Zootaxa 1372: 35–52 (2006)
www.mapress.com/zootaxa/

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

1372

Gollumjapyx smeagol gen. n., sp. n., an enigmatic hypogean japygid (Diplura: Japygidae) from the eastern Iberian Peninsula

ALBERTO SENDRA[1]*, VICENTE M. ORTUÑO[2]*, AGUSTÍN MORENO[3], SERGIO MONTAGUD[1] & SANTIAGO TERUEL[1]

[1]*Museu Valencià d'Història Natural (Fundación Entomológica Torres Sala). Paseo de la Pechina 15. 46008 Valencia,Spain*

[2]*Departamento de Zoología y Antropología Física. Facultad de Biología. Universidad de Alcalá. E-28871 Alcalá de Henares, Madrid, Spain*

[3]*Fundación Escuela Municipal de Jadinería. Excmo. Ajuntament de València. Paseo de la Pechina 15. 46008 Valencia, Spain*

**Corresponding author. E-mail: alberto.sendra@uv.es; vicente.ortuno@uah.es*

Abstract

A new species of subterranean japygid dipluran belonging to a new genus is diagnosed and described from the eastern Iberian Peninsula. The new species is highly adapted to hypogean life with very obvious troglobiomorphic features: unpigmented cuticle, an extraordinary lengthening of thorax and appendixes, multiplication of antennomeres and supernumerary placoid sensilla, not just in the apical antennomere but also in the preceding antennomeres. These traits make it the most exceptional of all the hypogean Japygidae known to date, with troglobiomorphic characteristics more accentuated than in other hypogean taxa known in the rest of the world. The cercal armature of the *Burmjapyx* type (Silvestri, 1930; *sensu* Paclt, 1957) together with the characteristics of the glandular organs of the first urosternite set it apart from the known Japygidae. However, those characteristics prove insufficient to establish a relation with other genera. It is therefore the only manifestly hypogean japygid species in the Iberian Peninsula, where only *Metajapyx moroderi* Silvestri, was known in certain caves of the eastern reaches of the Prebetic range. The new species has been located inside six average-sized underground caves, generally in the deepest areas, and may be one of the major hypogean predators in the Iberian Peninsula, with a diet that ranges from Acari to Anillini carabids. Its distribution along the limestone regions of the coastal ranges in the east of the Peninsula coincides with that of paleo-endemic troglobites. Therefore, it is possible to infer a remote origin for this species, as suggested by its high level of specialization in the subterranean ecosystems.

Key words: Hexapoda, Entognatha, taxonomy, cave fauna, troglobiomorphism, *Burmjapyx*, *Metajapyx moroderi*, Arthropoda

Accepted by R. Dalgleish: 10 Oct. 2006; published: 4 Dec. 2006

Introduction

Several species of hypogean Hexapoda (Bellés, 1987, *inter alia*) can be found in the entomological literature of the Iberian Peninsula. Only one species of japygid Diplura, however, is to be found in caves: *Metajapyx moroderi* (Silvestri, 1929). Silvestri (1929) reviews this species at Meravelles cave from Alzira (Valencia, Spain) and later (Silvestri, 1934) gives a detailed description of specimens collected in Meravelles and in neighbouring Buscarrón cave from Llombai (Valencia, Spain). More recently, Pagés (1964) provided new data on the presence of *M. moroderi* in Sant Joan cave from Pego (Alicante, Spain).

Over 25 years ago, members of the Barcelona Zoology Museum (Spain) collected a large japygid Diplura at Santa cave from Serra d'en Galceran (Castellón, Spain). Ten years ago two new specimens were collected in Serenge'pit and Mas de la Cova'pit, two adjacent caves in Cabanes (Castellón, Spain), and were deposited at the National Museum of Natural Sciences (Madrid, Spain). Five years ago, a new specimen was collected in a Canals pit from Ulldecona (Tarragona, Spain), and was deposited in the collection of the Barcelona Zoology Museum (Spain). In 2004–2005, a team of entomologists from the Valencia Natural History Museum (Spain) embarked on a thorough exploration of several caves around the limestone areas in "la Plana Alta" and "el Baix Maestrat", Castellón (Spain). As a result of this sampling effort four additional specimens of this enigmatic Diplura were collected. Finally, thanks to the kindness of our colleague Jordi Comas, the typical series comprising all the aforementioned specimens is increased by two, to a total number of 10.

The discovery of this enigmatic hypogean japygid from the eastern Iberian Peninsula is exceptional within the Japygidae, owing to its extraordinary troglobiomorphic traits. Only five species of Japygidae are known that present obvious adaptations to the subterranean ecosystems (Pagés, 1964, 1980; Muegge, 1992): *Metajapyx moroderi patrizianus* Pagés, 1953 from San Giovanni' cave (Sardinia, Italy), *Kohjapyx lindbergi* Pagés, 1962 from the Dahan-Ghar cave (Afghanistan), *Austrjapyx leleupi* Pagés, 1952 from the MBoma cave (Democratic Republic of the Congo), *Troglojapyx hauseri* Pagés, 1980 from a cave in Koutouki (Attica, Greece) and *Mixojapyx reddelli* Muegge, 1992 from six caves in Texas (USA).

Materials and methods

Specimens of the new species described here and of *Metajapyx moroderi* have been examined. Regarding *M. moroderi*, the examined material includes two forms with differences in body size, which occupy different habitats. These differences in size and habitat have never been described in any other japygid species. The epigean form is smaller in size (6–8 mm long) and the hypogean one is considerably larger (8–14 mm long).

Specimens of the epigean form of *M. moroderi:* 1 ♂, Ebo riverbed, La Vall d'Ebo (Alicante, Spain); 7-XII-2000; under a pebble; A. Sendra leg. 1♂, 2 ♀♀, Rugat (Valencia, Spain); 8-XII-2000; clayey soil in an orchard; A. Sendra leg. 1 ♀, Rótova (Valencia, Spain); 1-XI-2002; S. Teruel leg. 1 ♂, 1 ♀ and 2 young specimens, Pinos, Bernia range (Alicante); 5-II-2004; soil at the bottom of a ravine; V.M. Ortuño leg. 1 ♂, 1 ♀♀, Aitana range, 1,200 metres above sea level (Alicante, Spain); 24-V-2004; endogean environment; V.M. Ortuño leg. 1 ♂, Xaló (Alicante, Spain); 7-II-2004; V.M. Ortuño leg. 1 ♂, Castell de Castells (Alicante, Spain); 4-II-2004; soil at the bottom of a ravine; V.M. Ortuño leg.

Specimens of the hypogean form of *M. moroderi*: 1 ♀, Xurra cave from Gandia (Valencia, Spain); 19-I-2003; on the clayey surface in the deepest part of the cave; S. Teruel leg. 1 sex ?, Pinta Misteriosa cave from Callosa d'Ensarriá (Alicante, Spain); 30-V-1976; J. Comas and O. Escolà leg. 1 ♀, Somo cave from Castell de Castells (Alicante, Spain); 3-V-2003; V.M. Ortuño and J.A. Zaragoza leg.

Most specimens were washed in distilled water and prepared for microscopic examination with slides and glass coverslip, using either Marc André II's solution or glycerine; the preparation was then rehydrated and the specimens placed into 70% ethanol for storage.

A Wild M3Z stereomicroscope and a phase-contrast optical microscope (Leica DMLS) were used for microscopic examination of the specimens. Illustrations were made with a drawing tube. Two antennae and the abdominal terminal segments from two specimens were prepared for scanning electron microscopy (HITACHI S-4100), after drying at critical point with CO_2 and cover by palladium-gold.

The taxonomic descriptions, abbreviations and indexes used in this text follow the works of Pagés (1953) and Pagés & Schowing (1958).

Gollumjapyx Sendra & Ortuño *gen. nov.*

Etymology: The name of this genus comes from joining the prefix *Gollum* to the suffix *Japyx*. *Gollum* is the mythological character created by J.R.R. Tolkien, the dweller of the caves located below the Misty Mountains of Middle-earth.

Description: Body elongate and restricted dorso-ventrally, unpigmented cuticle; legs, thoracic segments and urite X extremely elongate (Figs 1 and 2a).

Head. 53 to 55 antennomeres per antennae, manifesting 13 typical trichobothria (*a* clearly distal); 14 to 16 placoid sensilla over apical antonnomere, scattered in 2 groups and with at least one or two supernumerary placoid sensilla over the penultimate antennomere (Figs 3a, b). Buccal pieces typical from this family with all five laminae pectinate of the maxillae.

Thorax. Exceptionally elongate. Pronotum 6+6 M (5+5 M typical plus 1+1 M postero-lateral) (Fig. 4c). Mesonotum 5+5 M typical (Fig. 4d). Metanotum 4+4 M (M2 absents) (Fig. 4e). Legs very elongate.

Abdomen. Tergite I: 0+0 M. Tergite II: 1+1 M. Tergites III–VII: 5+5 M and 1+1 m_3 (Fig. 5a). Tergite X with carinae distinct of subparallel margins with 4+4 M intracarinae (D) and 5+5 M carenae (L) (Fig. 3c and 5b). Urosternite I: 22+22 M (Fig. 6a). Urosternite II-VII: 28+28 M. Simple lateral subcoxal organs showing one or two rows of very short subequal glandular setae and a row of sensory setae (Fig. 6b). Median glandular organ with no apparent operculum and no pseudospori (Fig. 6a). Styli and exsertile vesicles typical of this family.

Cerci. (Fig 3c, d and 5b). Very protracted and robust with strongly sclerotized angles; slightly longer (in young specimens) or shorter (in adults) than the usually uncovered part of tergite X. Right cercus with a row of tubercles and simple denticles, with a strong sharp tooth clearly proximal; left cercus with double row of tubercles and postmedial tooth.

Affinities: *Gollumjapyx* **gen. n.** shares certain affinities with the controversial genus *Burmjapyx* Silvestri, 1930. Since its description, the taxonomy of the *Burmajapyx* genus has undergone several difficulties. Paclt (1957) groups as *Burmjapyx* nine genera sharing the same model of cercal armature, a few of them have well defined characteristics and geographical distribution (Silvestri, 1948), such as: *Protjapyx* Silvestri, 1948 and some species of genus *Megajapyx* (Verhoeff, 1904), scattered around the Mediterranean region; *Hapljapyx* Silvestri, 1949 and *Merojapyx* Silvestri, 1948 , found in the Neotropical region; *Austrajapyx* Silvestri, 1949, whose species range from the Neotropical region to the Ethiopean; *Xenjapyx* Silvestri, 1949, exclusive to the Ethiopean and, *Henicjapyx* Silvestri, 1949 from the Eastern region. Paclt (1957) grouped all the above with the true *Burmjapyx* and also included in this group some twenty more species, many of which belong to the heterogeneous genus *Japyx* Haliday, 1864. Pagés (1961, 1977, 1994, 2000) has repeatedly noted the artificiality of *Burmjapyx sensu* Paclt (1957), providing enough taxonomic evidence to return *Burmjapyx* to its initial taxonomic position.

Gollumjapyx shares several features with the *Burmjapyx* s. str., particularly in the cercal armature and, to a lesser extent, also in the antennal supernumerary placoid sensilla, which are similar in distribution and number (in some specimens) to those described by Pagés (1977) for *Burmjapyx inferus* (Carpenter, 1932) found at Batu Caves (Malaysia). However, *Gollumjapyx* does not show a median glandular organ with setae-shaped sensilla (Silvestri's "pseudospori"). In the new taxon, these sensilla appear on both sides of the central area. One more difference should be noted: a lack of setae with large setal socket preceding the glandular setae of the subcoxal organs, which are clearly recognisable in *Burmjapyx.*

Among the species of *Japyx* included by Paclt (1957) in *Burmjapyx* only *Japyx goliath* (Parona, 1888) from Guatemala, described again later by Silvestri (1928), manifests affinities with the new taxon. Although the type material is unknown -almost certainly disappeared-, from Silvestri's (1928) text and illustrations a few similarities with *Gollumjapyx* can be observed, for instance in the number of antennomeres, the robustness

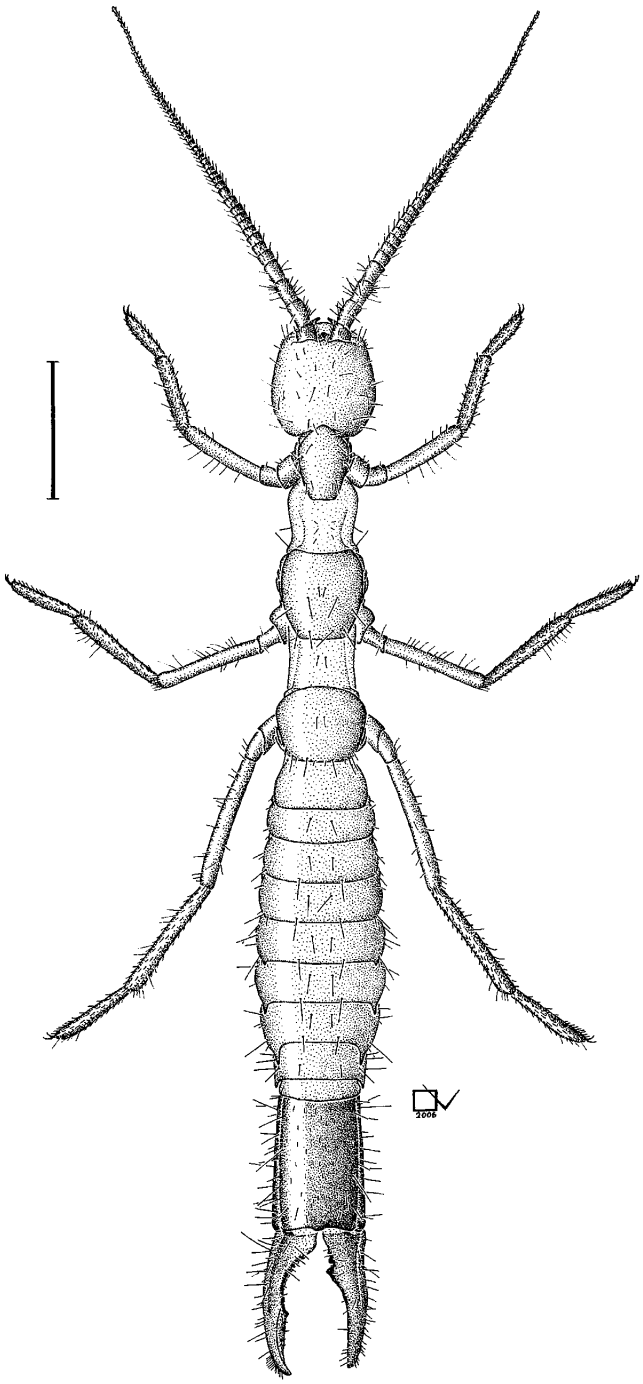

FIGURE 1. Habitus of *Gollumjapyx smeagol* Sendra & Ortuño **sp. n.** (scale: 3 mm).

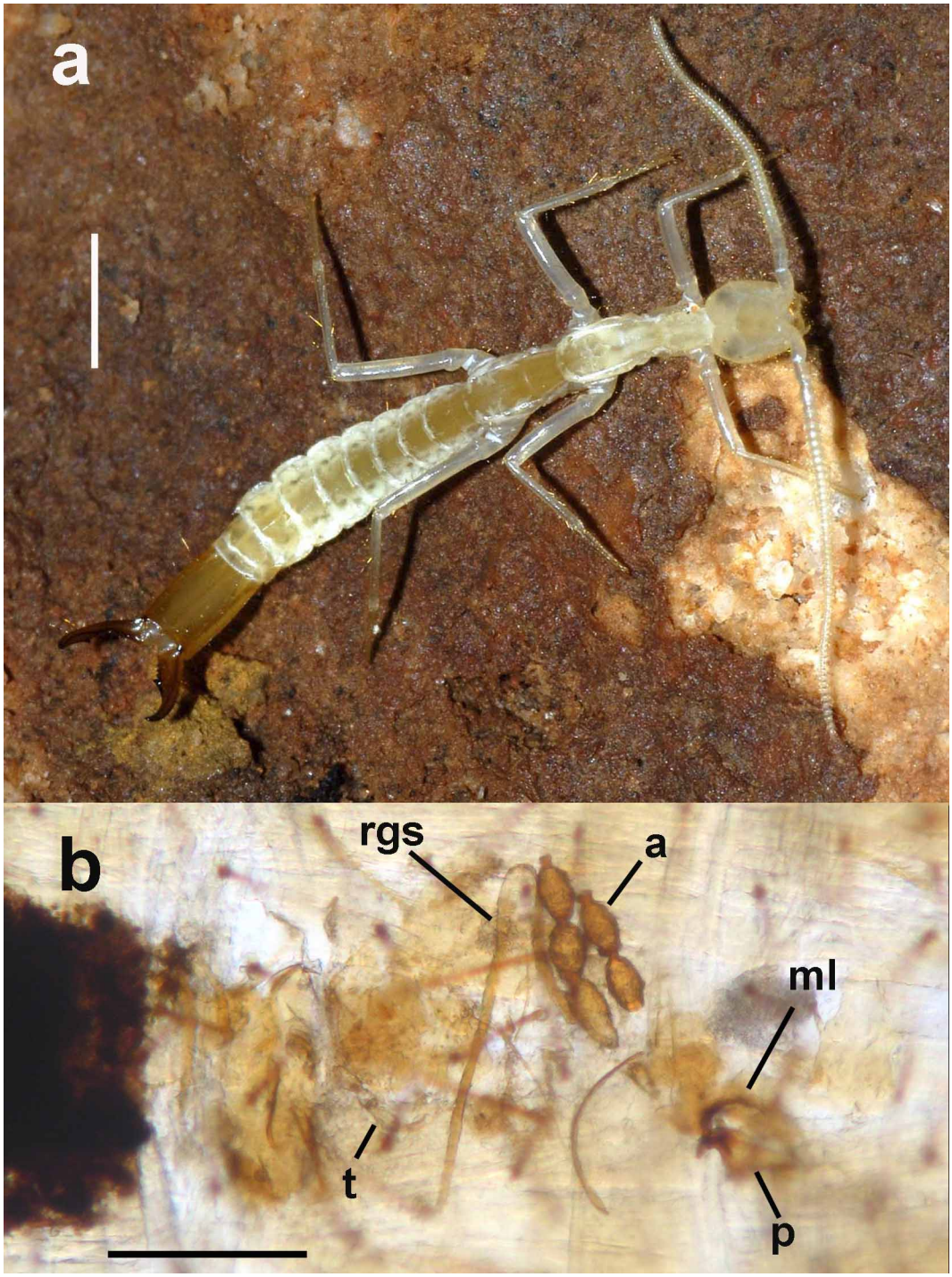

FIGURE 2. a. *Gollumjapyx smeagol* Sendra & Ortuño **sp. n.**, Avenc d'en Serenge cave from Cabanes, Castellón (Spain); b. detail of the contents from the digestive tract belonging to a specimen from Avenc d'en Serenge; all the fragments belong to a male of *Speleotyphlus aurouxi* (Carabidae, Anillini). Terms: a, antennomeres; rgs, ring of the genital segment; ml, median lobe; p, paramere; t, tarsomeres. (scales, a: 3 mm, b: 0.3 mm).

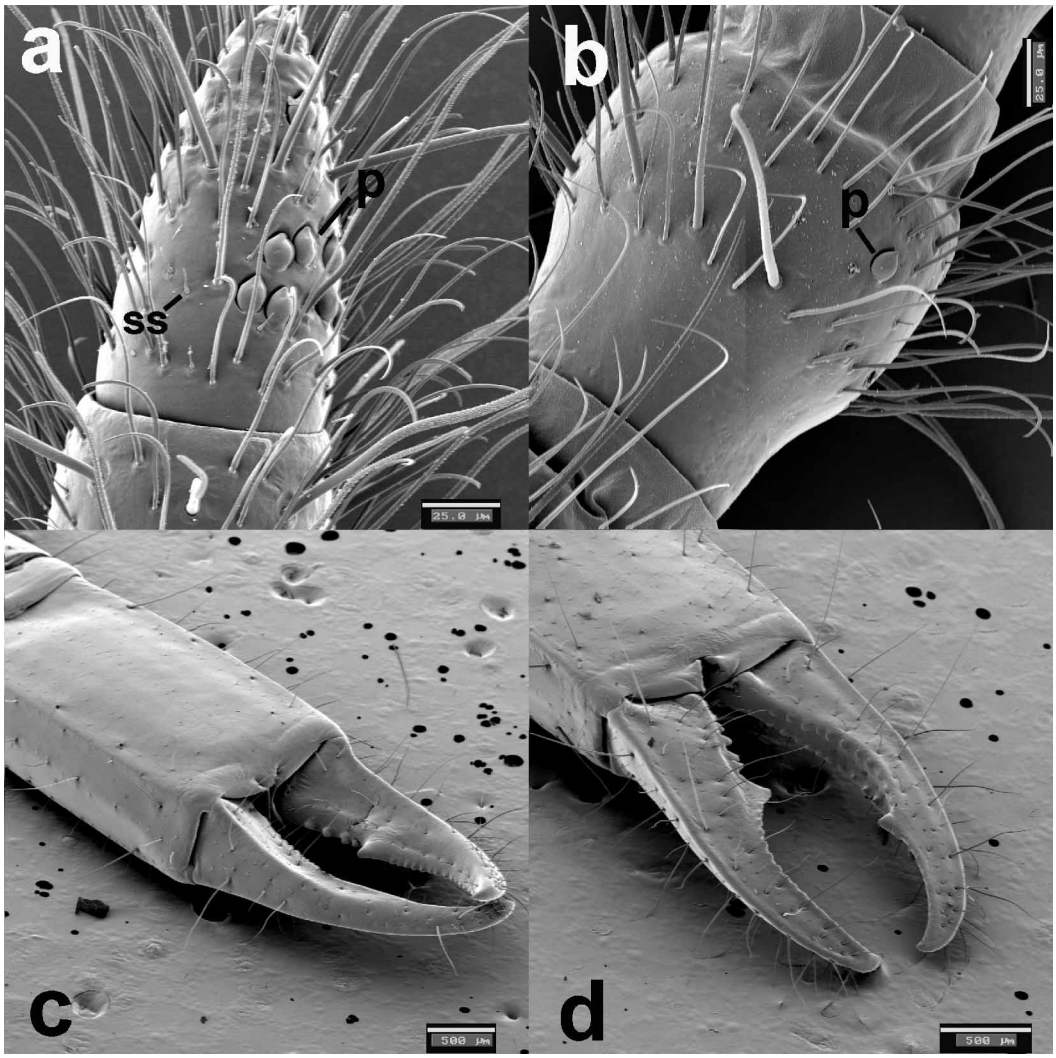

FIGURE 3. Scanning electron microscope photography of *Gollumjapyx smeagol* Sendra & Ortuño **sp. n.**. a. apical antennomere; b. XXXV antennomere; c. urite X and cerci, dorsal view; d. urite X and cerci, ventral view. Terms: p, placoid sensilla; ss, short sensilla. (scales, a and b: 25 µm; c and d: 500 µm).

of the cercal armature and the morphology of the glandular organs in the first urosternite. In the future, with new specimens, the true meaning of these affinities could be resolved. The general lengthening of the body, thorax and legs in particular, is so extraordinary as to distinguish *Gollumjapyx* from other known genera of the Japygidae family. This troglobite appearance with such elongate body can only be compared to the description of two hypogean species, *Troglojapyx hauseri* and *Mixojapyx reddelli* (Muegge, 1992; Pagés, 1980); nevertheless *Gollumjapyx smeagol* shows a greater thinning of the body, more

noticeable in the thoracic prescutum and legs. These traits suggest an adaptation of this new taxon to hypogeous life, as can be ascertained by the fact that they have been collected exclusively in caves.

Type-species: *Gollumjapyx smeagol* **sp. n.** Sendra & Ortuño

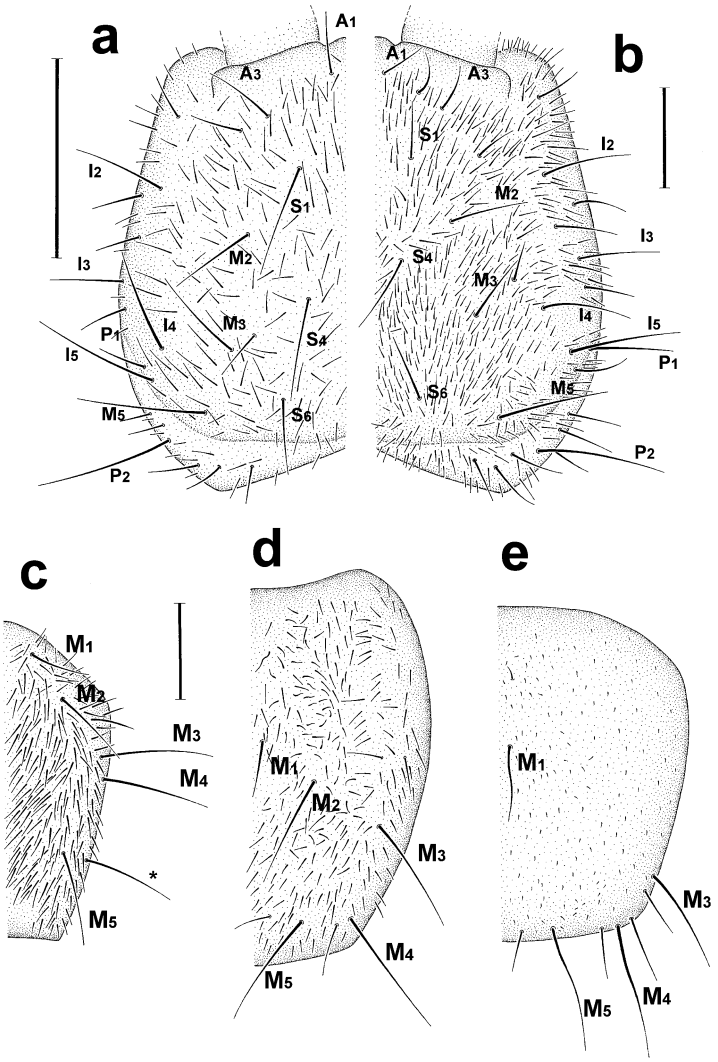

FIGURE 4. *Gollumjapyx smeagol* Sendra & Ortuño **sp. n.**. a. Vertex, young specimen from Avenc Mas Nou; b. Vertex, holotype; c. Pronotum, holotype; d. Mesonotum, holotype; e. Metanotum, holotype. Terms: A, S, V, M, I, P groups of large setae in vertex; M, macrochaeta thoracic. (scales: 1 mm).

Gollumjapyx smeagol Sendra & Ortuño sp. nov.

Holotype: ♀ 23.40 mm (cerci inclusive) nº 0815, Castellón, Serra d'en Galceran, "Cova del Mas de Gaspar" cave; 26-V-1980; J. Comas & O. Escolà leg.; preserved in ethanol 70º

+ glycerine and deposited at the Barcelona Zoology Museum (Spain).

Paratypes: 1 ♀, Tarragona, Ulldecona, "Avenc Canals" pit; 11-III-2000; F. Fadrique leg. 1 ♀, Castellón, Cabanes, "Avenc d'en Serenge" pit; 14-III-1982; J. Comas leg. 1 sex ?, idem; 12-XI-1995; E. Carabajal leg. 1 ♂, idem; 19-VII-2003; S. Montagud leg. 2 sex ?, idem; 26-II-2006; S. Montagud & A. Sendra leg. 1 ♂, Castellón, Cabanes, "Avenc Mas de la Cova" pit; 22-VII-1995; E. Carabajal leg. 1 ♂, Castellón, Coves de Vinromá, "Avenc Mas Nou" pit; 12.III.2005; S. Teruel leg. 1 sex ?, Castellón, Sant Mateu, "Cova dels Encenalls" cave; 9-III-2006; J. Comas leg. Preserved in ethanol 70º or 96º and deposited at: Muséum d'Histoire Naturelle Genève, Switzerland; National Museum of Natural Sciences, Madrid, Spain; Barcelona Zoology Museum (Spain) and Valencia Natural History Museum (Spain) — Fundación Entomolólogica Torres Sala-.
Total paratypes: 9 specimens; 3 ♂ ♂, 2 ♀ ♀ and 4 sex ?.

***Etymology*:** the specific epithet refers to Gollum's original name, who, in his epigean origin, was a hobbit named Smeagol.

DNA barcode: A nucleotide sequence of the 5' half of the cytochrome c oxydase subunit I (cox1) has been deposited in Genbank with accession number DQ993154.

TABLE 1. Length (in mm) of the body, appendixes and number of antennomeres found in the holotype and paratypes of *Gollumjapyx smeagol* Sendra & Ortuño **sp. nov.**

	Body*	Cerci**	Antennae**	Antennomeres**	Legs III**
♀, Avenc Canals	21.20	2.90	8.20	53	9.75
♀, holotype	20.15	3.25	9.00	54	9.79
♂, Avenc del Mas de la Cova	19.40	2.20	broken	-	broken
♀, Avenc d'en Serenge	17.00	2.40	8.8	55	8.75
sex?, Avenc d'en Serenge	16.40	2.20	8.50	54	8.66
sex?, Cova dels Encenalls	16.00	1.95	7.20	53	7.30
sex?, Avenc d'en Serenge	14.80	2.10	8.30	54	7.62
sex?, Avenc d'en Serenge	broken and not complete	-	8.05	55	-
♂, Avenc Mas Nou	13.26	1.50	7.40	53	4.81
♂, Avenc d'en Serenge	12.00	1.17	6.75	54	4.76

* Length body without cerci .

** Measurements taken of the two appendixes from the same specimen, although only the longest is recorded. In the case of two intact antennae from the same specimen, only the antennae with the most antennomeres is recorded.

Description: Long body, maximum and minimum body length (excluding cerci) from 21.20 to 12.00 mm. Other lengths described in Table 1. All three thoracic segments show a remarkable lengthening more obvious in mesothoracic and metathoracic prescutum.

Almost totally unpigmented cuticle. More or less apparent sclerotization of buccal pieces, anterior margin of head, claws and a large portion of urite X, becoming particularly evident in cerci. Abdominal segments clearly show a lateral expansion in the tergi, increasingly apparent from segment I to VII (Fig. 1 and 2 a). Ordinary setae noticeable on head, pronotum and mesonotum, more abundant in larger specimens. These ordinary setae are shorter in the mesonotum, becoming even shorter and sparse in the metanotum and in the abdominal sclerites (Fig. 4).

Head. Antennae with 53 to 55 antennomeres, measuring around half of body length (Table 1); 13 typical trichobothria on antennomeres IV–VI (1 ventral and 2 dorsal in IV), *a* clearly distal; all antennomeres generally pilose (Fig. 3b); antennomeres II to IV are largest and from antennomere V tapering to penultimate antennomere; pilose patches dense with long, robust setae, arranged in two whorls in proximal antennomeres, tapering to one whorl in distal antennomeres. These long and robust setae are accompanied by many thin setae, clearly shorter, covering almost all of each antennomere. Joining the pilose patch are many long, fine and hooked setae-shaped sensilla and also a few fine and short sensilla (Fig. 3a). Placoid sensilla of apical antennomere 14 to 16 in number, in two random groups (Fig. 3a). One or two placoid sensilla in the penultimate antennomere in some of the studied specimens. In three of the specimens from "Avenc d'en Serenge" placoid sensilla appear from antennomere XI or XII, ventrally and the next antennomeres show 0, 1 or 2 placoid sensilla (Fig. 3b).

Simple vertex setae increase noticeably the larger the body size of the specimen (Fig. 4a, b). However, the number and pattern of the large setae does not vary in the specimens under study. A comparison with the pattern of large setae proposed by Pagés (1984) in the case of *Indjapyx uvaianus* Pagés, 1984 proved complex; nonetheless the setae have been numbered, comparing their pattern of distribution. Out of 40 large setae proposed for *I. uvaianus* distributed in seven groups (A, S, V, M, I, L y P), only 14 seem to appear in *G. smeagol* (Fig. 4a).

Buccal pieces are consistent with the family: five laminae of the internal lobe of the maxilae with all five laminae pectinate; labial palpi 3.70 times longer than wide at base (423 μm holotype) covered with long setae; submentum with 1+1 large setae (almost equivalent to real macrosetae), postmentum with 1+1 large setae in the internal margin of the labial palpus; admentum with some large setae of which 2+2 are more noticeable; prementum (external lobe) with many setae among which a dozen small short setae. All large setae are longer than the labial palpus.

Thorax. Extremely elongate (Fig. 1 and 2a). Pronotum (Fig. 4c): typical 5+5 M and 1+1 M posterior lateral. Ordinary setae abundant, increasing relative to body length. Mesonotum (Fig. 4d): prescutum with few setae longer than ordinary (0+1 M in the paratype from "Avenc Canals"); scutum with 5+5 M (M1 and M2 in more posterior position, M1 even shorter than half of those remaining); with ordinary setae but less abundant than in the pronotum. Metanotum (Fig. 4e): Prescutum with 1+1 M or 0+1 M

(male from "Avenc Mas de la Cova" lacking M); scutum with 4+4 M (M2 absent; M1 shorter than those remaining); ordinary setae very short and abundant.

Exceptionally long legs. The end of metathoracic pretarsus exceeds half of urite X. Length (units in mm) of the metathoracic leg of the holotype (total length 9.79 mm): coxa (0.95), trochanter (0.60), femur (2.85), tibia (3.06), tarsus (1.92) and pretarsus (0.41). The tibia is the longest segment in the legs. In all specimens examined legs length is either equal or inferior to half the total length of the body (Table 1). Femur with short ordinary setae; femur and tibia with dozens of large setae; tarsus with 16–18 spiniform setae scattered in two ventral rows; well developed claws, posterior 1.2 times longer than anterior (holotype).

Abdomen. Tergite I. Prescutum and scutum: 0+0 M. Tergite II: 1+1 M (ma=M). Tergites III–VII (Fig. 5a): 5+5 M and 1+1 m_3 (ma=M, M_1 absent). Tergite VIII (Fig. 5a) nearly 2.30 times wider than long, 5+5 M (2+2 anterolateral, 2+2 posterolateral and 1+1 consistent with M_5). Tergite IX (Fig. 5a) around 3.30 times wider than long, M absent but with 4+4 M in the paratype from "Avenc Canals".

Urite X (Fig. 3c and 5b) nearly 1.60 longer than wide, distinctly marked carinae with subparallel margins, 4+4 M intracarinal (D) (3+3 M lateral and 1+1 M posterior) in both small and large specimens, although larger specimens show 3+3 large setae on both sides preceding posterior macrosetae; 5+5 M carinae (L).

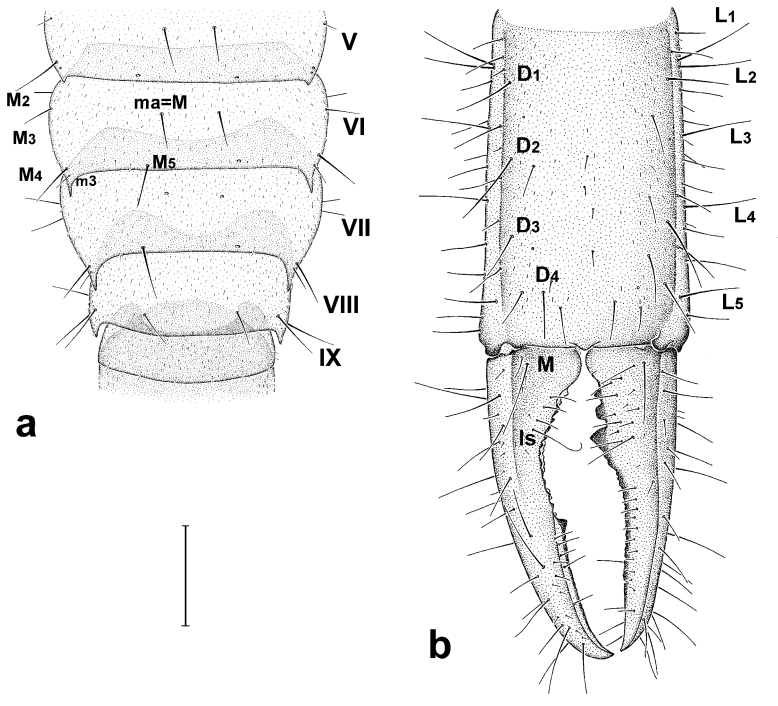

FIGURE 5. *Gollumjapyx smeagol* Sendra & Ortuño **sp. n.**, holotype. a. Tergites V to IX; b. Urite X and cerci, dorsal view. Term: M, macrochaeta; m, microchaeta; ls, large setae. (scale: 1 mm).

Very short ordinary setae, practically absent from the first tergites and progressively more abundant from tergite V.

Acropygium triangular, slightly protruding, rounded (Fig. 3c and 5b).

Tergites I–IV showing posterolateral angles either blunt or slightly rounded; angles found in tergite V are more conspicuous due to a small lobiform projection (Fig. 5a); tergites VI and VII show this projection more manifestly, although they are not visibly sclerotized (Fig. 5a); tergite VIII maintains this angular lobe but shorter than the two preceding ones; finally, the posterior angle of tergite IX lacks the aforementioned projection (Fig. 5a).

Relative lengths of segments VI–X (Fig. 5): 28–28–33–20–100.

Sternite I (Fig. 6a): Prescutum 5+5 M; scutum: 22+22 M and other 7–9+7–9 large setae consistent with true macrosetae; sternite totally covered with short ordinary setae, increasing in posteriorly and with longer and more robust setae scattered in two or three rows at the front of the lateral subcoxal organs (between 80 in the male specimen from "Avenc Mas de la Cova" and 60 in the female specimen from "Avenc Canals"). Subcoxal organs appear either invaginated below the posterior margin of sternite I or evaginated outwards, protruding over the margin of the urosternite (Fig. 6).

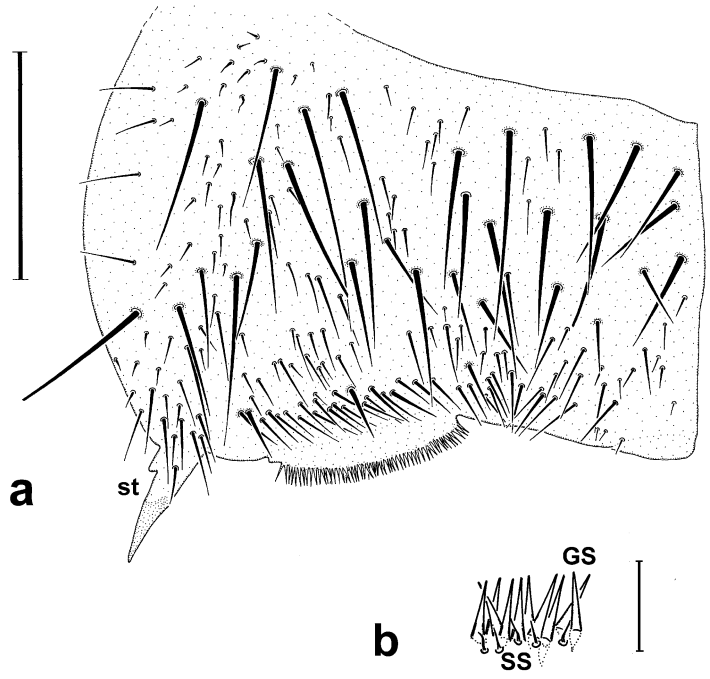

FIGURE 6. *Gollumjapyx smeagol* Sendra & Ortuño **sp. n.**, paratype female from Avenc Canals pit. a. urosternite I; b. Details of sensory and glandular setae of lateral subcoxal organ. Terms: st, styli; GS, glandular setae; SS, sensory setae. (scales, a: 0.5 mm; b: 0.05 mm).

The rows of setae on the subcoxal organs (Fig 6b) represent between 1/5 to 1/3 of interstyle width (0.19–0.27 in females and 0.25–0.57 in males and 0.31 in a specimen of unknown sex from "Avenc d'en Serenge"). About 65 short glandular setae in the male from "Avenc del Mas de la Cova", set in 1 or 2 rows, GS/st1= 0.14; nearly 80 glandular setae, equally short, in the female from "Avenc Canals", in 2 rows, GS/st1= 0.13; 25–28 sensory setae, SS/st1= 0.10 in the male and 35–38 sensory setae, SS/st1= 0.10 in the female.

Both visible median glandular organ and central setae-shaped sensilla missing. These sensilla appear in 4–8+4–8 in the internal side of the subcoxal organs (Fig. 6a).

Urosternites II–VII: 28+28 M, although missing some typical macrosetae (C2, C8, C10). Urosternite VIII: 12+12 M, in the largest specimens and 7+7 M in the smallest. Paratergite VIII: 1 M subposterior.

Elongate styli with sharp sclerotized points: s_1/s_7= 0.44–0.94; st_1/st_7= 0.59–0.76; s_1/st_7= 0.24–0.46; s_1/st_7= 0.26–0.59.

Male genital papillae could not be examined in the largest specimen from "Avenc Mas de la Cova"; however, genital appendices are wholly membranous and cylindrical-conic. No ventral glandular fossae have been found in males.

Cerci. (Fig. 3c, d and 5b). Large, at first slightly curved, becoming more curved towards the extreme, pointed. Length ranges from 3.25 mm in holotype to 1.17 mm in the smallest specimen; the relative size of the cercus increases larger in larger specimens (Table 1). In all specimens the length of the right cercus is slightly inferior to that of the left (0.95 to 0.97). Cerci slightly longer than the normally uncovered part of urite X in smaller specimens, but shorter in the larger specimens. Both cerci heavily sclerotized, in particular both external and internal margins and also in the dorsal carinae projecting from the acetabula, running the length of the right cercus and halfway on the left.

Right cercus. Triangular tooth, very strong, distinctly proximal, r_d= 0.40–0.65 (♀♀), 0.57–0.58 (♂♂); width of cercus at tooth level equals that of base; predental margin with 2 to 4 strong tubercles and very prominent in larger specimens, wherein 1 or 2 appear to be bitubercles; in smaller specimens tubercles are simple and smaller. Postdental arista is slightly concave, surrounded by tiny rounded denticles, tapering in size extremely even to the point of disappearance.

Left cercus. Sharp postmedian tooth, r_g= 1.14–1.60 (♀), 1.33–1.51 (♂); width of cercus at tooth level slightly larger or equal to half the base of the appendix; concave predental arista with 8–12/11–15 sharp/rounded tubercles; postdental arista slightly concave with very small denticles or showing a smooth surface in the smallest specimens.

Chaetotaxy: in dorsal view, the inside margin of both cerci has anterolateral M and a large setae, at tooth level, in the right cercus. The outside margins of both cerci support a dozen large setae each.

Comments. During this study, our colleague at the University of Murcia, José Luis Lencina, gave us a large japygid specimen (body length 22.6 mm, including cerci),

displaying troglobiomorphic features. Both the cercal armature and the lengthening of thorax and legs in this specimen show a strong resemblance to *Gollumjapyx smeagol*; its poor state of conservation, however, made it impossible to conduct a thorough study that could have confirmed or denied its inclusion in the species described in the present article.

Here follow the collection data: 1 ♀, Comunidad de Murcia, Murcia, Jumilla, "Cueva del Pozo"; 8-XII-1992; Grupo espeleológico Hinneni leg. (deposited at the Valencia Natural History Museum, Spain). Pozo cave (Jumilla, Murcia, Spain) is a fossil cave, more than 1 km in length and some 50 metres deep, located at an altitude of 498 metres, open in limestone and dolomites from the upper cretaceous at the Rajica de En Medio range, in the southern Prebetic mountain range. The specimen was collected 200 metres into the entrance, on damp clayey soil (despite low humidity), at a mean temperature of 26ºC, higher than expected according to the annual average for this locality (unpublished data, forwarded by the Hinneni Group).

Distribution, habitat and biology. To date *Gollumjapyx smeagol* **gen. n. sp. n.** has been found in six caves scattered along the limestone relief of "The Coastal Ranges". This geomorphological region defined by Garay (1995), comprises the low altitude coastal ranges (400–600 metres average height) from the Oropesa range (Castellón, Spain) to the Montsià range (Tarragona, Spain). It displays a series of particular palaeogeographic and stratigraphic traits which have seemingly allowed it to remain a refugium area throughout the Cenozoic era for a host of species, presently recognised to be relics or paleo-endemics (Ortuño *et al*., 2005).

The northernmost locality is the "Avenc Canals" in the Montsià range, a small cave with stalagmite formations. The specimen was retrieved at the base of the entry shaft, in a formation 20–40 cm from a debris base made up of dirt and vegetable detritus (F. Fadrique com. pers.).

In the "la Vall d'Àngel" range, towards the south, there is "Cova dels Encenalls" cave; it hosts a considerable catalogue of troglobite elements, including Zuphiini carabid *Ildobates neboti* Español, 1965 and Anillini carabids *Speleotyphlus jusmeti* (Español, 1971) and *Iberanillus vinyasi* Español, 1971; Dysderidae Araneae *Speleoharpactea levantina* Ribera, 1982; Neobisidae Pseudoscorpiones *Acantocreagris relicta* Mahnert, 1977; and Campodeidae Diplura *Paratachycampa hispanica* Bareth & Condé, 1981. This cave is, for the greater part of its 75 m width and only 10 m depth, covered in stalagmite floors, with small gours, generally flooded. The specimen was found wandering on the stony soil of a side gallery (J. Comas com. pers.).

"Avenc del Mas Nou" pit lies on the southern foothills of the "Serra d'en Galceran" range; access to its 28 m drop is gained through a narrow gap. The cave extends for 150 m and reaches a depth of 40 m. It is covered with stalagmite formations as well as clay deposits, all in an extremely humid environment. The specimen was collected crawling on the damp formations at over 30 m depth. Also spotted in that same area were many specimens of two detrivorous species of Campodeidae Diplura: *Paratachycampa*

hispanica and *Campodea maestrazgoensis* Sendra & Escolà, 2004. In this same mountain range there is a small cave, less than 70 m of practically horizontal extension, known as "Cova del Mas de Gaspar" or "Cova Santa", where the first specimen of this new taxon was discovered — which has been used as holotype in the description. *Gollumjapyx smeagol* shares this cave with other troglobite elements such as Leiodidae Coleoptera *Anillochlamys cullelli* Lagar, 1978 and Campodeidae Diplura *Campodea (Campodea) maestrazgoensis*.

The two southernmost localities are two pits in close proximity, the "Avenc d'En Serenge" and the "Avenc Mas de la Cova". Both are located in limestone elevations near the town of Cabanes, in Ferradura mountain. The "Avenc d'en Serenge", as well as being the typical locality of *Ildobates neboti*, is home to a great variety of troglobite forms with great interest from a palaeo- and biogeographical point of view: Neobisidae Pseudoscorpiones *Troglobisium racovitzai* (Ellingsen, 1912); Campodeidae Diplura *Paratachycampa hispanica*; Anillini carabid *Speleotyphlus aurouxi* (Español, 1966) and Pselaphidae *Tychobythinus escolai* (Besuchet, 1974). Five of the specimens of *Gollumjapyx smeagol* come from this cave which extends for 110 m and 34 m depth. Four of the aforementioned specimens were collected in the deepest and dampest areas of the cave, totally covered by calcareous formations, at more than 20 m depth. In the case of the "Avenc del Mas de la Cova" pit no precise data are available about the way the specimen was located. The cave runs for more than 141 m and reaches a depth of 43 m. From the base of the first shaft at 17 m depth, the cave remains very damp, with an abundance of stalagmitic formations and dripstones.

Gollumjapyx smeagol has been found in mesovoid deep substratum, in caves of average extension and little depth, excavated in limestone from the Lower Cretaceous, in altitudes between 300–500 metres. Ground temperature ranges from 14ºC to 17ºC, always in humid areas. It is therefore likely to be stenoterm and stenohygrobious, although not strictly, which would presumably allow it to survive in mesovoid shallow substratum (MSS).

It is well known that the most common feeding habit in Japygidae is to predate on smaller invertebrates. It has been stated that japygids refuse to feed on dead organisms (Pagés, 1967). Even though feeding in *Gollumjapyx smeagol* has not been observed, a thorough examination of the digestive content has been performed. Two specimens from the "Avenc d'en Serenge" showed fragments of Acari (legs and sclerites) inside the digestive tract. A third specimen from the same cave showed fragments of *Speleotyphlus aurouxi* (5 antennomeres, a leg, part of the ring of the genital segment and the whole aedeagus- median lobe and parameres still articulated) (Fig. 2b).

Conclusions

The few entomologists who have worked with the Japygidae have met with great difficulties owing to an external morphology with few consistent traits on which to base alleged biogeographical isolation. Hence, a proposal for phylogenetic relationships consistent with the present geographical distribution is hindered by: 1) the homogeneous reproductive structures, in both male and female genital papilla; 2) a repetition in the distribution pattern of large setae and macrosetae; 3) the variability in traits believed to be constant such as the cercal armature (Pagés, 1987). With respect to the European fauna of Japygidae, Pagés (1978) points out the artificiality of most of the known genera (*Unjapyx* Silvestri, 1948; *Monojapyx* Paclt, 1957; *Homojapyx* Pagés, 1953 and *Parindjapyx* Silvestri, 1933) or their heterogeneity, a way of suggesting polyphyly in some of them (*Japyx*; *Metajapyx* Silvestri, 1933 and *Megajapyx*). Despite the taxonomic effort conducted in the early 20th century by Italian entomologist Filippo Silvestri and in more recent times by Dr. Jean Pagés, the taxonomy of the Japygidae remains unresolved. In this situation any attempt at describing a new taxa should be approached with care and only if reproductive isolation is inferred, as is the case in *Gollumjapyx smeagol*, a specialized element in the subterranean ecosystem. In addition, new taxa to be supported by solid taxonomic traits and also to study intra as well as interpopulation variations. In the case of *Gollumjapyx smeagol* a collection of morphological features singles out this new organism in a way which leaves no doubt about its taxonomic novelty: the extraordinary length of the legs and thorax is unique in the whole Japygidae family; in addition to these singularities there are others relating to the supernumerary placoid sensila, the chaetotaxy in the thoracic tergites, the lack of pseudospori and disculli in the median glandular organ, macrosetae neotrichia of the urosternites or a robust urite X, cerci and their armature.

Nevertheless, phylogenetic relations can only be argued in a few cases and *Gollumjapyx smeagol* is no exception. As far as affinities go, there has been an analysis of possible taxonomic relations with *Burmjapyx* (*sensu* Paclt, 1957), particularly with *Japyx goliath*, but these perhaps only apparent similarities should not lead to propose a phylogenetic affinity. That *Gollumjapyx smeagol* shares habitat and distribution (subterranean ecosystem of limestone elevations in the eastern Iberian Peninsula) with palaeo-endemic elements such as troglobites *S. levantina, T. racovitazae, P. hispanica* or *I. neboti*, among others (Ortuño *et al*., 2005) could indicate an archaic origin. In any case, *Gollumjapyx smeagol* should be classified as an enygmatic japydig, one of the largest arthropod predators from the subterranean ecosystem possessing important troglobiomorphic characteristics.

Our observations of the contents of the digestive tract of a specimen from “Avenc d’en Serenge” (Fig. 2b) provide interesting data about the modality of predation, since the ingestion of large fragments precludes habits linked to preoral digestion, as is the case in important fluidophagous predators such as some carabids (Forsythe, 1982).

Finally, it is worth remarking that new collections of *M. moroderi* (see materials and

methods) locate it in epigeous as well as edaphic and endogeous environments and also in hipogeous ones, always within limits in the northeastern Prebetic ranges of the Iberian Peninsula. Therefore, given its wide habitat diversity it cannot be described strictly as a troglobite or hypogeous species, as it had been inferred up to the present. The data we now hold on its distribution, habitat and morphology thus confirm that *Gollumjapyx smeagol* is the only Iberian troglobite japydig .

Acknowledgements

Our thanks go to Oleguer Escolà of the Barcelona Zoology Museum, and Carolina Martín of the National Museum of Natural Sciences for allowing the use of their specimens of this new taxon. We would like to also extend our gratitude to those colleagues at the aforementioned institutions who collected some of the specimens, Jordi Comas, Floren Fadrique and Emilio Carabajal, and also to José Luis Lencina and members of the speleological group HINNENI from Jumilla (Murcia) for sharing with us the specimen from the Pozo cave.

We are indebted to the electron microscopy facility at the Universitat de València, in particular to Enrique Navarro, Pilar Gómez and Tomas Montán, for their help and instructions preparing the material for the scanning electron microscope and obtaining the photographs. At the molecular laboratory facility at the Universitat de Barcelona, many thanks to Miquel Arnedo, Mercè Loukota and Carles Ribera for their help in the DNA barcode of *G. smeagol*.

We also would like to give many thanks to our friend José María Azkárraga for the colour photo of *G. smeagol*.

Our gratitude is extended to Cecilia Fontelles and our colleague Dr. Enrique Font for his help with the English translation.

This study has been financed through: I + D a la conservación de los invertebrados cavernícolas de la Comunidad Valenciana, de la Consellería de Territori i Habitatge, Servei de Conservació i Gestió de la Biodiversitat, Generalitat Valenciana and by the Ministerio de Ciencia y Tecnología within the “Ramón y Cajal” plan.

References

Bellés, X. (1987) *Fauna cavernícola i intersticial de la Península Ibèrica i les Illes Balears*. Ed. Moll. Mallorca. 207 pp.

Forsythe, T.G. (1982) Feeding mechanisms of certain ground beetles (Coleoptera: Carabidae). *The Coleopterists Bulletin*, 36, 26–73.

Garay, P. (1995) Marco geológico estructural y geotectónica. *In:* Universitat de València & Asociación Española para Estudio del Cuaternario (Ed.). *El Cuaternario del País Valenciano*. Valencia, 31–42.

Muegge, M.A. (1992) New Species of Cavernicolous Japygid (Diplura, Japygiae) from Texas. *Annals Entomological Society of America*, 85, 406–412.

Ortuño, V.M.; Sendra, A.; Montagud, S. & Teruel, S. (2005) Systématique et biologie d'une espèce paléoendémique hypogée de la péninsule Ibérique: *Ildobates neboti* Español, 1966 (Coleoptera: Carabidae: Dryptinae). *Annales de la Société Entomologique de France (Nouvelle Série)*, 40, 459–475.

Paclt, J. (1957) Diplura. *In* : P. Wytsman (Ed.), *Genera Insectorum*. Crainhem, 212 fasc.: 1–123.

Pagés, J. (1953) Japyginae (Japygidae, Insecta, Diplura) de la Yougoslavie et des régions limitrophes. *Bulletin du Muséum d'Histoire Naturelle du Pays Serbe*, Série B, 235–264.

Pagés, J. (1961) Japygidae (Insecta, Diplura) de l'Afghanistan II. (Contribution à l'étude de la faune de l'Afghanistan. 58.). Comptes rendus du 86e Congrés des Sociétés savantes, Montpellier, 1961, 735–750.

Pagés, J. (1964) Remarques sur les Japygidae signales dans le domaine souterrain. *Internacional Journal of Speleology*, 1, 191–201.

Pagés, J. (1967) Données sur la Biologie de *Dipljapyx humberti* (Grassi). *Revue d'Ecologie et de Biologie du Sol*, 4, 187–281.

Pagés, J. (1977) Dicellurata Genavensia III. Japygidés du Sud-Est Asiatique Nº 1. *Revue suisse Zoologie*, 84, 687–698.

Pagés, J. (1978) Dicellurata Genavensia V. Espèces d'Europe et du bassin méditerranéen. Nº 1. *Revue suisse Zoologie*, 85, 31–46.

Pagés, J. (1980) Dicellurata Genavensia VII. Japygidés d'Europe et du bassin méditerranéen nº 2. *Revue suisse Zoologie*, 87, 637–645.

Pagés, J. (1984) Dicellurata Genavensia XIII. Japygidés du Sud-Est asiatique Nº 4. *Revue suisse Zoologie*, 91, 329–368.

Pagés, J. (1987) Dicellurata Genavensia XV. Japygidés d'Europe et du bassin méditerranéen nº 6. *Revue suisse Zoologie*, 94, 749–764.

Pagés, J. (1994) Japygidés (Diplura) du Sud-Est asiatique nº 6: Malaysia (Sabah). Dicellurata Genavensia XIX. *Revue suisse Zoologie*, 101, 413–434.

Pagés, J. (2000) Japygidés (Diplura) du Sud-Est Asiatique nº 9. Dicellurata Genavensia XXIV. *Revue suisse Zoologie*, 107, 737–764.

Pagés, J. & Schowing J. (1958) Diploures Japygids du Kivi et de l'Urundi. *Revue de Zoologie et de Botanique Africaines*, 57, 193–240.

Silvestri, F. (1928) Japygidae (Thysanura) di Cuba. *Bolletino del Laboratorio di Zoologa generale ed agraria del R. Istituto superiore agrario di Portici*, 22, 263–281.

Silvestri, F. (1929) Contribucin al conocimiento de los Japygidae (Thysan.) de España. *Eos*, 5, 81–95.

Silvestri, F. (1934) Biospeologica LXI Dicellura, Japygidae (premire srie). *Archives de Zoologie experimentale et generale*, 76, 385–398.

Silvestri, F. (1948) Contributo alla conoscenza degli Japygidae (Insecta Diplura). *Rendiconti dell'Accademia dei XL*. Serie III., 27, 3–115.

