups and other political entities in Florida, it is fitting to propose a common name for this new species. Thus, I am proposing *P. starkae* be known as the "Auburndale scrub scarab."

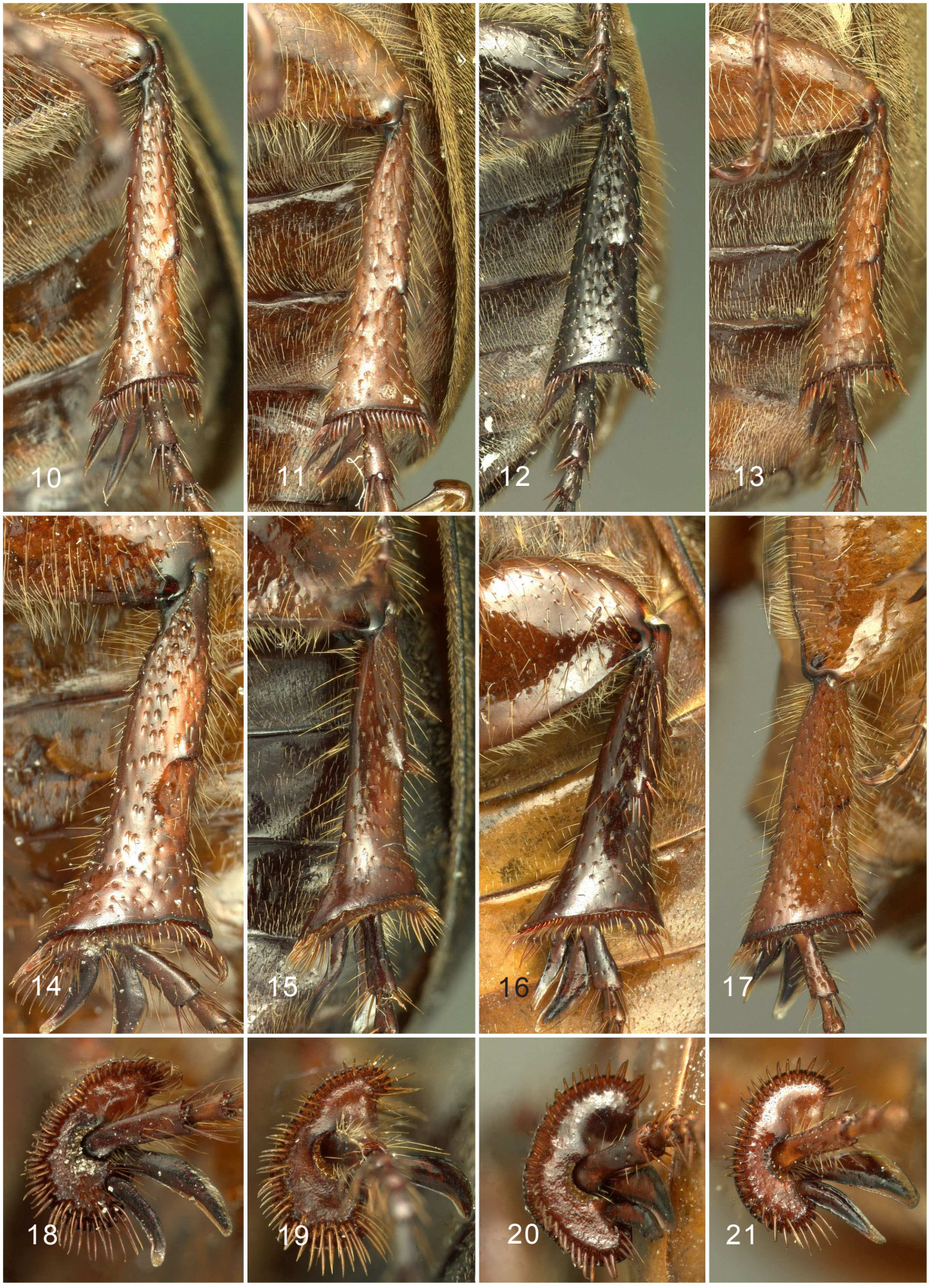
Biological Observations

In addition to a few works like LaRue (1998), who described previously unknown females of several species, data on the behavior and biologies of various North American *Polyphylla* can be found in scattered literature and personal observations by naturalists. While the latter is usually passed on only by word of mouth, some get mentioned in miscellaneous publications. All such data show that species of *Polyphylla* prefer sandy soils with relatively open habitats, confirm commonalities of adult behavior, and illustrate that many species exist in isolated areas. Some of these miscellaneous resources include: Downes and Andison (1940), Lilly and Shorthouse (1971), Hardy and Andrews (1978), Van Steenwyk and Rough (1989), Cunningham and Streit (1990), Ratcliffe and Paulsen (2008), Streit (2008), Warner (2008), and a multitude of websites as the widespread *P. decemlineata* (Say) is considered an occasional pest and the Californian *P. barbata* Cazier is a federally endangered species.

The following account on *P. starkae* is based on observations made by Dave Almquist, Roy Morris, Tom Palmer, Paul Skelley and Donna Stark during our work in 2009. These observations are similar to those for other species of the *Polyphylla* - pubescens species group as commented on by Skelley (2004), and other *Polyphylla* in general.

Habitat/Type Locality. Peninsular Florida contains a series of fossil beach dunes (called "ridges") that were formed with the rising and lowering of ocean levels between recent ice ages (e.g. Opdyke et al. 1984, Webb 1990, Colquhoun et al. 1991, DuBar et al. 1991, Menges 1999). Because of their isolation from each other, these ridges can have a unique history, which has lead to endemic species on specific ridge systems.

Figure 10-21 (opposite page). Hind legs of *Polyphylla* spp.: top row male metatibiae, middle row female metatibiae, bottom row female metatibial apical plates. **10, 14, 18)** *P. starkae*. **11, 15, 19)** *P. donaldsoni*. **12, 16, 20)** *P. pubescens*. **13, 17, 21)** *P. woodruffi*.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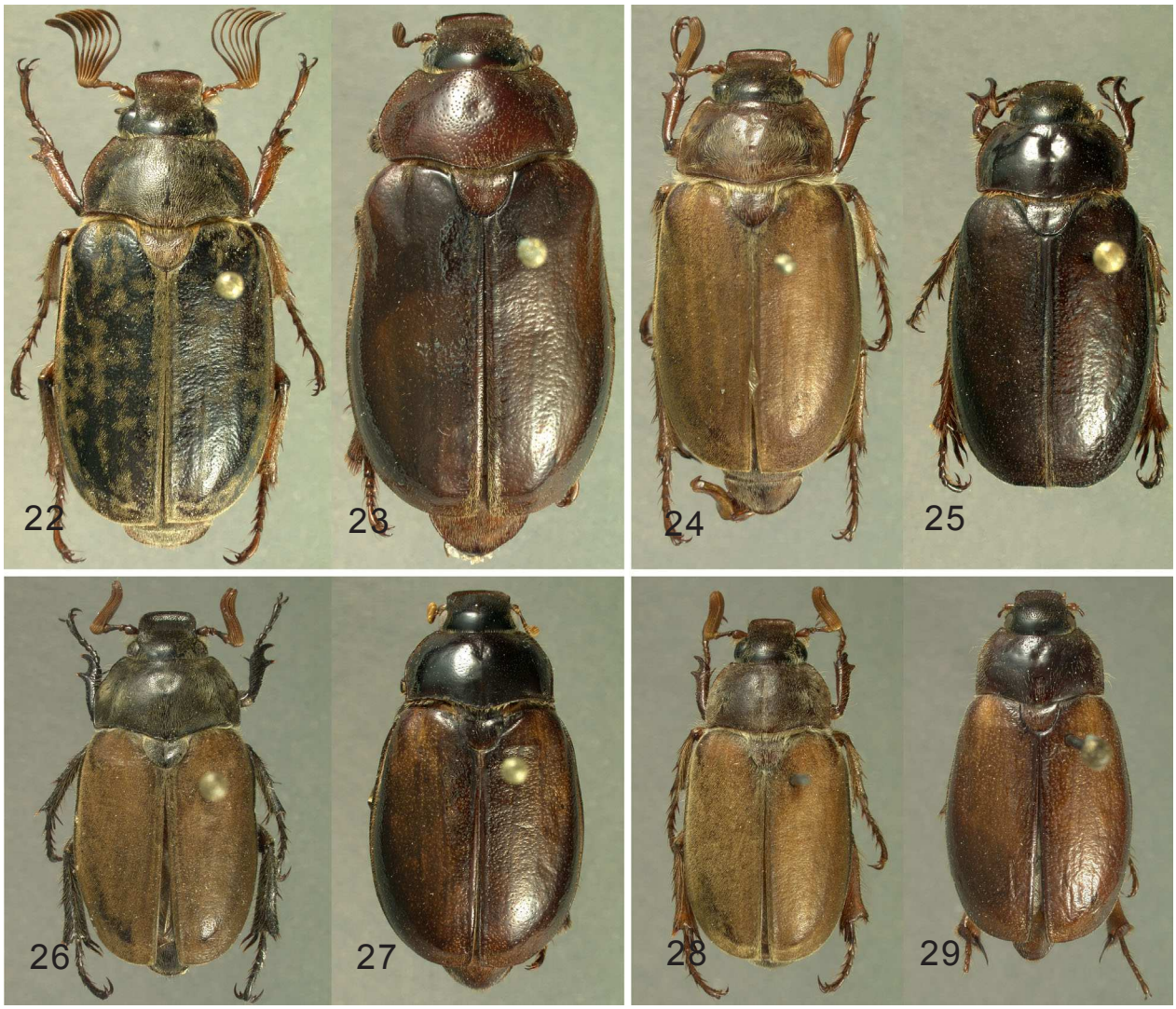

Figure 22-29. *Polyphylla* - pubescens species group, male (left) and female (right). **22-23)** *P. starkae*. **24-25)** *P. donaldsoni*. **26-27)** *P. pubescens*. **28-29)** *P. woodruffi*. These images were taken and reproduced at the same magnification.

While much work has been accomplished to discover and document certain ridge endemic biota, many systems remain poorly sampled for invertebrates.

The type locality of *P. starkae* is located on the Winter Haven Ridge, which is a mid-sized ridge to the west of the most often studied, large, central ridge, the Lake Wales Ridge. The type locality consists of about 36 hectares of mostly overgrown scrub divided into two sections by a road. The section where the beetle population was found has historically had some open parts with more grasses and herbaceous plants. Some of the plants found at this locality include Britton's beargrass [*Nolina brittonia* Nash: Ruscaceae], sandlace [*Polygonella myriophylla* (Small) Horton: Polygonaceae], lopsided indiangrass [*Sorghastrum secundum* (Elliot) Nash: Poaceae], silkbay [*Persea borbonia* (L.) Spreng. var. *humilis* (Nash) L.E. Kopp: Lauraceae], Deckert's pinweed [*Lechea deckertii* Small: Cistaceae], slenderleaf clammyweed [*Polanisia tenufolia* Torr. and A. Gray: Brassicaceae], garberia [*Garberia heterophylla* (W. Bartram) Merr. and F. Harper: Asteraceae], and scrub wild olive [*Osmanthus megacarpus* (Small) Small ex Little: Oleaceae]. A number of these plants are protected under federal and state laws. Also present in the area are other interesting plants such as Florida rosemary [*Ceratiola ericoides* Michx.: Ericaceae], which is known as an indicator of fossil beach dunes.

Figure 30-32. *Polyphylla starkae*, male genitalia. **30)** Caudal view. **31)** Lateral view. **32)** Dorsal view. Scale line = 1.0 mm.

To promote growth of various scrub plants, this section was clear-cut in 2007and should soon be burned following standard scrub management practices (Fig. 1). As of our 2009 survey, many of these plants were responding favorably. My present belief is that opening the scrub to foster these plants may foster growth and expansion of this beetle population, because roots of these plants are suspected to be the larval food.

At present, the rest of the type locality is overgrown, making survey work difficult. Thus, to gain the most information on this beetle during its short flight period, research efforts in 2009 focused on the open section where the known population occurred. Later in the season, some male beetles were found near the overgrown section. This may suggest the population occurs there also. Future survey work will give us better data on the full distribution of this beetle at this locality and hopefully elsewhere.

Adult Male Activity. April appears to be the peak period of adult activity, having been collected then by D. Stark for three years in a row, 2007-2009. In 2009, males were first observed the day following the first rain in over a month. What specifically triggers the males to fly is not known. From that point until early May, males appeared to fly every night. The early May observations are based on single males, not series, suggesting the flight period was over and the adult beetle numbers were in decline.

Initiation of flight varied each day and appeared to depend on ambient weather conditions. On warm sunny days, flight would begin after dusk. On cool overcast days, flight could begin in the afternoon or at varying times before dusk. One specimen was collected just before 5:00 pm, flying on an overcast, cool day with dusk occurring around 8:30 pm. On one occasion, several males were observed flying in the afternoon in heavy rain. On cold nights, flights occurred for a brief time after dusk. Flights apparently only last for 1-2 hours after dusk. In general, the temperature range when most flights were observed was between 16-24°C (60-75°F). Males were not seen flying more than 1-2 meters above the ground.

Many males were attracted to lights (mostly UV or blacklight). However, some experimentation showed they did not fly far from the central population, and appeared to be 'attracted' to lights only when they were close. Early in the season, mercury-vapor and fluorescent lights that illuminated nearby businesses were checked and no males were found. Also, it was noted that flying males did not come to light until well after dusk. The occasional males found near the overgrown section later in the season could have been dispersing to look for females, or possibly, the population also occurs in that section.

Interestingly, no captive males lived for more than a few days. Those that had mated died the next day. It is suspected that adult males do not normally live more than a couple weeks.

Mating. Male *Polyphylla* have greatly enlarged antennae that they use to locate females with a sexual pheromone emitted by the female (Lilly and Shorthouse 1971). Most psammophilus female *Polyphylla* are rarely collected and remain unknown for some species. For species in which the females are probably flightless, or nearly so, the best way to find them is to observe male flight behavior, waiting for him to drop to the ground when he senses a female. At night, one must listen for the sound of the males hitting the ground or vegetation. This was successfully done to locate five female *P. starkae*, with mating observed four times.

The females come to a position just beneath the sand's surface or just above it in piled detritus. Flying males detect the female, drop to the surface and immediately burrow through the detritus or starts excavating her out of the sand. Once the female senses the touch of the male, she raises her body, head down, and starts burrowing back into the sand. Quickly, the male takes a dorsal position and copulation proceeds. In a matter of seconds he is pulled down by his abdomen until the connection is broken. Within seconds the female is several inches (10 cm or more) deep and in search of suitable substrate to lay eggs. The males sit quietly for a few minutes then flies away. Although not actually timed, the total mating event did not last more than 2 minutes.

Adult Female Activity. We didn't look for females until about a week after the first males were observed. Subsequent investigation will show whether males emerge prior to females as has been found in other members of *Polyphylla*. Captured females kept alive allowed some behavioral observations. One of these females remained on top of the sand in a container for 10 days before dying. She would squeak when touched, kicking out her hind legs, but would always raise her abdomen. This may be an evasive behavior, to start burrowing if disturbed further. Or, possibly she was preparing for a male to mate. This female laid one infertile egg on the surface and borrowed into the sand on the day she died. I suspect this female was not mated.

Of the four females observed mating, three were collected, one of which died the following day (the allotype), reason unknown. Two other females immediately burrowed under the sand in their containers and did not come to the surface again. Ten days after collection, I dumped out the sand to check on their status. One female was already dead and had mold growing on her, which suggests she died a couple days earlier. The other female was barely alive and died later that day. However, each of these females laid eggs (35 and 40) scattered in the sand of the container. The eggs are oblong, approximately 4.0x2.5mm and creamy yellow. To continue biological observations, these eggs are being held in hope that they hatch and larvae can be reared.

As with the males, adult females appear to be short-lived and no females were observed flying. With non-flying females and brevity of adult life, the species' dispersal and colonization abilities are limited, affecting any potential for conservation.

Adult Feeding. Neither males nor females were observed feeding. Females were full of eggs ready to be laid shortly after mating, death following soon after that. Although not weighed, males that felt heavier were very active and ready to fly, while lighter males were more lethargic. Lighter males kept captive died in a day or two, while heavier males were released and flew away. This change in weight may suggest a loss of fats and water accumulated as larvae that are not replenished as an adult. Considering these observations, I suspect adults do not feed.

Larval Feeding. Larvae of other *Polyphylla* species are known to be polyphagous, feeding on roots of many types of plants, including seedling trees. However, most species of *Polyphylla* seem to prefer areas with sandy soils and there are a number of species restricted to various sand dune systems throughout the US, both present-day and relictual (Young 1988, Skelley 2004). Dune isolated species in the western US may be restricted to these sands because of their water retention ability (LaRue 1998). In the East, rains keep the dunes comparatively wet. The deep sandy soil's ability to rapidly drain yet retain moisture may be part of the substrate-limiting factors for *P. starkae* and related species. Plus, the abundant root growth from various plants in these sandy soils is suspected to be the preferred larval food.

Population Parameters. To estimate the population size, density and area of occurrence, we ran several fluorescent UV lights around the type locality one night about a week into the flight season. All males were collected, counted, and later released. That night, 60 males were collected on a 7 hectare parcel of the type locality, and few at the other lights. This suggested the population was centralized on this parcel, which was historically the most open part of the type locality and where we later found females. Considering the brevity of adult life and the fact that the flight period lasts about a month, it is safe to estimate that hundreds of males were present during the 2009 flight season. Considering that other species of *Polyphylla* are reported to take 2-4 years to grow from egg to adult (Ritcher 1966), we may only have observed a percentage of the total population in 2009. Other individuals may have been present as younger larvae. Extrapolating these data from the numbers of males observed in a single night and including all life stages (males, females and larvae), there could easily have been as many as 500-1000 individuals present. Mark and recapture surveys may be considered in the future to better estimate the male population size.

The number of females of *P. starkae* in the population will be very difficult to estimate because they appear to be mostly subterranean. Accurate sex ratios of related species are unknown. No report has been found which even suggests a sex ratio for any species in the genus. Museum collections of *Polyphylla* species indicate there are far fewer females than males. But, collecting records show a distinct bias toward flight worthy males which are attracted to lights. Females apparently fly much less, are often heavily weighted with eggs, and seem rarely attracted to lights. In some cases, females can't come to light because they may not fly. With successful rearing, we can estimate the sex ratio of *P. starkae*, make better estimates on the total population size, and better estimate the reproductive potential based on the number of eggs a female can lay.

Dispersal of *P. starkae* (range expansion) or establishment of new demes would appear to be slow and difficult. Although female flight wings appear fully developed, their elytral connection suggests flight is impossible. Thus, population movement or expansion is limited to the distance a grub or an adult female can burrow in its lifetime, the amount of appropriate soils and habitat available, and the corridors between them. Additional populations of *P. starkae* may exist outside of the type locality and are expected to be localized and difficult to find.

Other Biological Encounters. With females laying up to 40 eggs each, there is a good potential for population growth, depending on various naturally occurring predation and parasitism rates. For example, I have observed birds preying on mating aggregations of *Hypotrichia spissipes* LeConte, an endemic Floridian rain-flying melolonthine scarab, whose mating habits and apparently flightless females are similar to those of *P. starkae*. Other predators of adults and larvae could include invertebrates, like *Pasimachus* Bonelli (Coleoptera, Carabidae, a ground beetle), which were numerous at the type locality.

Many males of *P. starkae* have eggs of parasitic flies (family Pyrgotidae?) on their abdomen. These flies are known to parasitize June beetles (*Phyllophaga* Harris, Scarabaeidae; see Woodruff and Beck 1989). In general, the flies lay eggs on the dorsal abdomen of these beetles while they are flying and have their elytra spread. The fly larvae hatch, burrow in and parasitize the adult beetles. Considering the brevity of the adult's life, these flies are not expected to affect the beetles' population.

Adult female beetles had mites of the family Laelapidae under the elytra and behind the procoxae. Many beetles have phoretic mites, but the relationships between any specific mite and the host remain unknown for most. In this case, the mites were later found engorged on the beetle eggs. Most engorged mites were preserved, a couple were allowed to live and in a matter of days began laying their own eggs. While mite feeding opens eggs to pathogens and may reduce the available food for the developing beetle embryo, other egg feeding mites do not appear to kill the egg. It is expected that these mites are not host specific to *P. starkae* as other phoretic mites are often found on whatever insect will transport them to an appropriate niche (W. C. Welbourn, pers. comm.). This mite is being studied and a complete identification is pending.

Discussion

Species of *Polyphylla* are generally large beetles whose color patterns, interesting male antennae and defensive stridulation attract attention whenever they are found. Discovery of a new species in an urbanized area of central Florida, especially a large one that can be attracted to light, is remarkable. However, it illustrates just how much work remains to be done before we can confidently say we know our invertebrate fauna.

Polyphylla starkae appears most similar to members of the *Polyphylla* - pubescens species group. These species all appear to have females that do not fly, or do not live long enough to disperse far. Thus, as observed in the field, their populations appear to be localized. Knowing that these species exist in central Georgia, the Florida Panhandle, and now in central peninsular Florida, suggests that there may be intervening populations (or species) yet to be discovered on other isolated ridges in sandhill-scrub habitat. In general, increased invertebrate survey work is needed on our sand ridges in northern Florida and southern Georgia.

For the *Polyphylla* - pubescens species group, the best method of survey is lighting in appropriate habitats that remain mostly open with bare sandy patches. However, it appears the lights must be within 100 meters or so for males to be attracted. Plus, lighting must be accomplished during the months from April to June. Each of the now known species of the pubescens species group appears to be active during a specific month, apparently peaking during the weeks around the new moon. Data suggest that as we move north geographically, the beetle populations become active later in the year: *P. starkae* in April, *P. woodruffi* in May, *P. pubescens* and *P. donaldsoni* in June. Thus, for most of northern peninsular Florida (where isolated sand ridges remain unsampled) the best months to survey for these beetles would appear to be April-May.

Collecting a male at a light will indicate the species is in the area, but it may be a single male dispersing to locate a female. Because of the low dispersal abilities of the species, finding of a female will confirm the location of a population. Considering females are generally active on the surface for only a few minutes of their life, locating them in some habitat types or under certain conditions will be difficult.

Rare invertebrates are usually only rarely observed. Many of these taxa have more cryptic habits, are only locally abundant, or both. These species can persist in large numbers in very small areas, such as *P. starkae* at the type locality, and go undetected because of a lack of surveying. One reason this beetle was found is because appropriate habitat was still present and in good condition. Most of the Winter Haven Ridge has been developed, mined or turned over to agriculture and many plants and animals that depended upon on those lands are extirpated. Thus, conservation and proper management of natural habitats on all ridges are essential, even when the patches of habitat are small. This can be done through continued purchase of lands by public and private conservation organizations and by conservation easements. I hope additional sites can be located with populations of *P. starkae*. Even if they are not located, we should continue conservation efforts to preserve these small patches of ridge habitat and their biota to allow for future exploration and discovery.

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