Molecular and morphological systematics of soil-inhabiting Cryptorhynchinae of the genus *Acallorneuma* and the tribe Torneumatini (Coleoptera: Curculionidae), with description of two new species

With 23 figures, 3 keys and 2 tables

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Summary

Starting from an ecological classification of the morphotypes of apterous western Palaearctic Cryptorhynchinae, molecular systematic and morphological results for the monophyletic weevil genus *Acallorneuma* Mainardi, 1906 and the tribe Torneumatini Bedel, 1884 are presented. Based on the mitochondrial CO1 barcoding region, we discuss the limits of comparative morphology in the uniform *Acallorneuma* species. A catalogue and a pictorial key of all 8 species of *Acallorneuma* are provided. In a second step we compare morphology-based systematics of the genus *Acallorneuma* with our molecular reconstruction. Finally, we focus on the related blind, equally wingless and uniform, currently 71 species of the tribe Torneumatini living deep in the soil. This overview of the present state of research shows that molecular intrageneric resolution is highly dependent on the number of sampled species, especially in those cases with particularly long edges in the dendrogram. But although Torneumatini sampling was not complete due to the elusiveness of these subterranean species, some taxonomic changes could still be implemented: *Torneuma* s. str. with the type species *Torneuma caecum* Wollaston, 1860 occurs only on the Madeira archipelago. The species of the subgenus *Paratyphloporus* Solari, 1937 stat. nov. - only from the western Canary Islands(!) - must be transferred into the genus subgenus *Paratorneuma* Roudier, 1956 stat. nov. For all other species of the Mediterranean area and the eastern Canary Islands, the systematic classification needs to be remade (incertae sedis, see also appendix 2). *Torneuma deplanatum deplanatum* (Hampe, 1864) is the type species of the subgenus *Typhloporus* that includes some, but not all Mediterranean species with a constantly deep and wide pectoral canal, which - as it now seems likely – was developed several times. Two new species are described: *Torneuma* (s. str.) *isambertoi* Stüben spec. nov. from Madeira and *Torneuma* (s.l.) *cadizensis* Stüben spec. nov. from the south of Spain. In both cases keys are given to differentiate from the closely related species.

Key words

*Acallorneuma*, Torneumatini, *Torneuma*, Bayesian analysis, Integrative Taxonomy, morphology, CO1, new species, taxonomic changes, Western Palaearctic, Spain, Portugal, Canary Islands, Madeira
1. Introduction

1.1 Ecological-morphological considerations

Cryptorhynchinae occur in almost all terrestrial habitats. Within the deciduous and the evergreen western Palaearctic forests these habitats reach from canopies over trunks, shrub layer and herbaceous layer down to the leaf litter zone (Fig. 1). Cryptorhynchinae also live in the humus-rich topsoil or among calcareous or volcanic rocks of the subsoil. Their larvae feed on dying twigs, root crowns or roots of lignified (also poisonous) stressed plants that have previously been damaged e.g. by wind or rockfall.

It is noticeable that the morphological variability within genera is highest in the canopy and upper zones of the understory. Morphological similarity among congeneric species conspicuously increases closer to the soil level. Thus, leaf litter-dwelling species of the genus *Echinodera* show only limited exoskeletal differences, and an unambiguous identification by external morphology is highly difficult in *Acallorneuma* species living in the topsoil. Without consideration of the male genital, morphological identification becomes virtually impossible in the subterranean, blind and extremely uniform-looking species of Torneumatini.

In the following, some typical body plans of flightless Cryptorhynchinae are exemplarily presented (see also Fig. 1):

Species of *Dendroacalles / Silvacalles* s. str. live among the higher branches up to the canopy layer of the Macaronesian laurel forest. Long-legged, rich in forms and colours and partly with bizarre scales and prominently protruding setae or bristle tufts (molecular studies in: Stüben & Astrin 2010a).

Species of *Kykloacalles* s. str. live in the upper herbaceous layer (e.g. on Fabaceae or Euphorbiaceae) often of woodless habitats in West and Southwest Europe and Northwest Africa. However, there are also representatives of the genus *Kykloacalles* in Central and Southeast Europe inhabiting the lower understory layer of deciduous forests. These species of the subgenus *Palaeacalles* possess somewhat longer legs than their South European relatives with a cylindrical appearance, often smooth elytra and contrasting, spotted coloration (molecular studies in: Stüben & Astrin 2010b).

Species of *Onyxacalles* have nocturnal habits and their activity is centered around the tree trunks and stumps of the deciduous and the evergreen broad-leaved forests of Europe, North Africa and the Canary Islands. Predominantly black species, often marked with only a few bright elytral bands. Species identification based on elytral contour and bristles and on pronotum form is considerably more difficult than in the above-mentioned genera (molecular studies in: Stüben & Astrin 2012).
Cryptorhynchinae: Colonization of different strata and habitats

Camptorhinus statua (able to fly)

Treetops

Dendroacalles s.str.

Mediterranean forest

Kyklioacalles s.str.

Myloacalles setosus

Onyxacalles

Onyxacalles baracus

Acalles / Echinodera

Acalles parvulus

Acallorneuma

Acalomegacalamines macrotrichus

Torneum matreiensia

Torneum madagascana

2014
Species of *Acalles* can be collected by sieving from the top layer of leaf litter in Central European forests or the detritus of low shrubs in Central and Southern Europe. *Acalles* specimens are brown and low in visual contrast, without conspicuous elytral marks or bands; in most cases also without bristle tufts or elytral protuberances. Without knowledge on aedeagi, species identification can often be very challenging, in some cases even impossible (molecular studies in: Schütte & Stüben 2015).

Species of *Echinodera* occur mainly in the Mediterranean area and on the Macaronesian islands, often as endemics, and can be collected in considerable numbers from the bottommost, often moist layer of forest leaf litter. Other than the above species, these Cryptorhynchinae can usually not be collected by beating of shrubs or branches. Legs are very short, eyes narrow and partly reduced; overall body shape is oval. Species are hard to tell apart and punctuation of the pronotum, number of elytral bristles and shape of the aedeagus all need to be carefully scrutinized (molecular studies in: Astrin & Stüben 2010).

Species of *Acallorneuma* inhabit the uppermost thin soil layer among calcareous rocks in the southwestern Mediterranean zone, with numerous endemics. The inclusion of *Acallorneuma* within Cryptorhynchinae has yet to be validated (doubts arise e.g. from Stüben et al. 2015, similarly for *Acallocrates* and Torneumatini). *Acallorneuma* species are characterized by un_contrasting brown, flattened species, nearly 'bald', without protruding bristles. Eyes very small, strongly reduced. Species very difficult or impossible to tell apart without inspection of the aedeagus (morphological studies in: Stüben 2006a).

*Torneumatini* encompass Mediterranean and Macaronesian, almost exclusively endemic species that always follow a subterranean way of life and are associated with roots in often calcareous or volcanic rocks. All characters mentioned above are strongly reduced in this group: eyeless, extremely flattened, short-legged, nearly 'bald', light brown species; virtually indistinguishable based on outward exoskeletal characters. For morphological species identification, inspection of the aedeagus and its internal sac is indispensable (morphological studies in: Stüben 2007).

The interestingly complex habitat structures illustrated in figure 1 are interestingly mirrored – to some degree – by the phylogenetic reconstruction for western Palaearctic genera of Cryptorhynchinae based on the mitochondrial COI + 16S and nuclear 28S genes (see Stüben et al. 2013: fig. 1). Indeed and generalizing, it can be said, that - for example - the Macaronesian tree climbers, the species of *Dendroacalles* (Stüben et al. 2009), appear as highly derived, younger taxa, whereas the *Acallorneuma* and Torneumatini living near or within the soil are certainly older. It could be shown for the first species of *Acallorneuma* that they are around 30 million years old, whereas the species of *Dendroacalles* formed 7 millions of years ago, and some species of *Silvacalles* only separated just 600,000 years ago. The *Kyklioacalles* of the lower strata can be classified between these evolutionary tendencies: they probably have developed around 17 million years ago (Stüben & Astrin 2010b: fig. 1B).

It is questionable and not always helpful if such distinct genera and ecological classifications are partly ‘levelled out’ by molecular analyses based on mostly conservative (nuclear) genes. This low ‘resolution’ at genus level leaves something to be desired in the light of worldwide thousands of described Cryptorhynchinae species. And these sometimes lead to far-fetched proposals suggesting e.g. that a “splitting” in several Western Palaearctic genera could not be helpful and „Torneumatini (represented solely by [one specimen of] Torneuma in [the] analysis) appear to be part of the Acalles group” (Riedel et al. 2016: 9) - without having to preoccupy oneself with the substantial morphological and mitochondrial differences among the only 6 species-rich genera of the ca. 400 Cryptorhynchinae species in the Western Palaearctic; overlooking the fact that the habitat and host requirements of these species are completely different!

However, the different morphotypes (body plans) described above show a marked correlation with the ecological stratification in a tree/shrub community: in western Palaearctic Cryptorhynchinae, intrageneric morphological variability is highest in the canopy-dwelling taxa, decreases in the species living closer to the soil ('epigain') and reaches almost complete uniformity in exoskeletal characters in the soil-dwelling taxa ('edaphon'). In other words: the higher and brighter the inhabited layer, the larger the morphological differences among congeneric species, enabling easier and faster phenotypic identifications.

This also has substantial consequences for phylogenetic approaches in western Palaearctic Cryptorhynchinae. In this group, classification at genus level is still straightforward based on clear and practically useful morphological, ecological and molecular differences (a fact not recognized by Riedel et al. 2016, who muse about western Palaearctic cryptorhynchine genera while ignoring 98.7 % of the group’s diversity). However at species level, the situation changes gradually: Recognizing evolutionary novelties on a morphological basis, without associated molecular analyses (like DNA sequencing), is still very well possible in species of *Dendroacalles* (Stüben & Germann 2005), *Dichroma-calles* (Stüben & Behne 1998) or *Kyklioacalles* (Stüben 1999, 2003), but becomes much more challenging for species of *Acalles s. str.* (Schütte & Stüben 2015). Ultimately, for the strongly uniform epigean or edaphic species, phylogenetic reconstructions based exclusively on morphological characters would be impractical. It is already difficult to discern, without additional infor-
1. What do we have to take into account when describing mostly uniform (not cryptic) species of *Acallorneuma*, and where do we reach the limits of comparative morphology?

2. What can we learn from the molecular reconstruction of *Acallorneuma* phylogeny and where are the differences from purely morphological reconstruction (for example by *Osella & Zuppa* 2002)?

3. What can be said about genus-level systematics and taxonomy of the soil-dwelling higher taxa of *Torneumatini*?

### 1.2 Material and methods

A molecular phylogeny of the western Palearctic weevil genera *Acallorneuma Mainardi*, 1906 and *Torneuma Wollaston*, 1860 is presented here in a Bayesian analysis (Fig. 3). In total the dataset contains 7 *Acallorneuma* species, 11 *Torneuma* species, 2 *Paratorneuma* species and 1 *Paratypophilorus* species. Furthermore, we included 4 *Kykloiacalles* (Cryptorhynchinae) sequences as outgroup taxa. Collecting and vouchering information as well as GenBank accession numbers are given in Appendix 1. We sequenced the (5') barcoding section of the CO1 gene.

Altogether 22 sequences were generated specifically for this study, the remaining 20 sequences were taken from previous studies of the ZFMK and Curculio Institute. Sequence length was 658 bp for CO1. Total genomic DNA vouchers and voucher specimens are deposited at the Zoological Research Museum Alexander Koenig (ZFMK). The laboratory routine followed Schütte et al. 2013, except samples marked with a star* in Appendix 1, which were processed as described in Astrin & Stüben (2008). In both cases the same primers were used (Astrin & Stüben 2008), based on the typical barcoding primers (Folmer et al. 1994): LCO1490-JJ 5’-CHACW AAYCATAAAGATATYGG-3’ and HCO2198-JJ 5’-AWACTTVCAGGRTGVCGCAARA ATCA-3’.

DNA sequence alignment has been performed with Biomatters Geneious 6.1.8 (http://www.geneious.com, Kearse et al. 2012), with the integrated MUSCLE plugin by using default parameters (Drummond et al. 2012). Sequences were 658 nucleotides in length. For two sequences we could not retrieve the full length. *Acallorneuma doderoi* (I-0120-dod): 572nt; *Torneuma cadizensis* spec. nov. 100-PST Spain-Cadiz: 657 nucleotides. Missing characters have been coded as ‘N’. jModeltest 0.1.1 (Posada 2008), implementing the Bayesian information criterion (BIC, Schwarz 1978), identified the HKY+I+G model of nucleotide substitution (Hasegawa et al. 1985) as the best-fit model for the CO1 alignment provided. The sequence data of the mitochondrial CO1 gene was used in parallel Bayesian Markov chain Monte Carlo (MCMC) analyses, as implemented in MrBayes ver. 3.2.0 (Ronquist & Huelsenbeck 2003). We applied the model of sequence evolution diagnosed by the BIC (nst=2 rates=invgamma). Parameters were unlinked between the 3rd versus 1st plus 2nd codon positions. Analyses were run for 40 million generations using the default chain number and temperatures, sampling 40,000 trees (average standard deviation of split frequencies: 0.000816). Every 1,000th tree was sampled. Negative log-likelihood score stabilisation was determined graphically. Accordingly, we retained 39,000 trees. These were used for building a 50 %-majority rule consensus dendrogram with posterior probability values. Geneious was used to display the tree and also to calculate uncorrected (*p*)-distances provided in Fig. 7 and within the text.
2. The genus and the species of *Acallorneuma*, and the limit to a comparative morphology

2.1 Key to the genera

The genus *Acallorneuma* (and the tribe Torneumatini) can be distinguished from all other Western Palaeartic genera of the subfamily Cryptorhynchinae (Coleoptera: Curculionoidea) by the following characteristics:

Fig. 2: Pictorial key to the species of the genus *Acallorneuma*.
1. Eyes lacking; subterranean species. .......................................................... Torneumatini
2. Anterior femora edentate. ........................................................................ all other Western Palaearctic Cryptorhynchinae: e.g. Acalles, Acallocrates, Calacalles, Dendroacalles, Dichromacalles, Echinodera, Kykloacalles, Onyxacalles
3. Elytra covered densely with scales, bristles and bristle tufts. Mostly species with wings living on trees and in tree crowns. ............................................................... (Gasterocercus, Camptorhinus, Cryptorhynchus)

(Camptorhinus status is a not closely related flyer of all other Cryptorhynchinae s. str. In addition, we also include the flightless species Poggionymus crassus Colonnelli, 1983 with a large tooth on the bottom side of the anterior femur; probably introduced to Sardinia).

3*. Elytra bare of scales, only with free-standing bristles on the intervals, in a single row and very distant from one another. Species wingless, living between decaying leaves of the upper soil layer. Length: 2.5–3.5 mm. Distribution: western Mediterranean area (Fig. 2). .......................... Acallorneuma MAINARDI, 1906

**Fig. 2: (continued): Pictorial key to the species of the genus Acallorneuma.**
Fig. 3. Bayesian consensus tree (50% majority rule) for COI.

Stüben, P. E.; Schütte, A.; López, H. & Astrin, J. J.: Molecular and morphological systematics of Acallorneuma and Torneumatini.
2.2 Catalogue of the species of *Acallorneuma*

Species included in the molecular analysis are printed in bold.

**Genus Acallorneuma** Mainardi, 1906: 151 type species *Acallorneuma rettleri* Mainardi, 1906

doderoi A. & F. Solari, 1909: 275 E: IT (Sicily)  
sabellai Osella & Zuppa, 2002: 448 (synonymised by Stüben, 2006)  
ibericum Stüben, 2005: 87 E: SP  
ingoii Osella & Zuppa, 2002: 445 E: IT (mainland)  
mainardi A. & F. Solari, 1909: 275 E: IT (Sardegna)  
montisalbi Osella & Zuppa, 2002: 452 E: IT (Sardegna)  
peyerimhoffi, F. Solari 1938: 29 N: AG  
rettleri Mainardi, 1906: 151 E: IT  
sardiniense Osella & Zuppa, 2002: 454 E: IT (Sardegna)  
gasparoi Osella & Zuppa, 2002: 455 (synonymised by Stüben, 2006)  
poggii Osella & Zuppa, 2002: 453 (synonymised by Stüben, 2006)

The morphological characters mentioned below enable differential diagnosis and offer a rough orientation among the 8 valid species of *Acallorneuma*. Focus characters are 1) the median lobe of the aedeagus, 2) elytral punctuation or form and arrangement of bristles on the elytral intervals and 3) species-specific ventral indentation of front femora (see pictorial key). However these characters do not suffice for a phylogenetic reconstruction as shown below.

2.3 Key to the species of the genus *Acallorneuma*

Even with such a pictorial key (Fig. 2), it is difficult to identify unambiguously the often uniform species of *Acallorneuma*. Furthermore, there remains the question whether accurate species assignments can also be performed on females. Osella & Zuppa seem to believe this is feasible, as they depict the spiculum ventrale and the spermatheca in comparative tables of their revision of *Acallorneuma* (Osella & Zuppa 2002), and even base their species descriptions mainly on the female genital, sometimes considering only a single female (e.g. in *Acallorneuma sabellai* syn. or – based on three females – in *Acallorneuma poggii* syn.). The first author has demonstrated that, with the exception of very few characters of the spiculum ventrale (apodeme length, form of brachia), the female genital is unfit to characterize species of *Acallorneuma* adequately (Stüben 2006a). When larger series of specimens are available for investigation, the high variability of the spiculum ventrale (ibid. Tab. 454.14) and also (to a lesser extent) of the spermatheca become apparent. Osella & Zuppa (2002) failed to prove the stability of these in fact unspecific characters, especially with regard to the species *Acallorneuma rettleri*, where many specimens were available to them and where they acknowledged the high variability (Osella & Zuppa 2002: fig. 6a–c).

The high variability of the spiculum ventrale is typical not only for species of the genus *Acallorneuma*, but for all Cryptorhynchinae of the Western Palaearctic. Unambiguous (re-) description of species belonging to the genus *Acallorneuma* – or in fact to any other genus of Cryptorhynchinae – should therefore never be based solely on female specimens, especially not exclusively on the spiculum ventrale (in more detail: Stüben 2006a).

Concluding, we hold that the few (mostly male) morphological characters used here in compiling the *Acallorneuma* key can serve as a first orientation aid within the genus, but do not – as with the uniform Torneumatini (see below) – constitute a sufficiently solid basis to induce hypotheses on species relationship.

3. Morphological and molecular systematics of the species of *Acallorneuma* Mainardi

Our molecular analysis is based on 15 individuals belonging to 7 of 8 valid *Acallorneuma* species (sequence of *Acallorneuma peyerimhoffi* is not yet available). The resulting phylogeny shows marked differences from the first reconstruction for the genus obtained by Osella and Zuppa (2002) in their ‘analisi filogenetica del genere *Acallorneuma* Mainardi, 1906’. We have reproduced their ‘morphological’ (i.e. morphology-derived) tree in Fig. 3 (top right). Using the same weevil genus as a model system, we can thus contrast two different character systems typically used in phylogenetics against each other. Tautz (2006) holds that morphological and molecular trees have to be considered independently from one another. However, striking inconsistencies should prompt us to search for erroneous assumptions or glitches in either method. It has to be noted that *Acalorneuma ibericum* Stüben from southern Spain could not yet be included in the analyses of Osella & Zuppa (2002), as it was described at a later point (Stüben et al. 2005). Regarding the other taxa, phylogenetic placement varies considerably between the morphological tree and the molecular dendrogram presented here.

The taxa *Acallorneuma gasparoi* Osella & Zuppa 2002 and A. *poggii* Osella & Zuppa 2002, both synonymized (Stüben 2006a) with *A. sardiniense* Osella & Zuppa 2002, appear at different positions in the morphological tree. The species *A. sabellai* Osella & Zuppa 2002 has been synonymized by Stüben (2006a) based on both morphological and mitochondrial 16S data (see also Aastrin et al. 2012) with the species *A. doderoi* A. & F. Solari 1908,
equally described from Sicily. It appears closely related with *A. gasparoi*, the above-mentioned synonym of *A. sardiniense*. This species from Sardinia, according to our molecular analyses the sister taxon of the central Italian species *A. ingoi* Osella & Zuppa 2002 appears, in the morphological reconstruction, as sister to all other *Acallorneuma* species. Apart from the species pair *A. reitteri* (central Italy) and *A. montisalbi* (Sardinia), there exist almost no similarities between the trees. How can these differences be explained?

1. First of all we have to consider the imbalance between number of species vs. number of characters within the morphological reconstruction, an aspect often underestimated in morphology-based phylogenetics. It is difficult to imagine that, like in the present case, 15 characters should suffice to establish a meaningful cladogram (Hennig 1966) for 10 ingroup species (cf. Osella & Zuppa 2002: 464). In cases of morphological uniformity such as the present, DNA sequence analysis seems to be the better option as it offers many more (quantifiable) characters at species level. Within an integrative taxonomic framework, it has been frequently shown that DNA-based phylogenies prompted the search for new morphological characters, led to modified character weighting or helped in unmasking plesiomorphic morphological characters. Molecular data have long since become an important corrective for morphologically-oriented taxonomists.

2. A purely morphological phylogenetic reconstruction does not gain additional precision or meaningfulness by subdividing already analyzed characters into several subcharacters. Such a practice merely leads to multiplication of the existing evidence. Over-splitting of characters has to be critically kept in mind when considering the characters connected to the spiculum ventrale (female genitalia) or the median lobe of the aedeagus (male genitalia) (see Osella & Zuppa 2002: Table II). Splitting complex characters into various components would be justified, however, if a gradual evolutionary increase in character complexity had been proven. Otherwise, complex characters are weighted too strongly just because they ‘strike the eye,’ or because they fit the picture that already exists in the experienced taxonomist’s / systematist’s mind, a common danger in purely morphological phylogenies. It is not our intention to criticize such an intuitive phylogenetic approach by experienced taxonomists – on the contrary, the resulting concepts often show striking concordance with ‘proper’, quantitative molecular phylogenies without room for interpretation. If this was not the case, we would have to redefine the largest part of insect systematics.

Thus, our critique is mostly directed at a-posteriori pseudo-legitimations of such intuitive phylogenetic concepts, which – in morphologically highly similar taxa – expose themselves to the suspicion of manipulative selection of characters.

3. Conspicuously, numerous morphological detail homologies are missing from the analysis, as almost half of the species in the character matrix feature question marks, coding for an undefined character state (see Osella & Zuppa 2002: Tab. III). This applies especially to the species *A. sabellai* and *A. poggi*, both described based on females, without information on the male genital. Phylogenetic analysis is thus supported by only eleven characters, and the question arises whether or not it makes sense to compile phylogenetic matrices when dealing with species affected by such a degree of morphological stasis, especially when based on a single sex. In such a scenario, there always exists the risk (among other effects) that synonymous species are not even recovered as sister taxa, as in our example *Acallorneuma sardiniense* Osella & Zuppa, 2002 = *Acallorneuma gasparoi* Osella & Zuppa, 2002 syn. = *Acallorneuma poggi* Osella & Zuppa, 2002 syn. or *Acallorneuma doderoi* A. & F. Solari, 1908 = *Acallorneuma sabellai* Osella & Zuppa, 2002 syn.) (cf. Osella & Zuppa 2002: fig. 10).

By this we do not deny the usefulness of purely pheno-type-based phylogenetic analysis (see Sudhaus 2006). However, in similar organisms, which show only a few characteristics as result of the adaptation to a life in the soil and karst (like the species of Torneumatini and *Acallorneuma*, see Introduction), it can lead to considerable misconceptions as shown below.

In *Acallorneuma*, Osella & Zuppa (2002) perceived morphological similarity with the species close to *Kyklioacalles punctaticollis* (Lucas, 1849) – the species that today are grouped into the subgenus *Glaberacalles* Stüben & Astrin 2010, with equally almost ‘bald’, flattened and elongate elytra. This comparison brings both genera into close evolutionary relationship (‘affinitia’ is mentioned). However, molecular phylogenetic reconstructions of western Palaearctic Cryptorhynchinae have shown that the genus *Kyklioacalles* is in fact – contrary to the proposal of Osella and Zuppa – highly derived and not closely related to the ‘basal’ *Acallorneuma* (Stüben & Astrin 2010b, Stüben & Schütte 2013). Closest to *Kyklioacalles* are the genera *Coloracalles* and *Montana-acalles*. Together with *Kyklioacalles*, they form the sister group to the genera *Acalles*, *Onyxacalles* and *Echinodera* (Astrin et al. 2012). The equally flat and elongate build, almost without setae, of the *Kyklioacalles* subgenus *Glaberacalles* results from a similar, partly soil-related mode of life on and between roots and root crowns, e.g. on various Fabaceae species (see details in Stüben 2006b). The flattened build could well be the result of convergent or parallel evolution (starting from the originally tree-dwelling *Kyklioacalles* s. str. species and species of the subgenus *Palaeacalles* with strongly curved elytra). For the species of *Acallorneuma*, species that hide away...
among the upper rock crevices during the hot summer months, a flattened body shape is a functional necessity. The same applies to the species of *Glaberacalles*. But these adaptational (better: eco-functional) similarities in body plan cannot prompt the conclusion that both taxa are necessarily closely reated. In fact, *Acallorneuma* species always cluster very 'basally' (often in conjunction with *Acallocrates*) in the various molecular western Palaearctic Cryptorhynchinae trees (Astrin et al. 2012, Stüben et al. 2013), and it cannot even be taken for granted that their inclusion within the subfamily Cryptorhynchinae is justified.

4. Intergeneric classification of the Torneumatini Bedel, 1884

Even more uniform than *Acallorneuma* are the species of the tribe Torneumatini. If not for the partly complex internal sac structures of the aedeagus (endophal-lus), one would have to speak of cryptic species in most Torneumatini. The currently 71 valid species and subspecies in the tribe have been assigned, according to length and form of the pectoral canal, into initially three, later four genera (Stüben 2007, see Fig. 4):

– *Pseudotorneuma* Solari, 1937: lacks a pectoral canal or a mesosternal receptaculum between the mid-coxae;

![Fig. 4: Heuristic subdivision of Torneumatini by form of the pectoral canal (according to Stüben 2007) for fast species assignment to groups and species, based on the simplest hypothesis of a continuous transformation series.](image-url)
– Paratyphloporus Solari, 1937: with pectoral canal that forms only a flat depression in front of the fore-coxae (Paratyphloporus I) or that ascends right before or between the fore-coxae, to drop steeply from here towards the mesosternal receptaculum (Paratyphloporus II);

– Torneuma Wollaston, 1860: with a constantly deep, tube-formed pectoral canal, reaching from the anterior margin of the prosternum to the mid-coxae and ending between the mid-coxae in an equally deep mesosternal receptaculum.

This preliminary subdivision (see Fig. 4), oriented at morphologically easily evaluable characters as the pectoral canal and mesosternal receptaculum, was meant as a useful provisional solution from early on (see Stüben 2007). Such heuristic instruments cannot convey any meaning on character polarity. Therefore the question could not be addressed whether Torneumatini originally completely lacked any pectoral canal (this seems to be the notion of Roudier 1956), or if instead the lack of a canal constitutes a secondary reduction. If we were dealing with a gradual mode of evolution, we would always find transitional forms (as intermediate character states) and would never be able to define (sub)genus-specific characters with certainty or conclusively.

In fact, recent molecular phylogenetic reconstructions (e.g. Stüben & Astrin 2010a) have shown that the pectoral canal has been acquired and reduced several times in Torneumatini evolution. As a first approximation, we currently reach the following conclusions:

1. The species of Torneuma s. str. occur only on the Madeira archipelago (see tree in Fig. 3). Besides the type species Torneuma caccum Wollaston, 1860, they contain five additional species: T. picocasteloense Stüben, 2002, T. desilvai G. Osella & Zuppa, 1998, T. korwitzi Stüben & Schütte 2015, T. maderense Stüben, 2002 and the new species T. isambertoi Stüben spec. nov. (see description and key below).

2. The subgenus Paratorneuma Roudier, 1956 stat. nov. from the western Canary Islands with the type species Torneuma (Paratorneuma) orbatum Wollaston, 1865 (La Gomera) includes the species T. (Paratorneuma) aphroditaes (Germann & Stüben, 2006) (La Gomera), T. (Paratorneuma) franz (González, 1971) (Tenerife), T. (Paratorneuma) lindrothi (Franz, 1981) (La Palma) and T. (Paratorneuma) feloi (Stüben, 2007) (La Palma), an originally described species of the genus Paratyphloporus. All these species were – in the meantime - ‘erroneously’ transferred by the first author into the genus Paratyphloporus Solari, 1937 with the type species Paratyphloporus karamani (Formánek, 1912) from the Dalmatian coast, because also these species evolved the pectoral canal in form of a more or less shallow depression in front of the fore-coxae (Stüben 2007, 2008). However, it was overlooked, that the rhomboid-like structures of the internal sac of the aedeagus of the Paratorneuma species from the Canary Islands are very different from the complex structures of the Paratyphloporus species from the Mediterranean area (see the figures in Stüben 2007). Furthermore, the latter also have a deeper depression in front of the coxae and/or these fore-coxae are far away from each other. In other words: although the more or less deep canal of the rostrum in front of the fore-coxae is present in both genera - reaching its highest point between the coxae and dropping steeply from here towards the mesosternal receptaculum –, it seems to be clear that both genera are not closely related as we had stated previously. It should therefore be presumed that we are here confronted with a convergent evolution of a reduction of the rostrum-canal, which leads de facto to the total loss of the rostrum-canal in the case of the few North African Pseudotorneuma species.

What can we say conclusively about the three species from Gran Canaria, T. viti, T. solarii and T. canariense (all described by G. & M. Osella, 1984)? At this time, the molecular basis is too little and the high molecular p-distances of the mitochondrial CO1 gene do not allow to include the species into the subgenus Paratorneuma. Furthermore, the rostrum-canal of these species from the eastern Canary Islands is clearly deeper, the fore-coxae are wider compared to the Paratorneuma species, the elytrae are longer and the internal sac of the aedeagus, consisting of two parallel bars or lines, is different from the species of the western Canary Islands. Therefore these last three species cannot be directly allocated currently to a subgenus.

3. Most Mediterranean species, which also have a fully developed pectoral canal, should be grouped – after resynonymizing – to the subgenus Typhloporus Hampe, 1864 with the type species Typhloporus deplanatum deplanatum Hampe, 1864 (see Fig. 3).

However and for the time being, they are considered incertae sedis with regard to a subgenus until more molecular data of more Mediterranean species are available.

4. What does this mean in practice? Even though most Torneumatini cannot be told apart by exoskeletal characters, using the partly complex structure of the internal sac of the aedeagus usually allows easy assignment of specimens to individual groups (cf. Stüben 2007 with clear, copiously illustrated identification keys and scroll images). The speciose Mediterranean subgenus Typhloporus thus can be subdivided into ‘broad-nosed’ and ‘long-nosed’ species, the latter further into a T. damryi, a T. robustum, a T. tunuseum, a T. convexiusculus and a T. siculum group according to the internal sac structure (see Appendix 2).

We eagerly await if this preliminary classification into morphological groups (particularly with regard to the
structure of the internal sac of the aedeagus and the depth
of the rostrum channel) will hold in the light of a molec-
ular phylogenetic reconstruction by using more genes.
But the fact that ‘not more’ than 21 out of 71 species of
Torneumatini could be analyzed molecularly in the last
eight years exemplifies how much patience we will have to
muster until a conclusive systematic classification will be
reached: the search for these subterranean species in the
Mediterranean area and on the Macaronesian islands is
among the most difficult, but also among the most urgent
tasks in present-day Cryptorhynchinae research. (Neither
sieving nor floating techniques seem to have predictable
success – even in places where Torneumatini species have
previously been found). Therefore, and keeping in mind
the conspicuously long branches of the dendrogram
(CO1 p-distances among species mostly 15 % or above),
it would be premature (see Fig. 3) to formally consider a
homogeneous Typhloporus subclade.

5. Taxonomy

Preliminary remark: A quick and unambiguous determi-
nation of Torneumatini species should always begin with
a meticulous examination of the structure of the male
endophallus. An identification of females is not promis-
ing considering the high number of species and also in
the light of the taxonomic ‘meaninglessness’ of female
genitalia in the tribe. Description of new species based on
a single female should be avoided and make morphologi-
cal revision or simple species description impossible in
whole or in part! A molecular analysis should be obliga-
tory in any such case.

5.1. Torneuma s. str. isambertoi STÜBEN spe. nov.

Family: Curculionidae LATREILLE, 1802
Subfamily: Cryptorhynchinae SCHÖNHERR, 1825
Tribe: Torneumatini BEDEL, 1884
Genus: Torneuma WOLLASTON, 1860
Subgenus: Torneuma s. str.
Type species: Torneuma caecum WOLLASTON, 1860
(type locality: Madeira)

Key to the Torneuma s. str. species from the archipelago of Madeira

1. Elytra short-oval, broad: < 1.68 x as long as wide: (Fig. 8–9). ................................................................. 2
1*. Elytra oblong-oval, narrow: > 1.80 x as long as wide: (Fig. 5–6, 10–11). .......................................................... 3

2. Elytra more convex, broadest position in or behind the center; sides of pronotum from the center to the front-
margin nearly narrowing rectilinearly: (Fig. 8); aedeagus: apex of the median lobe in ventral view with less distinct
tip, sharply rounded (Fig. 14). Madeira. Body length: 1.95–2.05 mm. Torneuma caecum WOLLASTON, 1860
= Torneuma brincki ROUDIER, 1965 syn.

2*. Elytra strongly flattened, broadest position in front of the center, more oval; sides of pronotum evenly rounded:
(Fig. 9); aedeagus: apex of the median lobe in ventral view with a distinct tip (Fig. 15). Porto Santo. Body length:
2.25–3.00 mm. Torneuma picocasteloense STÜBEN, 2002

3. Elytra longer, ogival-shaped in front of the apex (more clearly in females) (Fig. 6); median lobe of the aedeagus
9x-10x as long as wide (Fig. 13). Madeira (Paul do Mar): Body length: 2.40–3.20 mm. ............................................

3*. Elytra shorter, ovaly rounded towards the apex (without flat dents on each side immediately before the apex)
(Fig. 5, 10–11); median lobe of the aedeagus at most 2.2x as long as wide (Fig. 12, 16–17). ...................................... 4

4. Lower part of the interior sides of fore-tibiae (♂) ‘sickle-shaped’; aedeagus: median lobe in the middle part
convex and more acuminate: (Fig. 16). Habitus: (Fig. 10); Madeira (Sao Vicente, Cruta do Cardal). Body length:
2.25–3.15 mm. Torneuma desilvai OSELLA & ZUPPA, 1998

4*. Interior sides of the fore-tibiae (♂) nearly straight; aedeagus: median lobe parallel or narrowing rectilinearly and
less acuminate: (Fig. 12, 17). ................................................................. 5

5. Elytra more slender and more curved (Fig. 11); aedeagus longer (2.2x as long as wide) and the structure of internal
sac different (Fig. 17). Body length: 2.25–2.95 mm. Torneuma maderense STÜBEN, 2002

5*. Elytra slightly broader and flatter (Fig. 5); aedeagus shorter (1.9x as long as wide) and the structure of internal sac
different (Fig. 12). Body length: 2.50–2.80 mm. Torneuma isambertoi STÜBEN spe. nov.
Type material: Holotype (HT): 1 ♂, “Madeira, Paul do Mar, 32°45'34"N 17°13'43"W, 62 m, banana terraces under Ficus carica and Euphorbia piscatoria, sifting, 4.4.2015, leg. Stüben (20)”, coll. Curculio-Institute, D-Mönchengladbach. / Paratype (PT): 5 ♂, 4 ♀, same locality as for holotype, 4.4.2015, 2.7.2014, coll. Stüben, Curculio-Institute and ZFMK (Bonn).

DNAtype: 1 ♂, data as for holotype, collector’s no: 2790-PST, DNA no: ZFMK-DNA-0169166963, GenBank acc.: KU170192 (COI).

Description (Fig. 5, 12):

Length: 2.5–2.8 mm (without rostrum).

Venter: With a constantly deep and wide pectoral canal, from the fore-margin of the prosternum to the mid-coxae, terminating between the mid-coxae in an equally deep mesosternal receptaculum (Fig. 5); fore-margin of the prosternum low-cut, forming an arc of a circle; the ground between the prae-coxae slightly lifted, dropping down towards the mesosternal receptaculum. The
distance between the prae-coxae is large, as is their diameter. The brink of the mesosternal receptaculum is semicircular and sharp-edged; base of the receptaculum with a step. 1st and 2nd abdominal segment of the male with a wide and flat hollow.

**Head & Rostrum:** Without eyes; *T. isambertoi* belongs to the 'long-nosed' species: rostrum brown, 3.50x (♂) and 3.70x (♀) as long as wide between the insertions of the antennae; with a fine median edge and on each side with a conspicuous and elongated edge; insertions of the antennae near the apex, approximately at the end of the first quarter (♂) or first third (♀).

**Pronotum:** 1.18–1.20x as long as wide; widest at the end of the basal third of the pronotum; narrowing rectilinearly laterally towards the fore-margin, clearly less rounded than towards base. Disc of pronotum flattened, with fine, not deep punctures, covered with numerous round scales. The fore-margin of the pronotum with a slight indentation in the middle.

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![Image of Torreuma korwitzi](image_url)

*Fig. 6: Torreuma korwitzi Stüben & Schütte 2015, ♂, holotype.*
Elytra: Brown-russet, strongly flattened and elongate, 1.80x (♀) – 1.90x (♂) as long as wide; elytra in both sexes approximately parallel-sided (‘cylindrical’) in the middle, ovaly rounded directly in front of the apex; base line of elytra curved slightly S-shaped. The puncture stripes clearly more slender than the slightly arched intervals. These are covered with a single row of very fine, short and hardly discernible bristles.

Fig. 7: Distribution of the Torneuma (s. str.)-species and p-distances of the mitochondrial COI gene between Torneuma isambertoi and the related species from the Madeira Archipelago (see also dendrogram Fig. 3); below right: habitat of T. isambertoi, Madeira: Paul do Mar.

Fig. 8: Torneuma s. str. caecum (habitus).

Fig. 9: Torneuma s. str. picocasteloense (habitus).
**Aedeagus:** Median lobe 1.9x as long as wide, viewed laterally it forms approximately a right angle (Fig. 12).

**Etymology:** The new species is dedicated to Isamberto Silva (Madeira, Funchal), who has supported the first author with his excellent expert knowledge to collect the Curculionidae on the Desertas Islands. As a "Vigilante da Natureza" he is doing outstanding conservation work on the Madeira archipelago. His collection of insects and molluscs is unique.

**Ecology:** The new species was sieved out of dead and broken branches (detritus) by the first author in the ground under *Ficus carica* and *Euphorbia piscatoria* always together with *Torneuma korwitzi* (Fig. 7, bottom right) in the proportion 1:3 from the banana plantations near Paul do Mar (Madeira).

**Distribution:** So far this species is only known from the southwest of Madeira (Portugal). An overview of the species, collecting localities and the populations of all *Torneuma* species known from the Madeira Archipelago as well as the p-distances of the mitochondrial COI gene between *Torneuma isambertoi* and the related species are presented here in map: (Fig. 7).
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5.2. Torneuma s.l. caedizensis STÜBEN spec. nov.

Family: Curculionidae LATREILLE, 1802
Subfamily: Cryptorhynchinae SCHÖNHERR, 1825
Tribe: Torneumatini BEDEL, 1884
Genus: Torneuma WOLLASTON, 1860
Group: Torneuma robustum

Type material: Holotype (HT): 1 ♂, “Spain: Cadiz, La Linea, Sierra Cabonera: Puerto Higuener, Cordel Ruta Verde, N36°13'16" W5°20'59", 147 m, 28.9.2010, Quercus coccifera, leg. J.L. Torres”, coll. Curculio-Institute, D-Mönchengladbach.

DNAType: data as for holotype, collector’s no: 100-PST, DNA no: ZFMK-DNA-0100417927, GenBank acc.: KC783806 (CO1).

Description of the holotype (Fig. 18, 20):

Length: 3.25 mm (without rostrum).

Venter: With a constantly deep and wide pectoral canal, from the fore-margin of the prosternum to the mid-coxae, terminating between the mid-coxae in an equally deep mesosternal receptaculum (Fig. 18); the distance between the prae-coxae is large, as is their diameter. The brink of the mesosternal receptaculum is semicircular and sharp-edged; base of the receptaculum with a step. 1st and 2nd abdominal segment of the male with a wide and flat hollow.
Head & Rostrum: Without eyes; *T. cadizensis* belongs to the ‘long-nosed’ species: rostrum brown, 3.8x (♂) as long as wide between the insertions of the antennae, without a mid-edge, but on each side with a short edge; insertions of the antennae near the apex, approximately at the end of the first third (♂).

Pronotum: 1.16x as long as wide; widest at the end of the basal second fifths of the pronotum; narrowing rectilinearly laterally towards the fore-margin, clearly less rounded than towards base. Disc of pronotum flattened, with fine, deep and extensively placed punctures, covered with numerous round scales and isolated, scarce bristles. The fore-margin of the pronotum with a slight indentation in the middle.

Elytra: Brown-russet, flattened (much flatter and broader than those of *T. morandae*, see Fig. 19), 1.72x (♂) as

Fig. 18: *Torreuma cadizensis* spec. nov., HT.
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Fig. 19: Torneuma morandae Hoffmann, 1958, HT.

Fig. 20: Torneuma cadizensis spec. nov., aedeagus, HT.

Fig. 21: Torneuma morandae Hoffmann, 1958, aedeagus, HT.
Key to the species of the *Torneuma robustum* group with a simply V-shaped endophallus

Note: This group contains in the broadest sense almost a dozen additional species with a more complex and larger structure of the endophallus (see Fig. 'Tab.Tor.6.1' and the pictorial keys in Stüben 2007, and Fig. 'Trob' in Stüben 2009).

| 1. Elytra broad: < 1.65x as long as wide; lateral margins of the prosternal pectoral canal semicircularly rounded. ...... 2 |
|---|---|
| 1*. Elytra more slender: > 1.72x as long as wide; lateral margins of the prosternal pectoral canal nearly straight or weakly S-shaped. ................................................................. 3 |
| 2. Habitus broad; premuco small, more inconspicuous, Morocco (Tanger. Body length: 2.40–2.60 mm. ................... Torneuma robustum (Dieck 1869) = Crypharis tingitana Dieck 1869 = Crypharis strigirostris Fairmaire 1873 |
| 2*. Habitus slightly more slender; premuco large; Morocco (Tanger). Body length: 2.60 mm. ............................. Torneuma robustum var. tingitanum (Dieck 1869) infrasubspecific name (ICZN: 2000: 45.5) |
| 3. Punctures of the very narrow elytral striae: on the two first elytral striae from base until center of elytra with at least 12 very fine, deeply penetrated (often a little oblong) punctures; pronotum densely punctured. Italy: island of Lampedusa. Body length: 2.50–2.90 mm. .................. Torneuma exstinguendum Magnano & Mifsud 2001 |
| 3*. Punctures of the wider elytral striae: from the base until the middle of elytra with at most 10 strong punctures or puncture cavities; pronotum sparsely punctured. ................................................................. 4 |
| 4. Pronotum barely longer than broad, more or less square-shaped; elytra cylindrical. Spain (Alicante). Body length: 2.35 mm. ................................................................. Torneuma morandae Hoffmann 1958 |
| 4*. Pronotum 1.16x as long as wide; from the center towards the fore-margin laterally narrowing rectilinearly; elytra much flatter and broader. Spain (Cadiz). Body length: 3.25 mm. ........... Torneuma cadizensis Stüben spec. nov. |

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Fig. 22: Type locality of *Torneuma cadizensis* spec. nov. near La Línea de la Concepción (Spain: Cadiz) under *Quercus coccifera* (i.i. Torres, photo: Torres).
long as wide; elytra approximately parallel-sided in the middle, ovaly rounded directly in front of the apex; base line of elytra curved slightly S-shaped. Puncture stripes on the front half almost as broad as the arched intervals, on the posterior half clearly more slender. These intervals are covered with a single row of very fine, but easily discernable bristles.

**Aedeagus:** Median lobe 1.45x as long as wide, with a simply V-shaped structure of internal sac (Fig. 20) characteristic for the species of the *T. robustum* group (see key below and also Fig. 21).

**Etymology:** The species name refers to the province of Cádiz (Spain), in which the new species was found near La Línea de la Concepción (Fig. 22).

**Ecology:** The single specimen of the new species was collected by the first author’s colleague J.L. Torres (Spain, La Línea) under Quercus coccifera.

**Distribution:** So far this species is only known from the Sierra Cabonera near La Linea de la Concepción in the south of Spain.

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**Fig. 23:** Species of the *Torneuma robustum* group with a V-shaped endophallus in comparison.
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Appendix 1

Table 1: Collecting data, voucher numbers and GenBank accession numbers for the analysed material. Collecting dates are given in the format dd.mm.yyyy. Country abbreviations: ES-Spain, IT-Italy, PT-Portugal.

30 GenBank acc. numbers (without star marking) are published in this study for the first time. 15 GenBank acc. numbers marked with a star* were taken from Astrin et al. 2012. 2 GenBank acc. numbers marked with two stars** were taken from Stüben et al. 2013. 3 GenBank acc. numbers marked with three stars*** were taken from Stüben & Schütte 2015.

| Taxon                        | Collecting Data                                                                 | Collectors no.          | ZFMK Tissue no. | ZFMK DNA no.          | COI Genbank acc. |
|------------------------------|---------------------------------------------------------------------------------|-------------------------|-----------------|-----------------------|------------------|
| Acallorneuma doderoi         | IT, Sicilia, 5 km E Partinico, Santuario del Romitello, N38°02'37" E13°09'51", 720 m, 10.10.2006, leg. Stüben, P., det. Stüben, P., Coll. ZFMK | I-0120-dod             | ZFMK-TIS-cI0120   | ZFMK-DNA-0100400689   | GU987795         |
| A. & F. SOLARI, 1909         |                                                                                 |                         |                 |                       |                  |
| Acallorneuma doderoi         | IT, Sicilia, 6 km SW Godrano, Bosco Ficuzza, Mte. Rocca Busambra, N37°51'38" E13°23'24", Quercus, Fraxinus, 1200 m, 16.10.2002, leg. Stüben, P., det. Stüben, P., Coll. ZFMK | S-0082-dod             | ZFMK-TIS-cS0082   | ZFMK-DNA-0100400941   | EU286457         |
| A. & F. SOLARI, 1909         |                                                                                 |                         |                 |                       |                  |
| Acallorneuma ibericum        | ES, Jaen, Sierra de Cazorla: N of Arroyo Frio, N38°00'13" W02°53'10", Quercus ilex, 762 m, 14.05.2013, leg. Stüben, P., det. Stüben, P., Coll. ZFMK | 1324-PST               | ZFMK-TIS-4140     | ZFMK-DNA-0100426145   | KJ867619         |
| Stüben, 2005                 |                                                                                 |                         |                 |                       |                  |
| Acallorneuma ibericum        | ES, Jaen, S of La Guardia: Sierra de la Pandera, N37°40'20" W03°29'53", Erinacea anthyllis, Quercus ilex, Astragalus spec., Bupleurum, 1527 m, 19.05.2013, leg. Stüben, P. & Schütte, A., det. Stüben, P., Coll. ZFMK | 1336-PST               | ZFMK-DNA-0100426140| ZFMK-TIS-4152     | KJ867619         |
| Stüben, 2005                 |                                                                                 |                         |                 |                       |                  |
| Acallorneuma ingoi           | IT, Lazio, Alvito, S. Onófria, Val de Rio, N41°44'46" W03°41'41", Carpinus, 840 m, 05.05.2014, leg. Stüben, P. & Schütte, A., det. Stüben, P., Coll. ZFMK | 1771-PST               | ZFMK-TIS-24095    | ZFMK-DNA-0171624093   | KP776642         |
| Osella & Zuppa, 2002         |                                                                                 |                         |                 |                       |                  |
| Acallorneuma ingoi           | IT, Lazio, above S. Donato Val Di Comino: La grotta dei tedeschi, N41°43'67" E13°48'45", Carpinus, 995 m, 06.05.2014, leg. Stüben, P. & Schütte, A., det. Stüben, P., Coll. ZFMK | 1774-PST               | ZFMK-TIS-24098    | ZFMK-DNA-0171624090   | KP776636         |
| Osella & Zuppa, 2002         |                                                                                 |                         |                 |                       |                  |
| Acallorneuma mainardii       | IT, Sardinia, NW Usassai: above Cant. Arqueri, N39°48'60" E09°21'59", Quercus, 976 m, 11.05.2014, leg. Stüben, P. & Schütte, A., det. Stüben, P., Coll. ZFMK | 1785-PST               | ZFMK-TIS-24109    | ZFMK-DNA-0171624076   | KP776638         |
| A. & F. SOLARI, 1909         |                                                                                 |                         |                 |                       |                  |
| Acallorneuma montisalbi      | IT, E-Sardinia, W Siniscola: Monte Albo, N40°33'37" E09°38'01", Quercus ilex, 778 m, 26.09.2010, leg. Stüben, P., det. Stüben, P., Coll. ZFMK | IT1066c                | ZFMK-TIS-cIT1066c | ZFMK-DNA-JJ1066      | KP776635         |
| Osella & Zuppa, 2002         |                                                                                 |                         |                 |                       |                  |
| Acallorneuma montisalbi      | IT, E-Sardinia, SW Siniscola: Monte Albo, N40°32'07" E09°36'13", Quercus ilex, 748 m, 26.09.2010, leg. Stüben, P., det. Stüben, P., Coll. ZFMK | IT1098c                | ZFMK-TIS-cIT1098c | ZFMK-DNA-JJ1098      | KP776633         |
| Osella & Zuppa, 2002         |                                                                                 |                         |                 |                       |                  |

DOI: 10.21248/contrib.entomol.66.2.169-199
| Taxon                                      | Collecting Data                                                                 | Collectors no. | ZFMK Tissue no. | ZFMK DNA no. | CO1 Genbank acc. | DOI: 10.21248/contrib.entomol.66.2.169-199 |
|-------------------------------------------|----------------------------------------------------------------------------------|----------------|-----------------|---------------|-------------------|---------------------------------------------|
| Acallorneuma reitteri                     | IT, Molise, Montenero Val Cocchiara, N41°43'22" E14°04'54", Quercus, Rubus, Fraxinus, 915 m, 06.05.2014, leg. Stüben, P. & Schütte, A., det. Stüben, P., Coll. ZFMK | 1777-PST       | ZFMK-TIS-24101  | ZFMK-DNA-0171624087 | KP776641 |                                |
| Acallorneuma reitteri                     | IT, Abruzzo, Castel dileri, Forca Caruso: Cantomiera, N42°04'16" E13°42'17", Corylus, Acer, 1092 m, 07.05.2014, leg. Stüben, P. & Schütte, A., det. Stüben, P., Coll. ZFMK | 1780-PST       | ZFMK-TIS-24104  | ZFMK-DNA-0171624084 | KP776639 |                                |
| Acallorneuma reitteri                     | IT, Abruzzo, Castel dileri, Forca Caruso: Cantomiera, N42°04'16" E13°42'17", Corylus, Acer, 1092 m, 07.05.2014, leg. Stüben, P. & Schütte, A., det. Stüben, P., Coll. ZFMK | 1782-PST       | ZFMK-TIS-24106  | ZFMK-DNA-0171624073 | KP776640 |                                |
| Acallorneuma sardiniense                  | IT, Sardinia, N Tortolì: P. Pedra Longa, N40°01'16" E09°41'17", Pistacia, 343 m, 10.05.2014, leg. Stüben, P. & Schütte, A., det. Stüben, P., Coll. ZFMK | 1783-PST       | ZFMK-TIS-24107  | ZFMK-DNA-0171624074 | KU170191 |                                |
| Acallorneuma sardiniense                  | IT, E-Sardinia, N Dorgali: M. Tuttavista (Gipfel), N40°22'46" E09°38'22", Quercus ilex, 801 m, 06.10.2010, leg. Stüben, P., det. Stüben, P., Coll. ZFMK | IT1096c        | ZFMK-TIS-cIT1096c | ZFMK-DNA-JJ1096 | JX181781* |                                |
| Kyklioacalles erinaceus                   | ES, Jaen, Sierra de Cazorla: N of Arroyo Frio, N38°00'13" W02°53'10", Quercus ilex, Smilax, 762 m, 14.05.2013, leg. Stüben, P. & Schütte, A., det. Stüben, P., Coll. ZFMK | 1298-PST       | ZFMK-TIS-4114   | ZFMK-DNA-0100426167 | KJ867609 |                                |
| Kyklioacalles punctaticollis meteoricus   | ES, Granada, E of Baul, Sierra de Baza: Santa Barbara, N37°23'10" W02°50'55", Bupleurum, Astragalus spec., 1911 m, 17.05.2013, leg. Stüben, P. & Schütte, A., det. Stüben, P., Coll. ZFMK | 1320-PST       | ZFMK-TIS-4136   | ZFMK-DNA-0100426156 | KJ867614 |                                |
| Kyklioacalles punctaticollis               | ES, Prov. Malaga, Algatocin: near Opayar, N36°34'39" W05°18'13", 576 m, 17.08.2010, leg. Stüben, P., det. Stüben, P., Coll. ZFMK | ES1063         | ZFMK-TIS-cES1063* | ZFMK-DNA-JJ1063 | KU170190 |                                |
| Torneuma (Paratorneuma)                   | ES, Canary Islands, La Gomera, S Hermigua, El Cedro: Meriga, 28°09'12"N 17°14'13"W, Persea indica, stream valley, soil sample from type locality, 829 m, 28.12.2009, leg. Stüben, P., det. Stüben, P., Coll. ZFMK | ES1014         | ZFMK-TIS-cES1014 | ZFMK-DNA-JJ1014 | XI81783* |                                |
| Taxon | Collecting Data | Collectors no. | ZFMK Tissue no. | ZFMK DNA no. | CO1 Genbank acc. |
|-------|-----------------|----------------|-----------------|--------------|-----------------|
| Torneuma (Paratorneuma) aphroditae | ES, La Gomera, Parque Nacional de Garajonay; 500 m SW Eremita de Nuestra Senora de Lourdes: Campamento viejo, MSS trap, N28°07'11.4" W17°13'33.2", 991 m, 17.11.2013, leg. Oromí, P., det. Stüben, P. | 2862-PST_ADN569 | n.a. | n.a. | n.a. |
| Torneuma (Paratorneuma) aphroditae | ES, La Gomera, Parque Nacional de Garajonay; 500 m SW Eremita de Nuestra Senora de Lourdes: Campamento viejo, MSS trap, N28°07'11.4" W17°13'33.2", 991 m, 17.11.2013, leg. Oromí, P., det. Stüben, P. | 2863-PST_ADN570 | n.a. | n.a. | n.a. |
| Torneuma (Paratorneuma) feloi | ES, Canary Islands, Tenerife, Balo Blanco (Lavada de Tierra), N28°21'58" W16°35'14", washing soil, 660 m, 15.10.2009, leg. Oromí, P. & López, H, det. Stüben, P., Coll. ZFMK | 2857-PST | ZFMK-TIS-4252 | ZFMK-DNA-FC17941527 | KX246400 |
| Torneuma (Paratorneuma) feloi | ES, Canary Islands, Tenerife, Balo Blanco (Lavada de Tierra), N28°21'58" W16°35'14", MSS trap, 660 m, 10.02.2014, le. Oromí, P. & López, H, det. Stüben, P., Coll. ZFMK | 2859-PST | ZFMK-TIS-4254 | ZFMK-DNA-FC17941543 | KX246400 |
| Torneuma (Paratorneuma) orbatum | ES, Canary Islands, La Gomera, Hermigua, Ibó Alfaro, N28°09'58" W17°12'11", Persea, 255 m, 09.10.2008, leg. Astrin, J. & Stüben, P., det. Stüben, P., Coll. ZFMK | E-733-orb | ZFMK-TIS-cE733 | ZFMK-DNA-0100404822 | FJ716580* |
| Torneuma (Paratorneuma) orbatum | ES, Canary Islands, La Gomera, Hermigua, Ibó Alfaro, N28°09'58" W17°12'11", Persea, 255 m, 09.10.2008, leg. Astrin, J. & Stüben, P., det. Stüben, P., Coll. ZFMK | ES1003 | ZFMK-TIS-cES1003 | ZFMK-DNA-JJ1003 | KP776634 |
| Torneuma (Paratorneuma) orbatum | ES, Canary Islands, La Gomera, S Hermigua, El Cedro: behind Aceviños, 28°08'02"N 17°13'44"W, Persea indica, 890 m, 04.12.2009, leg. Stüben, P., det. Stüben, P., Coll. ZFMK | HR-0312-kar | ZFMK-TIS-cHR0312 | ZFMK-DNA-0100400108 | KP776630 |
| Torneuma baeticum | UK, Gibraltar, Engineer Road, Upper Rock, 36°07'26N 5°20'50"W, Ficus carica, 160 m, 03.02.2010, leg. Perez & Bensusan, det. Perez and Bensusan, Coll. ZFMK | GI1044 | ZFMK-TIS-cGI1044 | ZFMK-DNA-JJ1044 | KP776630 |
| Torneuma cf. bensusani | ES, Ceuta, Mirador Isabel II, 35°53’33”N 5°21’47”W, Asphodelus sp., 207 m, 08.05.2010, leg. Bensusan & Guillem, det. Bensusan and Guillem, Coll. ZFMK | EI1043 | ZFMK-TIS-cES1043 | ZFMK-DNA-JJ1043 | KP776632 |
| Torneuma (s. I.) cadizensis | ES, Cádiz, La Linea, Sierra Carbonera, Puerto Higuieron, Cordel Ruta Verde cibrando Bajo Coscoja, N36°13’17” W5°20’60”, Quercus coccifera, 155 m, 28.09.2010, leg. Torres, J. L., det. Stüben, P., Coll. ZFMK | 100-PST | ZFMK-DNA-0100417927 | KC783806 |
| Torneuma (s. I.) cadizensis | PT, Madeira, 1 km S Curral das Freiras, Seara Velha, N32°42’35” W16°58’17”, Ficus carica, 384 m, 20.03.2008, leg. Astrin, J. & Stüben, P., det. Astrin, J. and Stüben, P., Coll. ZFMK | P-523-cae | ZFMK-TIS-cP523 | ZFMK-DNA-0100400286 | FJ716559* |
| Taxon                                      | Collecting Data                                                                 | Collectors no.               | ZFMK Tissue no. | ZFMK DNA no. | CO1 Genbank acc. |
|-------------------------------------------|--------------------------------------------------------------------------------|------------------------------|-----------------|--------------|------------------|
| Torneuma (s. str.) desilval               | PT, Madeira, São Vicent, N32°47'51” W17°02'33”, Laurus azorica, 85 m, 22.03.2008, leg. Astrin, J. & Stüben, P, det. Astrin, J. and Stüben, P, Coll. ZFMK | P-529-des                   | ZFMK-TIS-cP529  | ZFMK-DNA-0100400638 | FJ716547*        |
| OSSELLA & ZUPPA, 1998                     |                                                                                 |                              |                 |              |                  |
| Torneuma (s. str.) isambertoi sp. n.      | PT, Madeira, Paul do Mar (20), N32°45'34” W17°13'43”, under Ficus carica, E. piscatorial, 62 m, 04.04.2015, leg. Stüben, P, det. Stüben, P, Coll. ZFMK | 2790-PST                    | ZFMK-TIS-26144  | ZFMK-DNA-0169166963 | KU170192         |
| STÜBEN, 2016                              |                                                                                 |                              |                 |              |                  |
| Torneuma (s. str.) isambertoi sp. n.      | PT, Madeira, Paul do Mar (20), N32°45'34” W17°13'43”, under Ficus carica, E. piscatorial, 62 m, 04.04.2015, leg. Stüben, P, det. Stüben, P, Coll. ZFMK | 2791-PST                    | ZFMK-TIS-26145  | ZFMK-DNA-0169166951 | KU170193         |
| STÜBEN, 2016                              |                                                                                 |                              |                 |              |                  |
| Torneuma (s. str.) korwitzi               | PT, Madeira, Paul do Mar, N32°45'34” W17°13'43”, Ficus, 62 m, 02.07.2014, leg. Stüben, P, det. Stüben, P, Coll. ZFMK | 1860-PST                    | ZFMK-TIS-26063  | ZFMK-DNA-0171606097 | KP776628*        |
| STÜBEN, 2015                              |                                                                                 |                              |                 |              |                  |
| Torneuma (s. str.) korwitzi               | PT, Madeira, Paul do Mar, N32°45'34” W17°13'43”, Ficus, 62 m, 02.07.2014, leg. Stüben, P, det. Stüben, P, Coll. ZFMK | 1864-PST                    | ZFMK-TIS-26067  | ZFMK-DNA-0171606101 | KP776629*        |
| STÜBEN, 2015                              |                                                                                 |                              |                 |              |                  |
| Torneuma (s. str.) maderense              | PT, Madeira, W Porto Moniz, Santa Madalena: Rib. do Tristao, N32°51'20” W17°12'21”, Moraceae, 154 m, 29.06.2014, leg. Stüben, P, det. Stüben, P, Coll. ZFMK | 1842-PST                    | ZFMK-TIS-26045  | ZFMK-DNA-0171606127 | KP869115*        |
| STÜBEN, 2002                              |                                                                                 |                              |                 |              |                  |
| Torneuma (s. str.) maderense              | PT, Madeira, 3,5 km W Porto Moniz, Santa Madalena, N32°51'25” W17°12'18”, Ficus carica, 296 m, 19.03.2008, leg. Astrin, J. & Stüben, P, det. Astrin, J. and Stüben, P, Coll. ZFMK | P-522-mad                   | ZFMK-TIS-cP522   | ZFMK-DNA-0100400291 | FJ716558*        |
| STÜBEN, 2002                              |                                                                                 |                              |                 |              |                  |
| Torneuma mesegueri lineaensis             | ES, Cádiz, La Línea, Sierra Carbonera, between Puerto Higuero and Zabal Alto, N36°12’ W05°19’, Pistacia lentiscus, 09.10.2008, leg. Torres, J. L., det. Torres, J. L., Coll. ZFMK | E-788-lin                   | ZFMK-DNA-0100405063 | ZFMK-TIS-cE788 | GU988047*        |
| STÜBEN, 2009                              |                                                                                 |                              |                 |              |                  |
| Torneuma (s. str.) picocasteloense         | PT, Madeira, Porto Santo, 2,5 km N Vila Baleira, Pico Castelo - Pico do Facho, N33°04’27” W16°19’25”, Cynara cardunculus, 146 m, 26.03.2008, leg. Astrin, J. & Stüben, P, det. Astrin, J. and Stüben, P, Coll. ZFMK | P-535-pic                   | ZFMK-DNA-0100400629 | ZFMK-TIS-cP535 | FJ716552*        |
| STÜBEN, 2002                              |                                                                                 |                              |                 |              |                  |
| Torneuma sp. ♀                            | ES, Málaga, E Málaga, Macharaviaya, N36°45’54” W04°12’47”, Olea europea, Ulex, 218 m, 06.01.2009, leg. Stüben, P, det. Stüben, P, Coll. ZFMK | E-758-TOR                   | ZFMK-TIS-cE758   | ZFMK-DNA-0100405061 | GU988048*        |
| STÜBEN, 2002                              |                                                                                 |                              |                 |              |                  |
| Torneuma cf. viti                         | ES, Gran Canaria, Barranco de Los Rios: Los Berrazales, N28°04’08” W15°39’22.5”, MSS trap, 503 m, 30.12.2013, leg. López, H., det. Stüben, P, Coll. ZFMK | 2861-PST_ADN567             | n.a.            | n.a.          | KX246401         |
| Torneuma cf. viti                         | ES, Gran Canaria, Barranco de Los Rios: Los Berrazales, N28°04’08” W15°39’23”, MSS trap, 499 m, 30.12.2013, leg. López, H., det. Stüben, P, Coll. ZFMK | 2865-PST_ADN573             | n.a.            | n.a.          | KX246405
### Appendix 2

Currently classification of the tribe Torneumatini Bedel, 1884

**GENUS Subtorneuma Hoffmann, 1961:** 36, stat. nov., (upgraded from subgenus of *Torneuma Wollaston, 1860*, see differential diagnosis in: Stüben 2007), type species *Torneuma (Subtorneuma) normandi* Hoffmann, 1961

- *Tornatum* Osella, 1986: 7, type species *Torneuma syriacum* Reitter 1889
  - *besucheti* Osella, 1986: 13, Turkey
  - *normandi* Hoffmann, 1961, Algeria
  - *loebli* Osella, 1986: 11, Turkey
  - *syriacum galliaeae* Osella, 1986: 11, Israel
  - *syriacum simoni* Meyer, 1895: 295, Israel
  - *diversum* Osella, 1986: 11
  - *syriacum syriacum* Reitter, 1889: 39, Lebanon

**GENUS Torneuma WOLLASTON, 1860:** 453, type species *Torneuma caecum* Wollaston, 1860

- *Coelotyphloporus* Solari 1937: 16, type species *Torneuma curtulum* F. Solari, 1937
- *Crypharis* Fairmaire 1868: 498, type species *Crypharis planidorsis* Fairmaire, 1868
- *Pseudotyphloporus* Solari 1937: 17, type species *Torneuma grouvellei* Desbrochers, 1889

subgenus *Torneuma s. str.*

- *caecum* Wollaston, 1860: 455, Maderia
  - *brincki* Roudier, 1965: 45
- *picocasteloense* Stüben, 2002: 152, Maderia
- *desilvai* Osella & Zuppa, 1998: 4, Maderia
- *korwitzi* Stüben & Schütte 2015: 1, Maderia
- *maderense* Stüben, 2002: 151, Maderia
- *isambertoi* Stüben, 2016, Maderia
subgenus *Paratorneuma* Roudier, 1956: 132, resyn., stat. nov. (downgraded to subgenus of *Torneuma* Wollaston, 1860), type species *Torneuma orbatum* Wollaston, 1865

*Parahyloporus* Germann & Stüben, 2006: 167, (Paratorneuma), Canary Islands: La Gomera

*franzii* González, 1971: 7, (Paratorneuma), Canary Islands: Tenerife

*indrothii* Franz 1981: 331, (Paratorneuma), Canary Islands: La Palma

*orbatum* Wollaston, 1865: 48, Canary Islands: La Gomera

*incertae sedis* (see above; belong perhaps to the same or a closely related subgenus)

*canariense* G. & M. Osella, 1986: 57, Canary Islands: Gran Canaria

*solarii* G. & M. Osella, 1986: 59, Canary Islands: Gran Canaria

*viti* G. & M. Osella, 1986: 54, Canary Islands: Gran Canaria

*mesegueri lineaeensis* Stüben, 2009: 99, Spain

*mesegueri mesegueri* González, 1971: 11, Spain

*Canary Islands: La Gomera*

*Canary Islands: La Palma*

*Canary Islands: La Gomera*

*incertae sedis* (see above; belong perhaps to the same or a closely related subgenus)

*besucheti* González, 1966: 104 (Pseudotorneuma), Spain (Majorca)

*mallorcense* Stüben, 2005: 118 (Paratorneuma)

*ericeensis* Stüben, 2007: 97, (Paratyphloporus), Italy (Sicily)

*Canary Islands: Tenerife*

*Canary Islands: Tenerife*

*Canary Islands: Tenerife*

*Canary Islands: Tenerife*

*Canary Islands: Tenerife*

*Canary Islands: La Palma*

*Canary Islands: La Gomera*

*Canary Islands: La Gomera*

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*Canary Islands: La Gomera*
T. damry group
damryi Perris, 1875: 10 (Crypharis), France, Italy
grouvellei grouvellei Desbrochers, 1889: clviii, France, Italy
grouvellei liguricum Stüben, 2007b: 60, Italy

T. robustum group
robustum Dieck, 1869: 355 (Crypharis), Morocco
strigirostris Fairmaire, 1873: 346 (Crypharis)
tingitana Dieck, 1869: 356 (Crypharis)
cadizensis Stüben, 2016, Spain
cextinguendum Magnano & Mifsud, 2001: 455, Italy (Lampedusa)
morandae Hoffmann, 1958: 194, Spain
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baelicum Stüben, 2007: 44, Spain
maltense Magnano & Mifsud, 2001: 453, Italy (Sardinia), Malta
ficuzzense Stüben, 2007: 57, Italy (Sicily)
angelae Magrini & Paladini 2015: 63, Italy (Sicily)
longipenne Pic, 1910: 89, Portugal
sterni Stüben, 2008: 97, Spain
torresi Stüben, 2009: 97, Spain
trogodytis Stüben, 2009: 95, Morocco
incertae sedis
lagaudei F. Solari, 1955: 158, France
mateui Roudier, 1954: 100, Spain
bensusani Stüben, 2010: 1, Spain
penaensis Germann & Braunert 2014: 562, Portugal

“Broad-nosed species”

T. tunesium group
tunesium F. Solari, 1937: 19, Tunisia
rugosum Normand, 1937: 259
attenuatum Normand, 1937: 260
boiteli Normand, 1937: 260, Algeria, Tunisia

T. siculum group
siculum elegantulum Normand, 1937: 261, Algeria
siculum siculum Ragusa, 1881: 43, Italy (Sardinia)
minutum Meyer, 1895: 293, Italy (Sardinia)
clandestimum Magnano & Mifsud, 2001: 458, Italy (Lampedusa)
strictum Magnano & Mifsud, 2001: 452, Malta
curtulum curtulum F. Solari, 1937: 19, Italy (Sardinia)
curtulum vastum Stüben, 2007: 75, Italy (Sardinia)
istanense alhaurinense Stüben, 2008: 100, Spain
istanense istanense Stüben, 2008: 98, Spain

T. convexiusculum group
convexiusculum convexiusculum Fairmaire, 1873: 347 (Crypharis), Algeria
convexiusculum theryi Desbrochers, 1889: clviii, France, Algeria, Tunisia
rectirostris Hoffmann, 1956: 70
incallidum Normand, 1937: 260
incertae sedis
serpentinum Stüben, 2007: 78, Portugal
longicolle Tournier, 1874: ccx (Crypharis), Algeria (type missing)
subterraneum Fairmaire, 1873: 347 (Crypharis), Algeria (type missing)