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Small carrion beetles (Coleoptera: Leiodidae: Cholevinae) from caves in Iran, with additional taxonomical notes on *Anemadus sengleti* and *Catops farsicus*

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Abstract

Distributional data on Cholevinae found in caves in Iran are presented. In total, three species are reported. *Anemadus sengleti* Giachino & Vailati, 1993 is redescribed, including previously unknown female characters, based on material from two localities in Iran, with the first records from Isfahan, and Kohgiluyeh and Boyer-Ahmad Provinces. *Catops farsicus* Giachino & Vailati, 2000 is redescribed, including the previously unknown male characters, based on material from eight localities in Iran, with the first records from Chaharmahal and Bakhtiari, Isfahan and Kohgiluyeh and Boyer-Ahmad Provinces. The distribution of both species is mapped. The widely distributed *Cholevinus pallidus pallidus* (Ménétries, 1832) is reported for the first time from Isfahan and North Khorasan Provinces.

Key words: Leiodidae, Cholevinae, distribution, taxonomy, redescription, caves, Iran, Palaearctic Region

Introduction

The small carrion beetles subfamily (Coleoptera: Leiodidae: Cholevinae) is a large group with more than 2000 species distributed worldwide (Perreau 2000, Newton 2016; M. Perreau, unpublished). The recent checklist of Perreau *et al.* (2017) reported 13 genera and 41 species and subspecies of Cholevinae from Iran. Like to other beetles with a somewhat cryptic lifestyle, caves are among the preferred habitats for this group (see Tahami *et al.* 2016).

Here we report small but interesting material of Cholevinae, recently collected in caves in the south-western part of Iran. Additional material, accumulated by J. Růžička from different sources, is also included. Two species, for which previously only one sex was known, are provided with supplementary descriptions.

Material and methods

Field work (Figs. 19–30)**.** All caves are natural soluble, except for Kohangan Cave, which is a man-made long tunnel, however, having the same ecological conditions as other caves, such as, darkness, high humidity, and food paucity. Specimens were collected in the first two tentative zones as endogean, near the entrance, and parahypogean, the middle/twilight/ transition zone, where it is richer in energy sources comparing to the cave bottom (hypogean). However, in Deh Sheykh Cave, we found specimens mostly in the parahypogean and hypogean zones, it is highly probable that there were other entrances, but not of human-size, at the other end of the cave, as we were told during field work by local people. Dangezlu is a water-cave, with one of the largest and richest underground spring inside, and with big pools; the temperature inside is very low (Table 1) throughout the year and the source of energy is most probably notably poor, a reason why cave dwelling insects, including small

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carrion beetles, were seen and collected only up to the proximal part of middle zone (parahypogean) where the floors were not covered completely by water. The specimens were collected from the cave floor, sometimes under stones or decaying litter, and on the walls, using a fine brush. Some cave parameters are given in Table 1.

TABLE 1. Date, temperature, humidity and CO_2 concentration of collection zones of examined caves in Iran. Endogean: entrance, parahypogean: middle/transition zone.

Cave	Date of collection	Zone of collection	Temperature (°C)	Humidity (%)	CO2 (ppm)
Dangezlu	11.v.2016	endogean	9.5	70.0	878
		parahypogean	12.5	68.6	857
	27.ix.2016	endogean	10.4	61.0	689
		parahypogean	13.6	40.0	562
Cheshme Talou	25.ix.2015	parahypogean	14.3	76.0	267
Malousjan	22.ix.2015	endogean	14.6	88.9	1290
	12.iv.2016	endogean	15.5	79.0	1695
	7.xi.2016	endogean	19.5	68.3	1052
Deh Sheykh	17.x.2015	parahypogean	16.3	70.3	535
		hypogean	16.0	74.9	513
	8.x.2016	parahypogean	14.8	79.0	598
		hypogean	16.0	68.0	591
Kohangan	11.v.2016	endogean	11.9	70.1	753
		parahypogean	12.1	76.4	700
	27.ix.2016	endogean	14.5	64.8	558
		parahypogean	14.8	65.4	663
Sarab	8.v.2016	endogean	13.3	66.0	459
		parahypogean	13.5	65.0	493
	24.ix.2016	endogean	17.7	18.7	472
		parahypogean	17.1	17.9	473
Shahsavar	10.v.2016	endogean	22.6	70.5	586
		parahypogean	22.0	74.0	544
	25.ix.2016	endogean	28.8	7.4	528
		parahypogean	26.8	15.5	539

Museum abbreviations. The specimens examined in this study are deposited in the following museums and private collections (acronyms according to Arnett *et al.* 1993):

JRUC—collection of Jan Růžička, Prague, Czech Republic;
JVAC—collection of Jiří Vávra, Ostrava, Czech Republic;
ZM-CBSU—Zoological Museum and Biological Collection of Shiraz University, Iran.

Morphological analyses. Male and female genitalia were cleaned in a hot 10% KOH solution, and embedded in Euparal for permanent mounts on microslides, or placed in temporary mounts in glycerol or glycerol gelatine on slides. Details of genitalia were imaged using an Olympus XC30 Digital Colour Camera attached to Olympus CX41 biological microscope. Habitus photographs were taken using a Canon macro photo lens MP-E 65mm on a Canon 550D. Multiple layers of focus were combined using Zerene Stacker 1.04 (http://www.zerenesystems.com/cms/stacker) for the habitus images.

Measurements. The length of the pronotum was measured along the median line (as posterior angles are slightly prolonged in some species); the length of the elytra was measured from the posterior margin of the

scutellum to the tip of the elytra in dorsal view. Total body length was measured from the anterior margin of the labrum (with head in extended position) to the apex of the elytra.

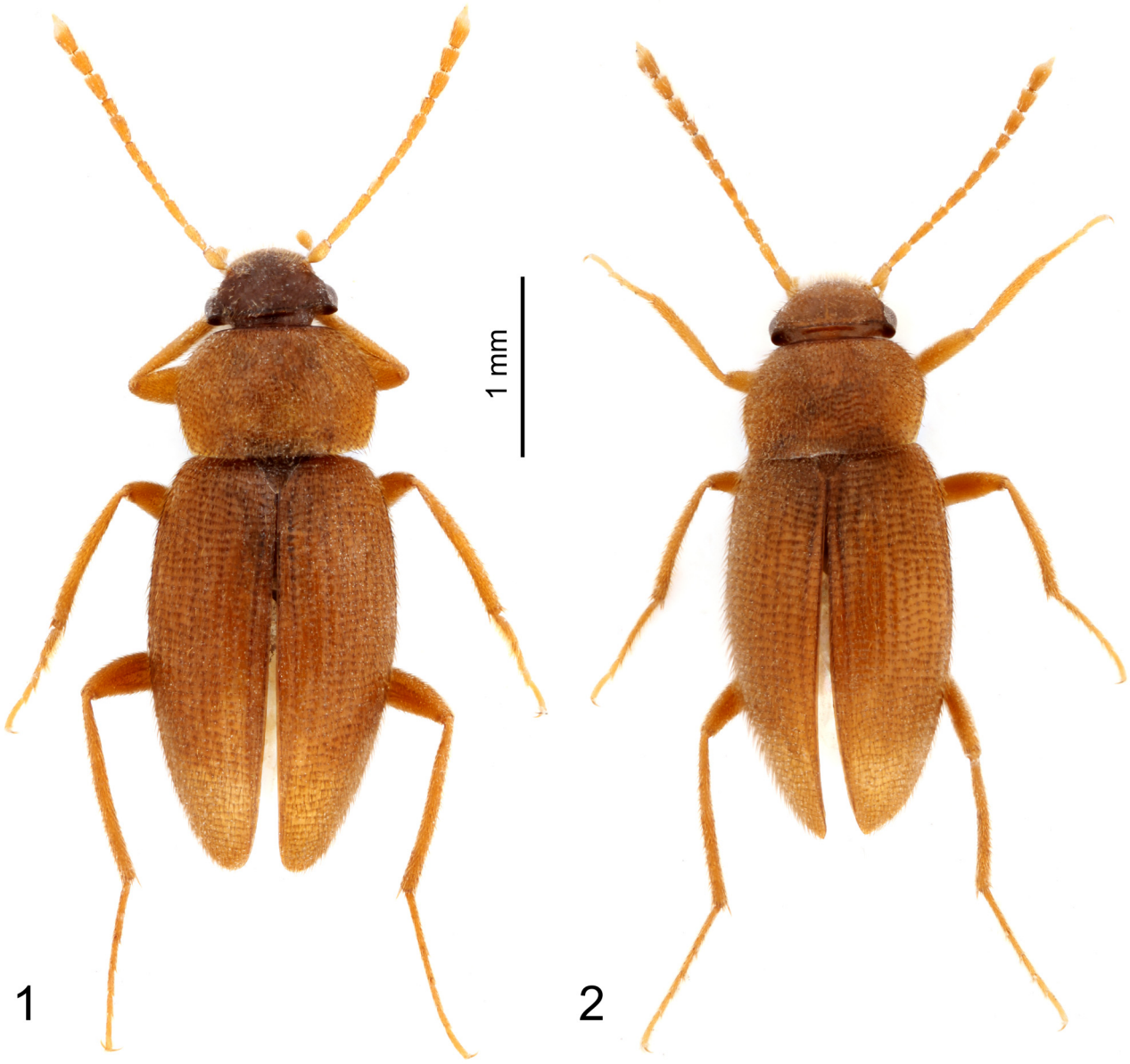
Maps. The distribution map was produced and edited in ESRI ArcMap 10.2 of ArcGIS Desktop 10.2 suite. For map layers, free level 0 and level 1 data from Global Administrative Areas (http://www.gadm.org, ver. 2.8) and Natural Earth (http://naturalearthdata.com, Cross Blended Hypso with Relief, Water, Drains, and Ocean Bottom) were used.

Results

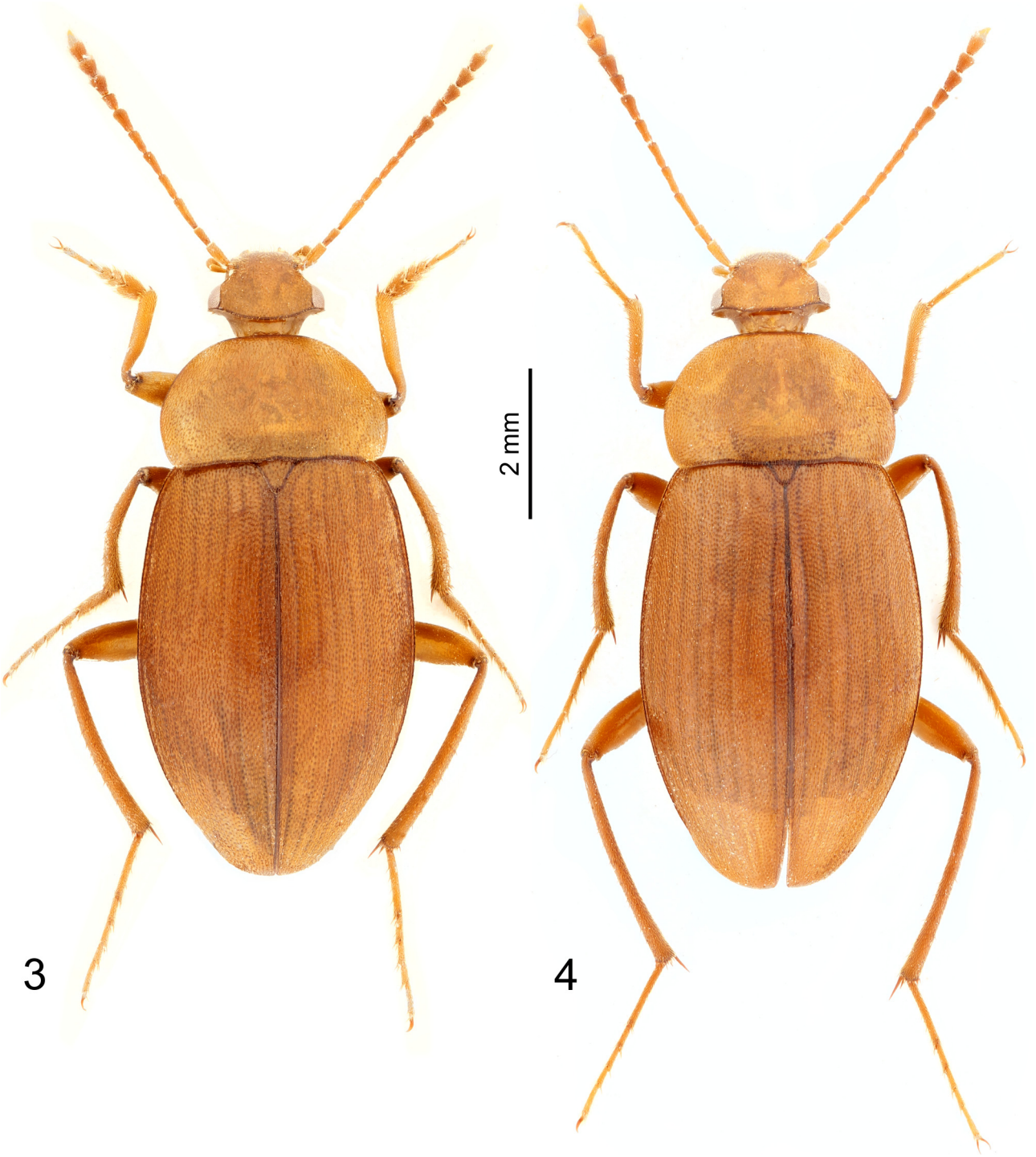
Anemadus sengleti Giachino & Vailati, 1993

(Figs 1, 2, 8–13, 18)

Anemadus sengleti Giachino & Vailati, 1993: 138 (type locality: Iran, Lorestan, Dizgarân, 33°44′N 46°59′E).



FIGURES 1–2. Habitus in dorsal view of *Anemadus sengleti* Giachino & Vailati (1, ♂, 2, ♀, both Deh Sheykh Cave).



FIGURES 3–4. Habitus in dorsal view of *Catops farsicus* Giachino & Vailati (3, ♂, 4, ♀, both Shapur Cave).

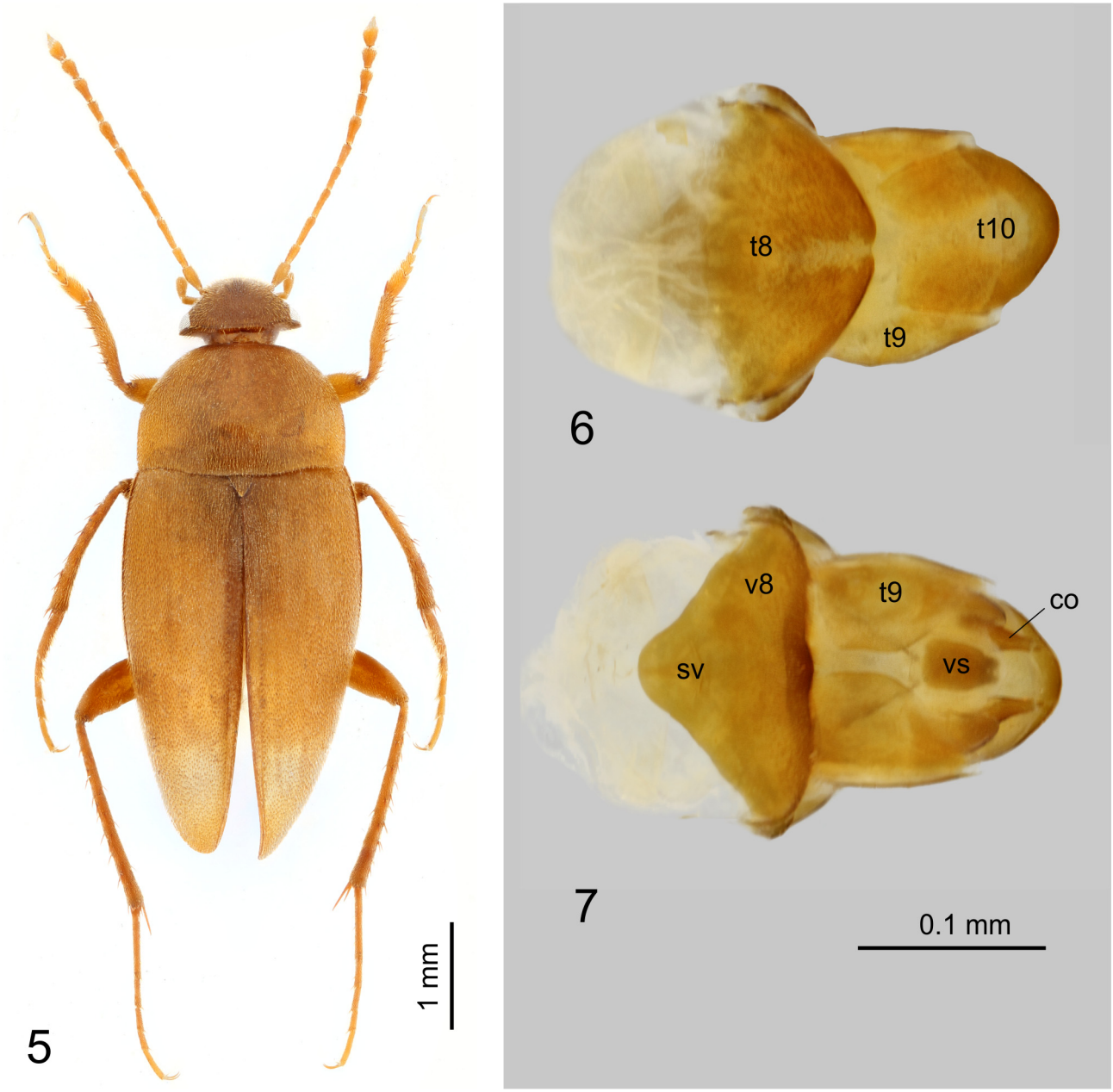
Material examined. Iran: Isfahan Province, Padena, Kohangan Village, Kohangan Cave, 30°53′31.9″N 51°38′54.1″E, 2196 m, 11.v.2016, M.S. Tahami & Y. Bakhshi leg., parahypogean habitat, 2 females (JRUC, ZM-CBSU); Kohgiluyeh and Boyer-Ahmad Province, Pataveh Village, Deh Sheykh Cave, 30°57′22″N 51°14′17″E, 1735 m, 17.x.2015, M.S. Tahami, Y. Bakhshi, M.J. Malek Hoseini & Z. Khazaei leg., parahypogean and hypogean habitats, 2 males, 2 females (JRUC, ZM-CBSU).

Supplementary description. Body length 3.7 mm in male, 3.5 mm in female. Body pale brown with dark brown head, completely pale brown in subteneral specimens (Figs. 1–2).

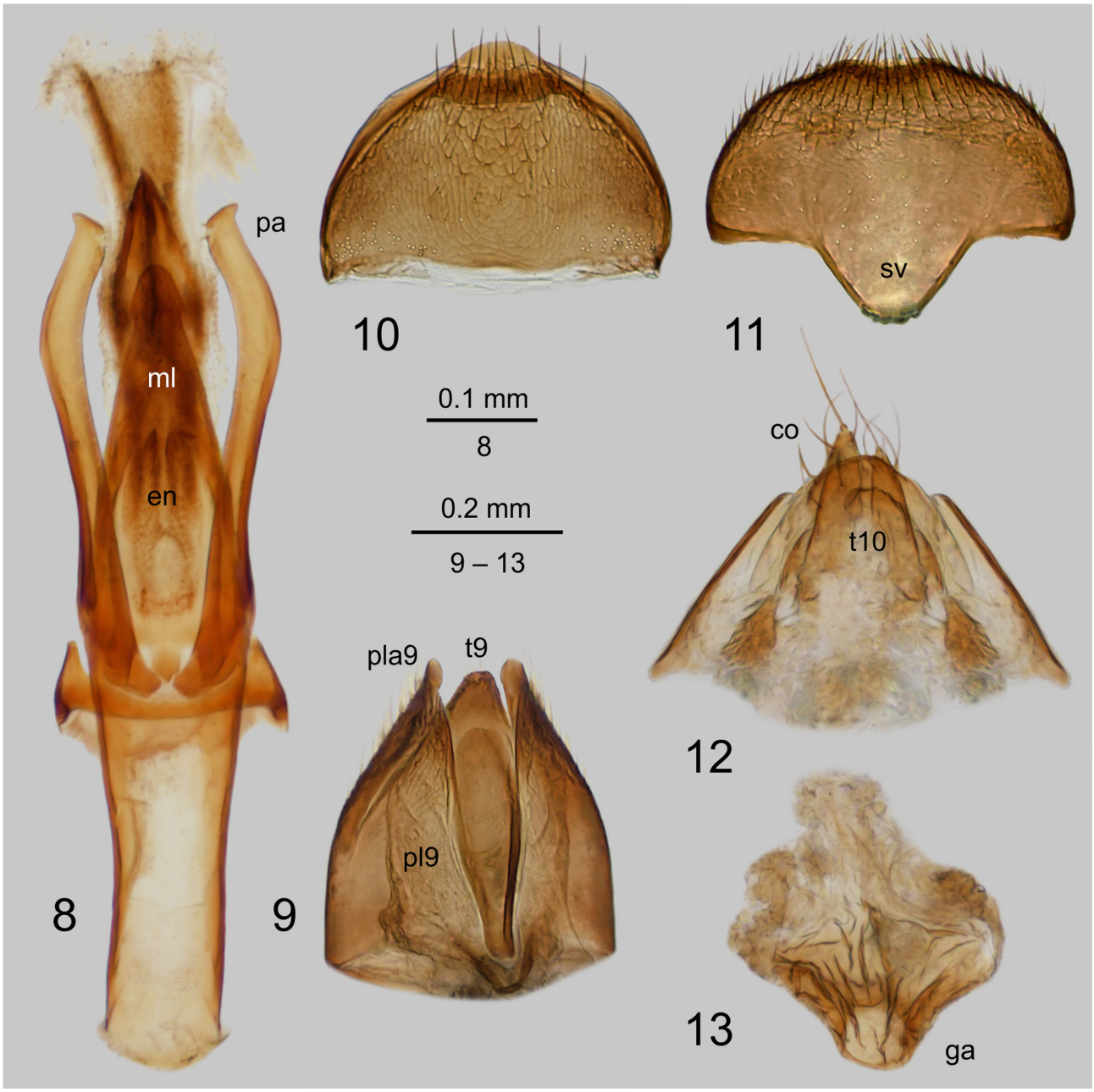
Male. Apex of elytra regularly rounded (Fig. 1). Tergum 9 of genital segment with apex narrow, regularly rounded (Fig. 9, t9). Pleurite 9 with narrow, regularly rounded apex in ventral view (Fig. 9, pla9). Aedeagus with

median lobe widely rounded, with subapical lateral constriction forming arrowhead-shaped apex in dorsal view (Giachino & Vailati 1993: 140, fig. 247; Fig. 8). Valves of genital orifice elongate, pointed apically (Fig. 8). Endophallus in examined specimen partly everted, with baso-medial sclerotized structures divided into two parts: a basal one, consisting of two parallel differentiated rows of strong spines and basal longer phanerae of undifferentiated spines, and a medial one, consisting of two parallel phanerae of undifferentiated spines (Giachino & Vailati 1993: 140, fig. 246; Fig. 8, en). Paramere significantly longer than aedeagus, with apex reversed outwards onto rounded points, with small apical outer seta and several inner setae (Fig. 8, pa).

Female. Apex of elytron pointed in female (Fig. 2). Tergite 8 regularly rounded, medially with rounded posterior elongation (Fig. 10). Ventrite 8 with posterior margin weakly, widely emarginate medially (Fig. 11), spiculum ventrale with convergent sides, widely triangular, anterior margin regularly rounded (Fig. 11, sv). Tergite 10 regularly rounded posteriorly, with setae of different sizes regularly dispersed in posterior part (Fig. 12, t10). Coxite with basal seta present (Fig. 12, co). Genital annulus small, its diameter less than 1/3 of the maximal width of tergite 10 (Fig. 13, ga).



FIGURES 5–7. Habitus in dorsal view of *Cholevinus pallidus pallidus* (Ménétries, 1832) (5, ♂, Kohangan Cave). Female genitalia of *Catops farsicus* Giachino & Vailati (6, dorsal view, 7, ventral view, Shapur Cave). Abbreviations: co—coxite, sv—spiculum ventrale, t8—tergite 8, t9—tergite 9, t10—tergite 10, v8—ventrite 8, vs—ventral sclerite.



FIGURES 8–13. Genitalia of *Anemadus sengleti* Giachino & Vailati (Deh Sheykh Cave). Aedeagus in dorsal view (8), male genital segment in ventral view (9), female tergite 8 in dorsal view (10), female ventrite 8 in ventral view (11), female genitalia in dorsal view (12), female genital annulus in dorsal view (13). Abbreviations: co—coxite, en—endophallus, ga—genital annulus, ml—median lobe, pa—paramere, pl9—pleurite 9, pla9—apex of pleurite 9, sv—spiculum ventrale, t10—tergite 10, t9—tergite 9.

Remarks. This species was described based on a single male from Iran, Lorestan, Dizgarân (Giachino & Vailati 1993, Perreau *et al.* 2017). It was classified as the only member of the *Anemadus sengleti* species group (Giachino & Vailati 1993, Perreau 2000). The combination of characters that separate this species from similar members of the *A. pellitus* species group include the unique shape of the aedeagus, with the median lobe having an arrowhead-shaped apex, and the absence of the central group of spines in the endophallus (species of the *A. pellitus* species group have the aedeagus narrowing to a simple, narrow apex of the median lobe, and the endophallus with a central group of large spines (Giachino & Vailati 1993)).

We have not examined the male holotype of *A. sengleti*, but the apex of aedeagus in material examined here (Fig. 8) corresponds well with the illustration of the same structure published in Giachino & Vailati (1993: 140, fig. 247).

Distribution. Endemic Iranian species (Fig. 18), first records from Isfahan and Kohgiluyeh and Boyer-Ahmad Provinces.

Catops farsicus Giachino & Vailati, 2000
(Figs 3, 4, 6–7, 14–17, 18)

Catops farsicus Giachino & Vailati, 2000: 157 (type locality: Iran, Fars, Shiraz, Deh Bava [ca. 29°57′N 51°56′E]).

Material examined. Iran: Chaharmahal and Bakhtiari Province: Farsan county, Baba Heidar Village, Sarab Cave, 32°18′13.9″N 50°24′27.5″E, 2377 m, 24.ix.2016, M.S. Tahami & Y. Bakhshi leg., parahypogean habitat, 1 female (ZM-CBSU); Lordegan county, Shahsavar Village, Shahsavar Cave, 31°37′59.4″N 50°29′55.5″E, 1197 m, 10.v.2016, M.S. Tahami, Y. Bakhshi & H. Darvishniya leg., endogean habitat, 1 female (ZM-CBSU); same data, parahypogean habitat, 1 female (ZM-CBSU); Isfahan Province: Padena, Dangezlu Village, Dangezlu Cave, 30°51′50.9″N 51°38′38.1″E, 2193 m, 11.v.2016, M.S. Tahami, Y. Bakhshi & H. Darvishniya leg., parahypogean habitat, 1 male, 1 female (JRUC, ZM-CBSU); Padena, Kohangan Village, Kohangan Cave, 30°53′31.9″N 51°38′54.1″E, 2196 m, 27.ix.2016, M.S. Tahami & Y. Bakhshi leg., endogean habitat, 1 male (ZM-CBSU); Fars Province: 25 km NNW of Kazerun, Bishapur env., Shapur Cave [ca. 29°48′12″N 51°36′41″E], 3.v.1996, David Král leg., 1 male, 1 female (JRUC), same data, 1 female (JVAC); Malousjan County, Malousjan Cave, 29°51′44.6″N 52°27′28.6″E, 1928 m, 12.iv.2016, M.S. Tahami, S. Sadeghi, E. Shaniti & N. Karimi leg., endogean habitat, 1 male (JRUC); same data, parahypogean habitat, 1 male (ZM-CBSU); Haft Barm, Cheshme Talou Cave, 29°50′19.4″N 52°01′38.7″E, 2136 m, 21.v.2016, M.S. Tahami, J. Muilwijk & R. Felix leg., parahypogean habitat, 1 male, 1 female (JRUC, ZM-CBSU); Kohgiluyeh and Boyer-Ahmad Province, 20 km SW Yasuj [ca. 30°32′N 51°26′E], 5.–6.v.2007, A. Anichtchenko leg., 1 male (JRUC).

Supplementary description. Body length 7.7–8.3 mm in males, 8.4–8.5 mm in females. Ratio of pronotum width/length is 1.60–1.63 in males, 1.59–1.70 in females. Ratio of elytra length/width is 1.3–1.4 in males, 1.4 in females. Body colour pale brown to light brown. Elytra with distinct, superficial striae, composed of large punctures (Figs. 3–4).

Male. Ventrites 3–7 without impressions in medial parts, posterior margin simply rounded. Ventrite 8 regularly rounded posteriorly, with wide, shallow medial emargination anteriorly. Genital segment wide, narrow laterally, short anteriorly (Fig. 16, gp). Spiculum gastrale short, distinctly sclerotized medially, bifid anteriorly (Fig. 16, sg). Aedeagus with median lobe compact, parallel laterally, regularly rounded in dorsolateral view (Figs. 14–15, ml). Apex of median lobe trapezoid in shape, almost straight laterally (only slightly sub-sinuate), with large, rounded lateral lobes and distinct, subrectangular median emargination (Fig. 17, ml). Valves of genital orifice straight, elongate, almost reaching the apical emargination of median lobe, apex narrowly rounded (Fig. 17). Endophallus with distinct, elongate medial sclerotization and with regular lateral row of large spines, more developed basally (Fig. 14), with heavily sclerotized, basal trilobed structure in dorsal view (Fig. 14) and apically with a single, large, median symmetrical spine in dorsal view (Fig. 17). Paramera short, slender, distinctly shorter than median lobe, with apical seta (Fig. 17, pa).

Female. Tergite 8 posteriorly regularly rounded, with median desclerotized region in dorsal view, posterior margin only weakly, narrowly emarginate medially, without apical denticle (Fig. 6, t8). Ventrite 8 triangular, transverse, posterior margin with small central bulb in ventral view (Fig. 7), spiculum ventrale widely rounded posteriorly in ventral view (Fig. 7, sv). Tergite 10 subpentagonal, broadly oval in dorsal view (Fig. 6, t10). Tergite 9 very broad, laterotergites only very narrowly separated in ventral view (Fig. 7, t9). Coxite robust, tubular in ventral view (Fig. 7, co). Ventral sclerite between coxites subrectangular, distinctly sclerotized (Fig. 7, vs).

Remarks. The species was described based on a single female from Iran, Fars Province, Shiraz, Deh Bava (Giachino & Vailati 2000, Perreau *et al.* 2017). Together with 10 additional species (eight of them being local endemics of Near East and Transcaucasia), it belongs to the *Catops picipes* species group (Perreau 2000, Giachino & Vailati 2000), which includes generally very large species, with body length over 6.5 mm (Giachino & Vailati 2000). *Catops farsicus* is probably the largest known species of *Catops* Paykull, 1798, with a body length reaching 7.7–8.5 mm.

The apex of the aedeagus of *C. farsicus* most closely resembles that of *C. kulzeri* Jeannel, 1936 from eastern Turkey—both species share an aedeagus with a trapezoid, only sub-sinuate lateral apex of the median lobe in

males, a distinct apical emargination and elongate valves of the genital orifice with a pointed or narrowly rounded apex (Giachino & Vailati 2000: 164, fig. 211; Fig. 17). In other related species of the *C. picipes* species group from the Near East, the apex of the aedeagus is more rounded laterally, apical emargination is v-shaped, and/or valves of genital orifice are shorter and apically truncate (Giachino & Vailati 2000: 164, figs. 212–215). Both species differs in body size and shape. The body length is generally greater in *C. farsicus*, 7.7–8.3 mm in males and 8.4–8.5 mm in females. The body length is smaller in *C. kulzeri*, 7.0–7.3 mm in males and 7.0–7.4 mm in females. The elytra are slightly more elongated in *C. farsicus* (ratio of elytral length/width is 1.3–1.4 in males, 1.4 in females), stouter in *C. kulzeri* (ratio of elytral length/width is 1.20–1.35 in males, 1.25–1.35 in females). In *C. farsicus*, the apex of aedeagus is more narrowly emarginated apically, and the valves of the genital orifice are slightly shorter and broader; the apical denticle of the endophallus is wide and shortly pointed (Fig. 17); *C. kulzeri* has the apex of aedeagus with a wider emargination apically, the valves of the genital orifice are more elongate and slender, and the apical denticle of the endophallus has a long, slender point (Giachino & Vailati 2000: 164, fig. 211).

FIGURES 14–17. Male genitalia of *Catops farsicus* Giachino & Vailati (Shapur Cave). Aedeagus in dorsal (14) and dorsolateral (15) views, genital segment in ventral view (16), apex of aedeagus in ventral view (17). Abbreviations: en—endophallus, gp—genital plate, ml—median lobe, pa—paramere, sg—spiculum gastrale.

We have not examined the female holotype of *C. farsicus*. Species identification is provided here based on extremely large size of examined specimens (corresponding with the size of the holotype, see above), and also on combination of the distinctly elongate elytra and the transverse pronotum (compare details provided above and illustrations on Figs. 3–4 and in Giachino & Vailati (2000: 159, fig. 209)). The type locality of *C. farsicus* (Giachino & Vailati 2000: 25, fig. 16) is located in the same area as the here examined material (Fig. 18). The only other species of *Catops picipes* species group known from Iran is *C. kurdicus* Giachino & Vailati, 2000, described from Kermanshah Province (Giachino & Vailati 2000: 25, fig. 16), ca. 350 km north-west from the known distribution of *C. farsicus*; also, its apex of aedeagus has valves of the genital orifice of different shape (Giachino & Vailati 2000: 164, fig. 212) from the here examined material (Fig. 17).

Occurrence in caves is also reported in Turkey for the related *Catops giganteus* Breit, 1913 and *C. arifensis* Giachino & Vailati, 2000; for some other species of this species group, no detailed ecological data are available (Giachino & Vailati 2000). All these species have developed flying wings and colonize subterranean habitats probably only as troglophiles.

Distribution. Endemic Iranian species (Fig. 18), first records from Chaharmahal and Bakhtiari, Isfahan and Kohgiluyeh and Boyer-Ahmad Provinces.

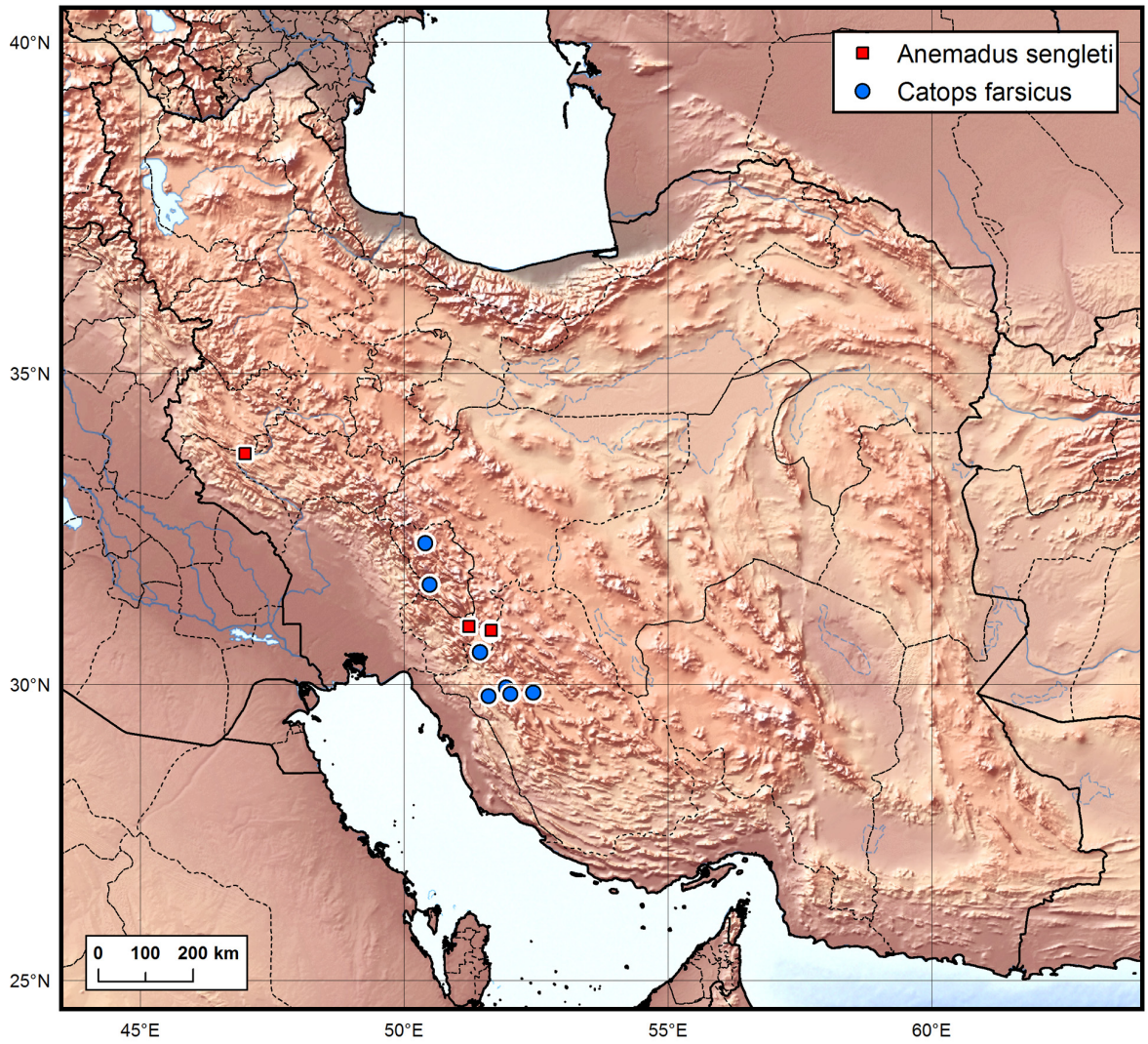


FIGURE 18. Known distribution of *Anemadus sengleti* (squares) and *Catops farsicus* (circles).

Cholevinus pallidus pallidus (Ménétries, 1832)

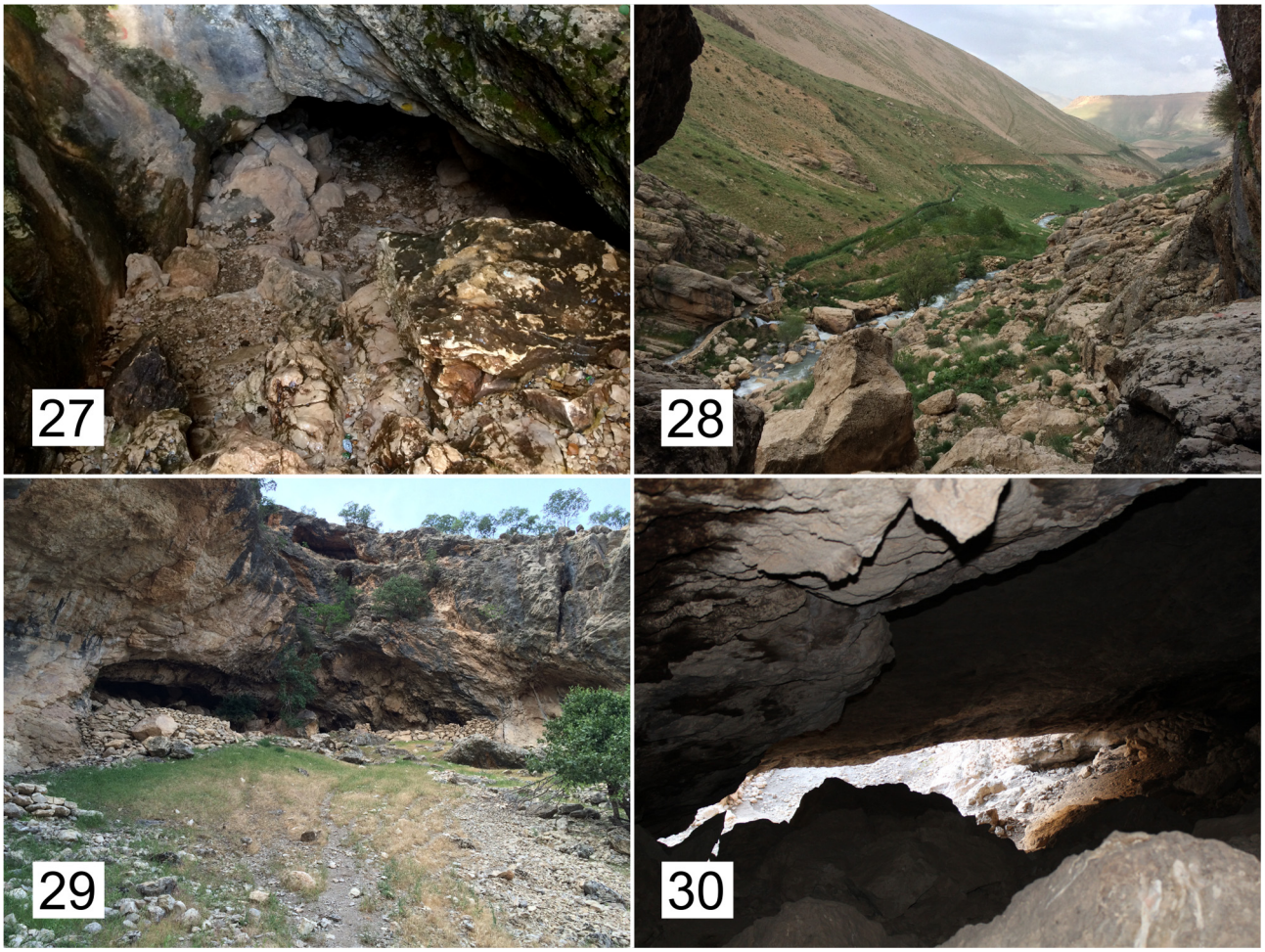
(Fig. 5)

Catops pallidus Ménétries, 1832: 169 (type locality: Bakou [= Baku, ca. 40°24′N 49°53′E]).

Material examined. Iran: Isfahan Province, Padena, Kohangan Village, Kohangan Cave, 30°53′31.9″N 51°38′54.1″E, 2196 m, 11.v.2016, M.S. Tahami & Y. Bakhshi leg., parahypogean habitat, 1 male, 1 female (JRUC, ZM-CBSU); North Khorasan Province, 30 km N Askhaneh, 8 km W Kalatah Chenar, 37°48′N 56°56′E, 810 m, 25.v.2006, A. Reiter leg., 2 males, 1 female (JRUC).

Distribution. Widely distributed species, the nominotypical subspecies is known from Afghanistan, Georgia, Iran, Iraq, Russia (Daghestan), Turkmenistan and Uzbekistan (Perreau 2015), generally showing an affinity with desert areas (Jeannel 1936). From Iran, reported twice (Perreau *et al.* 2017): from "Sargad" in Kerman Province (Jeannel 1936) and from "Luristan", i.e. Lorestan Province (Szymczakowski 1970). First records from Isfahan and North Khorasan Provinces of Iran.

FIGURES 19–26. Caves in Iran where Cholevinae were found. Deh Sheykh Cave (19), with record of *Anemadus sengleti*. Dangezlu Cave (20) with records of *Catops farsicus*, big pool inside. Entrance part of Kohangan Cave (21), man-made tunnel with records of *A. sengleti*, *C. farsicus* and *Cholevinus pallidus*. Chesme Talu Cave, with records of *C. farsicus* – wet internal part with fungi (22); entrance (with M.S. Tahami, J. Muilwijk & R. Felix standing) (23) and corridor (24). Malousjan Cave, with record of *C. farsicus*, entrance (25) and internal part (26).



FIGURES 27–30. Caves in Iran where Cholevinae were found. Sarab Cave, with records of *Catops farsicus*—entrance (27) and view from entrance (28). Shahsavar Cave, with record of *C. farsicus*—entrance (29) and internal part (30).

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