

Revision of the genus *Amadotrogus* Reitter, 1902 (n. stat.) (Coleoptera: Scarabaeidae: Melolonthinae) ⁽¹⁾

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Abstract – In this paper, the subgenus *Amadotrogus* Reitter, 1902 and its taxonomic status as a subordinate taxon of genus *Amphimallon* are reviewed. Two kinds of character sets are discussed; those relative to the external morphology of the adult and those of the male and female genitalia. Subgenus *Amadotrogus* is compared with its recognized allied genera in the same clade (Coca-Abia 1995) *Amphimallon* Berthold, 1827; *Geotrogus* Guérin, 1842; *Monotropus* Erichson, 1847; *Pseudoapeterogyna* Escalera, 1914 and *Rhizotrogus* Berthold, 1827 to assess the relationships of these taxa. Phylogenetic analysis discloses that *Amadotrogus*, considered to be a subgenus of *Amphimallon*, has synapomorphic characters which justify its elevation to generic rank. Thus, genus *Amadotrogus* includes seven species distributed across the Northern Mediterranean basin. The type species, *Amadotrogus quercanus* (Burmeister, 1855), and six others, transferred from genus *Rhizotrogus*: *Amadotrogus grassii* (Mainardi, 1902), *Amadotrogus insubricus* (Burmeister, 1855), *Amadotrogus oertzeni* (Brenske, 1886), *Amadotrogus patruelis* (Reiche, 1862), *Amadotrogus truncatus* (Brenske, 1886) and *Amadotrogus vicinus* (Mulsant, 1842) (Coca-Abia & Martín-Piera 1998). In addition, *Rhizotrogus rugifrons* Burmeister, 1855 is considered a new synonym of *Amadotrogus vicinus*. *Rhizotrogus bolivari* Martínez y Sáez, 1873, *Amphimallon catalaunicum* Báguena, 1956 and *Rhizotrogus lajonquierei* Baraud, 1970 are synonymized with *Amadotrogus patruelis*.

Résumé – Révision du genre *Amadotrogus* Reitter, 1902 (n. stat.) (Coleoptera: Scarabaeidae: Melolonthinae). – Dans cet article, le sous-genre *Amadotrogus* Reitter, 1902 est révisé et son statut taxonomique est précisé. Les caractères de la morphologie externe des adultes et des pièces génitales mâles et femelles sont ici discutés. Le sous-genre *Amadotrogus* est par ailleurs comparé aux genres voisins, notamment *Amphimallon* Berthold, 1827; *Geotrogus* Guérin, 1842; *Monotropus* Erichson, 1847; *Pseudoapeterogyna* Escalera, 1914 and *Rhizotrogus* Berthold, 1827 afin d'établir les relations phylogénétiques entre ces taxa. L'analyse phylogénétique met en évidence un certain nombre de synapomorphies qui justifient l'élévation au rang de genre du groupe des *Amadotrogus*, considéré comme sous-genre de *Amphimallon*. Le genre *Amadotrogus* regroupe actuellement sept espèces habitant les régions septentrionales du Bassin méditerranéen: l'espèce-type, *Amadotrogus quercanus* (Burmeister, 1855), *Amadotrogus grassii* (Mainardi, 1902), *Amadotrogus insubricus* (Burmeister, 1855), *Amadotrogus oertzeni* (Brenske, 1886), *Amadotrogus patruelis* (Reiche, 1862), *Amadotrogus truncatus* (Brenske, 1886) et *Amadotrogus vicinus* (Mulsant, 1842) (Coca-Abia & Martín-Piera 1998). Nous établissons par ailleurs la synonymie entre *Amadotrogus vicinus* (Mulsant, 1842) et *Rhizotrogus rugifrons* Burmeister, 1855, et les synonymies de *Rhizotrogus bolivari* Martínez y Sáez, 1873, *Amphimallon catalaunicum* Báguena, 1956 et *Rhizotrogus lajonquierei* Baraud, 1970 avec *Amadotrogus patruelis* (Reiche, 1862).

Amadotrogus was described by Reitter (1902) as a subgenus of *Amphimallon* Berthold, 1827. The author included two species in this subgenus: *Amphimallon (Amadotrogus) scutellaris* (Lucas, 1849), and *Amphimallon (Amadotrogus) quercanus* (Burmeister,

1855). In a taxonomic revision, Baraud (1992) excluded *Amphimallon scutellaris* from *Amadotrogus*, included *Amphimallon catalaunicum* Báguena, 1956 and designated *Amphimallon (Amadotrogus) quercanus* as type species of the subgenus. Coca-Abia (1992) considered *Amphimallon (Amadotrogus) catalaunicum* synonymous with *Rhizotrogus bolivari* Martínez y Sáez, 1873. Thus, to date *Amadotrogus* contains only the type species.

In a worldwide taxonomic revision of the genus *Rhizotrogus* Berthold, 1827 (Coca-Abia & Martín-Piera 1998), the authors transferred some taxa included in

(1) This work was supported by the Projects **Fauna Ibérica II**; D.G.I.C.Y.T.: PB89-0081 and **Fauna Ibérica III**; D.G.I.C.Y.T.: PB92-0121.

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Accepted le : 10-05-2002.

genus *Rhizotrogus*, particularly seven species in the “*Rhizotrogus vicinus* Mulsant, 1842” group (Baraud 1992), to other West-Palaearctic Melolonthini genera such as *Geotrogus* Guérin, 1842, *Monotropus* Erichson, 1847 and *Amadotrogus* Reitter, 1902, resulting in twenty one new taxonomic combinations.

Here, we focus on seven species which were placed in *Amadotrogus* (Coca-Abia & Martín-Piera 1998), promote *Amadotrogus* to genus level and analyze the phylogenetic relationships of *Amadotrogus* with its allied genera *Amphimallon*, *Rhizotrogus*, *Geotrogus*, *Pseudoapterogyna* Escalera, 1914 and *Monotropus*.

Material and methods

The specimens studied are in collections belonging to the following: Museo Nacional de Ciencias Naturales de Madrid (MNCN), Museum d'Histoire Naturelle de Paris (MNHN), Martin-Luther-Universität Halle-Wittenberg (Saale) (MLU), Fundación Entomológica “Torres Sala” of Valencia (FETS), Museo Civico “Giacomo Doria” of Genova (MCSN), Museum für Naturkunde (Berlin) (ZMB); Antonio Andújar (AA); Jacques Baraud (JB) in MNHN, José Luis Lencina (JLL), and José Miguel Avila (JMA).

The taxonomic discussion is based on external morphology and male genitalia. The morphology of female genitalia is very constant among the studied taxa and gives few diagnostic characters of low taxonomic rank (Coca-Abia & Martín-Piera 1991; Martín-Piera & Coca-Abia 1992).

The procedure for preparation of male genitalia was usual. First, the tegmen and endophallus were cleaned with hot water and potassium hydroxide (KOH 5%). Once the endophallus was cleaned, a sagittal cut was made in its face opposite the tígilla. Then the endophallus was dehydrated in a progressive alcoholic series (70%, 90%, 95%, a mixture of 50% ethyl alcohol and 50% xylol, and finally pure xylol) and mounted in Canadian Balsam on a microscopic slide.

The preparation of female genitalia for study was the same as that for male genitalia, but the dehydration was less intense. The two last steps of the progressive alcoholic series were replaced by 97% ethyl alcohol. The female genitalia were mounted in Euparal on a microscopic slide.

The phylogenetic analysis was carried out using PAUP 3.1.1 (Swofford 1993) and MacClade 3.01 (Madison & Madison 1992). The exhaustive search was used to find the most parsimonious trees. The robustness of the clades was assessed with bootstrapping (Felsenstein 1985).

All taxa which were hypotized to belong to the clade constituted by *Amadotrogus*, *Amphimallon*, *Geotrogus*, *Monotropus*, *Pseudoapterogyna* and *Rhizotrogus* (Coca-Abia 1995), were included in the analysis. *Geotrogus* and *Pseudoapterogyna* were represented only by their type species because, at supraspecific level of analysis, none of these genera showed significant variation for the characters used here. For *Amphimallon*, an array of four species was selected which express the taxon's variability (Montreuil 2000). The two species groups of *Rhizotrogus* (Coca-Abia 1995; Coca-Abia & Martín-Piera 1998) were represented

by a single species each. All species of *Amadotrogus* were included to show the maximum morphological and genitalic variation of that genus. Although we are working at supraspecific rank, the use of species, rather than making up an hypothetical ground-plan, allows for verification of homology hypotheses and to test the monophyly of the groups. Whenever possible, the type species of the genera were included in the analysis; however, specimens of the type species of genus *Monotropus* could not be obtained, so *Monotropus staudingeri* Schaufuss, 1861, was included instead.

Polyphylla fullo (L., 1758) and *Haplidia transversa* (F., 1801) were considered outgroups. The former was chosen because it belongs to the subtribe Melolonthina, the sister group of subtribe Rhizotrogina in which *Amadotrogus* and its allied genera are included. However, *Haplidia transversa* belongs to the tribe Rhizotrogini, the same that the ingroup (Coca-Abia 1995). Thus, it was possible to test the monophyly of the group that included *Amadotrogus* and its allied genera.

The data set comprises 20 characters scored across 18 taxa. Character selection included nine from external morphology; ten from male genitalia and one from female genitalia. Characters were polarised using the outgroup criterion described by Nixon & Carpenter (1993). All characters were treated as non-additive (Fitch 1971). In unordered multistate characters, the distance between all pairs of states was treated as a single step.

The data matrix (Table) represents the character systems and their comparison.

Table 1 – Character matrix used in the phylogenetic analysis (Characters are described in the text). Explanation of symbols: 0-2 = character states, ? = state unknown.

	1		11111	11112
	12345	67890	12345	67890
<i>Polyphylla fullo</i>	00000	00000	00000	00000
<i>Haplidia transversa</i>	10000	00010	00000	00000
<i>Geotrogus magagnosci</i>	10000	00111	10102	21200
<i>Pseudoapterogyna tusculus</i>	?0000	00111	10101	2120?
<i>Amphimallon pini</i>	00001	10011	20101	11100
<i>Amphimallon solstitialis</i>	00001	10011	20101	11100
<i>Amphimallon sainzi</i>	00010	00011	20101	11100
<i>Amphimallon naceyroi</i>	?0010	00011	20101	1110?
<i>Rhizotrogus aestivus</i>	00000	01011	20101	21210
<i>Rhizotrogus marginipes</i>	00000	01011	20101	21210
<i>Amadotrogus quercanus</i>	11100	00011	21211	22201
<i>Amadotrogus vicinus</i>	11100	00011	21211	22201
<i>Amadotrogus insubricus</i>	11100	0002?	?????	????1
<i>Amadotrogus oertzeni</i>	11100	00021	21211	22201
<i>Amadotrogus grassii</i>	11100	00011	21212	00001
<i>Amadotrogus patruelis</i>	11100	00011	21211	22201
<i>Amadotrogus truncatus</i>	11100	00011	2?2??	?????
<i>Monotropus staudingeri</i>	00010	00021	20102	00000

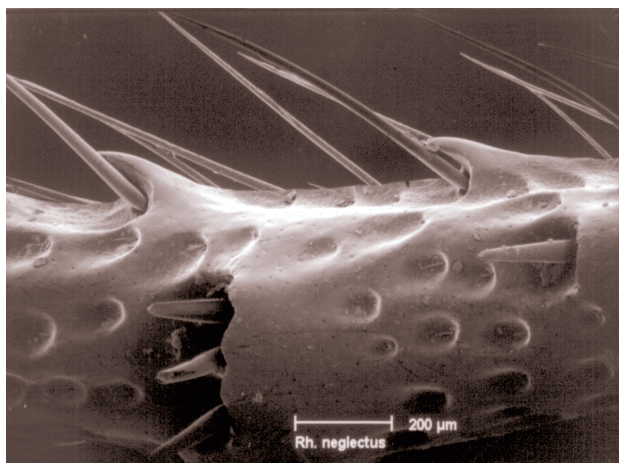


Figure 1
Dorsal spurs and texture of the metatibia of *Rhizotrogus neglectus*.



Figure 2
Simple claw with a basal tooth of *Rhizotrogus neglectus*.

List of characters

1. Sexual dimorphism in antennal club length: (0) antennal club of males longer than those of females; (1) antennal club length of sexes subequal.
2. Second segment of the palpi of the mentum: (0) shorter than the apical segment and getting wider apically; (1) longer than the apical segment and narrow.
3. Labrum shape: (0) depressed in the middle; (1) gently depressed in the middle with a soft prominence on the bottom of the depression.
4. Maxillary galea: (0) with strong teeth on the dorsal face; (1) smooth or with weak teeth on the dorsal face.
5. Elytral texture: (0) smooth; (1) striated.
6. Pubescence on abdominal sternites: (0) soft and scarce; (1) strong in the middle.

7. Dorsal ornaments of the metatibiae: (0) absent; (1) with spurs (fig. 1).
8. Metatibial texture: (0) with strong punctures (fig. 1); (1) smooth.
9. Shape of claws: (0) sickle-shape; (1) simple with a basal tooth (fig. 2); (2) simple without basal tooth.
10. Closing of the internal sac to the parameres: (0) by intermediary joining structures; (1) directly without other joining structures.
11. Dorsal membrane in the parameres: (0) absent; (1) wider in the middle; (2) straight or almost straight (fig. 3).
12. Dorsal sclerotized areas of the parameres: (0) absent; (1) present (fig. 3).
13. Vento-caudal membranous area in the parameres: (0): absent or reduced; (1) $\approx 1/3$ length of parameres; (2) more than $1/3$ length of parameres (fig. 3).
14. Shape of endophallus: (0) a simple sac; (1) with two caeca (fig. 4).
15. Internal structures of the endophallus: (0) plates; (1) tigillum (fig. 4); (2) absent.

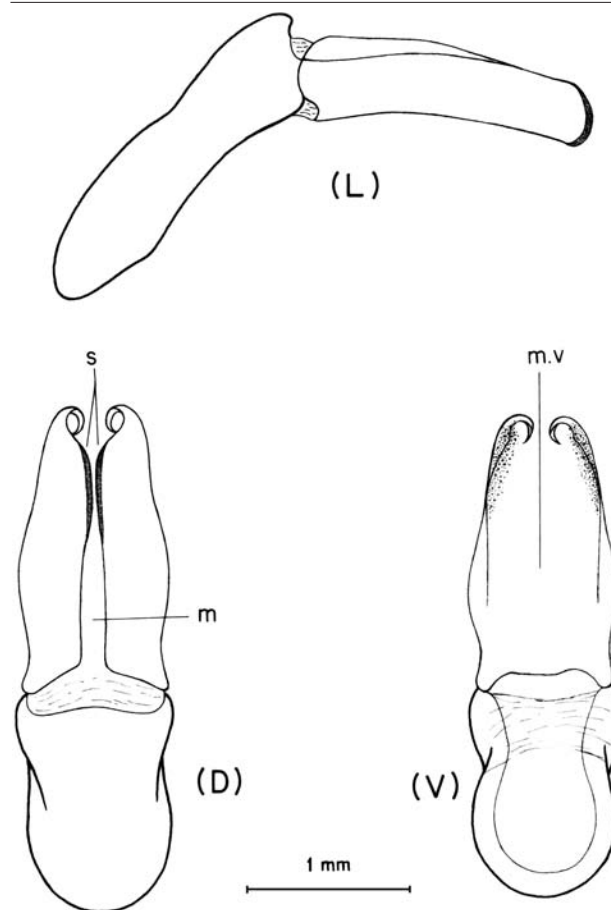


Figure 3
Tegmen of *Amadotrogus quercanus*. Lateral view (L), dorsal view (D) and ventral view (V). m: dorsal membrane; s: sclerotized areas; mv: ventro-caudal membranous area.

16. Construction of tigillum: (0) absent; (1) delicate; (2) strong.
 17. Shape of tigillum: (0) absent; (1) "V"-shaped; (2) variable-shape not V-shaped.
 18. Bifurcated extreme of the tigillum: (0) tigillum absent; (1) with bridge; (2) without bridge.
 19. Setae of the endophallus: (0) inconspicuous; (1) raspulate.
 20. Insertion of the spermathecal gland: (0) medial; (1) basal (fig. 5).

RESULTS

Genus *Amadotrogus* Reitter, 1902, n. stat.

Type species *Rhizotrogus quercanus* Burmeister, 1855 (designated by Baraud 1992).

Description – *Amadotrogus* may be described as follows. Antennal clubs shorter than the stem and about the same size in both sexes (character 1, state 1 - 1¹), palpi of the mentum with the second join long and narrow (2¹), labrum gently depressed with a prominence on the bottom of the depression (3¹). Pronotal surface glabrous and shiny, with scattered punctures; lateral margin is smooth or slightly serrate anteriorly. Elytra glabrous, shiny, and without striae (5⁰).

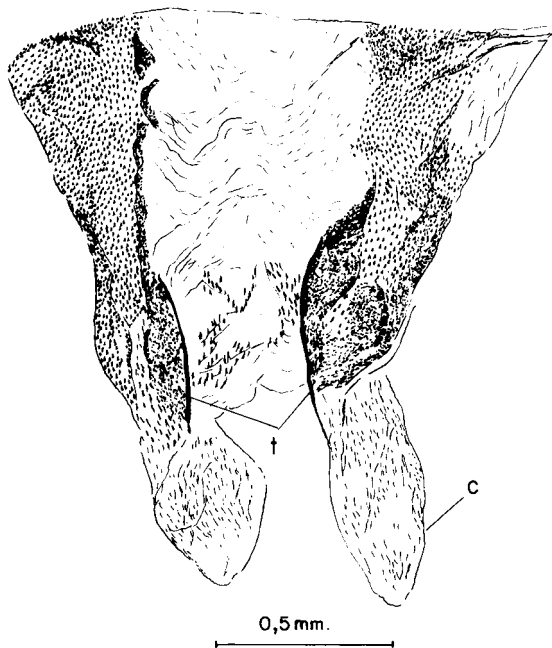


Figure 4
Endophallus of *Amadotrogus quercanus*. t: tigilla; c: caecum.

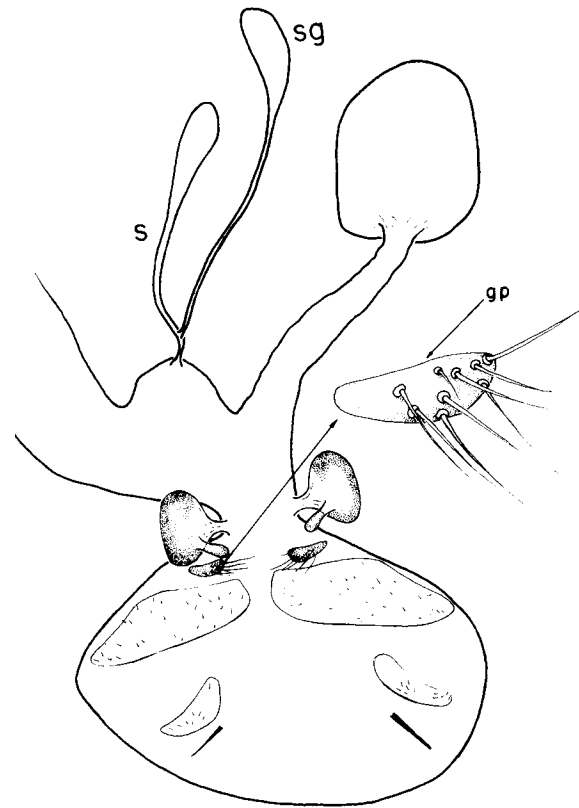


Figure 5
Female genitalia of *Amadotrogus patruelis*. S: Spermatheca; sg: spermathecal gland; gp: genital palpi.

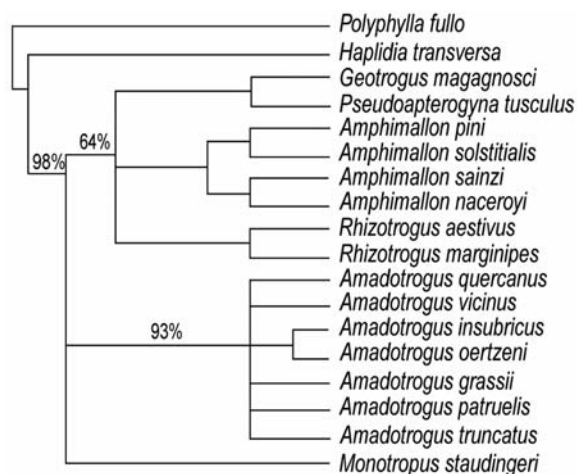
Antero-dorsal portion of the parameres with dark areas more sclerotized than the remaining part of the parameres (12¹) (fig. 3). Some species such as *Amadotrogus vicinus* (Mulsant, 1842), display wart-like sclerotized structures (fig. 7).

Apices of the parameres robust and rounded, truncated in lateral view. Ventro-caudal membranous area larger than 1/3 parameres length (13²) (fig. 3).

Endophallus with two caeca projected cephalically (14¹), without raspulae (areas with basiconic sensilla, Coca-Abia & Martín-Piera 1991; Martín-Piera & Coca-Abia 1992), only with areas of pointed sensilla (fig. 4). In some species (*A. vicinus*) wart-like sclerotized structures are present in the opposite wall of the tigilla (fig. 8).

Female genitalia similar to that described by Coca-Abia & Martín-Piera (1991) in the subtribe Rhizotrogina. The most peculiar feature in the female genitalia is the position of the spermathecal gland. Its insertion in the spermatheca is basal, close to the median oviduct (20¹) (fig. 5).

Distribution – *Amadotrogus* is a West-Palaeartic Melolonthini genus, distributed across the Northern Mediterranean basin, from Iberian Peninsula to Lebanon including Corsica and Sardinia (fig. 9).

**Figure 6**

Bootstrap 50% majority-rule consensus tree (100 bootstrap replicates). The number over the branch means the frequency of occurrence in percentage.

Key for identification of *Amadotrogus* species

1. Head with strong punctures and wrinkled looking 2
- Head with punctures but not wrinkled looking; at most, confluent punctures on the vertex 3
2. Posterior prothoracic angles right, with rounded apex. Tegmen and endophallus without wart-like sclerotized structures (figs. 3, 4) *quercanus*
- Posterior prothoracic angles obtuse, with sharp apex. Tegmen and endophallus with wart-like sclerotized structures (figs. 7, 8) *vicinus*
3. Pronotal surface with shallow punctures, lateral margins smooth 4
- Pronotal surface with deep punctures, lateral margin serrated at least anteriorly 5
4. Pubescence on pygidium inconspicuous even in profile . 6
- Pygidium with conspicuous, decumbent and heterogeneous pubescence. Male genitalia (figs. 10, 11) *oertzeni*
5. Pronotal punctures outlined. Pygidium with deep and confluent punctures, conspicuous pubescence . . *insubricus*
- Pronotal punctures not outlined. Pygidium with scattered punctures and inconspicuous pubescence even in profile *grassii*
6. Frontal carina softly developed. Punctures distributed more densely on vertex than on frons. Male genitalia (figs. 12, 13) *patruelis*
- Frontal carina absent. Punctures on head distributed homogeneously *truncatus*

Amadotrogus grassii (Mainardi, 1902)

Rhizotrogus grassii Mainardi, 1902: 105.

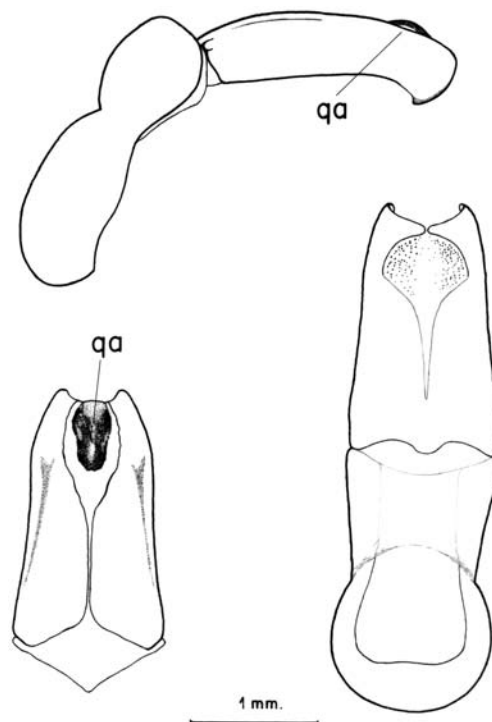
Description – Clypeus with the lateral sides very oblique; frontal carina absent or poorly defined. Lateral margins of the pronotum serrated anteriorly and not sinuated posteriorly. Pronotal

surface with deep punctures, posterior prothoracic angles sharp. Pygidium with inconspicuous pubescence. Fore tibia with very slight, obsolete third tooth.

Dorsal side of the parameres with dark areas which are more sclerotized than the remaining part of the parameres (fig. 14). Endophallus without tigilla or wart-like sclerotized structures and with numerous pointed sensilla (fig. 15).

Distribution – Italy (fig. 9). Type locality: Tombolo (Livorno).

Material examined – A male specimen of *Amadotrogus grassii* (Mainardi, 1902) placed in MCSN is designated as the Lectotype, labelled as follows: (white, handwritten): Tombolo Livorno Agosto A.M.; ii) (red, printed): syntypus, *Rhizotrogus grassii* Mainardi, 1902; iii) (white, handwritten): Collezione C. Mancini; iv) (white, handwritten): Museo Civico di Genova; v) (red, printed): Lectotipo, *Amadotrogus*, *A. grassii* (Mainardi, 1902) Coca Abia det. 1995; vi) (white, printed): Prep. genital no. 906 ♂, mounted by MM. Coca Abia. The remaining seven specimens from Tombolo (Livorno) labelled as syntypes are paralectotypes. One ♀ from Pisa (Italy) (MCSN); 1 ♂ from S. Alessandro (Roma, Italy) (JB in MNHN) and 2 ♂♂ from Emilia (Italy) (MNCN).

**Figure 7**

Tegmen of *Amadotrogus vicinus*. Lateral, dorsal and ventral views. qa: wart-like sclerotized structure.

Amadotrogus insubricus* (Burmeister, 1855)Rhizotrogus insubricus* Burmeister, 1855: 383.*Rhizotrogus fiorii* Brenske, 1893: 190 (Baraud 1992).

Description – Clypeus with the lateral sides oblique and straight, with reflexed anterior edge; frons convex not very rough but with punctures, frontal carina poorly defined. Pronotal surface with deep punctures, anterior lateral margins serrate; basal lateral margins smooth and softly sinuate; posterior prothoracic angles sharp. Elytra smooth. Pygidium densely punctate with decumbent yet distinct pubescence. Teeth of fore tibia three in number and stronger in females than in males.

Genitalia of type male specimen were lacked and thus could not be studied.

Distribution – Italy: Emilia and Liguria. France: Var and Alpes Maritimes (Baraud 1992) (fig. 9). Type locality: Piemont, La Spezia (Italy).

Material examined – A male specimen of *Amadotrogus insubricus* (Burmeister, 1855) placed in MLU is designated as the Lectotype, labelled as follows: 1) White, printed: La Spezia. 2) White, printed: MLU Halle, WB Zoologie, S.-Nr. 813115. 3) White handwritten: insubricas Villa La Spezia. 4) Red printed: Lectotype, *Amadotrogus insubricus* (Burmeister, 1855) Coca Abia det. 2001. The remaining two specimens (♀♀) from La Spezia are paralectotypes.

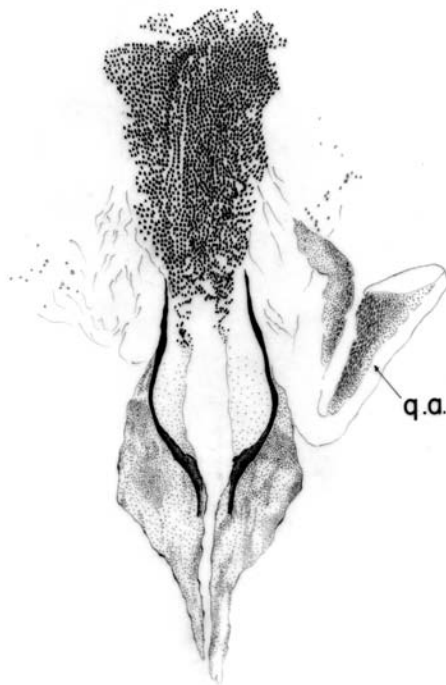


Figure 8
Endophallus of *Amadotrogus vicinus*: q.a: wart-like sclerotized structure.

Amadotrogus oertzeni* (Brenske, 1886)Rhizotrogus oertzeni* Brenske, 1886: 201.

Description – Clypeus with oblique and straight lateral sides, with reflexed anterior edge; frons not very roughly punctate, frontal carina poorly defined. Pronotum with lateral margins smooth or slightly serrate; posterior prothoracic angles straight and with the apex rounded; pronotal surface with shallow punctures. Elytra smooth. Pygidium with heterogeneous and decumbent, yet very distinct, pubescence. Fore tibia tridentate. Claws simple with poorly defined basal tooth.

Parameres robust and with more sclerotization dorsally; widened laterally and with lateral protuberances in proximal portion (fig. 10). Endophallus with tigilla (fig. 11).

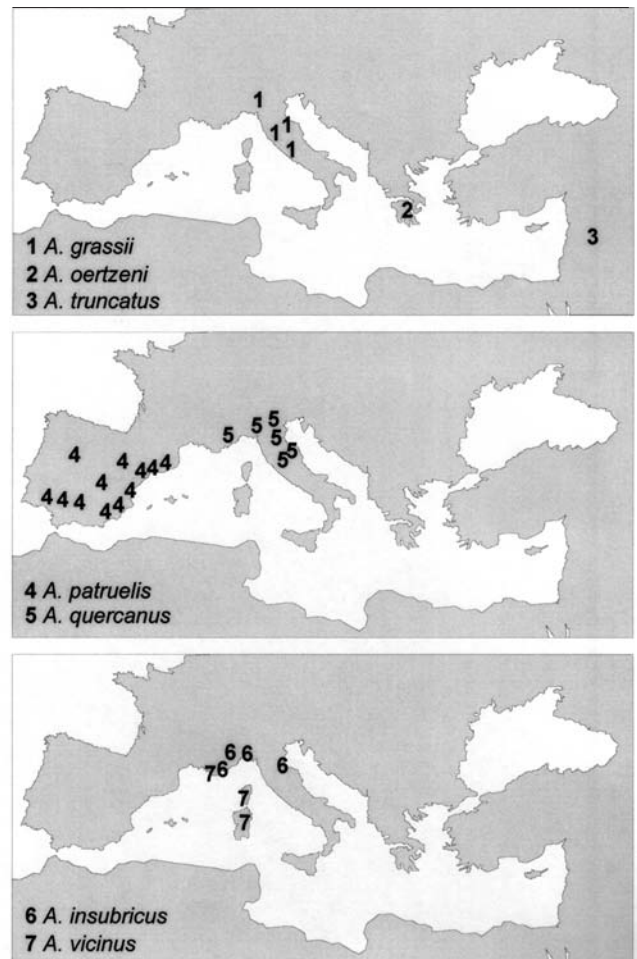


Figure 9
Geographic distribution of the species of *Amadotrogus*: (1) *A. grassii*; (2) *A. oertzeni*; (3) *A. truncatus*; (4) *A. patruelis*; (5) *A. quercanus*; (6) *A. insubricus* and (7) *A. vicinus*.

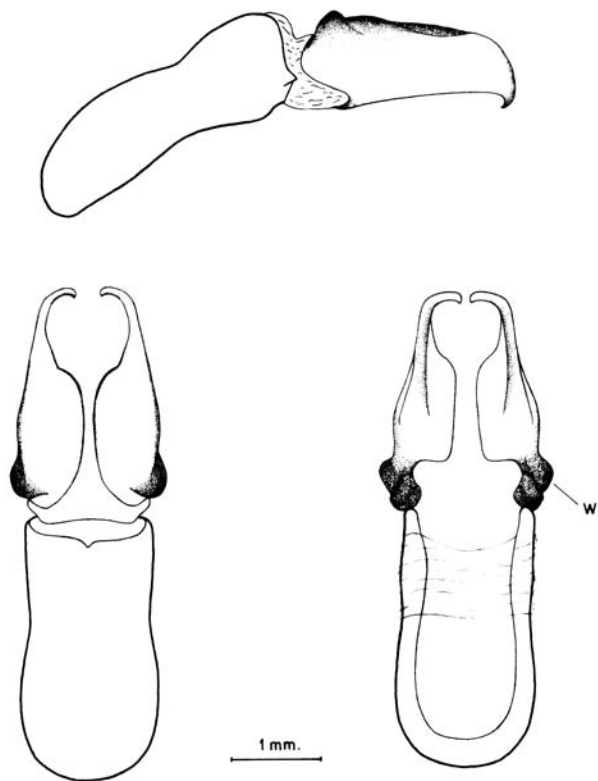


Figure 10
Tegmen of *Amadotrogus oertzeni*. Lateral, dorsal and ventral views. w: widening.

Distribution – Endemic to Greece. Type locality: Cephalonie, Thinos Mountain.

Examined material – A male specimen of *Amadotrogus oertzeni* (Brenske, 1886) placed in ZMB is designated as the Lectotype, labelled as follows: 1) White, handwritten: Cephalonia Thinos. 2) White handwritten: Rh. oertzeni Brenske. 3) White printed: Col. Brenske. 4) White printed: Zool. Mus. Berlin. 5) Red, printed: Lectotype, *Amadotrogus oertzeni* (Brenske, 1886) Coca Abia det. 2001. 1 ♀ Peloponeso (Greece) (JB in MNHN).

Amadotrogus patruelis (Reiche, 1862)

Rhizotrogus patruelis (Mannerheim) Reiche, 1862: 541.
Rhizotrogus bolivari Martínez y Sáez, 1873: 64 (**n. syn.**).
Amphimallon catalaunicum Báguena, 1956: 4 (**n. syn.**).
Rhizotrogus lajonquierei Baraud, 1970: 483 (**n. syn.**).

Description – Clypeus with slightly reflexed anterior edge; lateral sides oblique; front with carina poorly developed. Pronotum with smooth lateral margins and rounded posterior angles. Elytra smooth. Pygidium with short and scattered pubescence, setae scarcely evident. Fore tibia tridentate.

Tegmen robust (fig. 12). Endophallus with U-shaped tigilla and with the convergent ends not fused (fig. 13).

Remarks – *Rhizotrogus patruelis* was considered by Baraud (1992) to be a synonym of *Rhizotrogus parvulus* Rosenhauer, 1856. The external morphology and the genitalia (figs. 12, 13) prove that *Rhizotrogus patruelis* is a species belonging to *Amadotrogus*.

Conversely, Coca-Abia (1992) proved that *Amphimallon catalaunicum* Báguena, 1956 is a synonym of *Rhizotrogus bolivari* Martínez y Sáez, 1873. In a revision of genus *Rhizotrogus*, Coca-Abia & Martín-Piera (1998) established that *Rhizotrogus bolivari* and *Rhizotrogus lajonquierei* Baraud, 1970 share the external and genitalic features which characterize *Amadotrogus patruelis* (figs. 12, 13). Consequently, *Rhizotrogus bolivari*, *Amphimallon catalaunicum* and *Rhizotrogus lajonquierei* are synonyms of *Amadotrogus patruelis*.



Figure 11
Endophallus of *Amadotrogus oertzeni*.

Distribution – Endemic to the Iberian Peninsula. Mainly distributed throughout the eastern half of the Iberian Peninsula (fig. 9). Type locality: Hispania meridionale.

Material examined – *Amadotrogus patruelis*: A male specimen placed in MNHN is designated as the Lectotype, labelled as follows: i) (white, handwritten): *Rhizotrogus patruelis*; ii) (white, printed): Prep. genital no. 894 ♂, mounted by MM. Coca Abia; iii) (red, printed): Lectotipo, *Amadotrogus patruelis* (Reiche, 1862), Coca Abia det. 1994. Reiche never said how many specimens he studied, for that, and just in case other syntypes are found, this unique syntype is designated as Lectotype. 2 ♂♂ and 1 ♀ from Casas de Herrero (Valencia); 1 ♂ and 1 ♀ from Albufera (Valencia) (FETS). – *Amadotrogus bolivari*: Lectotype ♂ (Cuenca); 2 ♂♂ and 4 ♀♀ paralectotypes (Cuenca) (designated by Coca-Abia 1992); 1 ♂ Molinicos (Albacete); 11 ♂♂ and 2 ♀♀ Alicante; 1 ♂ Aracena (Huelva); 1 ♂ Sevilla; 1 ♂ Zamora and 5 ♂♂ and 4 ♀♀ from Tiermes (Zaragoza) (MNCN). 1 ♂ and 2 ♀♀ Almansa and 3 ♂♂ Nerpio (Albacete); 2 ♀♀ Los Escribanos (Murcia) (AA). 1 ♂ Molinicos (Albacete); 6 ♂♂ Cuenca; 1 ♂ Cazorla (Jaén); 1 ♂ Siles (Jaén); 8 ♂♂ and 5 ♀♀ Fortuna (Murcia); 55 ♂♂ and 15 ♀♀ Jumilla (Murcia)

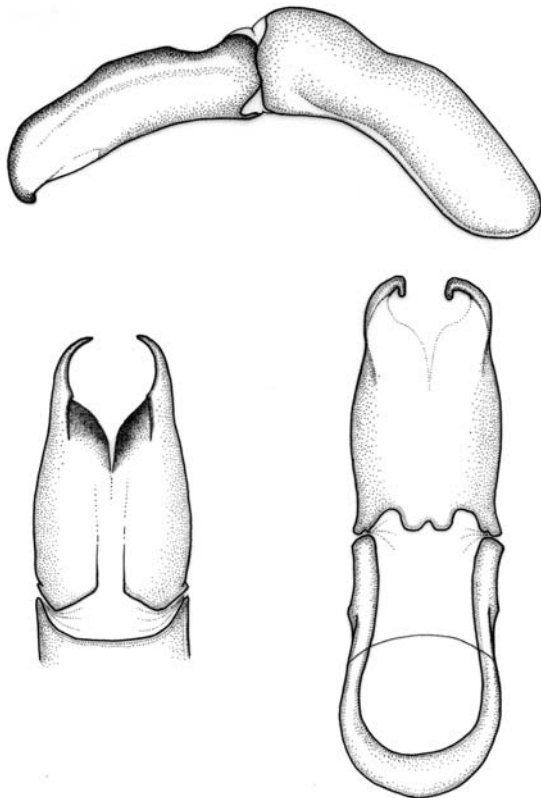


Figure 12
Tegmen of *Amadotrogus patruelis* in lateral, dorsal and ventral views.



Figure 13
Endophallus of *Amadotrogus patruelis*.

(JLL). 1 ♀ San Feliu de Guixols (Gerona) (JMA). – *Amadotrogus lajonquierei*: Holotype ♂ from Alhama de Murcia (Murcia) and Allotype ♀ from Peñíscola (Castellón) (JB in MNHN); 2 ♀♀ from Casa Cañada (Nerpio, Albacete) (AA); 3 ♀♀ from Jumilla (Murcia). – *Amadotrogus catalaunicum*: Holotype ♂ from Valls (Tarragona) and Allotype ♀ from Sta. María de Besora (Gerona) (MNCN).

Amadotrogus quercanus (Burmeister, 1855)

Rhizotrogus quercanus Burmeister, 1855: 395.

Description – Clypeus with reflexed anterior edge. Frontal carina evident and head with strong punctures. Pronotum darker in the middle, with slightly serrate lateral margins and rounded posterior angles. Pygidium with conspicuous pubescence. Fore tibia tridentate.

Tegmen with thin sclerotized dark areas in the dorsal side of the parameres (fig. 3). Endophallus with reduced and straight tigilla (fig. 4).

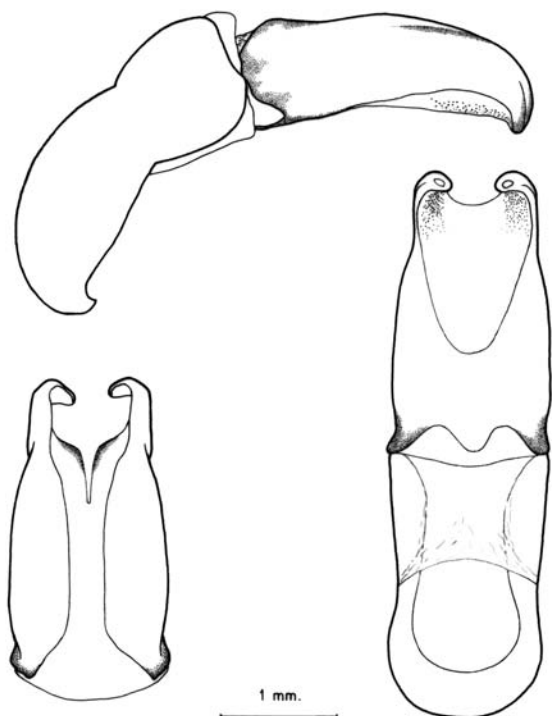


Figure 14
Tegmen of *Amadotrogus grassii* in lateral, dorsal and ventral.

Distribution – Italy: Lombardia, Piemonte, Emilia, Toscana, Abruzzo, Basilicata (fig. 9). France: Alpes-Maritimes (Baraud 1992). Type locality: Italy.

Material examined – A male specimen of *Amadotrogus quercanus* (Burmeister, 1855) placed in MLU is designated as the Lectotype, labelled as follows: 1) White, handwritten: 24901. 2) White, printed: MLU Halle, WB Zoologie, S.-Nr. 61416. 3) Brown handwritten: *quercanus* Burm. Piemont. 4) Red, printed: Lectotype *Amadotrogus quercanus* (Burmeister, 1855) Coca Abia det. 2001. 1 ♂ from Rivabella (Italy); 6 ♂♂ from Modena and 4 ♂♂ and 1 ♂ from Italy without more details (MNCN). The specimen (1 ♀) belongs to the syntype series has not been found.

Amadotrogus truncatus (Brenske, 1886)

Rhizotrogus truncatus Brenske, 1886: 202.

Description – Clypeus with oblique lateral sides and slightly reflexed anterior edge. Frons without carina. Pronotum with smooth lateral margins and obtusely rounded posterior angles. Elytra smooth. Pygidium with inconspicuous pubescence. Fore tibia tridentate, the third tooth is soft in males and strong in females.

The type male specimen with genitalia badly damaged; endophallum destroyed.

Distribution – Mediterranean East. Type locality: Beirut (Lebanon).

Material examined – Brenske (1886) described the species *Rhizotrogus truncatus* with a single male specimen placed in ZMB. This specimen is designated as Holotype, labelled as follows: 1) White, handwritten: Beirut. 2) White handwritten: *truncatus* Brenske. 3) White printed: Col. Brenske. 4) White printed: Zool. Mus. Berlin. 5) Red, printed: Holotype, *Amadotrogus truncatus* (Brenske, 1886) Coca Abia det. 2001. A male specimen placed in MNHN labelled as follows: i) (white, handwritten): Syrie; ii) (green, handwritten): *R. truncatus* Brenske Peyerimhoff det.; iii) (white, printed): Prep. genital no. 891 ♂, mounted by MM. Coca Abia.

Amadotrogus vicinus (Mulsant, 1842)

Rhizotrogus vicinus Mulsant, 1842: 438.

Rhizotrogus rugifrons Burmeister, 1855: 384. (**n. syn.**).

Rhizotrogus transfuga Gén  (Burmeister, 1855: 384) (**unavailable name**).

Description – Clypeus with oblique lateral sides; head with evident frontal carina and strong punctures. Pronotum with



Figure 15
Endophallus of *Amadotrogus grassii*.

softly serrated lateral margins and sharp posterior angles. Pygidium with short and decumbent, yet distinct pubescence. Fore tibia tridentate.

Tegmen with wart-like sclerotized structure in the dorsal side of the parameres (fig. 7). Endophallus with strong and sinuate tigilla, and dorsal wart-like sclerotized structure (fig. 8).

Remarks – A male specimen of *Rhizotrogus transfuga* Gén   labelled as “Transfuga Gén  ” without other specification is kept in MNHN. The first bibliographic reference to this taxon was Burmeister (1855), where it was mentioned as synonym of *Rhizotrogus rugifrons*. The original description of *R. transfuga* has been sought without success; we believe it is an unpublished taxon. Thus, according to the International Code of Zoological Nomenclature (ICZN) (1999) article 11 and 12, *Rhizotrogus transfuga* is an unavailable name.

The male specimen of *R. transfuga*, the type specimens of *Amadotrogus vicinus* (Mulsant, 1842) and type specimens of *Rhizotrogus rugifrons* Burmeister, 1855 have been studied. This allowed us to observe the similarity among these taxa. In addition to the strong frontal carina, they share the presence wart-like sclerotized structures on the parameres and endophallus (figs. 7, 8). Therefore, we can conclude that *A. vicinus* and *R. rugifrons* are synonymous taxa. *A. vicinus* is the valid taxon, which is assigned to genus *Amadotrogus*.

Distribution – France (included Corsica) and Sardinia (fig. 9). Baraud (1992) cited the species in France, Italy and Spain. However, he called the presence of this species in Italy into question. We do not know any specimen of *Amadotrogus vicinus* from Spain. The specimens placed in MNCN, labelled from Tiermes (Zaragoza) and identified as *Amadotrogus vicinus* are *A. bolivari*. Type locality: Marseille (France).

Material examined – *Amadotrogus vicinus*: A male specimen of *Amadotrogus vicinus* (Mulsant, 1842) placed in MNHN is designated as the Lectotype, labelled as follows: 1) White, printed: ♂. 2) White, printed: Museum Paris 1943 Coll. E. Mulsant. 3) Red, printed: Lectotipo *Amadotrogus vicinus* (Mulsant, 1842) Coca Abia det. 1993. 4) White, printed and handwritten: Prep. Genital N   870 ♂ Balsamo de Canad  . M.M. Coca-Abia. The remaining type specimens, two males, are paralectotypes. – *Amadotrogus rugifrons*: A male specimen of *Amadotrogus rugifrons* (Burmeister, 1855) placed in MLU is designated as the Lectotype, labelled as follows: 1) White, printed: MLU Halle, WB Zoologie, S.-Nr. 813115. 2) Brown handwritten: rugifrons Burm. Cors. Mill. 4) Red, printed: Lectotype, *Amadotrogus rugifrons* (Burmeister, 1855) Coca Abia det. 2001. The remaining type specimens, one male is paralectotype. 6 ♂♂ and 1 ♀ from Corsica. – *Rhizotrogus transfuga*: 1 ♂ with no label data.

Nota. The type specimens of *Rhizotrogus tarsalis* were not found. However, Reiche (1862) in describing this species realized its

similarity with *A. vicinus*. The description given by Reiche (1862) and Baraud (1992) suggest that this species can be included in genus *Amadotrogus*. Nevertheless, nothing can assure this until the type specimens are studied.

PHYLOGENETIC ANALYSIS

The analysis using equal weights yielded 95 equally parsimonious cladograms, each with 34 steps, consistency index (CI) of 0.794 and retention index (RI) of 0.899. Three rounds of successive weighting (base weight 1000) yielded 56 trees of length 235 steps, CI = 0.895 and RI = 0.955.

The genus *Amadotrogus* is phylogenetically related to the other West-Palaeartic genera of Melolonthini such as *Amphimallon*, *Rhizotrogus*, *Geotrogus*, *Pseudoapterogyna* and *Monotropus* (Coca-Abia 1995) and together they constitute a monophyletic group (fig. 6). The monophyly of this group is strongly supported (bootstrap of 98%) by the following synapomorphies: 1) insertion of the endophallus directly into the parameres without joining structures (10¹); 2) membranous dorsal structure of the parameres always present (11^{1,2}) and 3) ventro-caudal membranous area of the parameres always present (13^{1,2}).

The analysis (fig. 6) provided considerable support for one of the branches constituted by the species of *Amadotrogus* (93% of bootstrap). This clade is supported by the following synapomorphies: 1) palpi of the mentum with the second segment narrow and longer than the apical (2¹); 2) labrum with a prominence on the bottom of the depression (3¹); 3) dorsal sclerotized areas of the parameres present (12¹) (fig. 3); 4) size of the ventro-caudal membranous area in the parameres more than 1/3 parameres length (13²) (fig. 3); 5) endophallus shape with two caeca (14¹) (fig. 4) and 6) female genitalia with the spermathecal gland inserted in basal position (20¹) (fig. 5).

DISCUSSION AND CONCLUSIONS

The Palaeartic genera *Amadotrogus*, *Amphimallon*, *Rhizotrogus*, *Geotrogus*, *Pseudoapterogyna* and *Monotropus* constitute a monophyletic group (Coca-Abia 1995) (fig. 6) very well supported (bootstrap 98%) by three synapomorphic characters (10¹, 11^{1,2} and 13^{1,2}). On the other hand, *Amadotrogus* is a clade strongly supported (bootstrap 93%) (fig. 6) by six autapomorphic characters (2¹, 3¹, 12¹, 13², 14¹ and 20¹) which distinguish it from its allied genera. These distinctive characters are exclusively shared by the type species (*A. quercanus*) plus

six species transferred from *Rhizotrogus* to *Amadotrogus* (Coca-Abia & Martín-Piera 1998).

In contrast, those characters shared by *Amadotrogus* and *Amphimallon* (i.e. endophallus directly joined to the apices of the parameres, presence of dorsal membrane in the parameres and presence of ventro-caudal membranous area in the parameres) are also shared by their allies. This points out the overall similarity among *Amadotrogus*, *Amphimallon*, *Geotrogus*, *Monotropus*, *Pseudoapterogyna* and *Rhizotrogus* (Coca-Abia & Martín-Piera 1998) and the plesiomorphic significance of these characters for the clade.

Therefore, morphological and genitalic features currently used as taxonomic characters do not support treating *Amadotrogus* as a subordinate taxon of *Amphimallon*. As a consequence, subgenus *Amadotrogus* is elevated to the same taxonomic rank as its allies *Amphimallon*, *Geotrogus*, *Monotropus*, *Rhizotrogus* and *Pseudoapterogyna*, which are considered in current classifications to be genera.

Except for the type species *Amadotrogus quercanus* (Burmeister, 1855), the remaining species were new taxonomic combinations (Coca-Abia & Martín-Piera 1998). *Amadotrogus grassii*, *A. insubricus*, *A. oertzeni* and *A. vicinus*, were so far included in genus *Rhizotrogus* Berthold, 1827, specifically, in the "*Rhizotrogus vicinus*" group (Baraud 1992). *Amadotrogus truncatus* (Brenske, 1886) was never mentioned after publishing. *Amadotrogus patruelis* (Reiche, 1862) was considered to be a synonym of *Rhizotrogus parvulus* Rosenhauer, 1856, which remains in genus *Rhizotrogus*.

Rhizotrogus lajonquierei Baraud, 1970, *Rhizotrogus bolivari* Martínez y Sáez, 1873 and its synonymous

Amphimallon catalaunicum Báguena, 1956 (Coca-Abia 1992) also were included in the "*Rhizotrogus vicinus*" group (Baraud 1992). Now, they are considered synonyms of *Amadotrogus patruelis* (Reiche, 1862). Their remarkable similarities in external morphology and genitalia (tigilla-shape, aedeagus-shape, etc.) (figs. 12, 13) allow us to consider them to be one taxon.

In the same way, the taxonomic distinction between *Amadotrogus vicinus* (Mulsant, 1842) and *Rhizotrogus rugifrons* Burmeister, 1855 as different species is not justified. The frontal carina and the sclerotized structures in the parameres (fig. 7) and endophallus (fig. 8) indicate that they are synonymous taxa.

Finally, *Rhizotrogus tarsalis* Reiche, 1862 is expected to be studied; however, descriptions of it (Reiche 1862 and Baraud 1992) suggest that it could be a representative of genus *Amadotrogus*.

Acknowledgments – We thank Drs.: Claude Girard (Museum d'Histoire Naturelle of Paris); Roberto Poggi (Museo Civico "Giacomo Doria" of Genova); Alberto Sendra (Fundación "Torres Sala" of Valencia); Karla Schneider (Institut für Zoologie der Martin-Luther-Universität Halle) and Hella Wendt (Museum für Naturkunde of Berlin) for the loan of reference materials. Drs. Antonio Andujar, Jose Miguel Avila and Jose Luis Lencina for the loan of material from their collections. Dr. Miguel Angel Alonso Zarazaga and Antonio Sánchez Ruiz (Museo Nacional de Ciencias Naturales of Madrid) for taxonomic and nomenclatural advice. Dr. Olivier Montreuil (Museum d'Histoire Naturelle of Paris) for the help and suggestions regarding the manuscript. Dr. Patricio Domínguez Alonso (Natural History Museum of London) for providing computer facilities for computer graphic design; as well as Emilio Soterias, José Arroyo (Museo Nacional de Ciencias Naturales of Madrid) and Ignacio González Kortaberria for making the illustrations.

REFERENCES

- BÁGUENA CORRELLA L. 1956 – Dos especies nuevas más de Scarabaeidae de la fauna española. – *Graellsia*, **14**: 3-4.
- BARAUD J. 1970 – Contribution à l'étude du genre *Rhizotrogus* Berth. (Col., Scarabaeoidea). 3ème note: espèces nouvelles d'Europe occidentale et d'Afrique du Nord. – *Annales de la Société entomologique de France* (n.s.), **6**: 475-492.
- BARAUD J. 1992 – Coléoptères Scarabaeoidea d'Europe. Faune de France 78. Lyon: Publication of Fédération française des Sociétés de Sciences Naturelles et Société Linnéenne de Lyon, 856 p.
- BERTHOLD A.A. 1827 – *Latreille's natürliche Familien des Thierreichs mit anmerkungen und Zusätzen*: Weimar, 602 p.
- BRENSKE E. 1886 – Ueber Melolonthiden. – *Deutsche Entomologische Zeitschrift*, **30**: 195-207.
- BRENSKE E. 1893 – Ein neuer *Rhizotrogus* Italiens aus der Gruppe des *vicinus* und übersichtstabelle der Arten dieser Gruppe. – *Entomologische Nachrichten*, **19**: 188-191.
- BURMEISTER G. 1855 – Coleoptera Lamellicornia Phyllophaga chaenochela. Familie Phyllophaga. Gatt. *Rhizotrogus*. – *Handbuch der Entomologie*, **4**: 373-397.
- COCA-ABIA M. 1992 – *Amphimallon catalaunicum* Báguena, 1956 (Col. Melolonthidae) nueva sinonimia de *Rhizotrogus bolivari* Martínez-Sáez, 1873. – *Eos*, **68**: 203-204.
- COCA-ABIA M. 1995 – *Taxonomía, Filogenia y Biogeografía del género Rhizotrogus Berthold, 1827 en el Mediterráneo Occidental*. – Ph.D. Dissertation, Universidad Complutense, Madrid, 351 p.
- COCA-ABIA M., MARTÍN-PIERA F. 1991 – Anatomy and morphology of the genitalia in the subtribe *Rhizotrogina* (Col. Melolonthidae, Melolonthini): taxonomic implications. In: Zunino M., Belles X. & Blas M. (eds), *Advances in Coleopterology*, p. 61-78. Association European of Coleopterology: Barcelona.
- COCA-ABIA M., MARTÍN-PIERA F. 1998 – *Revisión taxonómica del género Rhizotrogus Berthold, 1827 (Coleoptera, Scarabaeidae, Melolonthinae)*. – *Elytron Monographs*, **2**: 116 p.
- ERICHSON W.F. 1847 – *Naturgeschichte der Insecten Deutschlands. Coleoptera. Scarabaeides pleurosticti. Melolonthidae*. Berlin: Nicolaische Buchhandlung, p. 656-661.
- ESCALERA M.M. 1914 – Los Coleópteros de Marruecos. – *Trabajos del Museo Nacional de Ciencias Naturales. Serie Zoológica*, **11**: 169-175.
- FABRICIUS J.C. 1801 – *Systema Eleutheratorum*. **2**: 687 p.
- FELSENSTEIN J. 1985 – Confidence limits on phylogenies: an approach using the bootstrap. – *Evolution*, **38**: 16-24.
- FITCH W.H. 1971 – Towards defining the course of evolution: Minimal change for aspecific tree topology. – *Systematics Zoology*, **20**: 406-416.
- GUÉRIN-MÉNEVILLE F.E. 1842. – Sur un groupe à séparer du genre *Rhizotrogus* Latr. et description du *R. Mayagnoscii*. – *Revue de Zoologie*: 6-8.

- ICZN 1999 – International Code of Zoological Nomenclature.
- LINNÉ C. 1758 – Systema Naturae. Ed. 10. Holmiae, 823 p.
- LUCAS P.H. 1846 – *Exploration scientifique de l'Algérie. Zoologie* (Mit untertitel: Histoire Naturelle des Animaux Articulés), **2**: 277-288.
- MADDISON W.P., MADDISON D.R. 1992 – MacClade: Interactive analysis of phylogeny and character evolution. Version 3.07. Massachusetts. 199 p.
- MAINARDI A. 1902 – *Rhizotrogus grassii* nuovo Coleottero italiano. – *Bollettino della Società entomologica Italiana*, **34**: 105-111.
- MARTÍN-PIERA F, COCA-ABIA M. 1992 – Revisión taxonómica del género *Rhizotrogus* Berthold, 1827: El grupo de *R. cicatricosus* Mulsant, 1842 (Coleoptera: Melolonthidae). – *Elytron*, **6**: 199-219.
- MARTÍNEZ Y SÁEZ F. 1873 – Datos sobre algunos coleópteros de los alrededores de Cuenca. – *Anales de la Real Sociedad española de Historia Natural*, **2**: 62-66.
- MONTREUIL O. 2000 – Cladistic systematics of the genus *Amphimallon* (Coleoptera: Scarabaeidae: Melolonthinae). – *European Journal of Entomology*, **97**: 253-270.
- MULSANT E. 1842 – *Histoire Naturelle des Coléoptères de France Lamellicornes*. Genre *Rhizotrogus*; *Rhizotrogue*: Latreille, p. 427-440.
- NIXON K.C., CARPENTER J.M. 1993 – On outgroups. – *Cladistics*, **9**: 413-426.
- REICHE M.L. 1862 – Espèces nouvelles de Coléoptères appartenant a la faune Circa-Méditerranéenne. – *Annales de la Société entomologique de France*, (4) **2**: 539-546.
- REITTER E. 1902 – Bestimmungs-Tabelle der Melolonthidae aus der Europäischen Fauna und den angrenzenden Ländern. III. Pachydemiini, Sericini und Melolonthini. – *Verhandlungen des Naturforschenden Vereins in Brünn*, **40** [1901]: 234-248.
- ROSENHAUER W.G. 1856 – *Die Thiere Andalusiens nach dem Resultate einer Reise zusammengestellt, nebst den Beschreibungen von 249 neuen oder bis jetzt noch unbeschriebenen Gattungen und Arten*. Erlangen, Blaesing, **8**: 17-406.
- SCHAUFUSS L.W. 1861 – Ueber 22 zum Theil neue käferarten. – *Issis*, 47-51.
- SWOFFORD D.L. 1993 – PAUP: Phylogenetic Analysis Using Parsimony, Version 3.1. Illinois. 253 p.