

AMERICAN MUSEUM *Novitates*

PUBLISHED BY THE AMERICAN MUSEUM OF NATURAL HISTORY
CENTRAL PARK WEST AT 79TH STREET, NEW YORK, N.Y. 10024

Number 3206, 27 pp., 47 figures

August 29, 1997

South American Rophitine Bees (Hymenoptera: Halictidae: Rophitinae)

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ABSTRACT

Males and females of *Goeletapis peruensis*, new genus, new species, are described from three localities in Peru. The genus is compared with *Penapis* and *Ceblurgus*, the other two known gen-

era of South American Rophitinae, as well as with other rophitine genera. Morphological evidence suggests that the South American genera represent a single clade with possible affinities to Old World

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genera rather than North American taxa. A key to the South American genera of the Rophitinae is presented.

Specimens of *Goeletapis* were collected as they foraged from (and almost certainly sought mates at) flowers of *Exodeconus* (Solanaceae) at a number of localities. Data are presented concerning ovaries and oocytes.

Penapis Michener is redescribed in the format

used for *Goeletapis*, and its female characters are recorded for the first time. Two new species in addition to *P. penai* Michener are recognized: *P. molderkei* Bohart, Toro, and Rozen and *P. toroi* Rozen. These three species are quite similar anatomically, and their distinguishing features are illustrated. A key to them is offered, and their known distributions, all in Chile, are mapped.

INTRODUCTION

Although the Rophitinae (= Dufoureae) are well known from the Holarctic and Africa, their presence in South America was undetected until 1965, when *Penapis penai* was described (Michener, 1965) based on a single male specimen from Chile. Other specimens of *Penapis* have been collected through the years, but no new finds were reported until *Ceblurgus longipalpis* was described from Brazil more than a quarter of a century later (Urban and Moure, 1993). Now, yet another rophitine genus and species, here named *Goeletapis peruensis* Rozen, has been discovered in Peru. With this addition, the South American fauna of the subfamily consists of three genera, all from xeric regions. *Goeletapis* and *Ceblurgus* remain monotypic at this time, but two new Chilean species are herein recognized in *Penapis*.

ACKNOWLEDGMENTS

The field trip that led to the discovery of *Goeletapis peruensis* in 1995, as well as a subsequent venture there in 1996, was made possible through the support of Mr. Robert G. Goelet. On both trips, Señor Alfredo Ugarte Peña provided invaluable field assistance and participated in collecting the type series. I wish to thank Dr. Gerardo Lamas, Museo de Historia Natural, Lima, for his counsel as to localities where bees might be active in Peru at the time of the trips. Dr. Asunción Cano Eschevarría, Museo de Historia Natural, Lima, kindly identified the host plant from the first trip. Host plants from the 1996 trip were identified by Dr. Jackie Kallunki, New York Botanical Garden, New York.

I thank Mr. Seth Budick, Participant, NSF

Research Experience for Undergraduates Program, American Museum of Natural History, who contributed to the manuscript by searching for taxonomic characters of *Goeletapis* and by preparing some of the illustrations.

Dr. John L. Neff, Central Texas Melittological Institute, Austin, Texas, freely offered his detailed notes and illustrations comparing *Penapis* with specimens of *Goeletapis* (see Remarks, below) collected by Dr. Beryl Simpson from near Paiján, Peru. Dr. Simpson was the first person to collect this genus, at the Paiján CIPA-III Experimental Station, Dept. La Libertad, July 10, 1983, on native cotton (*Gossypium barbadense*). When he examined the specimens, Dr. Neff recognized that they represented a new genus and species and thus prepared his notes. The specimens were subsequently sent to the USDA Bee Biology and Systematics Laboratory, Utah State University, Logan, Utah. Dr. Terry L. Griswold and Dr. G. E. Bohart retrieved the single male from that series and loaned it to me. The cooperation of all of these individuals leaves little doubt that this early collection was *Goeletapis peruensis* and led to the rediscovery of the species near Paiján on the 1996 trip.

I acknowledge the kind cooperation of Prof. Haroldo Toro, Universidad Católica de Valparaíso, Valparaíso, Chile, and Dr. Bohart. They shared their unpublished manuscript on *Penapis*, they were the first to recognize *Penapis molderkei* to be distinct, and they permitted me to publish its description herein. Specimens of *Penapis* loaned by Drs. Bohart, Griswold, and Neff and by Prof. Toro made possible the study and descriptions of the species of that genus. The recognition of these species provided evidence

of character variation within that genus, which, in turn, was helpful in determining generic boundaries between *Penapis* and *Goeletapis*.

Dr. Charles D. Michener, University of Kansas, Lawrence, Kansas, kindly loaned a male paratype of *Ceblurgus longipalpis* Urban and Moure, and Dr. Danúncia Urban and Padre Jesús Santiago Moure, both of Universidade Federal do Paraná, Brazil, loaned a male and female of the same species collected after the type series. On a visit to the Snow Museum at the University of Kansas, I was able to study the holotype of *Penapis penai* and examine certain rophitine taxa not present in the collections of the American Museum of Natural History.

Versions of this manuscript were read by Drs. Bohart, Griswold, Michener, and Neff and by Prof. Toro. Their comments and suggestions were carefully considered and have improved the paper.

PHYLOGENETIC RELATIONSHIPS AND CLASSIFICATION

An analysis of the Rophitinae was conducted to determine the relationships among the three South American genera. Representatives of all but two rophitine genera (*Trilia* and *Morawitzella*) were studied. For the analysis, males of the following non-South American taxa were examined: *Dufourea marginata* (Cresson), *D. australis* (Michener), *D. versatilis rubriventris* Michener, *D. novaeangliae* (Robertson), *Protodufourea eickworti* Bohart and Griswold, *Sphecodosoma dicksoni* (Timberlake), *Conanthalictus conanthi* (Cockerell), *C. deserticola* Timberlake, *Micralictoides quadriceps* Bohart and Griswold, *Michenerula beameri* Bohart, *Xeralictus bicuspidariae* Snelling and Stage, *Rophites trispinosus* Schummel, *R. quinquespinosus* Spinola, *Systropha planidens* Giraud, *Systropha* sp., *Morawitzia panurgoides* Friese, and *M. fuscescens* Friese. Head capsules of specimens of most of the species listed above were cleared in an aqueous solution of sodium hydroxide and placed in glycerin so that sutures, internal ridges, tentoria, and mouthparts were clearly visible.

Goeletapis peruensis, *Penapis*, and *Ceblurgus longipalpis* share certain unusual fea-

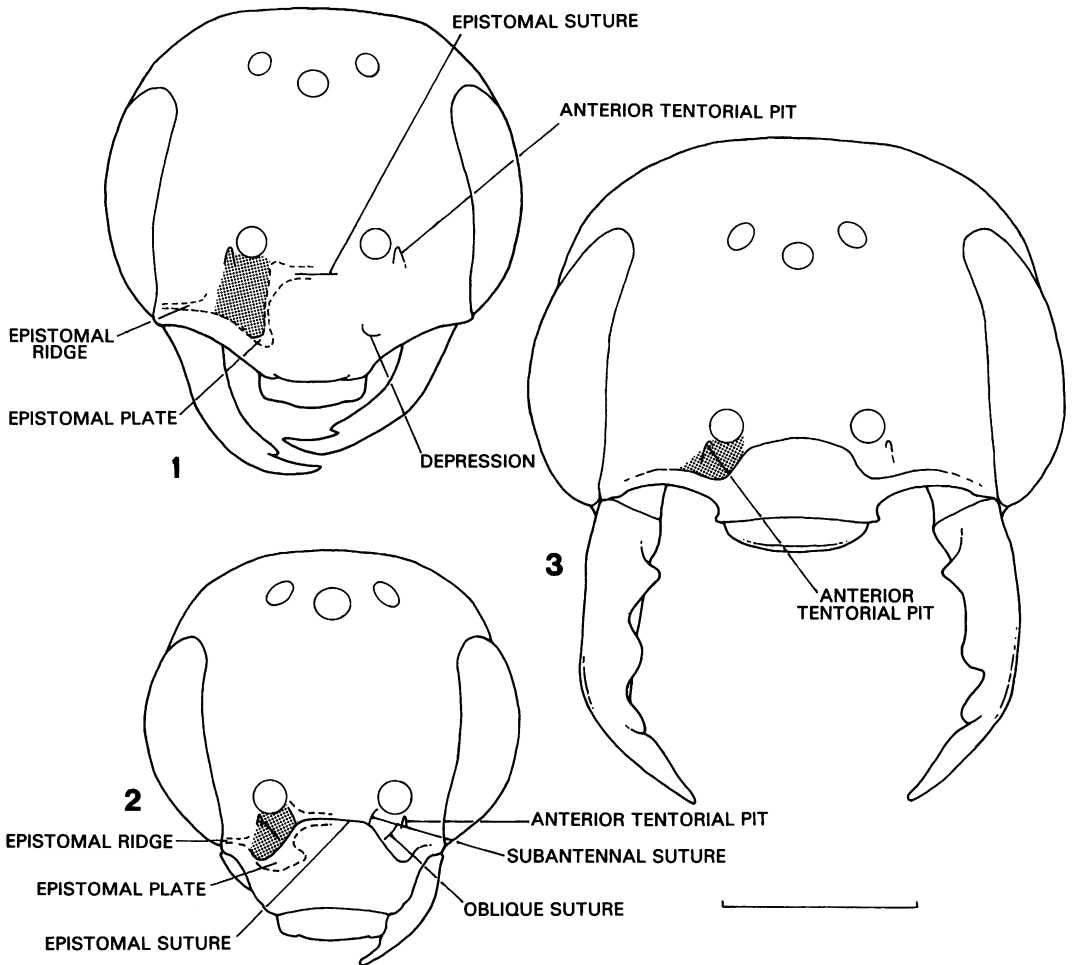
tures that appear to be synapomorphies, suggesting that the South American rophitines represent a single clade. These features are discussed as items 1 through 7 below.

1. The anterior tentorial pits of all three South American genera are situated adjacent to the lower outer edge of the antennal sockets (figs. 1–3). This character seems particularly strong because in other rophitines the pits are generally far removed from the sockets on or just above a well-defined epistomal suture. The position of the pits in the Old World *Systropha* appears somewhat intermediate, a fact that may prove important when the phylogenetic relationships within the subfamily are considered.

2. The postpalpal part of the galea (galeal blade) (fig. 6) in the three genera is elongate, that is, equal in length to or somewhat longer than the stipes, whereas in most other New World rophitine genera the galeal blade is distinctly shorter than (often less than one-half the length of) the stipes. *Dufourea novaeangliae* and *D. versatilis rubriventris* are exceptions, however. An elongate galea is also characteristic of the Old World genera *Rophites* and *Morawitzia* (but not *Systropha*), another possible consideration when the phylogeny of the subfamily is investigated. A short galeal blade is characteristic of both the Nomiinae and Halictinae, possibly indicating that the elongate condition is derived, presumably a number of times, where it is found in the Rophitinae.

3. In contrast to most other rophitines, the three South American rophitine genera, as well as *Rophites*, *Morawitzia*, and *Systropha* have unusually long, gradually tapering glossae (fig. 6), which are as long as, to much longer than, the stipes. Glossae of *Dufourea* are shorter to longer than the stipes (Ebmer, 1984, 1993). The other rophitine genera have short glossae, which are usually less than one-half the stipital length (somewhat more than one-half in *Sphecodosoma*).

4. The maxillary palpi (fig. 6) are shorter than the galeal blade in *Goeletapis*, *Penapis*, *Ceblurgus*, and *Rophites*, whereas in most other genera (including *Morawitzella* [Warncke, 1979: fig. 2], *Dufourea novaeangliae*, and *D. versatilis rubriventris*, but apparently not including *D. minutissima* Ebmer [Ebmer, 1993: fig. 15]), the palpi are longer



Figs. 1–3. Heads of males of South American Rophitinae, frontal view. Shaded area to the left represents the smooth, glabrous area below the antenna. In figures 1 and 2, dashed lines depict the internal epistomal ridge and associated epistomal plate. 1. *Goeletapis peruensis*, n. sp. (type locality). 2. *Penapis mordenkei*, n. sp. (26 mi S Copiapó, Atacama Prov., Chile, Oct. 19, 1969 [Rozen and Peña]). 3. *Ceblurgus longipalpis* Urban and Moure (paratype, Alagoinha, PE, Brasil, 23 March 1988 [I. C. S. Machado], in *Cordia leucocephala*). Scale (1.0 mm) refers to all figures. Labra flexed variably.

than the blade. The maxillary palpi are also shorter than the labial palpi in these same four genera and in *Systropha*, which has a relatively short galeal blade. In *Morawitzia* the maxillary palpus is slightly shorter than the galeal blade.

5. The outer edge of the galeal blade of *Goeletapis*, *Penapis*, and *Ceblurgus* is unpigmented and unsclerotized, a condition paralleled somewhat by that of *Rophites* and *Morawitzia* but not any other examined rophitines (including *Dufourea novaeangliae*).

In *Dufourea versatilis rubriventris*, the blade is perhaps somewhat less pigmented along the outer side, but the blade beyond the base is unusually thin, making this feature difficult to interpret. (Any study of the phylogeny of the subfamily should include this species because of its elongate mouthparts, unflattened but dorsomedially membranous labial palpus, and thin and perhaps membranous outer edge of the galeal blade.)

6. The labial palpi (fig. 6) of the South American rophitines are flat, with the dorsal

surface membranous, at least for the basal three segments. In *Rophites* and *Systropha* the basal segments are somewhat flattened, but at least the first segment is not membranous dorsally. It is uncertain, therefore, whether the flattened condition found in the South American genera is homologous with that in the Old World genera. In *Morawitzia* the first two segments are flattened and presumably membranous along the inner surface, and the last two segments are not. The labial palpi of *Dufourea novaeangliae* and *D. versatilis rubiventris* are not flattened. The dorsomedial surface of the palpus of the latter may be membranous, and that of *D. novaeangliae* is not only heavily sclerotized but bears stiff setae in the female that apparently are involved with pollen gathering, as are similar setae on other parts of the proboscis (Eickwort et al., 1986).

7. The labial palpi (fig. 6) are extremely elongate in the South American rophitines, *Rophites*, and *Systropha*: longer than the prementum and sometimes as much as two times as long as the prementum. In other genera (including *Morawitzella* [Warncke, 1979: fig. 2]), the labial palpi are distinctly shorter than the prementum except in *Dufourea novaeangliae*, *D. versatilis rubiventris*, and perhaps some Old World *Dufourea* (Ebmer, 1984, 1993), where they are subequal to the prementum.

The elongate glossa, the flattened, sheath-like labial palpi, and the elongate galeal blade of the South American rophitines and *Rophites* probably function much as do these structures in long-tongued bees (Michener and Brooks, 1984), as was already recognized by Urban and Moure (1993) for *Penapis* and *Ceblurgus*. It seems likely that the membranous outer edge of the elongate galea of these genera is also functionally involved with the labial mouthparts. These similarities would seem to be derived and suggest that possible phylogenetic connections between the South American and Old World rophitine faunas should be investigated, not just those between the South American and North American faunas. This is also suggested by the fact that no North American rophitine examined in this study possessed anterior tentorial pits adjacent to the antennal sockets, but the pits of *Systropha* were intermediate

in position. *Systropha*, unlike any other rophitines, is perplexing in that it has an extremely long glossa and elongate labial palpi, but the galea is not elongate nor is its outer edge membranous. Dried specimens with the proboscis extended show that the labial palpi alone surround the glossa and thus create a channel for nectar ingestion.

The similarities in mouthpart structure and function shared by these long-tongued rophitines and so-called long-tongued bees (Apidae and Megachilidae sensu Roig-Alsina and Michener, 1993) are interesting and deserve further investigation.

Although the similarities shared by the three South American rophitine genera suggest that they comprise a distinct clade, the relationships among the three genera are not clear. Adults of *Goeletapis peruensis* resemble those of *Penapis* in size, coloration, and body form. They also share slender, elongate male genitalia (fig. 10) and a similar S7 (fig. 13), features that appear to be synapomorphies and that are not characteristic of *Ceblurgus*. On the other hand, *Goeletapis* and *Ceblurgus* agree in that both sexes display four-segmented maxillary palpi and a terminal labial palpal segment that does not angle from the palpal axis. Males of both genera have a relatively long scape, short flagellum, and inner eye margins that diverge below. Females of the two share branched scopal setae on the hind tibia and basitarsus, a feature uncommon in the rest of the Rophitinae. At least some of these characteristics are derived, and none is shared with *Penapis*.

Finding a third distinctive rophitine entity in South America having possible synapomorphies with one or with both of the other two entities (genera) raises the question of what taxonomic level should be assigned to them. I here propose that the new entity be accorded generic status. Although *Goeletapis* superficially resembles *Penapis*, and the similarities of the genitalia and some of the male sterna of *Penapis* and *Goeletapis* appear to be synapomorphies, there are striking differences between the two genera in the anatomy of the other sterna. In addition, there are numerous other differences detailed in the description below, which together indicate that the phenotypic gap between these two genera (as well as between them and *Ceblurgus*) is

as great as, or greater than, the gaps between some of the other rophitine genera.

The three species of *Penapis* are very similar to one another, and none shows any anatomical feature that can be interpreted as being intermediate between the other two species and *Goeletapis*: that is, *Penapis* is remarkably homogeneous and quite distinct from *Goeletapis*. It seems likely that, with further exploration of the South American small-bee fauna, other species of *Goeletapis* and *Ceblurgus* will come to light.

All three genera could be relegated to a single genus, as separate subgenera. Such an arrangement would reflect the hypothesis that the three belong to a single South American clade. However, the distinctive differences among these genera and the lack of knowledge of their relationships to other taxa (such as *Rophites* and *Systropha*) argue for a more neutral designation, albeit provisional. The subfamily is interesting, and the appropriate time to assign suitable rank to its components is when relationships are analyzed broadly.

MORPHOLOGY

Michener (1965) in his description of *Penapis* noted the presence of "defined subantennal areas" but was uncertain "whether the 2 subantennal sutures [under each antennal socket] are comparable to those of Andrenidae." He was, of course, constrained in his investigation because he had only a single specimen to study. More specimens have now been collected, and because of the relevance of this problem to *Goeletapis*, the cephalic exoskeletons of *Penapis moldenkei* and *Goeletapis peruensis* have been examined in detail. This was undertaken in part to determine whether double subantennal sutures of the Andrenidae were homologous to those reported by Michener for *Penapis* and in part to understand the differences in the external appearance of this area between these two genera. Internal structures were observed on head capsules cleared in an aqueous solution of potassium hydroxide. Female cephalic anatomy did not differ significantly from that of conspecific males.

In both *Penapis* and *Goeletapis*, a relatively smooth, glabrous area exists beneath each antennal socket, suggesting a subanten-

nal area as found in the Andrenidae. Furthermore, in *Penapis* (but not *Goeletapis*) the smooth area is bordered mesally by a suture (fig. 2, subantennal suture) running from the inner antennal socket to the epistomal suture. On the outside, the area is bordered by the slitlike anterior tentorial pit (fig. 2). No external suture runs along the outer side of the smooth area, although internally the darkly pigmented anterolateral extension of the anterior tentorial arm curves here to fuse with the lateral epistomal ridge. Michener (1965) observed a fine suture (fig. 2, oblique suture) in *Penapis penai* that extends obliquely across the smooth area from the anterior tentorial pit inward to the faint but evident epistomal suture. He (personal commun.) interpreted it to be the outer suture. Neither the slitlike anterior tentorial pits nor the oblique suture that cuts across the area can qualify as homologous to the outer subantennal suture of the Andrenidae because they extend only from near the tentorial pit to the epistomal suture and not from the antennal socket to the epistomal suture. The outer subantennal suture of the Andrenidae extends from the outer edge of the antennal socket to the anterior tentorial pit, which is close to or on the epistomal suture. Confusion here has been the result of the unusually close approximation of the anterior tentorial pits to the antennal sockets. The smooth, glabrous integumental areas should probably be considered a feature associated with the anterior tentorial pits rather than with the antennal sockets because similar, though smaller, specialized areas are associated with the anterior tentorial pits in at least males of *Systropha*, *Sphecodosoma*, and *Conanthalictus*.

The oblique suture of *Penapis* apparently is associated with the attachment of the mesal branch of the anterior tentorial arm to the front of the head and seems to arise at the base of the articulatory process for the cardo, which ends just behind the face. This suture is not in evidence on the cleared head capsule of *Goeletapis* or on any of the other rophitines examined, suggesting that it is a secondary development apparently idiosyncratic to *Penapis* (the cleared head capsule of *Ceblurgus* should be examined in this regard).

Both *Penapis* and *Goeletapis* exhibit a fine but weak median epistomal suture that, in the

case of *Goeletapis*, becomes obscure in the vicinity of the dorsolateral angles of the clypeus. In the case of *Penapis*, the median section of the epistomal suture is represented by a strong internal ridge that divides (or widens) when it approaches the antenna, with the dorsal branch curving toward the antennal suture. A fanlike extension of the anterior tentorial arm curves mesally and joins this dorsal branch just before it meets the antennal suture. The subantennal suture is the external evidence of the joining. The ventral branch of the median epistomal ridge dips downward and then curves toward an anterolateral extension of the anterior tentorial arm and then toward the anterior mandibular articulation. This curving branch is accompanied by a fine external line that is the lateral part of the epistomal suture. The large external surface that the suture partly circumscribes is the glabrous area beneath the antennal socket and has at its upper end the anterior tentorial pit. Its integument in *Penapis* is clear and less pigmented than the integument elsewhere, and the darkly pigmented articulatory process for the cardo can be seen just behind it on the cleared head capsule. Near the bottom of the curvature, the ridge fans out into a broad, obliquely truncated, pigmented apodemelike structure, here termed the epistomal plate.

In *Goeletapis* (fig. 1) the internal anatomy is somewhat similar even though the external sutures are obscure in many places. The elongate anterior tentorial pit is situated close to the lower outer edge of the antennal socket, and the glabrous area lies ventral to it. The horizontal median section of the epistomal ridge divides laterally, but the dorsal branch ends before it reaches the antennal socket and, as a consequence, an external subantennal suture is not expressed. The dorsal branch is, however, met internally by the mesal extension of the anterior tentorial arm. The ventral branch descends abruptly and then rises to meet the anterolateral extension of the anterior tentorial arm. The darkly pigmented epistomal plate is acutely pointed in this species and curves mesad. Although no external integumental suture can be observed on an uncleared specimen, a fine dark line is visible on the cleared head capsule and probably is correctly called the epistomal suture. On both

cleared and uncleared specimens, there is a visible shallow integumental depression at the lowest end of the dip in the epistomal ridge, at the point where the epistomal plate attaches.

In summary, the head capsule of *Goeletapis* differs externally from that of *Penapis* in the absence of the oblique suture, the absence of the subantennal suture, and the reduction of expression of the epistomal suture. Internally, they are fundamentally the same, primarily because of the unusual closeness of the anterior tentorial pits to the antennal sockets.

As far as can be determined through examination of the uncleared head capsule of *Ceblurgus*, this genus will probably be found to be similar internally to the other two genera. Externally (fig. 3) the median transverse section of the epistomal suture is clearly evident and, just before it reaches the antennal socket, it curves down and then up again before it extends laterally toward the base of the mandible. The smooth, glabrous area between it, the antennal socket, and the anterior tentorial pit is shorter than in the other two genera, corresponding to the shorter, wider lower face of *Ceblurgus*.

KEY TO GENERA OF SOUTH AMERICAN ROPHITINE BEES

The generic key of the Rophitinae of the Western Hemisphere (Michener, 1965) is no longer serviceable because of characteristics of *Ceblurgus* and *Goeletapis*.² The three South American genera can be distinguished from North American forms on the basis of the following: forewing with three submarginal cells; maxillary palpus shorter than galeal blade; anterior tentorial pit adjacent to antennal socket (figs. 1–3); integument of vertex and scutum punctate but not pebbled as in *Conanthalictus*. None of the North American genera possesses this combination of characters. The key below separates the three South American genera.

In some *Conanthalictus*, the anterior ten-

² Persons using the keys in Michener (1965) and Michener et al. (1994) for identifying North American rophitines should be aware that some males of *Sphecodosoma* have two submarginal cells and therefore will not key correctly.

torial pits are rather close (but nowhere near as close as in the South American forms) to the antennal socket, about one-half socket diameter away. This feature is presumably created by the low placement of the sockets on the face rather than by upward migration of the pits as in the South American genera. In other North American genera, the anterior tentorial pits are about one socket diameter removed from the socket.

Hereafter, T = metasomal tergum and S = metasomal sternum. Hence, T2 refers to the second metasomal tergum, S7 to the seventh metastomal sternum, etc.

1. Maxillary palpus 4-segmented; median, depressed, dorsal surface of propodeum variously microscopically textured but never with radiating striae; labial palpus with axis of fourth segment continuous with that of preceding segments; males with antennal scape (exclusive of basal ball) longer than distance between antennal sockets; males either without pygidial plate or with slender plate many times longer than basal width; midtibia of females with stout, curved, dark or amber spinelike setae apically in addition to pale, thin, plumose setae; midtrochanter of female without ventral carina; scopal setae on hind tibia distinctly plumose. . . . 2
- Maxillary palpus 6-segmented; median, depressed area of dorsal surface of propodeum with striae radiating from base; labial palpus with fourth segment angled outward from axis of preceding segments; males with antennal scape (exclusive of basal ball) shorter than distance between antennal sockets; males with large, broad, glabrous pygidial plate, basally as broad as length; midtibia of females with only slender, plumose, pale setae; midtrochanter of female with ventral carina; scopal setae mostly simple (but some setae with one or more very short branches). . . . *Penapis*
2. Maxillary palpus tapering to fine point (fig. 7); median depressed surface of propodeum finely roughened, nonstriate; male mandible without basal tuft of long white hair on dorsal surface; T7 of male covered by long setae without distinct pygidial plate; scopal setae of female hind tibia with relatively few long branches arising apically (fig. 17). . . . *Goeletapis*
- Maxillary palpus normal, not tapering to fine point; median depressed area of dorsal surface of propodeum with transverse, subparallel striae; male mandible with conspicuous

basal tuft of long white hairs on dorsal surface; T7 with conspicuous, narrow pygidial plate with carinated sides and with only minute setae; scopal setae of hind tibia with dense, short branches (fig. 19) arising along shaft. . . . *Ceblurgus*

CEBLURGUS URBAN AND MOURE

Figures 3, 19–24

Ceblurgus Urban and Moure, 1993: 102. Type-species *Ceblurgus longipalpis* Urban and Moure. Monobasic.

Because this genus (and its only known species) was recently described, it is not re-described here, but certain of its features are treated comparatively elsewhere in this paper.

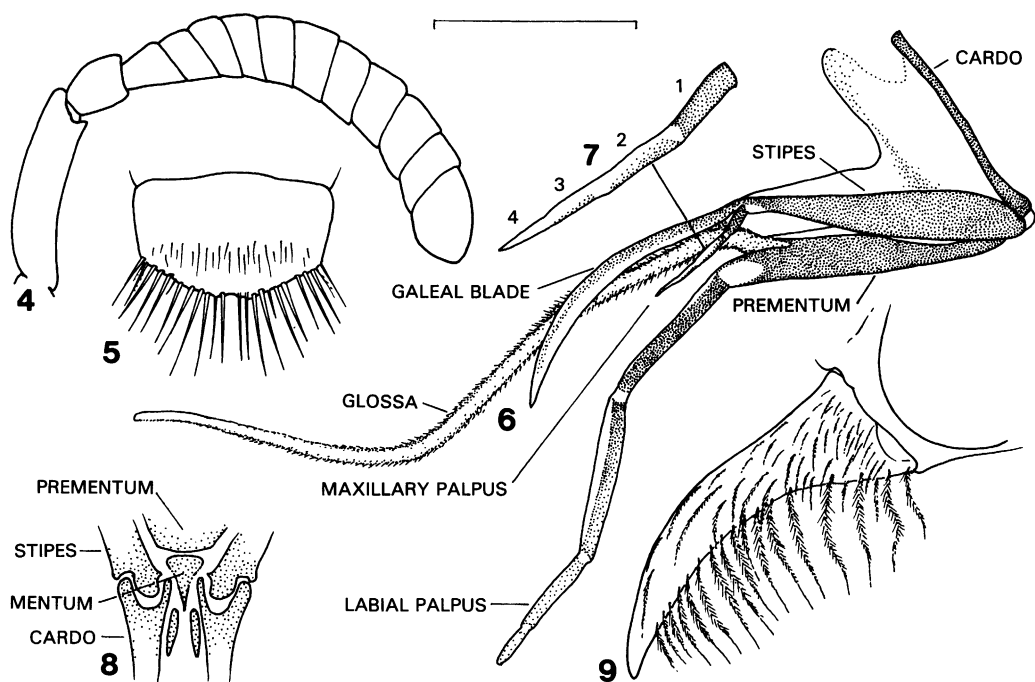
Goeletapis peruensis Rozen, new genus and species

Figures 1, 4–17

Goeletapis is monotypic as of this time; its type is here designated to be *G. peruensis* Rozen. Whether characters presented below are generic or specific is problematic. For that reason and because a single description should be easier for the user, the following account validates both genus and species. Characters thought to be diagnostic compared with other rophitine genera are italicized; those features by which *Goeletapis* differs from its most similar-appearing relative, *Penapis*, are in boldface type. In the description, extensive comparisons are made of *Goeletapis* with *Penapis* and *Ceblurgus*. Male genitalia and terminal sterna of *Ceblurgus*, described by Urban and Moure (1993), were not examined for this study because too few specimens were available.

DIAGNOSIS: This genus can be distinguished from all North American and Old World genera except for some *Systroph*a by the placement of the anterior tentorial pits adjacent to the outer lower edge of the antennal sockets (fig. 1). The postpalpal part of the galea of *Goeletapis* is longer than the stipes and the maxillary palpus is much shorter than the galeal blade (fig. 6), whereas in *Systroph*a the galeal blade is distinctly shorter than the stipes and the maxillary palpus is longer than the blade.

With respect to the South American Ro-



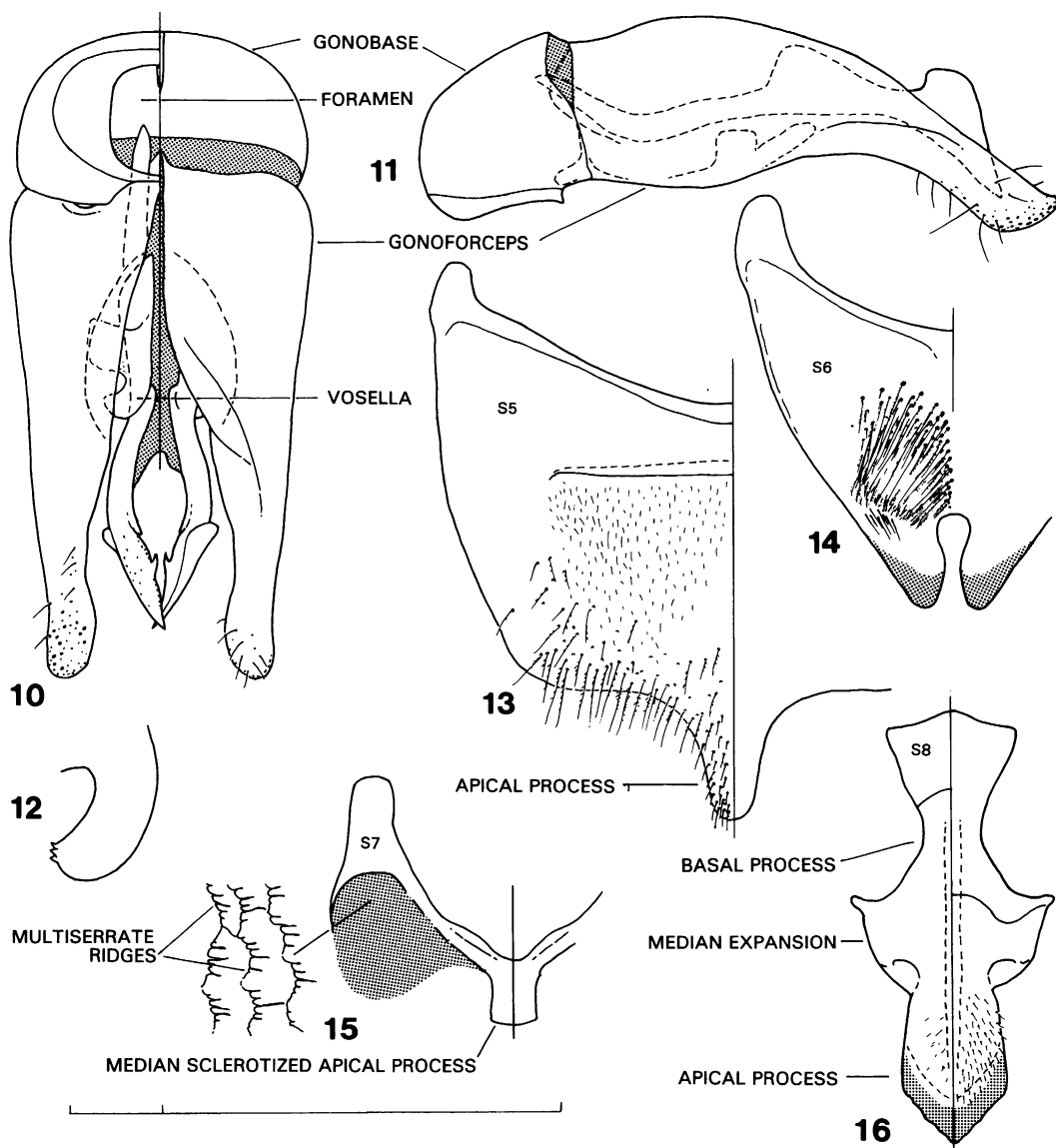
Figs. 4–9. *Goeletapis peruensis*, male. 4. Antenna. 5. Labrum, frontal view. 6. Proboscis, lateral view. 7. Maxillary palpus, lateral view. 8. Mentum and surrounding mouthparts, ventral view. 9. Left mandible and malar area, lateral view. Scale = 1.0 mm for figure 6 and 0.5 mm for all other figures.

phitinae, males of *Goeletapis* lack a glabrous pygidial plate defined by ridges, whereas *Penapis* (Michener, 1965: fig. 20) and *Ceblurgus* (Urban and Moure, 1993: fig. 5) have such plates (which are very different in the two genera). Females of *Goeletapis*, like those of *Ceblurgus*, have tibial scopas of strongly branched setae, whereas scopal setae of *Penapis* (fig. 18) lack branches (or have a few branches that are so obscure that setae appear simple). Whereas scopal hairs of *Goeletapis* have comparatively few long branches (fig. 17), those of *Ceblurgus* are densely covered with short branches (fig. 19). Females of *Ceblurgus* have inner eye margins that diverge somewhat below (but not so much as in conspecific males) and a maxillary palpus that does not taper to a point (as in Urban and Moure, 1993: fig. 1a). In female *Goeletapis*, the inner eye margins are subparallel, and the maxillary palpi taper to a point (fig. 7). A unique, conspicuous feature of both sexes of *Ceblurgus* is the densely plumose, scattered, variable-length setae (fig. 20) on the galea, stipes, and basal two

segments of the labial palpus. The dense, very short branches give these setae the appearance of being unusually thick. Comparable setae on *Penapis* and *Goeletapis* are shorter, fine, almost microscopic, and non-plumose, at least under stereoscopic magnification. Numerous other features separating *Goeletapis* from *Penapis* and *Ceblurgus* are presented in the description below.

DESCRIPTION: Male. Body length 5.8–8.7 mm (holotype 6.9 mm). Length of forewing from costal sclerite to wing tip 4.0–5.5 mm (holotype 4.5 mm).

Integumental texture, color, vestiture. Integument nonmetallic in contrast to faint greenish reflections on propodeum and vertex of *Ceblurgus* and to more pronounced metallic reflections on some species of *Conanthalictus* and *Dufourea*; integument of head and mesosoma black, shiny, mostly sparsely and finely punctured; upper middle part of clypeus more sparsely and more finely punctured than comparable area of *Penapis*; dorsal surface of propodeum polished, except median depressed area more or less



Figs. 10–16. Male genitalia and apical sterna, *Goeletapis peruensis*. Membranous areas shaded. **10.** Genital capsule, ventral view on left, dorsal view on right. **11.** Same, lateral view. **12.** Apex of vosella, ventral view. **13.** S5, left side, ventral view. **14.** S6, left side, ventral view. **15.** S7, left side, ventral view, with microscopic sculpturing of membranous area enlarged on left. **16.** S8, ventral view on left, dorsal view on right. Scale = 1.0 mm; entire scale bar refers to figures 10 and 11; right segment of scale bar refers to figures 13–16.

faintly roughened but **never with fine radiating striae as in *Penapis*** or with transverse striae as in *Ceblurgus*; undersurface of flagellum ochraceous; legs dark to medium brownish, except foretibia and foretarsus often more or less ochraceous (in *Ceblurgus* all

tarsi more or less ochraceous); integument of metasoma black to very dark brown. Body pubescence consisting of (1) inconspicuous, fine, faintly brownish, recumbent setae that are short and apparently nonplumose, and (2) *conspicuous grayish white, erect setae that*

are plumose and moderate in length, but only about half as long as those of *Penapis* and *Ceblurgus*; erect setae sparse over most of body, generally not dense enough to obscure body surface. **Pubescence on ventral surface of mandible (fig. 9) highly plumose and organized as fringe**; mandible without conspicuous basal tufts of long, white hair as found in *Ceblurgus* (Urban and Moure, 1993: figs. 3, 4); long, erect setae of maxilla and labial palpus fine, nonplumose, moderate in length, inconspicuous as in *Penapis* (in contrast, those of *Ceblurgus* long to very long, densely minutely plumose, conspicuous, as in fig. 20); **anterior (ventral) surface of forecoxa with only short setae, none of which are more than half as long as coxa; pubescence on outer surfaces of mid- and hind tibiae and basitarsi semirecumbent, dense, arranged in orderly, parallel fashion, moderate in length, strongly plumose, partly obscuring integument (in *Penapis*, setae on midtibia long, semierect, weakly plumose, not organized in parallel but dense so as to partly obscure integument; on hind tibia similar to midtibia but less dense; in *Ceblurgus*, setae on midtibia short, semi-erect, weakly plumose, not organized in parallel, sparse, not obscuring integument; on hind tibia, setae extremely elongate, strongly erect, not obscuring integument); midcoxa without inner apical tuft of white setae that are nearly as long as trochanter, as found in *Ceblurgus*; midfemur with small basal patch of appressed golden setae on anterior surface, these setae shorter and less plumose than longer white setae on rest of segment (golden setae absent in *Penapis* and *Ceblurgus*); hind trochanter without outer and more mesial specialized, long, thick, curved, apical setae as in *Ceblurgus*. Metasomal pubescence not forming bands on T1–T5; premarginal and marginal areas of T2–T5 with very fine recumbent setae arising from very fine uniform punctures; some punctures on T4, T5 also larger; T5 with tuft of elongate, plumose setae at apicolateral angles; T6 with rather dense, long, plumose apical hairs, generally covering T7; T7 completely pilose dorsally with apical hairs long; S3 and S4 with sublateral marginal patches of recumbent whitish plumose setae that are sometimes also vaguely**

present on S2; on some specimens, patches on S4 tending to coalesce, forming marginal hair band; setal patterns of S5–S8 described below; gonoforceps (figs. 10, 11) bearing scattered long setae at apex.

Structure. Head breadth only slightly greater than length, not 1.4 times length as in *Ceblurgus*. Antennal sockets far below middle of face (fig. 1). *Anterior tentorial pits adjacent to outer lower edge of antennal sockets, much as in *Penapis* and *Ceblurgus*; subantennal sutures not apparent; area below antenna invading clypeus on each side; these areas glabrous, rather smooth, not defined by external epistomal suture, but clearly identified by broad internal epistomal ridge on cleared specimen* (see Morphology, above, for interpretation and comparison with *Penapis*). Clypeus moderately short, length about one-third distance between lower inner orbits in frontal view, but not very short as in *Ceblurgus* (fig. 3); median part of epistomal suture (fig. 1) evident externally as fine integumental line somewhat below level of antennal sockets but *lateral parts not defined externally (but see Morphology, above)*; frontal carina absent; facial fovea absent; malar space virtually absent, with anterior mandibular articulation only slightly farther removed from eye than posterior articulation (fig. 9); vertex produced well above upper ends of eyes. **Inner margins of eyes diverging slightly below (fig. 1), not diverging as much as those of *Ceblurgus* (fig. 3).** Labrum (fig. 5) broader than long, its width about 1.5 times maximum length, hence distinctly longer than that of *Penapis* and *Ceblurgus*; *anterior surface essentially flat at base but bending at about one-third way to apex so that its apical surface in different plane; at junction, two surfaces forming low transverse ridge from which irregular row of short simple setae arises; row of long, tapering, mostly simple setae arising from apex.* Mandible elongate, about as long as eye seen laterally, with preapical inner tooth, without peculiar modifications of *Ceblurgus* (Urban and Moure, 1993: figs 3, 4). Proboscis (fig. 6) elongate, in repose reaching between forecoxae; glossa (fig. 6) very long; annular hairs of glossa simple, acutely pointed, elongate (like those of *Penapis*, longer than those of *Ceblurgus*; more

distal ones of *Ceblurgus* tapering to flat, parallel-sided blade that abruptly narrows apically to end in simple or bifid sharp-pointed apex); paraglossa small, linear; mentum a small, triangular sclerite (fig. 8) with basal point elongate; lorum (fig. 8) membranous except for elongate sclerite on each side; flabellum absent; *labial palpus* (fig. 6) *much longer than maxillary palpus, shorter than glossa*; segment one not unusually narrowed at base; segments one and two equal in length, *extensively flattened on dried specimen, with only ventral surface sclerotized*; length of segment three two-thirds length of segment two (equal to segment two in *Ceblurgus*), appearing not flattened because of lack of sclerotization but probably actually flattened in life; **segment four about one-half length of segment three** (about three-fourths length of segment three in *Ceblurgus*), *scarcely flattened, not angled from other segments as is also true for Ceblurgus* (i.e., its long axis a continuation of segment three), **contrasting with very short, cylindrical segment four of *Penapis*, which angles outward from long axis of segment three**. *Galea elongate, postpalpal part slightly longer than stipes*, without comb on inner surface; outer edge of galeal blade membranous, with many short setae and few longer ones, much as in *Penapis* and *Ceblurgus* (but galea of *Ceblurgus* with many more short setae than in *Goeletapis* and *Penapis*); *maxillary palpus* (figs. 7, 8) **gradually tapering to pointed apex, slightly less than half as long as galeal blade** (compared with nearly as long as blade in *Penapis*), with three sclerotized segments and one unsclerotized segment (not six sclerotized segments as in *Penapis*); first segment cylindrical, second and third segments, sclerotized only on outer surface, **flattened**; second segment slightly longer than first, third segment subequal to second; **fourth segment unsclerotized, one-half length of third, not obvious on dried specimen, appearing as tapering distal end of segment three** (in contrast, maxillary palpus of *Ceblurgus* even shorter compared with postpalpal part of galea, composed of four segments, all of which are at least partly sclerotized and do not taper toward palpal apex).

Scape (fig. 4) moderately long and flagellum short, so that length of scape, exclusive of basal ball, equal to or longer than combined length of first five flagellomeres (about as in *Ceblurgus*); in contrast, scape of *Penapis* short and flagellum elongate, so that scape shorter than first three flagellomeres; flagellomeres (fig. 4), except first and last, broader than long, without elongate specialized hairs; each flagellomere normal, without raised ring of sensilla that partly circumscribes subsegment half-way as in *Spheodosoma*.

Pre-episternal groove well developed below level of scrobe; mesepisterna forming only shallow longitudinal groove along ventral midline, less pronounced than median grooves of *Penapis* and *Ceblurgus*. Dorsal surface of propodeum about as long as scutellum.

Forewings dusky because setae more numerous and perhaps darker brown than in *Penapis* and *Ceblurgus*; veins dark brown, about the same as in *Penapis penai*; stigma with marginal veins dark, disc pale, as in *P. moldenki*; three submarginal cells present, last two together about as long as first; basal vein strongly curved, about as in *Penapis*. Legs relatively unmodified, like those of *Penapis* except where noted, not highly modified like those of *Ceblurgus* and *Dufourea*; legs slender; fore- and midfemur, tibia, and tarsus not as robust as those of *Penapis*; **forebasitarsus long, distinctly more than one-half length of entire tarsus (not distinctly less than one-half length of tarsus); foretarsal claws appearing simple but actually microscopically cleft with rami scarcely diverging (as in male *Ceblurgus*), not with pronounced inner tooth as on other legs or as on foretarsus of *Penapis*; strigilis normally long, not short as in *Ceblurgus*; midtibia with thornlike apical projection on outer surface; midbasitarsus moderately long, almost or actually as long as midtibia, so that first two tarsomeres together longer than midtibia (in *Penapis* midbasitarsus shorter, little more than one-half length of midtibia, and midtibia equal in length to first four tarsomeres); disc of basitibial plate partly obscured by recumbent setae; hind basitarsus almost as long as hind tibia (in *Penapis*, hind basitarsus slightly less than one-half as long as**

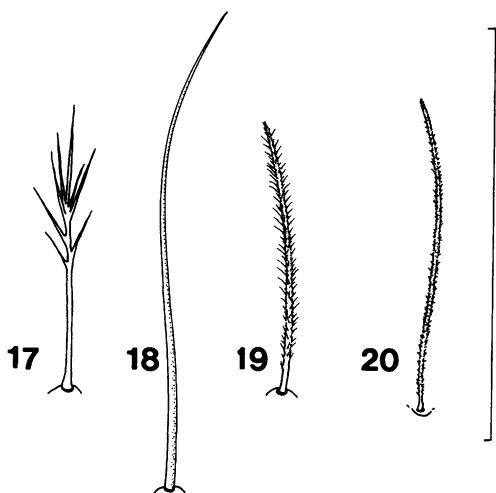
tibia); tibial spurs minutely ciliate; **outer hind tibial spur about two-thirds as long as inner one (outer one almost as long as inner one in *Penapis*)**; arolia present.

Metasoma with posterior margins of terga moderately depressed; gradulus of T2 directed backward at side, above and behind spiracle; **posterior margin of T6 weakly impressed; T7 normally hidden by T6, dorsally evenly rounded, punctate throughout, without impunctate pygidial area defined by strong carina as in *Penapis* (Michener, 1965: fig. 20) and *Ceblurgus* (Urban and Moure, 1993: fig. 5)**. S2 slightly depressed immediately behind gradulus (more broadly depressed in *Penapis*); S3 and S4 normal convex plates, not highly modified as in *Penapis*; S5 normally convex, not emarginate apically, without sublateral downward-directed processes, and with pronounced median punctate apical process (fig. 13); erect setae along posterior margin of sternum moderately long, plumose, but setae on apical two-thirds of posterior median process becoming somewhat shorter and nonplumose; S6 (fig. 14) generally triangular, with narrow median apical emargination that is narrower than that of *Penapis* (Michener, 1965: fig. 21) and without transverse incisions on each side; sternum normally convex, without sublateral mounds, becoming membranous toward posterior margin; S6 with pronounced tuft of long, erect, plumose hairs on each side of midline directed posterolaterally, so that setae appear parted along midline of sternum; these setae arising from darkly pigmented alveoli; sternum also with pair of smaller recumbent setal tufts posterior to plumose tufts; these setae shorter, nonplumose, directed posteromedially, but difficult to see on uncleared specimens because they are hidden beneath plumose tufts (in *Penapis*, integument of S6 with sublateral moundlike process on each side, with narrow transverse incision on each side [figs. 32, 38, 44], and with glabrous, nonpilose region along midline); S7 (fig. 15) *wishbone-shaped, without lateral lobes, as in *Penapis* (Michener, 1965: fig. 26)*, but with median sclerotized apical process narrower than in *Penapis*; lateral membranous areas with fine transverse, multiserrate ridges that anastomose in some plac-

es, producing reticulate pattern (fig. 15); S8 with maximum width of basal process only slightly wider than that of apical process and with median expansion wider than both (fig. 16); sclerotized part of apical process with dorsal surface more or less evenly covered with moderately short simple setae (fig. 16); ventral surface with only scattered setae, as illustrated (fig. 16), **without subapical clump of setae as in *Penapis***; extreme apex of apical process membranous or semimembranous. *Genital capsule (fig. 10) unusually elongate, even more so than that of *Penapis*, widest at base of gonoforceps in dorsal or ventral view (in *Penapis* widest at base of penis valve)*; anterior foramen of gonobase ventral in position as in *Penapis*, oval in shape, somewhat longer than wide (fig. 10), but not about three times longer than middle width as in *Penapis* (Michener, 1965: fig. 25); *vosella moderate in size, larger than in *Penapis**, apparently consisting of single complex sclerite bearing approximately 3–5 stout, dark teeth at apex of curved distal process; **gonoforceps rounded apically as seen from above or below (fig. 10)**; penis valve (fig. 10) with round, partly sclerotized, subapical, dorsal projection that may appear recurved because of backward-directed, sclerotized element, with subapical pointed dorsal process on inner surface, and with sharp-pointed, sclerotized, recurved ventral projection apicad of dorsal projection (contrasting with unmodified penis value of *Penapis* as seen in lateral view).

Female. Body length 6.5–8.8 mm (allotype 7.7 mm). Length of forewing from costal sclerite to wing tip 4.2–5.1 mm (allotype 4.4 mm).

Integumental texture, color, vestiture. Integument as in male except for following: undersurface of flagellum brown, not ochraceous; foretarsus and foretibia brown, not ochraceous; on three specimens, integumental color of metasomal terga reddish infused with brown on anterior part of T1 and laterally and immediately anterior to marginal areas on other terga; on other specimen, all terga generally medium brown. Body pubescence only slightly shorter than that of female *Penapis* and *Ceblurgus*; that on ventral surface of mandi-



Figs. 17–20. Setae of South American Rophitinae. 17. *Goeletapis peruensis*, scopal seta. 18. *Penapis penai*, scopal seta. 19. *Ceblurgus longipalpis*, scopal seta. 20. *Ceblurgus longipalpis*, long seta from labial palpus of female. Scale (=0.5 mm) refers to all figures.

ble somewhat less plumose than that of male, variable in length, and therefore not appearing fringelike; **forecoxa with plumose setae less than one-half length of coxa**; *long dorsal hairs of foretarsus longer than hairs on ventral brush, not curved at tips, with short but clearly visible branches*; **outer apex of mid-tibia with dark, sharp, curved, thick, non-plumose, spinelike setae (sometimes difficult to see on dried specimen because of dense, pale, semirecumbent, plumose setae, but conspicuous on cleared specimen in glycerin; similar setae also present in *Ceblurgus*)**; **midbasitarsus obscured dorsally by dense, tan, plumose setae**; scopal setae present on hind basitarsus, femur, tibia, and apparently trochanter and coxa, and also apparently on apical areas of basal metasomal sterna (but not on sides of metasoma); **scopal setae on anterior surface of basitarsus less than one-half as long as basitarsus**; these setae tan, semirecumbent, highly plumose, and dense, obscuring basitarsus; **scopal setae of hind tibia moderately tan, long, erect, highly plumose with long, conspicuous branches arising distally (fig. 17)**; these setae similar to those of *Ceblurgus* except latter with denser, shorter branches (fig. 19); these setae also similar to those of most, but

not all, species of *Conanthalictus*, and contrasting with predominantly simple scopal setae of *Penapis*, *Xeralictus*, *Protodufourea*, *Sphecodosoma*, *Rophites*, and *Dufourea*; **at least some scopal (discal) setae of S2 with long, conspicuous branches** (those of *Ceblurgus* with short dense branches); sternal scopal setae arising from raised, darkly pigmented sockets on posterior parts of S2, S3, and S4; **integument anterior to band of sockets on each of these segments somewhat dull due to tessellate surface and presence of very fine recumbent setae that are paler than erect brownish scopal setae**; prepygidial fimbria dense with even denser mass of shorter reddish plumose setae at midline.

Structure. Position of antennal sockets, anterior tentorial pits, and median section of epistomal suture as in male; subantennal sutures and epistomal ridges also as in male; frontal carina absent; facial fovea not clearly present, but faint depression immediately mesad of inner orbit and slightly modified integument between there and antennal socket possibly fovea (this area would not have been so identified if more pronounced, concave fovea had not been identified in female *Penapis*; fovea not evident in *Ceblurgus*); **anterior and posterior mandibular articulations equidistant from eye**. Inner margins of eyes subparallel. Labrum as described for male except without transverse row of simple setae about two-thirds way to apex, but with very short setae scattered over apical one-third. Mandible normal in length, with rounded dorsal subapical tooth. Other mouthparts as described for male.

Scape exclusive of basal ball moderately long, somewhat longer than distance between antennal sockets.

Mesosomal and wing characters as described for male. **All tarsal claws simple as in *Ceblurgus*, not bifid as in female *Penapis***; **midtrochanter like that of *Ceblurgus*, without ventral carina**; hind basitarsus giving rise to second tarsomere at apex; tibial spurs and arolia as described for male.

Metasoma with posterior margins of terga only moderately depressed. Terga unremarkable; T2 with lateral blackish areas in position of foveae (as in *Ceblurgus*), but these areas neither concave nor with modified setae or integumental sculpturing; T5 not di-

vided posteriorly along midline by cleft or by specialized area of fine punctures and short setae; exposed sterna not modified (except for integumental and setal characters above); internal apical structures not examined. Pygidial plate normally hidden; surface curved, sides strongly carinate, coming to acute apex with apex itself narrowly subtruncate, with narrow rim.

TYPE MATERIAL: PERU: **Lima Dept.:** holotype male, allotype, 8 male, 3 female paratypes, 15 km WSW Sayán, VI-26-28-1995 (J. G. Rozen, A. Ugarte), on *Exodeconus*, probably *maritimus*; 57 male, 24 female paratypes, same except VI-27-1995; 2 male, 2 female paratypes, same, preserved in Kahle's solution; 23 male, 2 female paratypes, same locality and collectors, V-11-1996, no plant data; 31 male, 22 female paratypes, same except V-12-1996, on *Exodeconus prostratus*; 13 male, 2 female paratypes, 2 km NE Sta. Rosa de Quives, near Yangas, V-27-1996 (J. G. Rozen, A. Ugarte), on *Exodeconus* probably *prostratus*; 11 male, 6 female paratypes, Sta. Rosa de Quives, near Yangas, V-28-1996 (J. G. Rozen, A. Ugarte), on *Exodeconus* probably *prostratus*; 46 male, 27 female paratypes, same except V-28-29-1996; 4 male, 3 female paratypes, same except V-29-1996, preserved in Kahle's solution. **La Libertad Dept.:** 3 male, 3 female paratypes, La Gloria, 7.5 NNW Paiján, V-20-1996 (J. G. Rozen, A. Ugarte), on *Exodeconus prostratus*; 1 male, 6 female paratypes, same except V-22-1996; 31 male, 14 female paratypes, same except V-23-1996. The holotype and allotype are in the collections of the American Museum of Natural History. Paratypes are deposited there and in the following: Museo de Historia Natural, Lima, Peru; Central Texas Melittological Institute, Austin, Texas; Snow Entomological Division, Natural History Museum, University of Kansas, Lawrence, Kansas; Universidade Federal do Paraná, Brazil; USDA Bee Biology and Systematics Laboratory, Utah State University, Logan, Utah; collection of Prof. Toro, Universidad Catolica de Valparaiso, Valparaiso, Chile.

As indicated in figure 21, the distribution of this species is restricted to the arid coastal region of Peru west of the Andes.

ETYMOLOGY: The generic name honors Mr.

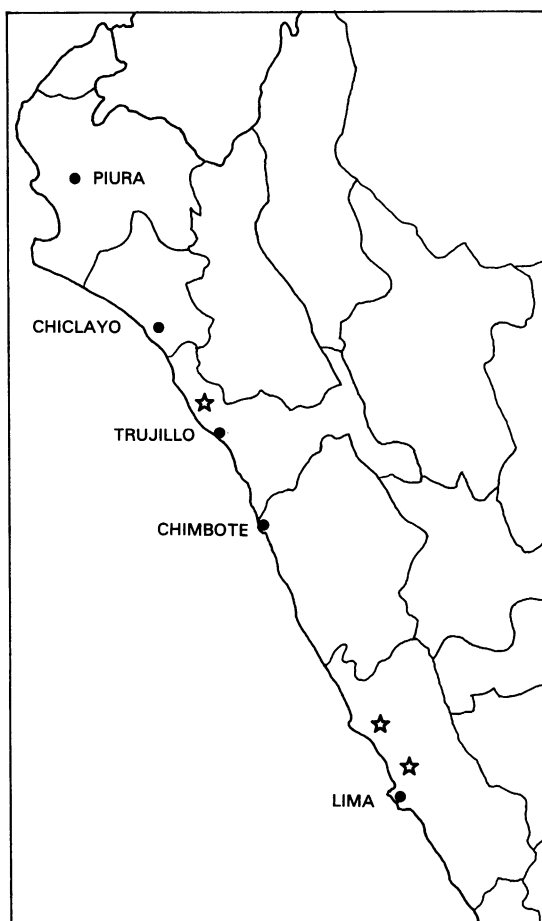


Fig. 21. Map of northwestern Peru from Lima Dept. northward, showing collection localities (stars) of *Goeletapis peruensis*.

Robert G. Goelet, Chairman Emeritus of the Board of Trustees of the American Museum of Natural History, in recognition of his long interest in enhancing the collections of this institution. The trivial name refers to the country in which the specimens were collected. Pronunciation: gō-lēt-á-pīs.

REMARKS: The single male collected by Dr. Simpson from near Paiján (metasomal apex lost, labrum hidden from view) that is available to me differs from the type series as follows: Body smaller and somewhat more slender (wing length 3.7 mm) than even the smallest male in the type series; midtibia with basal patch of short recumbent setae nearly white, concolorous with longer setae elsewhere on segment. Female specimens

collected by Dr. Simpson near Paiján agreed in that they too possessed branched scopal setae on their hind legs, according to notes by Dr. Neff. Neff's illustrations of the male genitalia and terminal sterna and his notes describing mouthparts agree with the description above. This information and the fact that some of the paratypes were collected from the Paiján area in 1996 leave little doubt that Simpson's 1983 collection was this species. The unusually small male from that series was atypical, as apparently was the association of the series with native cotton (see Biology, below).

BIOLOGY: Host plants were low-growing members of the Solanaceae. In 1995, they were identified as *Exodeconus*, probably *maritimus* (Benth.) D'Arcy, but possibly *E. prostratus* (L'Herit.) Def., and in 1996 as *E. prostratus*. At the site near Sayán, they grew in sandy, more or less horizontal areas in a boulder-strewn ravine (figs. 22, 23). The Sta. Rosa de Quives site was mostly along the lower edge of a steep hillside from which corn (maize) had recently been harvested and which was also an archaeological site. At La Gloria, near Paiján, the plant grew at the edge of, and in open areas in, an abandoned olive grove where the sandy ground surface was nearly horizontal (fig. 24). All three sites were sandy and exposed to the sun where the host plants grew. The flowers of the host plant were funnellform, approximately 3 cm across, with the limb (outer part) nearly white and the basal (inner) part purple. At least at Sta. Rosa de Quives and La Gloria, flowers opened around noon and closed again around 3 p.m. Although occasional males were observed before noon, almost all diurnal activity by males and females occurred during the 3-hour period when flowers were open. At this time these bees were abundant, the most common insect visiting the plants. Other bees foraging from, and seeking mates at, these plants included *Spinoliella* (*Spinoliella*) at Sayán (in 1995 and 1996) and La Gloria and *Callonychium* (*Paranychium*) at all three sites.

The specimens Simpson collected near Paiján were taken on native cotton, *Gossypium barbadense*. Neff (personal commun.) commented, "Although collected on cotton, the relatively dense scopae with branched

hairs suggests it is not likely to be a cotton (or any big pollen) specialist." Discovery of this species in the Paiján area visiting *Exodeconus prostratus* bears out this prediction.

At all collection localities, males flew rapidly from flower to flower, almost certainly in search of mates. However, no copulations were observed, perhaps because they occur within the throat of the flower (fig. 23) where they would be difficult to detect. Obviously males and females did not fly in copula, because, had then done so, mating pairs would have been seen, as were mating pairs of the much less common *Callonychium* (*Paranychium*). Males frequently landed on the flowers and usually straddled the throat. This stance is interpreted to be part of mate searching. Occasionally, however, males entered the throat head first, presumably to feed.

Females, always less common than males, also flew swiftly and, on landing on flowers, immediately entered head first to gather pollen and nectar. Many captured females exhibited dry, lavender pollen of the host plant on their mesosomal venters, midcoxae, and midtrochanters and on all segments of their hind legs, as well as ventrally on the basal segments of their metasomas. Females did not vibrate the anthers of *Exodeconus*; because these anthers are not porous, the flowers do not require buzz pollination as do those of *Solanum*.

Although considerable effort was expended in attempting to find nests, none was found at any of the localities. Hence, nests of none of the South American rophitines have been discovered to date, and their immature stages are unknown. No cleptoparasitic bees were discovered at localities where *Goeletapis* was observed.

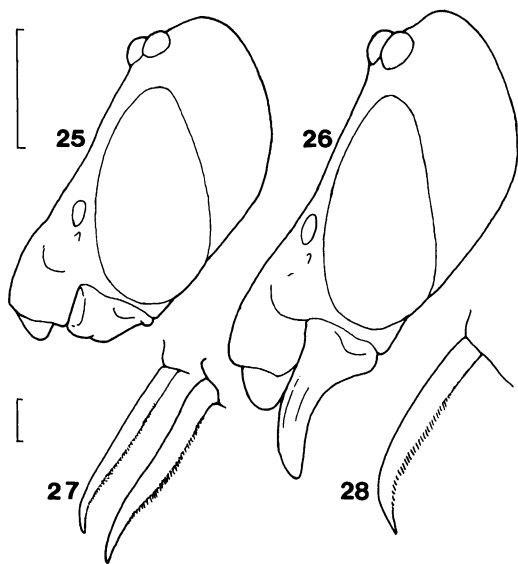
Dissection of one female preserved in Kahle's solution yielded information concerning its ovaries and oocytes, apparently the first such data reported for any rophitine. Each ovary consisted of three ovarioles (3:3). A single elongate mature oocyte (chorion visible through follicular wall) was present (mature oocytes/ovary = 0.5); its length was 1.85 mm. The egg index (E/M) (Iwata and Sakagami, 1966) was 0.96. The oocyte was unremarkable, like the eggs and oocytes of most other short-tongued bees. It was



Figs. 22, 23. 22. Habitat of *Goeletapis peruensis* at 15 km WSW Sayán, Lima Dept., Peru. Figure near middle is standing next to mat of host plant, *Exodeconus*. 23. Same locality, closeup of host plant, with eyeglass case in foreground.



Fig. 24. Habitat of *Goeletapis peruensis* at La Gloria, 7.5 km NNW Paiján, La Libertad Dept., Peru, showing author collecting on *Exodeconus prostratus*.



Figs. 25–28. 25, 26. Heads of *Penapis mol-denkei* and *P. toroi* respectively, lateral view. 27, 28. Midtibial spurs of same species. 27. Straight spur (left), recurved spur (right). Upper scale (= 0.5 mm) refers to figures 25, 26; lower scale (= 0.1 mm) refers to figures 27, 28.

curved, widest near its anterior end, and gradually tapered posteriorly. Its chorion was smooth, semitransparent, and without reticulations or other sculpturing. These data agree with what is known about the other halictid subfamilies (Iwata and Sakagami, 1966, and references therein).

PENAPIS MICHENER

Figures 2, 18, 25–47

Penapis Michener, 1965: 324. Type-species: *Penapis penai* Michener. Monobasic.

DIAGNOSIS: In addition to the features identified in the treatment of *Goeletapis*, males of all three species of *Penapis* are more coarsely punctate, hairier with longer setae, and in general less shiny than those of *Goeletapis*.

DESCRIPTION: Male. Body length 6.0–8.8 mm. Length of forewing from costal sclerite to wing tip 4.3–4.8.

Integumental texture, color, vestiture. Integument nonmetallic, black to very dark brown; integument of head and mesosoma

moderately punctate, more coarsely so than that of *Goeletapis*; integument of upper part of head microscopically uneven though somewhat shiny; upper middle part of clypeus coarsely, irregularly punctured; dorsal surface of propodeum with smooth areas less extensive than in *Goeletapis* because of more extensive sculpturing and punctation, hence not appearing polished; undersurface of flagellum brown to dark brown; legs entirely dark brown to almost black. Body setae tending to be long, disorganized, often partly obscuring integument. Pubescence on ventral surface of mandible long to moderately short, not arranged as organized fringe as in *Goeletapis*; mandible without conspicuous basal tuft of long, white hairs as in *Ceblurgus* (Urban and Moure, 1993: figs. 3, 4); setae of maxilla and labial palpus fine, nonplumose, short, inconspicuous, not long and plumose as in *Ceblurgus*; anterior surface of forecoxa with setae yellowish to white, some long, as long or nearly as long as coxa; pubescence on outer surface of mid- and hind tibiae and basitarsi more or less erect, plumose but with short branches, moderately dense so as to partly obscure integument, not organized in parallel as in *Goeletapis*; midfemur without basal patch of short, golden setae on anterior surface as in *Goeletapis*, all setae there long, plumose, and similar to those on venter of mesosoma; hind trochanter without apical, specialized, long, curved setae as in *Ceblurgus*. Metasomal pubescence not forming bands on T1–T5; dorsal surface of T2–T4 with very fine, recumbent setae arising from fine punctures at base of discs, elsewhere with scattered, coarser punctures and larger, pale, erect setae; margins of T1–T6 glabrous dorsally; lateral surfaces of metasomal terga with scattered, long, plumose, erect setae and some with finer, recumbent setae as well; pygidial plate of T7 completely glabrous; S1–S3 with short recumbent setae and sublateral vague patches of long, erect setae, conspicuousness of which varies specifically; setae of S4–S8 described below under Structure; apex of gonoforceps nonsetose, in contrast to that of *Goeletapis*, but gonoforceps with scattered, moderately long setae subapically on ventral surface and scattered, short setae subapically on dorsal surface.

Structure. Head breadth approximately

equal to length. Antennal sockets far below middle of face. Anterior tentorial pits close to outer lower edge of antennal sockets; antennal suture present but weak; integument between antennal socket and lateral section of epistomal suture smooth, impunctate, and with more or less evident suture extending obliquely downward from anterior tentorial pit to epistomal suture, as discussed in Morphology. Clypeus moderately long, length distinctly more than one-third distance between lower inner orbits in front view, its length and protuberance varying according to species; median section of epistomal suture (fig. 2) weak but evident; lateral section evident as it extends downward from junction of antennal suture and then runs laterally (see description in Morphology); frontal carina absent except for small longitudinal tubercle about halfway between level of antennal sockets and median ocellus; facial fovea absent; malar space nearly absent, with anterior mandibular articulation slightly farther removed from eye than is posterior articulation; vertex produced well above upper ends of eyes. Inner margins of eyes subparallel to slightly converging below. Labrum much broader than long, width more than 2 times length along midline; anterior surface evenly curved, without transvers ridge; row of long, tapering, simple setae arising from apex. Mandible elongate as seen in maximum profile but somewhat shorter than eye in lateral view, with preapical inner tooth. Proboscis long, in repose reaching between forecoxae; glossa elongate; annular hairs of glossa simple, acutely pointed, elongate; paraglossae small, linear; mentum semimembranous, somewhat pigmented; lorum membranous except for elongate sclerite on each side; flabellum absent; labial palpus much longer than maxillary palpus, somewhat shorter than glossa; segment one not unusually narrowed at base; segments one and two subequal in length, extensively flattened on dried specimens, with only ventral surface sclerotized; length of segment three one-third to nearly one-half as long as two, hence relatively shorter than in *Goeletapis*, clearly flattened; segment four a little more than one-third to less than one-quarter length of three, scarcely flattened, angled from axis of other segments. Galea elongate, postpalpal part

slightly longer than stipes, without comb on inner surface; outer edge of galeal blade membranous, with many short setae and a few longer ones; maxillary palpus elongate, only slightly shorter than galeal blade, six-segmented; all segments sclerotized, normally successively thinner, but palpus not coming to point as in *Goeletapis*; inner surface of segment two and perhaps of segment three membranous; segment two approximately 1.5 times length of segment one; segments one and three subequal in length; segments four, five, and six subequal in length, together as long as segment two.

Scape very short, length exclusive of basal ball approximately twice maximum diameter, shorter than distance between antennal sockets, and shorter than first three flagellomeres; middle flagellomeres tending to be about as long as broad; flagellum without elongate specialized setae; flagellomeres without rings of specialized sensilla as in *Sphecodosoma*.

Pre-episternal groove well developed below level of scrobe; ventral median longitudinal pro- and mesepisternal groove somewhat more deeply impressed than in *Goeletapis*. Dorsal surface of propodeum about as long as scutellum.

Forewings hyaline, with fewer setae than in *Goeletapis*; veins medium brown to dark brown; stigma uniformly brown or paler with dark border; three submarginal cells present, last two together slightly longer than first; basal vein strongly curved, about as in *Goeletapis*. Legs little modified; fore- and mid-femur, tibia, and tarsus moderately robust, somewhat more so than those of *Goeletapis*; length of forebasitarsus somewhat less than one-half length of tarsus; foretarsal claw with pronounced inner tooth as large as those of midtarsus and hind tarsus; strigilus normally long; midtibia with thornlike apical projection on outer surface; midbasitarsus moderately short, not much more than one-half length of midtibia; midtibia equal in length to at least first two tarsomeres and sometimes to first four tarsomeres; disc of basitibial plate partly obscured by recumbent setae; hind basitarsus slightly less than one-half length of hind tibia; tibial spurs minutely ciliate; outer hind tibial spur more than two-thirds as long as inner spur; arolia present.

Metasoma with posterior margins of terga

depressed, somewhat more so than in *Goeletapis*; gradulus of T2 directed backward at side, above and behind spiracle; posterior margin of T6 well impressed and well differentiated from disc; T7 exposed, with well-defined, large, glabrous pygidial plate with carinated edges (Michener, 1965: fig. 20); S2–S4 with disc of postgradular area concave; posterior margin of S4 (figs. 29, 35, 41) with uniform comb of stout, simple setae on each side; in front of comb, disc with cluster of long, outwardly recurved, plumose setae on each side medially in addition to long and short, straight setae elsewhere; S5 (figs. 30, 36, 42) deeply emarginate from behind medially, with each side of emargination produced as pronounced, sharp, flattened process directed downward and backward; shape of process varying according to species; middle of emargination produced posteriorly as median, pointed process, size and shape of which depending upon species; S6 (figs. 32, 38, 44) bearing narrow, transverse incision on each side (apparently permitting flexing of apical part of sternum), bearing sublateral, moundlike process on each side, and with fully sclerotized apex moderately broadly emarginate medially; S7 without paired apical lobes; S8 (figs. 34, 40, 46) with maximum width of basal process much wider than maximum width of apical process; median expansion slightly narrower to slightly wider than maximum width of basal process. Genital capsule elongate (Michener, 1965: fig. 25); anterior foramen of gonobase very elongate, somewhat dumbbell shaped in that anterior and posterior ends wider than midwidth, more than three times longer than midwidth.

Female. Body length approximately 6.5–8.8 mm. Length of forewing from costal sclerite to wing tip 4.7–5.2 mm.

Integumental texture, color, vestiture. As described for male except for following: Erect setae of frons and scutum somewhat longer than those of *Goeletapis*, but in general these setae tending to be shorter than those of male; forecoxa with some setae nearly as long as coxa; long dorsal hairs of foretarsus appearing nonplumose (but actually some with submicroscopic branches apically), longer than hairs on ventral brush of tarsus, not curved at tips; outer apex of mid-

tibia lacking sharp, curved, stout, nonplumose, spinelike setae as found in female *Goeletapis* and *Ceblurgus*; midbasitarsus only partly hidden by setae that are longer, paler, more erect, but less dense than those of female *Goeletapis*; scopal setae apparently present on hind basitarsus, femur, tibia, trochanter, coxa, and apparently on apical areas of basal metasomal sterna, as in *Goeletapis*, as judged by presence of long, erect setae; at least some scopal setae on outer surface of hind basitarsus longer than one-half length of basitarsus; these setae nonplumose, pale cream color, and more erect and less dense than comparable setae of *Goeletapis*, so that basitarsus clearly visible through them; almost all scopal setae of hind tibia very long, nonplumose (fig. 18) (some setae near base of tibia with one or two fine branches on some specimens); scopal setae of S2 mostly nonplumose; some sternal scopal setae elsewhere with branches; pale sternal scopal setae arising from pronounced sockets that are not more darkly pigmented than surrounding integument, which is dark brown; integument anterior to band of sockets on S2–S4 rather shiny, less tessellated than in *Goeletapis* and almost devoid of fine, pale, recumbent setae; prepygidial fimbria dense with even denser mass of shorter, reddish setae at midline, as in *Goeletapis*.

Structure. As described for male except for following: Head breadth slightly greater than length. Clypeal length and protuberance not varying according to species; frontal carina absent; facial fovea represented by slightly dull, vaguely concave area immediately mesad of eye, somewhat more pronounced than in female *Goeletapis*; on cleared specimen, integument of fovea more darkly pigmented than that of rest of frons. Inner margins of eyes subparallel or slightly diverging below. Mandible normal in length with rounded dorsal subapical tooth.

Scape exclusive of basal ball short, but not as short as that of male, about 3 times maximum diameter, slightly shorter than, or subequal to, distance between antennal sockets. Middle flagellomere broader than long.

Length of forebasitarsus about one-half length of tarsus; tarsal claws bifid, in contrast to simple tarsal claws of female *Goeletapis* and *Ceblurgus*; midtrochanter with ventral

carina; midbasitarsus about equal in combined length to remaining four tarsomeres (exclusive of pretarsus).

Metasoma with posterior margins of terga moderately depressed. Terga unremarkable; T2 with foveae not indicated by pigmentation, sculpturing, or setal patterns; T5 not divided posteriorly along midline by cleft or by specialized area of fine punctures and short setae. Pygidial plate normally hidden; at least in some species, surface curved, sides strongly carinate, coming to acute apex, with apex broadly subtruncate.

REMARKS: The three species of *Penapis*, all known only from Chile (fig. 21), are remarkably similar. The differences separating males are consistent and are identified in the key below and in the following descriptions. Most of these characters are sex-limited. However, the female characters also seem to be consistent although subtle and difficult to quantify.

In the lists of specimens examined, some of the provincial assignments have been altered from those given on labels to correspond to currently recognized political boundaries in Chile.

KEY TO SPECIES OF *PENAPIS*

1. S6 of male with sublateral process backward-pointed at approximately 45° in strict lateral view (fig. 45); S5 of male with median process slightly longer than sublateral processes in ventral and lateral views (figs. 42, 43); S4 of male with median clump of approximately 8–12 long, plumose, outwardly recurved setae on each side (fig. 41); pterostigma of both sexes with veined margins somewhat darker than disc; midtibial spur of both sexes gently curved to base (fig. 28); scopa strongly amber colored; midfemur of female with ventral half of anterior surface shallowly but broadly concave . . . *Penapis toroi* Rozen
- S6 of male with sublateral process evenly rounded in lateral view (figs. 33, 39); S5 of male with median process slightly shorter or much shorter than sublateral processes in ventral or lateral views (figs. 30, 31, 36, 37); S4 of male with median clump of 5 or fewer plumose, outwardly recurved setae on each side (figs. 29, 35); these setae tending to be somewhat shorter than those of *P. toroi*; pterostigma of both sexes either uniformly dark brown (*P. penai*) or with pale disc

much paler than veined border (*P. molderkei*); midtibial spur of both sexes straight or recurved at midlength (fig. 27); scopa grayish white (*P. molderkei*) or grayish amber (*P. penai*); midfemur of female convex over most of anterior surface, with only narrow, inconspicuous, shallow concavity along extreme lower edge) 2

2. S6 with sides of sublateral process compressed so that process more linear in ventral view (fig. 32); S5 with median process longer, nearly as long as sublateral processes (fig. 30); pterostigma of both sexes uniformly dark brown, disc concolorous with veined margins; scopa and metasomal setae (exclusive of orange pseudopygidial tuft) tending to be more amber colored *Penapis penai*

Michener

S6 with sides of sublateral process not compressed so that process more oval in ventral view (fig. 38); S5 with median process short, poorly developed, distinctly shorter than sublateral process (fig. 36); pterostigma of both sexes with veined margins dark, disc paler; scopa and metasoma setae (exclusive of orange pseudopygidial tuft) tending to be more grayish white . . . *Penapis molderkei*

Bohart, Toro, and Rozen

Penapis penai Michener

Figures 18, 29–34, 47

Penapis penai Michener, 1965.

DIAGNOSIS: See key and description below.

DESCRIPTION: **Male.** Lower part of face (Michener, 1965: fig. 27) only moderately drawn out, about as in *Penapis molderkei* (fig. 25), less than in *P. toroi* (fig. 26). Pterostigma uniformly dark brown, disc almost same color as marginal veins. Midtibial spur (as in fig. 27) in lateral view straight or slightly recurved at midlength. S4 (fig. 29) with median cluster of 3–5 long, plumose, outwardly recurved setae on each side (and sometimes with similar but shorter setae laterad of main cluster); simple setae of apical comb only faintly amberish, numerous, approximately 20 on each side. S5 (fig. 30) with median apical process of sternum moderately long, shorter than that of *P. toroi* but longer than that of *P. molderkei*; apically this process somewhat flattened but not as strongly keellike as in *P. toroi*; sublateral process in strict lateral view (fig. 31) usually without projection along posterior margin although sometimes slightly

projecting but never as much as in *P. molderkei* (this character often difficult to see because of tuft of dense, plumose setae along posterior edge of process). S6 with sublateral, moundlike process evenly rounded in lateral view (fig. 33) (about as in *P. molderkei*); this process laterally compressed so that in ventral view (fig. 32) appearing more linear than that of *P. molderkei*. S8 as figured (fig. 34).

Female. As described for male (exclusive of sex-limited male characters) except for following: Midfemur convex over most of anterior surface but with inconspicuous shallow concavity along extreme lower edge; scopal hairs tinged grayish amber.

MATERIAL EXAMINED: CHILE: **Elqui Prov.:** 1 female, Llano de la Higuera, N of El Tofo, X-14-1971 (Rozen and Peña); 2 males on plants no. 41722, 41724, 6 females on plants no. 41723, 41726, 41736, 41910, 41911, 41912, Carretera Pan-Am al norte de La Serena, Int. Biol. Program, 1970–1972 (A. R. Moldenke); 9 males, 1 female, El Tofo, IX-23-1980 (V. Cabezas, M. Rojas, H. Toro); 2 males, same except X-1972 (L. Ruz, V. Cabezas) on *Argylia radiata*. **Huasco Prov.:** 1 male (holotype), Chañaral de Aceituno, X-23–25-1957 (L. Peña).

At present, the distribution of this species (fig. 47) appears to be allopatric with that of the other two species and is the most southern. The type locality is near the coast, west of Domeyko, and should not be confused with Chañaral, Chañaral Prov.

BIOLOGY: So far as is known, the only host plant of this species is *Argylia radiata* (Bignoniaceae).

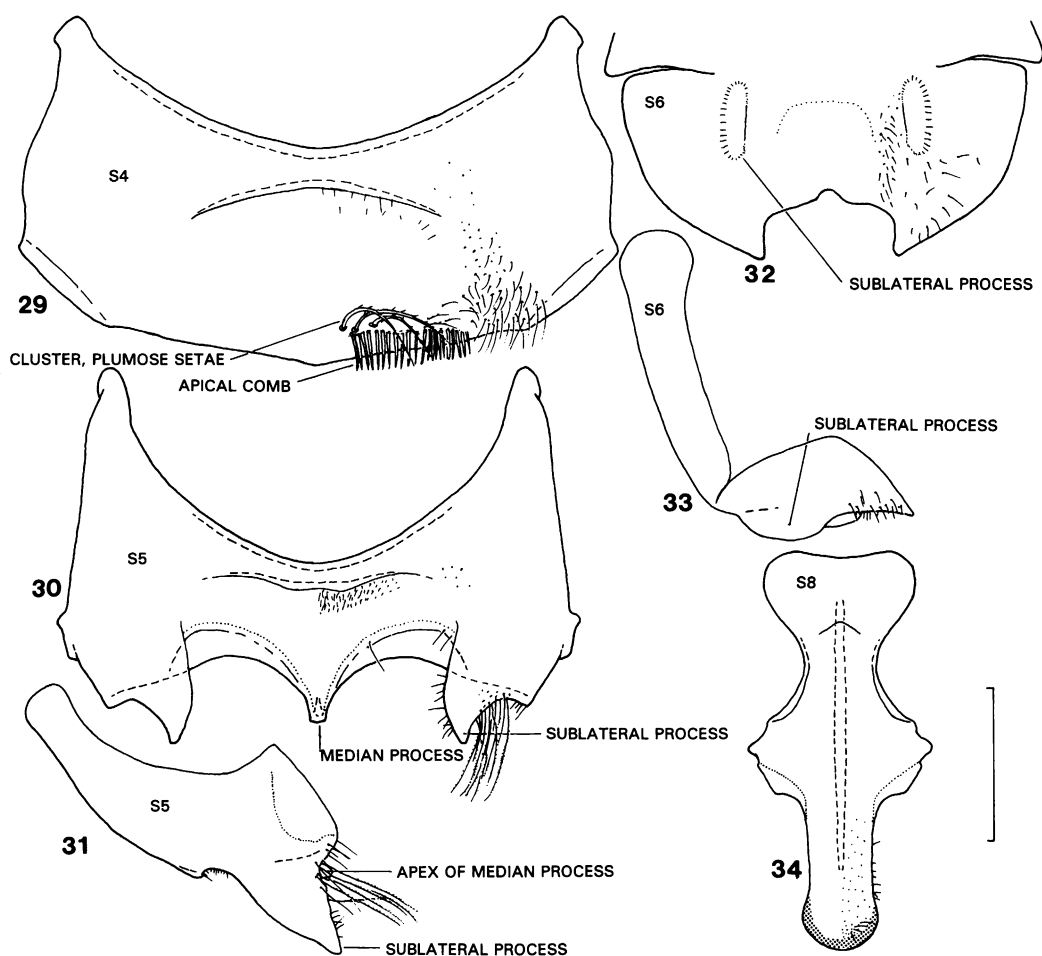
Penapis molderkei

Bohart, Toro, and Rozen, new species

Figures 2, 25, 27, 35–40, 47

DIAGNOSIS: See key and description below.

DESCRIPTION: **Male.** Lower part of face (fig. 25) only moderately projecting, about as in *Penapis penai*, less than in *P. toroi* (fig. 26). Pterostigma with pale disc bordered by dark brown marginal veins. Midtibial spur (fig. 27) in lateral view straight or slightly recurved at midlength. S4 (fig. 35) with median cluster of 3–6 long, plumose, outwardly recurved setae on each side; simple setae of apical comb only faintly amberish, number-



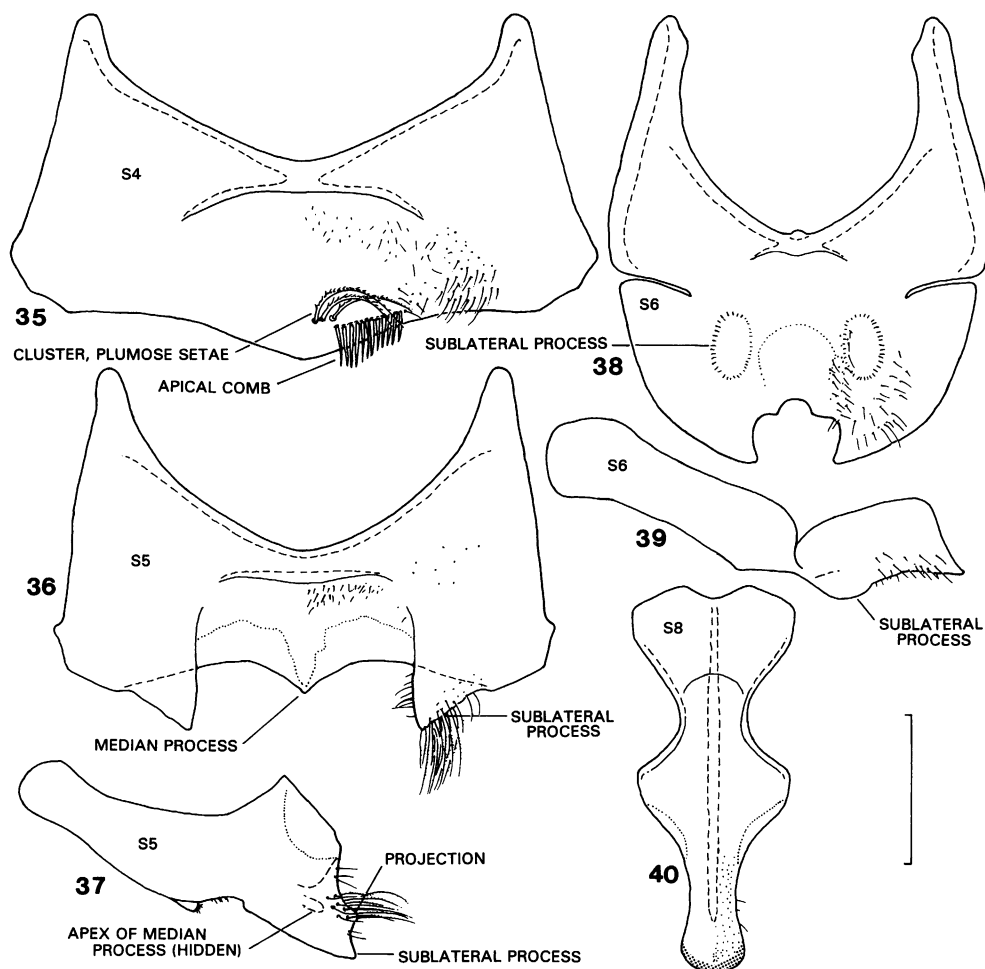
Figs. 29–34. *Penapis penai*, male. 29. S4, ventral view, setae shown only on right. 30, 31. S5, ventral (setae on right) and lateral views, respectively. 32, 33. S6, ventral (setae on right) and lateral views, respectively. 34. S8, ventral view, setae shown only on right. Scale (=0.5 mm) refers to all figures.

ing approximately 12–15 on each side. S5 (figs. 36, 37) with median apical process of sternum short compared with that of either *P. penai* or *P. toroi*; apically this process not strongly flattened, not forming keellike ridge; sublateral process in strict lateral view (fig. 37) with pronounced, angled projection along posterior margin. S6 with sublateral, moundlike process evenly rounded in lateral view (fig. 39), about as in *P. penai*; this process not laterally compressed so that in ventral view (fig. 30) appearing oval, not as linear as that of *P. penai*. S8 as figured (fig. 40).

Female. As described for male (exclusive

of sex-limited male characters) except for following: Midfemsur convex over most of anterior surface but sometimes with shallow concavity along extreme lower edge; scopal hairs tending to be more grayish white in contrast to more amberish scopas of *Penapis penai* and *P. toroi*.

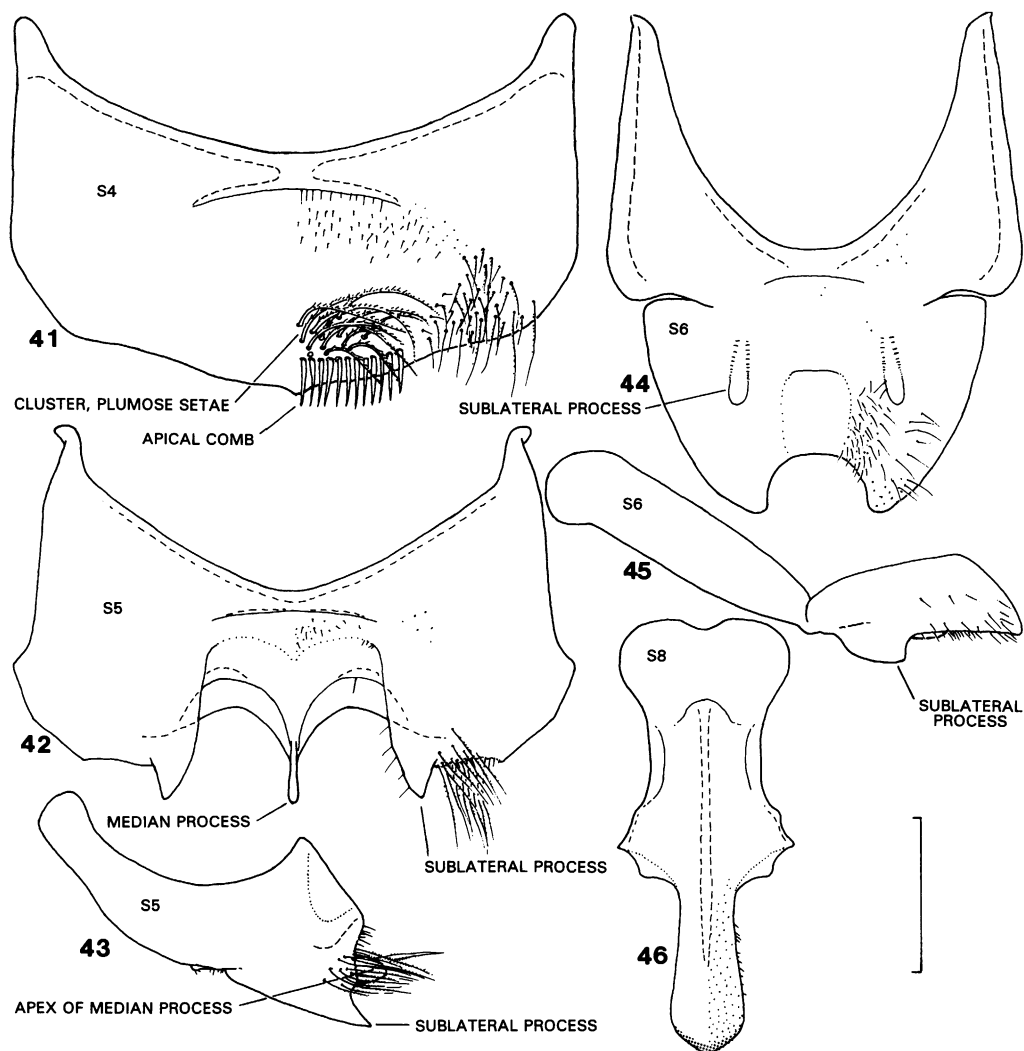
TYPE MATERIAL: CHILE: **Copiapó Prov.:** holotype male, allotype, 13 male, 13 female paratypes, 85 km S Copiapó, X-23-1991 (J. G. Rozen, L. Peña), on *Argylia radiata*; 12 male paratypes, 40 km S Copiapo, IX-19-1972, 1610–1700 hours (J. L. Neff) on *Argylia puberula*; 9 male, 1 female paratypes, same except IX-20-1972, 0800–0930 hours;



Figs. 35–40. *Penapis moldenkei*, male. 35. S4, ventral view, setae shown only on right. 36, 37. S5, ventral (setae on right) and lateral views, respectively. 38. Posterior part of S6, ventral view, setae shown only on right. 39. S6, lateral view. 40. S8, ventral view, setae shown only on right. Scale (=0.5 mm) refers to all figures.

4 male paratype, 50 km S Copiapo, IX-29-1992, 1100 hours (J. L. Neff) on *Argylia puberula*; 1 male paratype, same except on *Calandrinia*; 3 male paratypes, 26 mi S Copiapó, X-19-1969 (Rozen & Peña); 2 male, 1 female paratypes, 44 km S Copiapó, X-21-1971 (Rozen & Peña); 2 male, 4 female paratypes, Travesia, X-11-1977 (L. Ruz, H. Flores, J. C. Magunacelaya); 10 male, 4 female paratypes, same locality, X-1969 (L. Ruz, H. Toro); 27 male, 11 female paratypes, same locality, IX-29-1983 (R. Aldunate, B. Dyer, F. Rodriguez, C. Massad, C. Tobar, H. Toro, J. Vial); 1 male paratype, same locality,

IX-1971 (L. Ruz); 2 female paratypes, same locality, X-1972 (L. Ruz), on *Argylia radiata*; 2 female paratypes, 10–40 km SE Caldera, X-17-1969 (Rozen and Peña); 1 female paratype, Mineral Atacama, NW Copiapó, 1100 m, X-4-1980 (L. E. Peña). **Huasco Prov.:** 1 male paratype, 90 km S Copiapó, X-19-1971 (Rozen & Peña); 12 male, 6 female paratypes, Algarrobal, X-11-1977 (V. Cabezas, H. Flores, H. Toro); 1 male paratype, S of Canto del Agua, X-23-1980 (L. E. Peña). **Chañaral Prov.:** 1 male paratype, Chañaral, X-1991 (H. Toro); 1 female paratype, same except X-1987 (De La Hoz); 18



Figs. 41–46. *Penapis toroi*, male. 41. S4, ventral view, setae shown only on right. 42, 43. S5, ventral (setae on right) and lateral views, respectively. 44, 45. S6, ventral (setae on right) and lateral views, respectively. 46. S8, ventral view, setae shown only on right. Scale (=0.5 mm) refers to all figures.

male paratypes, 30 km S Chañaral, X-1-1972, 0930 hours (J. L. Neff) most males sleeping in flowers (*Argylia puberula*) but some patrolling; 1 male paratype, 40 km S Chañaral, X-12-1983 (J. L. Neff); 6 female paratypes, same except on *Argylia*; 3 female paratypes, same except on *Argylia radiata*. **El Loa Prov.:** 1 male paratype, Chiu-chiu, IX-27-1983 (De La Hoz). **Antofagasta Prov.:** 1 male, 2 female paratypes, Paposo, X-1-1993 (E. Chiappa). **Iquique Prov.:** 1 male paratype, La Tirana, IX-29-1983 (De

La Hoz); 1 male paratype, same except IX-15-1994 (V. Ruiz).

The holotype and allotype are deposited in the American Museum of Natural History. Paratypes are there and in the following: collection of Prof. Toro, Universidad Catolica del Valparaíso, Valparaíso, Chile; Snow Entomological Division, Natural History Museum, University of Kansas, Lawrence, Kansas; Central Texas Melittological Institute, Austin, Texas; Universidade Federal do Paraná, Brazil; and USDA Bee Biology and

Systematics Laboratory, Utah State University, Logan, Utah.

The distribution of this species (fig. 47) broadly overlaps that of *Penapis toroi*, and the two have been collected at Chañaral, Chañaral Prov., Paposo, Antofagasta Prov., and La Tirana, Iquique Prov.

ETYMOLOGY: This species is named in honor of Dr. Andrew R. Moldenke of Oregon State University, Corvallis.

BIOLOGY: The recorded host plants of this species apparently are *Argylia radiata* and *A. puberula* (Bignoniaceae). According to Dr. Jackie Kallunki, these are the same species, the former being the correct name. This plant species is also the larval food source of *Penapis penai*. *Calandrinia* (Portulacaceae) may also host *P. moldenkei*. When queried about possible host plants for this species and *P. toroi*, Toro (personal commun.) stated that he "used to collect males [of *Penapis* (without reference to species)] "sleeping in flowers of *Argylia* and both males and females visiting *Calandrinia*."

***Penapis toroi* Rozen, new species**

Figures 26, 28, 41–47

DIAGNOSIS: See key and description below.

DESCRIPTION: Male. Lower part of face strongly drawn out in lateral view (fig. 26), more so than in *Penapis penai* and *P. moldenkei* (fig. 25). Veins of forewing brown, about as in *P. moldenkei*; pterostigma with disc medium brown, bordered by dark brown marginal veins, but contrast of pale disc with dark border not so pronounced as in *P. moldenkei*. Midtibial spur in lateral view (fig. 28) evenly curved its entire length. S4 (fig. 41) with median cluster of approximately 12 long, plumose, outwardly recurved setae on each side; simple setae of apical comb amber colored, numbering approximately 12 on each side. S5 (figs. 42, 43) with median apical process of sternum long, longer than that of either *P. penai* or *P. moldenkei* and in ventral view extending beyond sublateral processes; apically this process flattened, forming keellike median ridge; sublateral process in strict lateral view (fig. 43) with angled projection along posterior margin. S6 with sublateral, moundlike process with backward-projecting angle, almost always of

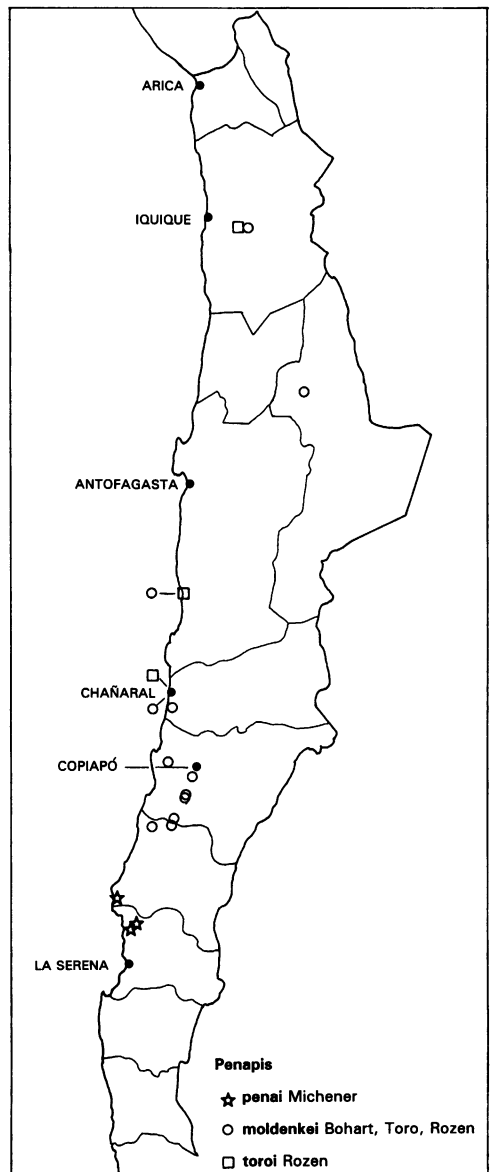


Fig. 47. Map of Chile from Limari Prov. northward, showing known distributions of the three species of *Penapis*.

about 45° in lateral view (fig. 45); this process laterally compressed so that in ventral view (fig. 44) appearing linear. S8 as figured (fig. 46).

Female. As described for male (exclusive of sex-limited male characters) except for following: Pterostigma with disc medium brown, veined border slightly darker, but

contrast between disc and border even less pronounced than in male. Midfemur with anterior surface broadly concave along lower half; scopal hairs tinged with grayish amber, about as in *Penapis penai*, contrasting with whitish scopal setae of *P. moldenkei*.

TYPE MATERIAL: **Antofagasta Prov.:** holotype male, 10 male paratypes, Paposo, X-1-1983 (H. Toro); allotype, 15 male paratypes, same except collector (F. Rodriguez); 48 male, 1 female paratypes, same except collectors (E. Chiappa, B. Dyer, De La Hoz, O. Martinez, M. Rojas, C. Tobar). **Chañaral Prov.:** 1 male, 1 female paratype, Chañaral, X-1987 (De La Hoz). **Iquique Prov.:** 9 male paratypes, La Tirana, IX-29-1983 (B. Dyer, O. Martinez, F. Rodriguez, M. Rojas).

The holotype, allotype, and paratypes are in the collection of Prof. Toro, Universidad Catolica de Valparaiso, Valparaiso, Chile.

Other paratypes are in the American Museum of Natural History; Central Texas Melittological Institute, Austin, Texas; Snow Entomological Division, Natural History Museum, University of Kansas, Lawrence, Kansas; and USDA Bee Biology and Systematics Laboratory, Utah State University, Logan, Utah.

The distribution of this species is mapped (fig. 47).

ETYMOLOGY: It is a pleasure to name this species in honor of Prof. Haroldo Toro in recognition of his distinguished contributions to our understanding of the bees of Chile.

BIOLOGY: No host plant of this species has been identified. However, the fact that the bee has been collected at three localities with specimens of *Penapis moldenkei* suggests that it too may visit *Argylia*. See Biology, *P. moldenkei*, above.

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