

## Article

# Combination of Morphometric and Morphological Analyses: An Effective Approach for the Study of *Platynus* from the Italian W Alps (Coleoptera, Carabidae, Platynini)

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**Abstract:** In the W Italian Alps, an area characterized by considerable environmental complexity, the widespread *Platynus* were studied by focusing on their species composition. The ecological niche realized by the genus in this area encompasses a preference for humid and cold environments, sometimes associated with altitude. Several specimens from private and public collections were investigated by geometric morphometrics, a powerful technique capable of detecting even minor morphological variation. The quantitative analysis was paired to a qualitative survey of anatomical traits. To classify and discriminate species, external traits (head, pronotum, right elytron) and internal structures (male and female genitalia, mouthparts) were evaluated by direct examination and dissection. The results supported the presence of the five species already known from the study area and also helped to identify four new cryptic taxa to which the specific rank was assigned. They are herein described as *Platynus maritimus* n. sp., *Platynus occitanus* n. sp., *Platynus simonisi* n. sp., and *Platynus vignai* n. sp.

**Keywords:** *Platynus*; geometric morphometrics; ground beetles; conservation; cryptic species



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## 1. Introduction

The ground beetle *Platynus* Bonelli, 1810 *sensu lato* is an extremely widespread speciose and almost a surely paraphyletic genus that is still scarcely understood. The majority of records come from Palearctic and Nearctic regions (<https://www.gbif.org>, accessed on 15 February 2023), but samples have thus been collected from any biogeographical region [1].

Presently, Nearctic species are perhaps the better-known ones [2], and their number keeps increasing. To date, the genus has more than 190 described species [3], but the real number is likely to be more than double. The genus is divided into some subgenera that are commonly regarded as different lineages [2]. Although some past attempts have been made to split *Platynus* into different genera, this proposal was not universally accepted [4], and, today, the taxonomic arrangement of this genus is still being debated [5]. A noteworthy point that should be addressed in any future phylogenetic study about *Platynus* s.l. is that the taxa included in the genus are either plesiomorphic with bilateral testes or monorchic with only one testis, being the Alpine species examined here included in the former group [6].

Identification in this taxon is not easy, and a large part (likely the majority) of these carabid species remains unknown. In 1992, the revision of the *Platynus degallieri* species group led to 25 new species being described, and their number in this lineage almost

doubled [4]. The number of unknown *Platynus* species could, potentially, be very large and even larger than previously hypothesized.

In such a diverse and variegated genus, the W Palearctic region is characterized by a few entities that usually belong to Alpine fauna. Some others such as *P. livens* (Gyllenhal, 1810) have been recorded from all over Europe, their distribution also extending eastwardly, while some others are only known from E Europe. However, one subset of the species has a narrower distribution, which is the case of *P. lindrothi* Baehr, 1982 from France [7]. Within this framework, we focused on a group of species from the Alpine area, specifically the Italian Alps:

*P. depressus* Dejean, 1831,  
*P. complanatus* Dejean, 1828,  
*P. peirolerii* Bassi, 1834,  
*P. erythrocephalus* Bassi, 1834,  
*P. teriolensis* K. & J. Daniel, 1898.

These are medium-sized ground beetles with a dark-brownish or blackish, very depressed body, long antennae and legs, and wide, flattened elytra. They are normally found at high altitude in montane forests, near glaciers, snow borders, and cold streams. Their peculiar ecological requirements and their elusiveness make these species a difficult study subject and, thus, very little is known about their biology. As these species also share very similar external features, their identification is difficult and ambiguous, and specific attribution is often performed by applying a geographic criterion.

The biodiversity of the Alpine area is rich [8–13] and is, at the same time, vulnerable to ongoing climate changes that occur at an unpredictable rate [14,15]. Similar to many other cold-adapted organisms [16], this extreme specialization has made them especially threatened by rapid climate change and habitat degradation [17,18]. Cold-adapted ground beetles are endangered by not only loss and fragmentation of glacier habitats, but also by isolation. In fact, this could cause frequent inbreeding and, consequently, high homozygosity (i.e., a loss of biodiversity) [19]. As a rule, the *Platynus* s.l. has shown a high level of heterozygosity; however, in the Nearctic montane *P. angustatus* Dejean, 1828, low levels of gene flow were detected [20], and thus localized extinction is a possible issue being the species unable to recolonize.

As these *Platynus* species are wingless, their dispersal power is poor, which suggests that they are closely related to their habitat and are extremely sensitive to its changes. Wingless *Platynus* s.l. have shown a maximum migration rate that is about half of winged *Platynus* s.l. and 1% of lowland species such as *Agonum elongatulum* Dejean, 1828 [21]. Some studies have suggested that ground beetles move only a few meters a day [22–25]. As with other carabid taxa, W Alps *Platynus* can be regarded as watchers and victims of climate change and are at risk of becoming extinct even before having been fully recognized and described [15,26].

The aim of the present research work was to evaluate the *Platynus* that inhabits the W Alps to not only confirm the genus' current systematics in this portion of the Palearctic region, but to also check for new taxonomic entities. To individuate these unknown taxa, the geometric morphometrics approach was applied to examine the size and shape variation in some anatomical structures that are commonly used in coleopteran systematics. These new species were defined based on qualitative and quantitative characters and then compared to the known *Platynus* species from the Italian Alps.

## 2. Materials and Methods

We examined about 2200 individuals belonging to the ground beetle genus *Platynus* Bonelli, 1810, collected from the Italian slope of the W Alps. The type of material was also studied to assess individuals' correct identification. The studied material was housed in the following museal and private collections:

MBCG—Museo di Scienze Naturali “Enrico Caffi”, Bergamo, Italy  
 MIZT—Museo di Zoologia dell’Università, Torino, Italy

MNHN—Muséum national d’Histoire naturelle, Paris, France  
 MRSN—Museo Regionale di Scienze Naturali, Torino, Italia  
 MSNG—Museo Civico di Storia Naturale “Giacomo Doria”, Genova, Italy  
 ZSM—Zoologische Staatssammlung, München, Germany  
 CAI—Gianni Allegro Collection, Moncalvo (AT), Italy  
 CBI—Luigi Bisio Collection, Cuorgnè (TO), Italy  
 CCA—Achille Casale Collection, Torino, Italy  
 CGH—Claudio Ghittino Collection, Torino, Italy  
 CGI—P.M. Giachino Collection, San Martino Canavese (TO), Italy  
 CSI—Antonio Simonis Collection, Torino, Italy

Our dataset included not only the four known *Platynus* species from the W Alps area, but also the fifth species known from Italy, E Alps *P. teriolensis* (material preserved in the MBCG collection) to represent all the variability of this carabid genus in the following analyses. In Italy, the distribution of these brachypterous carabids covers a large alpine area of the NW Alps from Piedmont (*P. peirolerii*, *P. erythrocephalus*, *P. complanatus*, and *P. depressus*) to Lombardy (*P. teriolensis*).

All specimens were examined by applying both a morphological survey by sight and a geometric morphometrics analysis (hereinafter quoted as the GM analysis).

To identify the appropriate set of characters to be used in the taxonomic rank definition and the individual attribution, we focused mainly on the well-known internal and external anatomical traits that have been widely selected in coleopteran systematic studies [27,28]. Among others, we tested the efficacy of head, pronotum, and right elytron and also examined genitalia and mouthparts.

MicroCT noninvasive 3D techniques were applied to evaluate the genitalia and mouthpart structures in situ following the method and the instrument parameters proposed by Kerman et al. [29] for other coleopteran taxa. Scans were performed by a Bruker® SkyScan 1174 (Bruker microCT, Kontich, Belgium) using the Bruker SkyScan (Bruker microCT, Kontich, Belgium) software series (i.e., SkyScan 1174v2 control software v1.1, NRecon v1.7.1.0, Data Viewer v1.5.2.4, and CTVOX v3.3.0) for data acquisition and reconstruction purposes. Each scan took about 4 h on average.

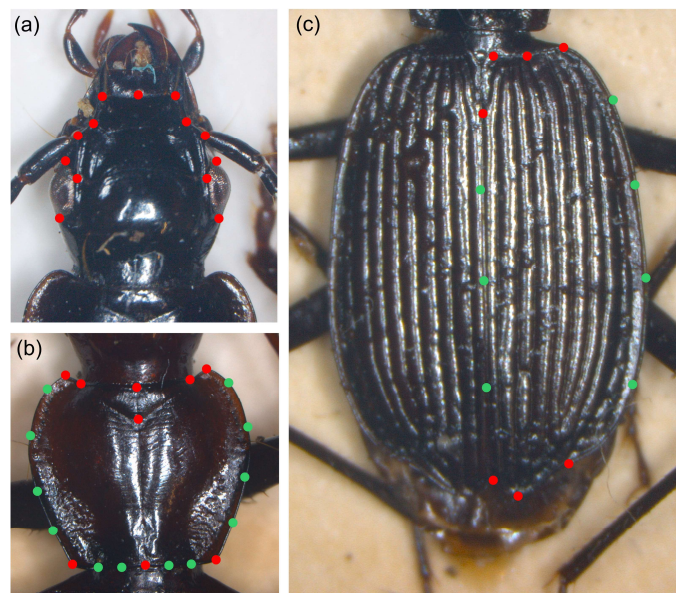
We georeferenced the collection localities and used the QGIS 3.26.3 [30] open source software to build a map with the shape files obtained from the HISTALP (Historical Instrumental Climatological Surface Time Series Of The Greater Alpine Region) [31].

To avoid any bias caused by sexual dimorphism, analyses were carried out by keeping sexes separated after identifying them by the presence/absence of the adhesive phanerae on the protarsi. Head, pronotum, and right elytron were photographed with a Leica® DMC4500 digital camera mounted on a Leica® Z16APO stereoscope (Leica Microsystem AG, Wetzlar, Germany), which was connected to a computer. Images were acquired by the Leica Application Suite software (Leica Microsystem AG, Wetzlar, Germany).

We removed any specimen with damaged or missing structures from the dataset. The analysis was performed with the tps series software [32–34]. We followed a landmark-based approach to study the head shape and a semi-landmark-based approach for both pronotum and elytron [33]. Point configurations (13 landmarks for head, 21 for pronotum, and 14 for the right elytron, see Figure 1) were defined with tpsDig2 v2.31 [35] and tpsUtil v1.82 [36]. As previously performed in other carabid studies [37–39], we examined structures separately to avoid measurement errors due to incorrect mutual positions of anatomical parts in the shape analysis.

To evaluate whether the amount of shape variation in each dataset was small enough to allow the GM analysis, the tpsSmall 1.36 [40] software was used.

A PCA (principal component analysis) was performed with tpsRelw v1.75 [41], and the relative warps (RWs) and centroid size (CS) values were then used to analyze the size and shape variation among and within the *Platynus* species with the IBM SPSS Statistic software, v28 (IBM Corp; Armonk, NY, USA) [42].



**Figure 1.** Configuration of landmarks: (a) head, dorsal view,  $N_H = 13$ ; (b) pronotum, dorsal view,  $N_P = 21$ ; (c) right elytron, dorsal view,  $N_E = 14$ . Red dots = landmarks, green dots = semi-landmarks.

We employed the centroid size values (CS) of pronotum as a good proxy of body size [38]. Then, the CS values for pronotum were plotted to show the size variation within and among these species using the PAST v4.08 software [43]. The Kruskal–Wallis nonparametric test was applied as implemented in the statistical software SPSS to evaluate whether body size was significantly different among species.

To evaluate if anatomical traits showed similar patterns of variation, the shape covariation was calculated on traits in pairs by the tpsPLS software, v1.25 [44]. The values of the first dimension (D1) were examined. The results were then tested to assess if covariation was due to chance or not by Permutation Tests with 1000 random permutations.

For each anatomical trait, the RWs that described 100% variance [37–39,45] were retained from the PCA to test taxa assignment correctness by the canonical variate analysis (CVA) using the SPSS software and examining the structure datasets separately and together.

The following measures were taken and included in the description of the new species: T = body total length, from the anterior margin of clypeus to the apex of elytra, measured along the elytral suture.

L = overall body length, from apex of mandibles to the apex of elytra, measured along the suture.

PL = pronotum maximum length, measured from anterior to the basal angle.

PW = pronotum maximum width.

EL = elytron maximum length, from shoulder to apex.

EW = elytron maximum width.

MH = maximum head width across eyes.

MF = minimum frons width between eyes.

### 3. Results

We examined all the *Platynus* specimens by evaluating their taxonomic position using the selected qualitative and quantitative characters and by checking for any possible differences. Five species were initially recognized: *Platynus depressus*, *P. complanatus*, *P. peirolerii*, *P. erythrocephalus*, and *P. teriolensis*. Only part of the individuals could not be assigned with absolute certainty to any of the known species and were marked as “unknown taxa”.



These last individuals were then carefully studied and compared to known species. GM analyses were applied to depict the taxonomic boundaries within the *Platynus* taxa. The quantitative analyses findings (i.e., pronotum, head, and elytra shape variation) were tested on qualitative characters (e.g., features of median lobe of the aedeagus, chaetotaxy) to verify any discrete variation. Both discrete and continuous information types were used to define specimens' taxonomic status.

Among the unknown individuals, four new species were thus identified, which have been herein named and described (see below):

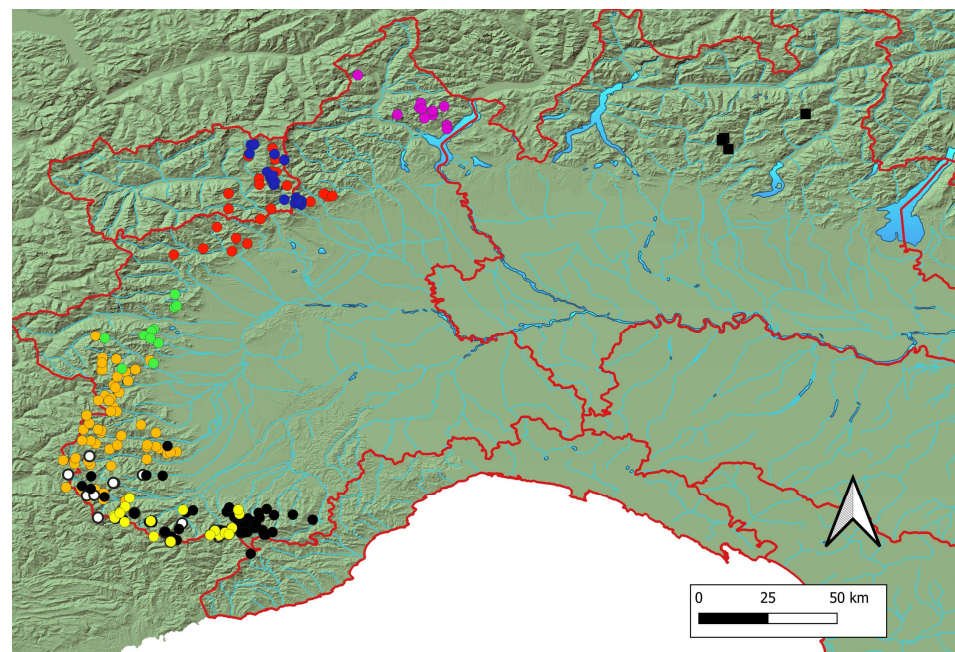
*Platynus maritimus* n. sp.

*Platynus occitanus* n. sp.

*Platynus simonisi* n. sp.

*Platynus vignai* n. sp.

The georeferenced collection data were examined to define the distribution of each species and were drawn on a map to visualize reciprocal settings (Figure 2). Overall, the *Platynus* species showed rather distinct distributions, with the collection area partially overlapping for the majority of the species, such as *P. depressus/complanatus*, *P. peirolerii/maritimus*, or *P. occitanus/peirolerii*. Other species were characterized by a more separated distribution, being superimposed only on borders, which was, e.g., the case of *P. simonisi/erythrocephalus*.



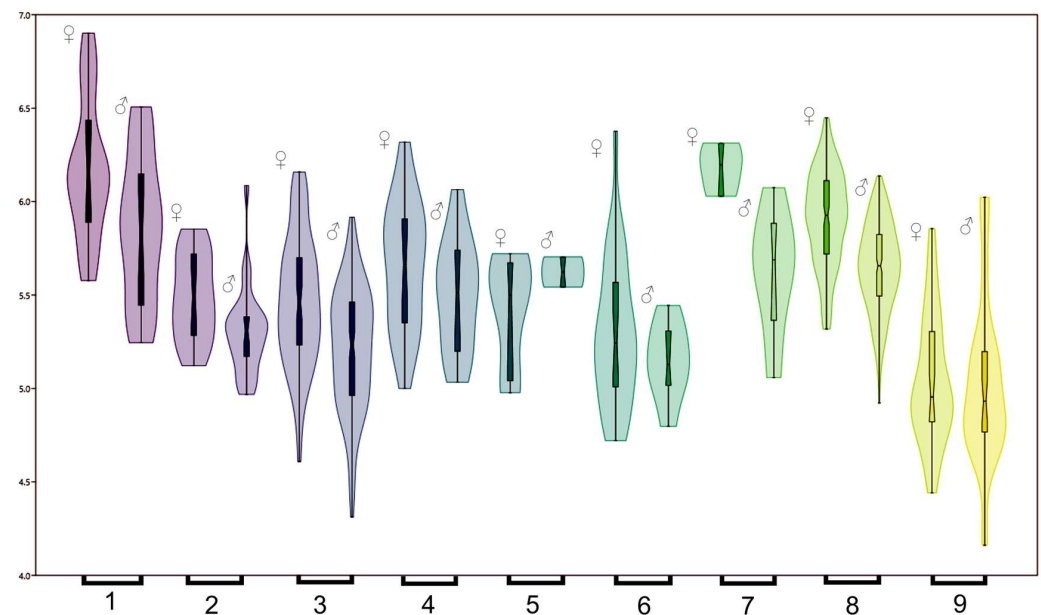
**Figure 2.** Distribution map of the *Platynus* species: black dots = *P. maritimus* n. sp.; white dots = *P. occitanus* n. sp.; yellow dots = *P. peirolerii*; orange dots = *P. erythrocephalus*; green dots = *P. simonisi* n. sp.; red dots = *P. complanatus*; blue dots = *P. depressus*; violet dots = *P. vignai* n. sp.; black squares = *P. teriolensis*.

*Platynus peirolerii*, *P. maritimus*, and *P. occitanus* were collected from the SW Alps and *P. complanatus*, *P. depressus*, and *P. vignai* from the NW Alps. *P. depressus* is also known from a small area in the E Alps (not examined in this study). Instead *Platynus erythrocephalus* and *P. simonisi* were from both the SW Alps and NW Alps sectors, while *P. teriolensis* was collected from the SE Alps (see [46] for the definition of the geographical sectors of the Alpine arc).

### 3.1. Morphometrics Analysis

#### 3.1.1. Size Analysis

For each species, we compared variations in size (i.e., CS values of pronotum) and evidenced differences between sexes as the most common pattern in *Platynus* already on the plot (Figure 3), with females normally being larger than males. Within this framework, *P. simonisi* showed a bigger overall size difference between males and females, and its females were also among the larger ones, together with those of *P. complanatus*. *Platynus vignai* had instead smaller females and also smaller differences between sexes, as highlighted when examining the means (Table 1).



**Figure 3.** Boxplot of the CS values of the pronotum in the *Platynus* species. The sexes were examined separately. A common pattern is identified in all the species, with the females usually larger than the males. The numbers correspond to the *Platynus* species: 1 = *P. complanatus*; 2 = *P. depressus*; 3 = *P. erythrocephalus*; 4 = *P. maritimus* n. sp.; 5 = *P. occitanus* n. sp.; 6 = *P. peirolerii*; 7 = *P. simonisi* n. sp.; 8 = *P. teriolensis*; 9 = *P. vignai* n. sp.

**Table 1.** Descriptive statistics of the body size (i.e., CS values of pronotum) in the *Platynus* species, with females and males treated separately.

Species	Female Mean	Female Range	Male Mean	Male Range
<i>P. complanatus</i>	6.163 ± 0.092	1.311	5.857 ± 0.078	1.261
<i>P. depressus</i>	5.479 ± 0.053	0.712	5.306 ± 0.049	1.117
<i>P. erythrocephalus</i>	5.472 ± 0.043	1.528	5.213 ± 0.028	1.604
<i>P. maritimus</i>	5.652 ± 0.075	1.331	5.504 ± 0.088	1.032
<i>P. occitanus</i>	5.425 ± 0.113	0.743	5.622 ± 0.081	0.162
<i>P. peirolerii</i>	5.295 ± 0.078	1.670	5.146 ± 0.080	0.647
<i>P. simonisi</i>	6.178 ± 0.088	0.299	5.630 ± 0.126	1.016
<i>P. teriolensis</i>	5.921 ± 0.211	1.124	5.648 ± 0.156	1.215
<i>P. vignai</i>	5.050 ± 0.054	1.427	5.020 ± 0.071	1.862

According to the descriptive statistics results (i.e., means and ranges, see Table 1), females' higher mean size value was obtained for *P. complanatus* and *P. simonisi*, with the smallest one for *P. vignai*, as previously pointed out. Males' higher mean value was calculated for *P. complanatus*, while *P. occitanus*, *P. simonisi*, and *P. teriolensis* were slightly smaller than *P. complanatus* and were similar in size. The other species (for males and females) displayed quite a certain size likeliness and were far less differentiated from one

another. The only exception to the most common pattern defined for *Platynus* (i.e., females larger than males) was *P. occitanus*, for which the mean size was smaller in females than in males.

The range of males and females was relatively different in each species. Sometimes it was substantially wider for males than for females, as in *P. depressus* and *P. simonisi*. The case of females obtaining higher range values than males is shown instead for, e.g., *P. complanatus*, *P. maritimus*, and *P. peirolerii*.

Applying an Independent Samples Kruskal–Wallis test (see in Table 2 the pairwise comparisons), we overall evidenced a statistically significant difference in size among the different species of *Platynus* for each sex ( $p < 0.001$  for both sexes).

**Table 2.** Significance levels for pairwise comparison for CS values of pronotum, where \* = 0.05; \*\* = 0.01; \*\*\* = 0.001; n.s. = not significant. The numbers correspond to the *Platynus* species: 1 = *P. complanatus*; 2 = *P. depressus*; 3 = *P. erythrocephalus*; 4 = *P. maritimus* n. sp.; 5 = *P. occitanus* n. sp.; 6 = *P. peirolerii*; 7 = *P. simonisi* n. sp.; 8 = *P. teriolensis*; 9 = *P. vignai* n. sp. In the upper triangle, there are the female significance values, and the male ones in the lower triangle.

	1	2	3	4	5	6	7	8	9
1	-	***	***	***	***	***	n.s.	n.s.	***
2	***	-	n.s.	n.s.	n.s.	n.s.	**	***	**
3	***	n.s.	-	n.s.	n.s.	n.s.	**	***	***
4	*	n.s.	*	-	n.s.	**	*	**	***
5	n.s.	n.s.	n.s.	n.s.	-	n.s.	**	**	n.s.
6	***	n.s.	n.s.	*	n.s.	-	***	***	n.s.
7	n.s.	*	**	n.s.	n.s.	*	-	n.s.	***
8	n.s.	***	***	n.s.	n.s.	**	n.s.	-	***
9	***	n.s.	n.s.	***	*	n.s.	***	***	-

Among these species from W Alps different patterns were highlighted:

- (i) *P. vignai* (9) was significantly different in size from the majority of the other species, at least for one sex, i.e., from *P. depressus* and *P. erythrocephalus* (females) and from *P. occitanus* (males). The only exception is the pair *P. vignai/peirolerii*, which gave a not-significant result for both sexes.
- (ii) *P. maritimus* (4) was significantly different from *P. complanatus*, *P. peirolerii*, and *P. vignai* for both sexes and from *P. erythrocephalus*, *P. simonisi*, and *P. teriolensis* for the females alone.
- (iii) *P. occitanus* (5) was, instead, significantly different from *P. complanatus* for both males and females, from *P. simonisi* and *P. teriolensis* for females, and from *P. vignai* for males.
- (iv) *P. simonisi* (7) was significantly different in size with *P. depressus*, *P. erythrocephalus*, *P. peirolerii*, and *P. vignai*. The female pairs showing significant differences in size were *P. maritimus* and *P. occitanus*, while no significances were obtained for the pairs *P. simonisi/teriolensis* and *P. simonisi/complanatus*.
- (v) *P. depressus* (2) was the species with less significant differences related to size: this species was significantly different from *P. complanatus*, *P. simonisi*, *P. teriolensis*, and *P. vignai* (the latter one, only females).
- (vi) *P. complanatus* (1), instead, was the species with the higher significant difference from the others: only the pairs *P. complanatus/simonisi* and *P. complanatus/teriolensis* showed no significant differences in size, and the pair *P. complanatus/occitanus* gave a significant result, although only for the females.
- (vii) *P. erythrocephalus* (3) was significantly different from *P. complanatus*, *P. simonisi*, and *P. teriolensis* (both sexes), *P. vignai* (females), and *P. maritimus* (males).
- (viii) *P. peirolerii* (6) showed significant differences from *P. complanatus*, *P. maritimus*, *P. simonisi*, and *P. teriolensis*, and no significant differences in size were shown for the other cases.

### 3.1.2. Shape Analysis

Each dataset gave quite a good correlation (uncentered) value, with 1.000 for head, the right elytron, and pronotum in both sexes. Thus, the results allowed the subsequent GM analyses to be done.

*Principal component analysis (PCA).* The overall shape variation in each examined structure gave similar results in both sexes:

1. For the head, a more than 64% overall shape variation was given by the first six out of 22 RWs in both males (64.47%) and females (64.34%);
2. For the pronotum, 76.25% was explained by the first three RWs in females and 77.93% by the first four RWs in males, with 100% overall shape variation explained by the first 32 out of 38 RWs;
3. For the right elytron, the first three RWs gave 85.41% variation in females and 82.25% in males, with 100% variance of shape given by 18 out of 24 RWs.

According to the above values, shape variation was quite scattered along a large number of RWs for all the structures (as it would be for the semi-landmark approach). Thus, the comparison of RWs in pairs by scatterplots (not provided here) cannot show the full amount of differences in shapes of structures.

*Partial least squares (PLS) analysis.* In females (Table 3), a strong correlation was evidenced between the head and pronotum, with the cross-set analysis giving 90.28% covariance in D1 with  $r = 0.66496$ , and the Permutation Tests confirming the significance of the paired shapes (the number and percent of correlations  $\geq$  observed being 0.10%).

**Table 3.** Results of the PLS analysis for each pair of the examined structures. Only the dimensions showing in the permutation tests a number and percent of correlations 0.10 were included in the table. The first dimension was higher than this value, and the following ones were discarded. Additionally, the dimensions with percent of covariance  $< 1.0$  were discarded. Only D1 is being discussed in the text, since the covariance values of the other dimensions were less than half of the first dimensions.

Structure Pairs		Dimension	% Covariance	r Correlations
Female	head      right elytron	D1	63.05	0.42830
		D2	14.86	0.35781
		D3	12.41	0.31195
		D4	6.04	0.34223
	head      pronotum	D1	90.28	0.66496
		D2	4.34	0.43758
		D3	2.79	0.37339
		D4	1.02	0.35253
	right elytron      pronotum	D1	56.05	0.35627
		D2	24.69	0.47111
		D3	15.84	0.36841
		D4	1.16	0.36602
Male	head      right elytron	D1	68.10	0.48597
		D2	23.34	0.42342
		D3	4.60	0.32166
		D4	2.08	0.34024
	head      pronotum	D1	86.68	0.65990
		D2	7.63	0.42802
		D3	2.28	0.32786
		D4	1.33	0.29334
	right elytron      pronotum	D1	57.76	0.30909
		D2	29.68	0.51212
		D3	9.34	0.29528



For the other structures, a lower correlation value was obtained for the pairs head vs. elytron and pronotum vs. elytra. For both analyses (head vs. elytron D1 covariance = 63.05%,  $r = 0.42830$ ; pronotum vs. elytron D1 covariance = 56.05%,  $r = 0.35627$ ), the number and percent of correlations  $\geq$  observed was 0.10% (a lower value than that expected merely due to chance). Thus, the calculated correlations were smaller than for the pair head vs. pronotum.

In males, the results were congruent with those shown above, with, e.g., the calculated covariance of head vs. elytron (D1 covariance = 68.10%,  $r = 0.48597$ , Permutations Tests = 0.10%) being almost identical to that of females. The same results (with identical Permutation Tests values to the former analysis) were obtained for the other two shape comparisons: the pair elytron vs. pronotum gave the lower correlation (D1 covariance = 57.76%,  $r = 0.30909$ ), while a higher correlation was obtained for the pair head vs. pronotum (D1 covariance = 86.68,  $r = 0.65990$ ).

In all the tested pairs, the other dimensions were not further examined, as they revealed far lower covariance indices (Table 3).

*Canonical variate analysis (CVA)*. The head, pronotum, and right elytron analyses gave different results in males and females. In each analysis, the RWs that explained 100% overall shape variation were included, and the number for each anatomical trait in both sexes was the same.

In the CVA of the female head (Figure 4a), *P. maritimus* (4) was well separated from the other species, as were *P. simonisi* (7), *P. teriolensis* (8), and *P. occitanus* (5). The last one was nearer to both *P. vignai* (9) and *P. peirolerii* (6). These two species showed some likeness in head shape, and the other species seemed more closely related to one another, with *P. complanatus* (1), *P. depressus* (2), and *P. erythrocephalus* (3) forming a closer group. The male head results (Figure 4b) suggested quite a striking head likeness in all the species. Nevertheless, *P. vignai* (9) and *P. peirolerii* (6) were closer than the other species, as previously seen in females.

Pronotum showed some differences in both sexes (Figure 4c,d) because *P. erythrocephalus* (3) was well separated from the other species in males but was very close to *P. complanatus* (1) in females. In both sexes, *P. occitanus* (5) was quite near *P. peirolerii* (6) and *P. maritimus* (4). In females, *P. depressus* (2), *P. simonisi* (7), and *P. vignai* (9) were also grouped together on the plot. *Platynus teriolensis* (8) was, instead, well separated from the other species in both sexes. In males, *P. complanatus* (1), *P. depressus* (2), and *P. simonisi* (7) were similar, while *P. vignai* (9) was separated from both the 1st group with *P. occitanus* (5), *P. maritimus* (4), and *P. peirolerii* (6) and the 2nd group with *P. complanatus* (1), *P. depressus* (2), and *P. simonisi* (7).

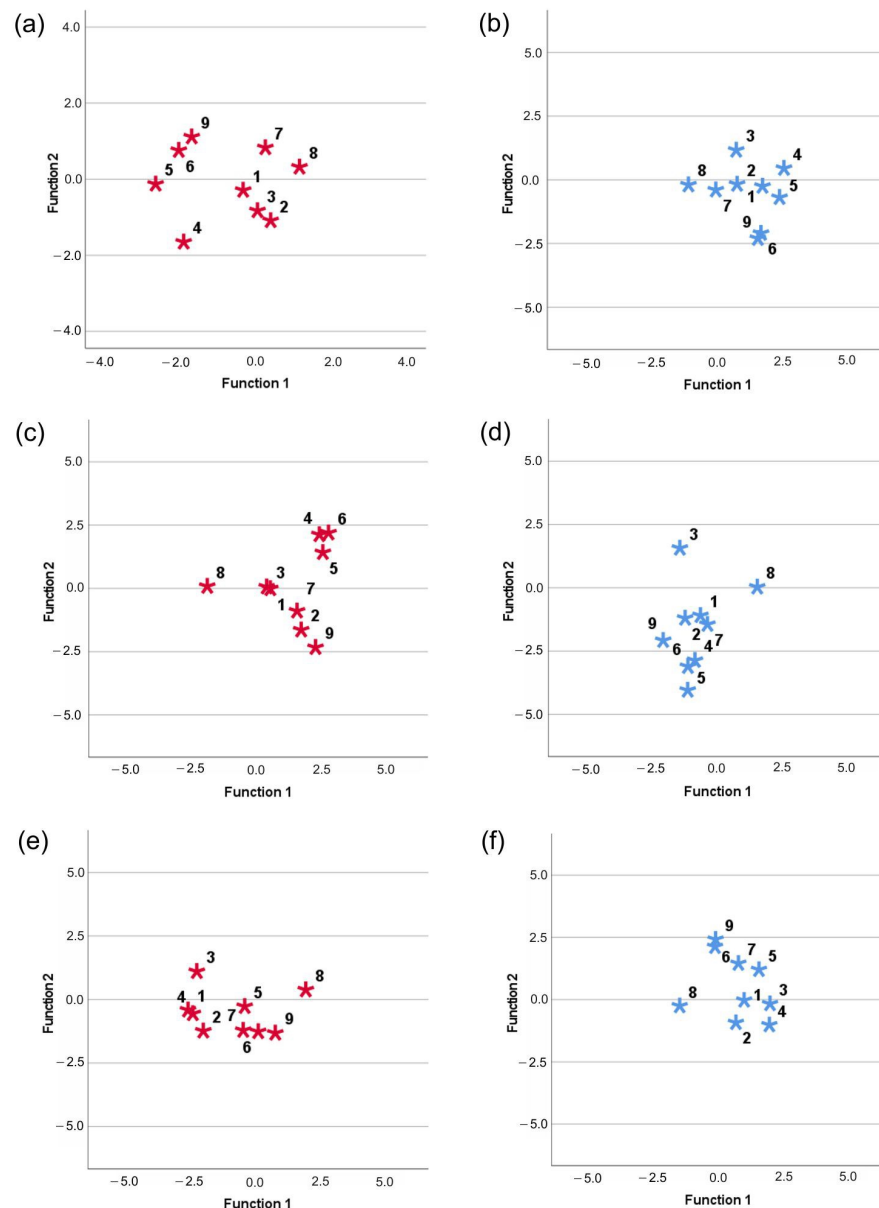
For the right elytron (Figure 4e,f), similarities were evidenced between sexes, and were more marked than for any other examined trait. *Platynus teriolensis* (8) was still the most isolated species in both sexes. Some grouping was evidenced and constituted by:

- (i) *P. erythrocephalus*, *P. depressus* (2), *P. complanatus* (1), and *P. maritimus* (4)
- (ii) *P. occitanus* (5), *P. simonisi* (7), *P. peirolerii* (6), and *P. vignai* (9).

In the latter group, some closer relationships appeared between *P. vignai* (9) and *P. peirolerii* (6) in males, while *P. occitanus* (5) was slightly separated from the other three species in females.

When comparing species' positions on the CVA plots of the different structures per sex, relationships among species were quite different when examining the three structures. In both the female and male analyses, *P. teriolensis* (8) remained isolated from the W Alps species. In females, *P. peirolerii* (6) and *P. vignai* (9) formed a close group for head but were more distant on the scatterplot for pronotum and elytron. Only on the pronotum plot did *P. peirolerii* (6) come close to *P. maritimus* (4) and *P. occitanus* (5), while *P. vignai* (9) was near *P. depressus* (2). The head and pronotum of *P. complanatus* (1) and *P. erythrocephalus* (3) were similar, while these two species were further away on the elytron scatterplot, where *P. complanatus* (1) was closer to *P. maritimus* (4). In male specimens, *P. peirolerii* (6) and

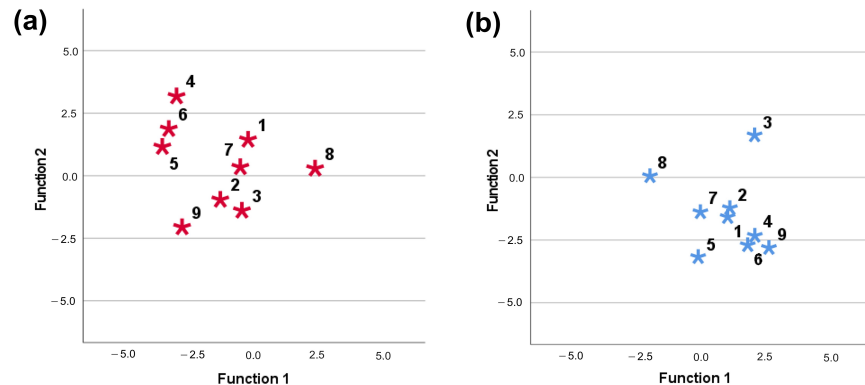
*P. vignai* (9) displayed a similar distribution to that of the females for head but were also very close on the elytron plot.



**Figure 4.** Scatterplots of the CVA of the three structures. The sexes were examined separately. Between brackets, the percentage of original cases correctly classified: (a) female head (57.2%); (b) male head (72.3%); (c) female pronotum (86.7%); (d) male pronotum (85.0%); (e) female elytron (78.2%); (f) male elytron (74.8%). The numbers in each plot correspond to the *Platynus* species: 1 = *P. complanatus*; 2 = *P. depressus*; 3 = *P. erythrocephalus*; 4 = *P. maritimus* n. sp.; 5 = *P. occitanus* n. sp.; 6 = *P. peirolerii*; 7 = *P. simonisi* n. sp.; 8 = *P. teriolensis*; 9 = *P. vignai* n. sp. Red star = centroid of female data, blue stars = centroid of male data.

Based on the former results, another CVA was, subsequently, performed (by always maintaining each sex separately) and included the RWs of head and pronotum together with the CS values of pronotum to build a single matrix to evaluate the goodness of the structures to groups attribution. As the PLS analysis results gave a low covariance rate for elytron and any of the other traits, the former structure was excluded from the current dataset.

The CVA of the females gave 93.3% of the original grouped cases being correctly classified. On the plot (Figure 5a), the relative position of the group centroids partly mirrored species distributions (Figure 2). On the plot, *P. peirolerii* (6), *P. occitanus* (5), and *P. maritimus* (4) seemed to be more closely related to one another than to the other W Alps species, while *P. teriolensis* (8) was clearly separated from the entire W component of *Platynus*. *Platynus vignai* (9) was isolated from the other four species, which formed two pairs constituted by *P. complanatus* (1) and *P. simonisi* (7) and by *P. erythrocephalus* (3) and *P. depressus* (2).



**Figure 5.** Scatterplots of the CVA of head and pronotum shapes, and body size together. The sexes were examined separately: (a) female and (b) male plots. The numbers in each plot correspond to the following *Platynus* species: 1 = *P. complanatus*; 2 = *depressus*; 3 = *erythrocephalus*; 4 = *maritimus* n. sp.; 5 = *occitanus* n. sp.; 6 = *peirolerii*; 7 = *simonisi* n. sp.; 8 = *teriolensis*; 9 = *vignai* n. sp. Red star = centroid of female data, blue stars = centroid of male data.

The CVA for males gave analogous results, with 92.3% for the original grouped cases being correctly classified. Remarkably, the males plot (Figure 5b) gave slightly different information about species relationships. While *P. teriolensis* (8) was, once again, the most isolated one, *P. erythrocephalus* (3) was also well separated from other species. In the remaining W Alps species, *P. occitanus* (5) was distinct from both the first group including *P. simonisi* (7), *P. depressus* (2) and *P. complanatus* (1), and the second group containing *P. peirolerii* (6), *P. maritimus* (4) and *P. vignai* (9).

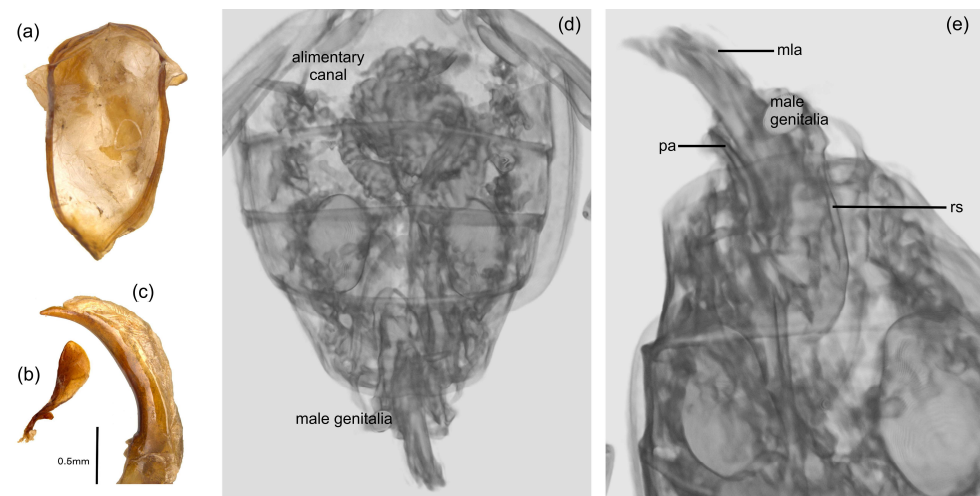
### 3.2. Morphology of Genitalia and Mouthparts in *Platynus*

We also examined some other anatomical traits, such as the genitalia of both sexes and mouthparts. Although male genitalia are often used as a diagnostic character in carabid taxonomic studies [37,47], female genitalia had not yet been examined in the *Platynus* from the W Alps until now. Thus, female genitalia are presently known only for a part of these ground beetle species [48–50].

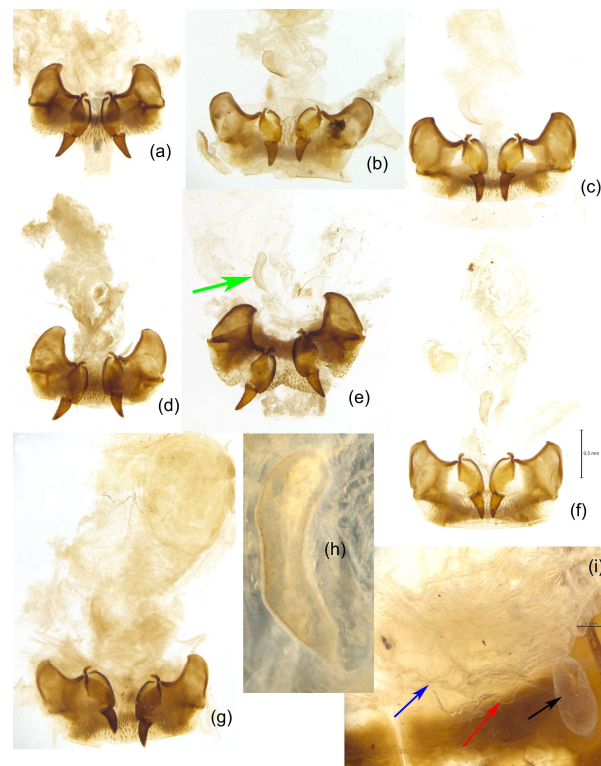
Specimens were dissected following the well-established methods for preparation [51]. Male genitalia, constituted by the median lobe of the aedeagus, parameres, and ring sclerite (Figure 6) were used (see below) to discriminate among the taxonomic entities detected in the present research.

Female genitalia (Figure 7) have been examined, and the various structures were evaluated for their usefulness in identifying the W Alps *Platynus*. In these species, the bursa copulatrix is elongate, without a microtrichial band. The spermatheca is an elongate, tubular, basal sclerite on the left side of bursa copulatrix. The spermathecal duct is short; the spermathecal gland carries an elongate receptaculum seminis, which is shorter than spermathecal gland duct. The gonocoxa is bipartite, and the basal gonocoxite is without an apical fringe of setae. The apical gonocoxite is subtriangular, basally narrow with the subangulate apex, bearing three short lateral ensiform setae and one apical nematiform near the gonocoxal apex. After a careful examination, the morphological traits revealed a

remarkable morphological uniformity in the different species (Figure 7), thus they were not here used in the taxonomic identification at specific level.



**Figure 6.** Genitalia of *P. teriolensis*. Male: (a) ring sclerite, rs; (b) paramere, pa; (c) The median lobe of the aedeagus is, mla; (d) microCT image of male abdomen; (e) microCT image, including detail of the distal part of abdomen in male, with the genitalia partly exposed, and the reciprocal position of the parts marked.

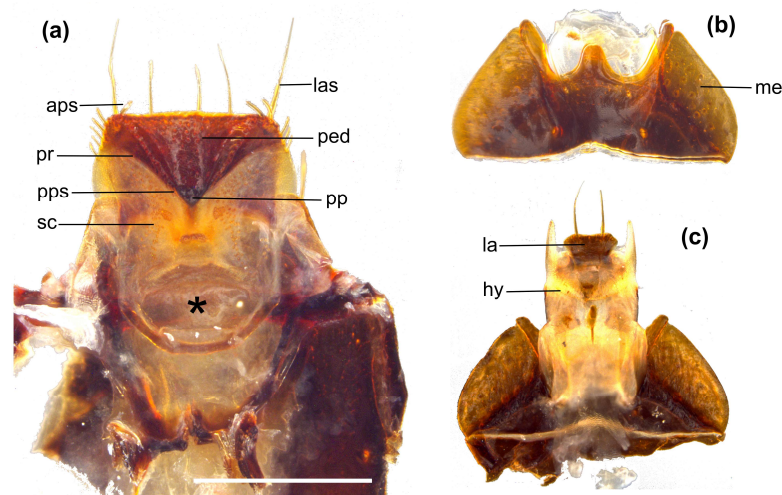


**Figure 7.** Female reproductive structures (ventral view): (a) *P. depressus*; (b) *P. vignai* n. sp.; (c) *P. complanatus*; (d) *P. erythrocephalus*; (e) *P. simonisi* n. sp.; (f) *P. peirolerii*; (g) *P. maritimus* n. sp.; (h) basal sclerite; and (i) spermathecal gland. Green arrow: natural position of basal sclerite. Black arrow: spermathecal gland. Red arrow: ductus of spermathecal gland. Blue arrow: insertion point of ductus. Scalebar= 0.5 mm (a–g) and 0.1 mm (i).



The 3D images obtained from the microCT techniques allowed us to analyze genitalia, mainly male ones (Figure 6f,g), and mouthparts without dissecting them to exactly define their reciprocal position and the correct relationships among parts.

The mouthparts of *Platynus* (Figure 8a–c) have not yet been examined in detail and are shown here for the first time. In coleopteran taxa, these structures have proved very useful not only for species identification but also for defining relationships among closely related taxa [52,53].



**Figure 8.** Mouthparts of *P. complanatus*: (a) epipharynx (ep): aps = anterior parapedial setae; las = labral apical seta; ped = pedium; pp = parapedial projection; pr = parapedial ridge; pps = posterior parapedial setae; sc = sensillum coeloconicum. The cibarial opening (identified by the asterisk) is markedly surrounded by a sclerotized arc. Scalebar = 0.5 mm. (b) mentum (me) and ventral view. (c) labium (la) and hypopharynx (hy). The labial palps were cut off.

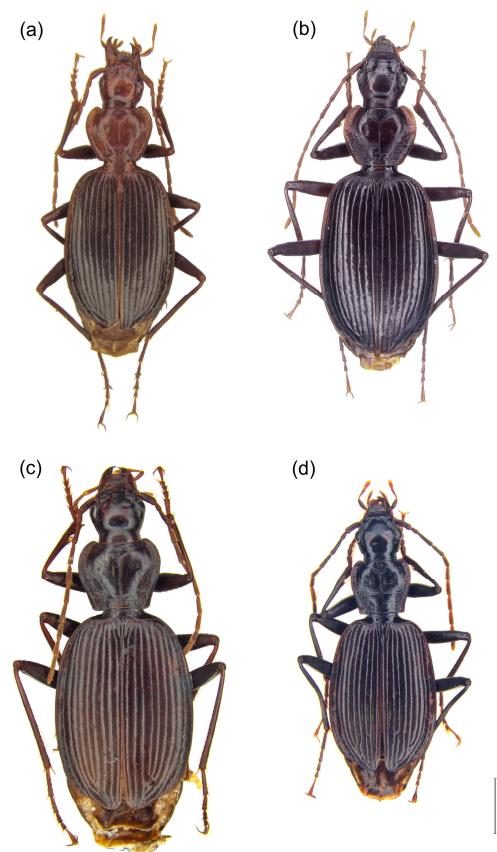
The various parts were recognized and named following what was formerly proposed in [54,55] for Adephaga. The mouthparts of the *Platynus* species were examined, and major differences were evaluated for the pedium (pe) size and shape, mentum (me) shape, labium shape, and hypopharynx. Neither mandibles nor maxillae (not shown here) displayed any evident differences at the species level in *Platynus*.

### 3.3. Taxonomy

Four new taxonomic entities of specific level were identified and are herein described (Figure 9). The new species were assigned to the genus *Platynus*. An identification key of the W Alps *Platynus* species is also provided. The order of species follows the one proposed in the identification key (see Section 3.3.11.).

#### 3.3.1. Historical Notes

The *Platynus* of the W Alps have always been considered a group taxonomically difficult to deal with. This is also because the types of many of the species described in the nineteenth century were considered lost or no longer identifiable. Many years ago, one of the authors (AC) clashed with this situation when he was stopped by the unavailability of the types of the different species described by Dejean and also by Bassi. A recent contribution [56] allowed the identification of these types and their examination. We refer to this original work and to the details of this operation of historical reconstruction. In this paper, the genus *Platynus* (type species: *Carabus assimilis* Paykull, 1790) is considered monophyletic and with no subgeneric attributions, in accordance with Schmidt [5,57].



**Figure 9.** Habitus of *Platynus* species: (a) *P. maritimus* n. sp.; (b) *P. occitanus* n. sp.; (c) *P. simonisi* n. sp.; (d) *P. vignai* n. sp.

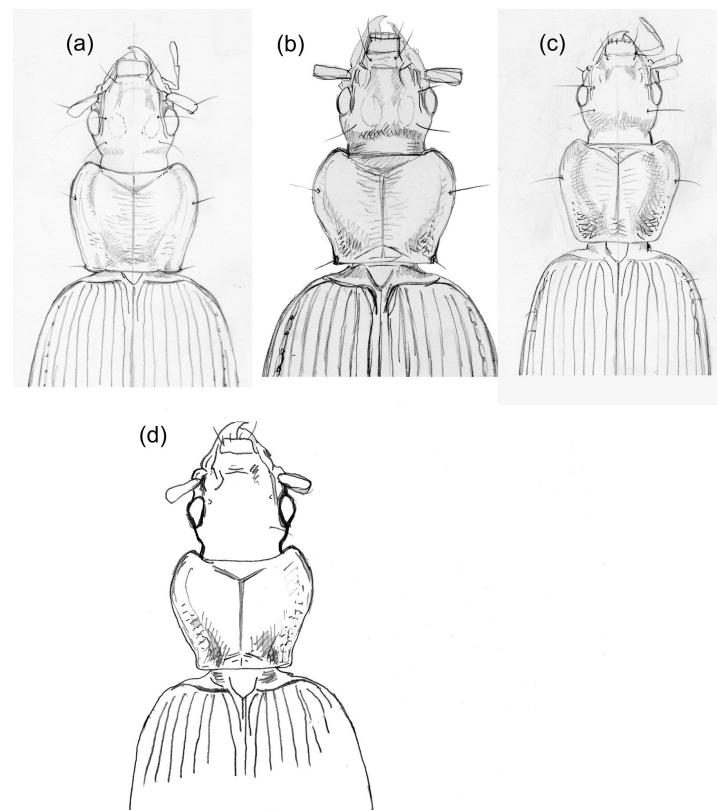
### 3.3.2. Taxonomic and Nomenclatural Acts

The results of identifying the *Platynus* types described by Bassi and Dejean have repercussions on the group taxonomy and forces us to make some nomenclatural changes.

(1) The identification of the type of material of *Platynus peirolerii* Bassi, 1834 in the Spinola of Tassarolo Collection and the certainty that it does not come from M. Viso (as Bassi wrote in the original description), but rather (according to the Manuscript Catalog of Peiroleri) from Valdieri, forces us to reconsider the identity of this species. *P. peirolerii* (*sensu auct.*) has always been considered a species with a distribution that ranges approximately from the Grana Valley to the Casotto Valley. Now, the available data on geometric morphometry show that the situation is quite different. The number of species of *Platynus* sympatrically living in the Maritime Alps actually is, at least, three, two unpublished and never identified as such.

The examination of the type material from Valdieri clarifies that *peirolerii sensu novo* coincides with the taxon distributed in the middle part of the distribution area of this species group, also including *P. maritimus* n. sp. and *P. occitanus* n. sp.

(2) Bassi described *P. erythrocephalus* from M. Viso on material sent to him by Peiroleri [58]. The same origin is reported by Peiroleri in his catalog. In the Spinola Coll., there are two specimens collected by Peiroleri that perfectly correspond to Bassi's description from 1834. K. Daniel and J. Daniel in 1898 were probably deceived by the fact that *erythrocephalus* was, at the time, considered a synonym of *P. complanatus*, and described *P. sexualis* from the same areas [59]. The comparison made to the type of K. and J. Daniel made in 1978 by one of the authors (AC), who drew the type (Figure 10) and, to recent materials, highlights the conspecificity of *erythrocephalus* and *sexualis*. The following synonymy follows: *Platynus erythrocephalus* Bassi, 1834 = *Platynus sexualis* K. Daniel and J. Daniel, 1898 **nov. syn.**



**Figure 10.** Historical materials of some *Platynus* species: (a) *P. sexualis* K. and J. Daniel 1898. Type ♂; (b) *P. complanatus* Dejean, 1828. Lectotypus ♀(MNHN); (c) *P. peirolerii* Bassi, 1834 from de Breme Coll. (MRSN); (d) *P. complanatus* Dejean, 1828. Dejean Coll. (MNHN). Original drawings by A. Casale.

(3) The de Breme Collection includes three specimens labeled as *P. depressus* Lasserre, Helvetia. One of these specimens, which bears the round tag of the Dejean Coll., is a female that perfectly matches the *depressus* from the Pennine Alps. Among the other two, there is a male specimen extracted and drawn by AC in 1978 and labeled “Pedemont”, which is, quite probably, an *erythrocephalus*. We use the specimen from the Dejean Collection as Lectotypus to keep the nomenclature stable.

(4) Back in 1978, one of the authors (AC) made a first attempt to solve the intricate taxonomic question of this group of species, but he clashed with the impossibility of finding the types of the species described by Bassi. AC examined all the types of the other species in the group by drawing their habitus and male genitalia. These drawings (Figure 10) are now very useful to confirm, or disprove, the correct interpretation of some taxa.

### 3.3.3. *Platynus depressus* Dejean, 1831

**Type locality:** Helvetia

**Lectotype:** *Platynus depressus* Lasserre, Helvetia, 1625 (white by hand); “17” (white by hand); Coll. Dejean (white circular label, print). ♂, *Platynus depressus* Dejean, 1831 Giachino, Casale, Allegro des. 2022 (red, print). Coll. De Breme [MRSN]. Male specimen in very bad conditions, with the contents of abdomen destroyed by *Anthrenus* sp.

**Other material:** 1 ♂, Italia, Valle d’Aosta (AO), Fontainemore, Col Gragliasca, m 2100, 11.vii.2013, P.M. Giachino leg. [CGi]; 1 ♂ 2 ♀♀, Italia, Piemonte, Oropa (BI), Lago del Mucrone m 1890, 31.vii.2004, P.M. Giachino leg [CGi]; 3 ♂ 3 ♀♀, Oropa (BI), lago del Mucrone 1910 m, 15.vii.1999, leg. Allegro [CAI, CGi]; 1 ♀, Lago del Mucrone (VC), m 1868, 25.vi.67 [CCa]; 1 ♀, Santuario Oropa, m 1180, 15.vi.67 Casale [CCa]; 7 ♂ 4 ♀♀, Italia, Piemonte, Oropa (VC) 2200 m, Monte Camino, 27.vii.1983, leg Giachino [CGi]; 3 ♂♂, Italia, Piemonte, Oropa (VC) 2050 m, Colle della Balma, 14.vii.1983, leg Giachino [CAI] [CGi]; 4 ♂♂, Italia, Valle d’Aosta (AO), Fontainemore 11.vii.2013, Col Gragliasca m 2000,

P.M. Giachino legit [CAL, CGi]; 3 ♀♀, Ris. Mont Mars (AO), bordo nevaio m 2000, 5.vi.2005  
 G. Allegro legit [CAL] [CBi]; 1 ♂, Ris. Nat. Mont Mars (AO), Col Chardon 2100 m, 20.vii.2004,  
 G. Allegro legit [CAL]; 2 ♂♂, Ris. Nat. Mont Mars (AO), Col Chardon 2300 m, 20.vii.2004,  
 G. Allegro legit [CAL] [CBi]; 1 ♂ 2 ♀♀, Ris. Mont Mars (AO), Lago Balma m 2010, 10.vii.2004  
 G. Allegro legit [CAL] [CBi]; Gressoney; Alpe Mos (Ciaval, Gressoney la Trinité) m2200;  
 Alpe Spissen (Gressoney la Trinité) m1900; Colle della Gragliasca, m2000–2200; Lago Balma,  
 m2000–2200; Bivacco Città di Mariano (Saint Jacques) m2700; lago Blu (Saint Jacques)  
 m2300; Laghi d’Estoul (Brusson) m2500; Punta Regina (Estoul, Brusson) m.2000; Monte  
 Nery, m2200–2400; Lago di Frudière (Graines) m2100; passo di Frudière (Graines) m.2300;  
 valle di Gressoney; val d’Ayas.

**Description of male genitalia:** Median lobe of aedeagus (Figure 11a,b), in lateral view, short, slightly and regularly curved from base to apex; in dorsal view preapically not expanded on the left side, the apical blade subrectilinear; the basal part stout and dorso-ventrally compressed. The apical blade, in dorsal view, long and sub-triangular, symmetrical, sub-acuminate at tip. Apical ostium dorsal, not turned at the sides. Right paramere in lateral view (Figure 11d) short and widened, leaf-shaped. Male invaginated segment large, ovoidal and elongated (Figure 11c).



**Figure 11.** Male genitalia: The median lobe of the aedeagus is in lateral and dorsal view, IX invaginated segment and right paramere of: (a–d) *P. depressus*; (e–h) *P. vignai* n. sp.; (i–l) *P. teriolensis*.

**Comparative diagnosis:** The comparison is made with *P. vignai* n. sp., which is the geographically closest species. *P. depressus* is distinguishable from *vignai* n. sp. by the smaller pronotum, which is less transverse with a narrower base. The elytra are more widely rounded, with less distinct shoulders. At the level of the aedeagus, the median lobe of the *P. depressus* shows a preapical expansion on the left side and a shorter apical blade, which is less sharp and twisted to the left.

**Distribution:** The Pennine and Lepontine Alps (the sites of the Lepontine Alps will be analyzed in the future together with the Swiss ones). To the west, it crosses the Aosta Valley settling on the extreme Eastern part of the Graian Alps.



**Taxonomic notes:** As recently clarified by [56], the choice of LT as the specimen from the de Breme Collection identified with the n° 17 was made because this is the only specimen coming with certainty from the Dejean Collection. Two other male specimens labeled Helvetia and Pedemont belong to the same series. The specimen labeled “Helvetia” was extracted by AC in 1978, and the *P. complanatus* specimen labeled “Pedemont” is actually a *P. depressus*.

### 3.3.4. *Platynus vignai* n. sp. Giachino, Casale, Allegro (Figure 9d)

<http://zoobank.org/urn:lsid:zoobank.org:act:7D8FF79B-B793-4F5A-A6BF-DB14413E579D>

**Type locality:** Piemonte (VB), P.N. Valgrande, Cima Marona, m 1500/2050

**Holotype:** ♂, Piemonte (VB), P.N. Valgrande, Cima Marona, m 1500/2050, 4.VI.1997, P. Audisio [MSNG].

**Paratypes:** 2 ♂♂2 ♀♀, same data [MSNG]; 2 ♂♂2 ♀♀, Piemonte, P.N. Valgrande, Alpe della Colma, 1730–2000 m, Punta Proman, 1.vii.1997, P. Audisio—S. de Felici leg. [MSNG]; 5 ♂♂4 ♀♀, Piemonte (VB), P.N. Valgrande, Cima della Laurasca, m 1400–2000, 6.vi.1997, P. Audisio [MSNG] [CGi]; 1 ♀, Piemonte (VB), P.N. Valgrande, tra Cicogna e Pogallo, m 700–800, 3.VI.1997, P. Audisio, [MSNG]; 6 ♂♂4 ♀♀, Piemonte, Premeno, Pian di Sole, V.1944, Cost. Binaghi [MSNG]; 1 ♂1 ♀, Piemonte Premeno, IV.1943, C. Binaghi [MSNG]; 6 ♂♂3 ♀♀, Alpe Cortenuovo (m 1760), Val Loana, Malesco (VB), 24.VI.2011, C. Ghittino legit. [CGh, CGi]; 8 ♂♂9 ♀♀, Cima Laurasca, Alpe Scaledi, m 1700–2000, 1.VII.2011, G. Allegro legit. [CAL, CGi]; 1 ♀, Italia, Piemonte, Val Vigizzo (NO), Cima della Laurasca, m 2000, 21.VI.1983, P.M.Giachino [CGi]; 2 ♂♂3 ♀♀, Italia, Piemonte, Val Vigizzo (NO), Cima della Laurasca, m 2000, 26.VII.1984, P.M.Giachino [CGi]; 1 ♂, Italia, Piemonte (VCO), Cima Laurasca m 1750, 31.VII.2009, P.M. Giachino leg. [CGi] 5 ♂♂8 ♀♀, Piemonte, pendici M. Zeda, m 1400, 23.IV.44, G. Binaghi [MSNG]; 2 ♂♂, Piemonte, M. Zeda (Novara), 8.VIII.1935, G. Binaghi [MSNG]; 2 ♂♂, Piemonte, Falmenta (VCO), M. Zeda, Alpe Fornà, m 1650, 16.VI.2012, C. Ghittino leg [CGh, CGi]; 1 ♀, Monte Zeda, m 1700, 25 Giu. 1972, leg. Vald-inazzi [CGi]; 4 ♂♂6 ♀♀, A. Lep., M. Zeda, m 2000, 19.6.77, A. Casale leg. [CCa, CGi]; 1 ♀, Alpi Lepont., M. Zeda, m 1500, 25.VII.72, A. Casale leg. [CCa]; 1 ♂1 ♀, Italia, Piemonte (NO), Malesco, Val Loana, m 1200, 13.IX.87, Leg. A. Casale [CCa].

**Other material:** 1 ♂2 ♀♀, Piemonte, Val Divedro, 26.6.31, S. Prezioso [MSNG].

**Description:** L: ♂♂9.5–10.0 mm, ♀♀10.9–11.4 mm. T: ♂♂10.8– mm, ♀♀10.8–11.3 mm. Dorsal surface black, shiny; femora, tibiae, tarsomeres, antennae, palpi and labrum black-reddish; mandibles black. Head with two reddish spots, barely evident.

Head large, longer than wide. Frontal impressions deep, anteriorly subrectilinear, posteriorly widely divergent, smooth and shorter than supraorbital carina; vertex smooth or delicately roughly. Temples rectilinear; eyes large and convex. Neck constriction distinct, without distinct step (such as in *P. complanatus*). Antennae long, just reaching the middle of elytra.

Pronotum wider than long, cordiform (PW/PL = 1.1 ♂♂♀♀), with maximum width at level of anterior fourth and minimum width at the basal angles. Sides gently and regularly arcuate anteriorly, sub-rectilinear posteriorly from half-length, slightly sinuate before base; anterior margin concave, fore angles prominent. Basal angles from right to obtuse and not prominent, with sharp apex. Basal seta present. Disk with mid longitudinal line well impressed and base distinctly punctate. Lateral furrows wide, hollowed and punctate, posteriorly confluent in the basal impressions, which are wide, long, well impressed and punctate.

Elytra ovoidal, not depressed, slightly elongate (EL/EW 1.5 ♂♂, 1.6 ♀♀), with maximum width at base of the posterior third; shoulders rounded but distinct. Elytral striae well impressed and punctate; intervals convex. Two discal setae on the second stria, the first at half-length of elytra, the second at base of apical third.

Legs long and robust. First protarsomere, in male, 2–2.5 times longer than wide. Onychium with or without rows of 3–4 long setae on the ventral side.

**Description of male genitalia:** Median lobe of aedeagus large (Figure 11e,f), in lateral view slightly and irregularly curved from base to apex, with apical part less curved; in dorsal view preapically expanded on the left side. Apical blade sub-rectilinear, with the basal part subcylindrical, uncompressed and unexpanded. Apical blade, in dorsal view, short and sub-triangular, asymmetrical, rounded at tip. Apical ostium dorsal, not turned at sides. Right paramere in lateral view (Figure 11h) long, leaf-shaped. Male invaginated segment large, oval and elongated (Figure 11g).

**Comparative diagnosis:** The comparison is made with the geographically closest species: *P. depressus* and *P. teriolensis*. *P. vignai* n. sp. is distinguishable from *depressus* by the larger pronotum, which is more transverse, with a wider base. The elytra are less widely rounded, with more distinct shoulders. The median lobe of the aedeagus of *P. vignai* n. sp. with a longer apical blade is sharper and not twisted, without a preapical expansion on the left side. It differs from *P. teriolensis* by the median lobe, showing a longer and more acuminate apical blade and a subapical expansion on the left side (such as in *depressus*).

**Etymology:** We are pleased to dedicate this interesting species to the memory of our friend Augusto Vigna Taglianti, who was the first to understand that it is a new species [8].

**Distribution:** We know *P. vignai* n. sp. only from the portion of the Lepontine Alps between Val Vigezzo, Val Grande, and Mount Zeda.

**Ecology:** *P. vignai* n. sp. was collected directly under stones in damp and cold places, often along the edge of snowfields.

### 3.3.5. *Platynus complanatus* Dejean, 1828

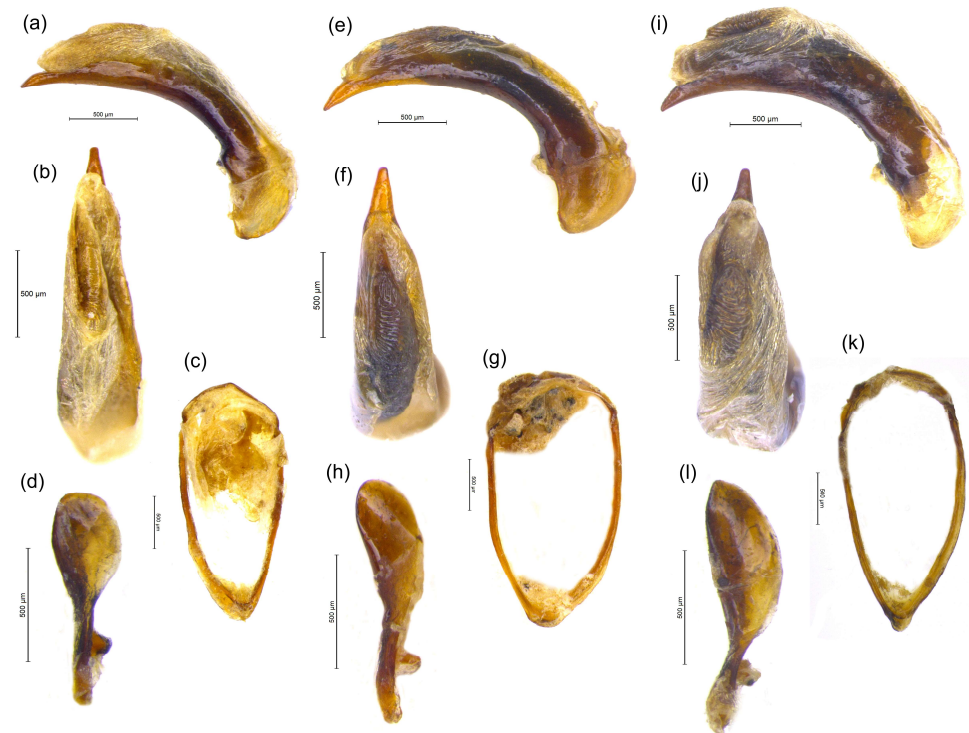
**Type locality:** Pedemont

**Lectotype:** ♀, *complanatus* bon.in Pedemont (handwrite by Dejean); Bonelli (handwrite by Dejean); ex Musaeo Chaudoir (printed); Lectotypus ♀ *Platynus complanatus* Dejean, 1828. 99–100, des. J. Schmidt 1998 (red printed) [MNHN].

**Other material:** 1 ♂, Italia, Piemonte, Ribordone (TO), m 1100, 22.IV.1979, Giachino leg. [CGi]; 1 ♂, Italia, Piemonte, M. Verzel, m 1500, VII.2009, P.M. Giachino leg, [CGi]; 2 ♂♂ 4 ♀♀, Italia, Piemonte, Monte Verzel (TO), Palasot 1500 m, 27.iv.1980, leg Giachino [CGi]; 1 ♂ 1 ♀, Italia, Piemonte, Monte Verzel (TO), Palasot 1100 m, 6.vi–17.vii.1987, leg Giachino [CGi]; 1 ♂ 1 ♀, Italia, Piemonte, Monte Verzel (TO), Palasot 1500 m, 5.iv.1981, leg Giachino [CGi]; 1 ♂, Italia,, Piemonte (TO), Castelnuovo Nigra, loc Palasot 1500 m, 28.iv.1979, leg Giachino [CGi]; 8 ♂♂ 3 ♀♀, Italia, Piemonte (TO), Castelnuovo Nigra, Monte Verzel, loc Palasot 1500 m, 28.iv.1979, leg Giachino [CGi]; 1 ♂, Italia, Piemonte (TO), Castelnuovo Nigra, Monte Verzel, loc Palasot 1500 m, 1.v.1980, leg Giachino [CGi]; 1 ♂ Italia, Piemonte, Oropa (BI), lago del Mucrone, torrente 1890 m, 31.vii.2004, leg Giachino [CGi]; 1 ♀, Italia, Piemonte, Oropa (BI), 1480 m Gall. Rosazza, C.ne Orone, 30.viii.2008, N 45°30'23.6" E 7°58'50.5", P. M. Giachino [CGi]; 1 ♂, Bocchetto Sessera, 19.ix.1970, lg. O. Cantamessa [CAL]; 6 ♂♂ 5 ♀♀, Piemonte, Bocchetto Sessera (VC) 1400 m 4.vii.1978, leg. Giachino-Varola [CGi]; 2 ♂♂ Bocchetto Sessera (BI) 1300 m 4.viii.2000 leg. G. Allegro [CAL]; 1 ♀ Piemonte, Val Sessera, Bioglio (BI), Pietra Bianca Rondolere, ex Miniera Pietra Bianca\_2, m1270, 27.x.2001 Giachino [CGi]; 1 ♀ Piemonte Val Sessera Monte Marca 28.vi.1942 Bari leg. [CGi]; 2 ♂♂ 1 ♀, Locana (TO), M. Tovo m 2400, 15.VI.77, Casale [CCa]; 1 ♀, M.Verzel (S. Elisabetta), m 1500, 13.VI.87, Casale [CCa]; 1 ♀, Ribordone, 4.VIII.71, Casale [CCa]; 1 ♂ 2 ♀♀, Champorcer (AO), Laris, m 1500, 16.VI.70, Casale [CCa]; 1 ♀, M. Verzel, m 1300, 13.VI.87, Casale [CCa]; 1 ♀, Bec Renon (Can.se), m 1500, 26.VII.87, A. Casale [CCa]; Gaby; vallone di Frudière m1400; Gressoney Saint Jean m1400; vallone Ranzola, Gressoney Saint Jean m1800; Gressoney la Trinité m1650; ghiacciaio del Lys m2700; vallone di Rechantez (Pont San Marten); Mont Avic, media Val Chalamy; Gressoney; Graines m1300; vallone di Chasten (Challant Saint Anselme) m1300; Valle Orco; Val Soana; valle di Gressonay; val d'Ayas; valle di Champorcher.

**Description of male genitalia:** Median lobe of aedeagus (Figure 12i,j) in lateral view slightly and regularly curved from base to apex; apical blade subrectilinear; basal part of median lobe subcylindrical, uncompressed and unexpanded; in dorsal view, preapically expanded on right side. Apical blade, in dorsal view, long and sub-triangular, symmetrical,

sub-acuminate at tip. Apical ostium dorsal, not turned at sides. Right paramere in lateral view (Figure 12l) long, leaf-shaped. Male invaginated segment large, oval and elongate (Figure 13k).



**Figure 12.** Male genitalia: The median lobe of the aedeagus is in lateral and dorsal view, IX invaginated segment and right paramere of: (a–d) *P. erythrocephalus*; (e–h) *P. simonisi* n. sp.; (i–l) *P. complanatus*.



**Figure 13.** Male genitalia: The median lobe of the aedeagus is in lateral and dorsal view, IX invaginated segment and right paramere of: (a–d) *P. occitanus* n. sp.; (e–h) *P. peirolerii*; (i–l) *P. maritimus* n. sp.

**Comparative diagnosis:** The comparison is made with the two geographically closest species: *erythrocephalus* and *simonisi* n. sp. *P. complanatus* is distinguishable from *P. erythrocephalus* by the clearly elongated pronotum (distinctly more transverse in *erythrocephalus*). Moreover, in *complanatus*, as well as in *erythrocephalus*, the sides of pronotum are posteriorly straight, whilst they are distinctly sinuated in *simonisi* n. sp. Elytral intervals are convex in *complanatus* (and *erythrocephalus*) and flat in *simonisi* n. sp. The first protarsomere, in males, is three times longer than wide (two times in *erythrocephalus*, four times in *simonisi* n. sp.). Moreover, *P. complanatus* is easily distinguishable from *erythrocephalus* and *simonisi* n. sp. by the temples overlooking the neck (Figure 9d). The median lobe of the aedeagus is large and slightly curved as in *erythrocephalus*, and it is larger and less curved than in *simonisi*. The IX segment is invaginated in the male and is larger than in *simonisi* and smaller than in *erythrocephalus*.

**Taxonomic notes:** One of the specimens deposited in MNHN was studied and drawn (Figure 10b) by one of the authors (AC) in 1978. AC defined this specimen as “conforming to the material present in the de Breme Coll. at MIZT”. Subsequently, the same specimen was studied [5] and, since this specimen was the only one of sure origin from Bonelli (by Dejean Coll.), unlike the material present in the de Breme Coll., it was chosen as a Lectotype [5]. A second specimen present in MNHN was studied and drawn by one of the authors (AC) in 1978. AC defined and drew this specimen “with temples overlooking the neck” (Figure 10d), a typical characteristic of some specimens of *P. complanatus*.

**Distribution:** We know *P. complanatus* from the Graian Alps and from the western portion of the Pennine Alps. The sites mentioned [10] for the Cottian Alps probably to refer to other species.

**Ecology:** *P. complanatus* is usually found under stones in damp and cold places, often along the edge of snowfields or in *Fagus* forest.

### 3.3.6. *Platynus erythrocephalus* Bassi, 1834

**Type locality:** mont Viso, en Piemont, près des sources du Pò.

Type series of *P. erythrocephalus* Bassi, 1834:

**Lectotype:** ♀, “*Platynus erythrocephalus* Bassi, D. Peiroleri, Alpes” (white by hand); “1” (white by hand); Lectotypus ♀*Platynus erythrocephalus* Bassi, 1834. P.M. Giachino, A. Casale, G. Allegro des. 2022 (red printed) [Spinola collection at MRSN].

Type series of *P. sexualis* K. Daniel and J. Daniel, 1898:

2 ♂♂2 ♀♀V. Maira, 28.5.98, complan. sexuelle (by hand from Daniel); Sammlung Dr. K. Daniel; Type v. Ag. sexuelle Dan, (red by hand) [ZSM]. This material was studied and drawn by one of the authors (AC) in 1978 (Figure 10b).

**Other material:** 7 ♂♂3 ♀♀, Italia, Piemonte, Val Varaita (CN), Lemma, 12.IV.1982, P.M. Giachino leg. [CGi]; 2 ♂♂, Italia, Piemonte, Val Chisone, Villar Perosa, La Russa, 11.VIII.1982, P.M. Giachino leg [CGi]; 1 ♀, Piemonte, Roccabruna (CN), Buco del Partigiano, 1313 Pi/CN, m 1170, 8.V.2015, Chesta, Lana, Poggi [CGi]; 1 ♀, Italia, Piemonte, Valle Maira, Acceglio (CN), Lago Visaisa m 2000, 21.VI.2008, M. Isaia leg, [CGi]; 1 ♂, Piemonte, Val Maira, Chiappera, m 1650, 29-VI-1968, B. Bari [CGi]; 1 ♂Val Chisone Vallone Albergian (Laux) 1600–1700 m 4.vi.2007 Bisio [CBi]; 1 ♀Val Germanasca (To) Alpe Balma Valle Rodoretto 1800 m 5.vi.1994 leg. Bisio [CBi]; 6 ♂♂1 ♀Val Germanasca Bergerie Balma (Rodoretto) 1850 m 19.v.2003 Bisio [CBi]; 1 ♂Val Germanasca Didiero (Salza) 1300 m 25.iv.2003 Bisio [CBi]; 2 ♂♂1 ♀Val Germanasca M. Gardetta (V. Faetto Perrero) 1600–1800 m 15.v.2006 Bisio [CBi]; 2 ♂♂V. Germanasca Colle della Bocchetta (Ghigo, Praly) 2200 m 12.vi.2003 Bisio [CBi]; 1 ♂V. Germanasca Miandetta (Ghigo, Praly) 1700 m 5.v.2003 Bisio [CBi]; 2 ♂♂Val Germanasca Bergerie Vialti (Salza) 1600 m 14.v.2006 Bisio [CBi]; 1 ♂Val Pellice (TO) Loc. Anchiocchia (Angrogna) 1400 m 1.v.1992 leg. Bisio [CBi]; 1 ♂Val Pellice (TO) Loc. Anchiocchia (Angrogna) 1400 m 22.iv.1996 leg. Bisio [CBi]; 1 ♂1 ♀M. Vandalino Torre Pellice 2000 m 11.vi.1978 leg. Bisio [CBi]; 2 ♂♂4 ♀♀Valle Pellice Torino Alpe della Sella Vecchia Angrogna 2000 m 23.vi.1999 leg. Bisio [CBi]; 3 ♂♂1 ♀Alpe della Sella Vecchia Angrogna 2000 m 25.vi.1977 leg. Bisio [CBi]; 1 ♂Val Pellice (TO) Col Proussera (Bobbio Pellice) 2100 m



6.vi.1992 lg. Bisio [CBi]; 2 ♂♂Valle Pellice Torino Alpe della Sella Vecchia (Angrogna) 1600–1800 m 24.v.1999 leg. Bisio [CBi]; 10 ♀♀Valle Pellice Torino Alpe della Sella Vecchia Angrogna 2000 m 23.vi.1999 leg. Bisio [CBi]; 1 ♀Col Vittona Bobbio Pellice 2500 m 8.vii.1979 leg. Bisio [CBi]; 1 ♂Col Vittona Bobbio Pellice 2500 m 8.vii.1979 leg. Bisio [CBi]; 1 ♀Col Barant (Bobbio Pellice) 2300 m 26.vi.1978 leg. Bisio [CBi]; 1 ♂Val Pellice loc Selle (Bobbio Pellice) 1600 m 25.v.1991 L. Bisio [CBi]; 1 ♂Val Pellice (TO) Loc. Anchiocchia (Angrogna) 1400 m 12.iv.1999 leg. Bisio [CBi]; 1 ♂Col Barant (Bobbio Pellice) 2300 m 12.vii.1978 leg. Bisio [CBi]; 1 ♂Col Barant (Bobbio Pellice) 2300 m 15.vi.1980 leg. Bisio [CBi]; 1 ♂Col Barant (Bobbio Pellice) 2300 m 26.vi.1978 leg. Bisio [CBi]; 6 ♂♂5 ♀♀Val Pellice (TO) Col Barant (Bobbio Pellice) 2000 m 2.vii.1992 leg. Bisio [CBi]; 2 ♀♀Val Pellice (TO) Alpe Bancet (Bobbio Pellice) 2300 m 15.vi.1997 [CBi]; 1 ♀Val Varaita Ponte-Chianale 1650 m 10.ix.2007 Bisio [CBi]; 1 ♀Val Pellice (To) Alpe Chiabreassa (Villar Pellice) 1700 m 27.v.1995 Bisio [CBi]; 1 ♂ 7 ♀♀Val Varaita (CN) V. dell'Agnello (Chianale) 2150 m 25.v.1998 leg. L. Bisio [CBi]; 4 ♂♂Val Varaita (CN) V. dell'Agnello (Chianale) 2100 m 25.v.1998 leg. L. Bisio [CBi]; 5 ♀♀Val Varaita (CN) Vallone Soustra (Chianale) 2100 m 25.v.1998 lg. Bisio [CBi]; 1 ♂ 1 ♀Val Varaita Vallone Gilba (Brossasco) 1350 m 23.iv.2007 leg. Bisio [CBi]; 2 ♂♂Val Varaita Vallone Gilba (Brossasco) 1400 m 23.iv.2007 leg. Bisio [CBi]; 2 ♂♂Val Varaita Vallone Gilba (Brossasco) 1400 m 25.iv.1997 leg. Bisio [CBi]; 5 ♂♂2 ♀♀Val Varaita (CN) Sampeyre loc. S. Anna 1900 m 23.iv.1989 leg. Bisio [CBi]; 4 ♂♂2 ♀♀Val Varaita (CN) Colle di Sampeyre -Sampeyre 2100 m 15.vi.1989 leg. Bisio [CBi]; 3 ♀♀Val Maira (CN) Col Sautron (Saretto) 2500 m 30.vi.1994 leg. Bisio [CBi]; 3 ♂♂1 ♀Val Varaita (CN) Campanesio (Sampeyre) 1500 m 23.iv.2003 [CBi]; 2 ♂♂ 1 ♀S. Anna di Bellino CN 1900 m 24.v.1980 L. Bisio [CBi]; 1 ♂1 ♀Val Varaita (TO) Grange Malbuiset (S. Anna di Bellino) 2000 m 14.vi.1994 L. Bisio [CBi]; 2 ♀♀Valle Maira (CN) Grange Resplendino (Prato Rotondo) 1900 m 31.v.1993 L. Bisio [CBi]; 1 ♀Val Varaita Ballatori (Melle) 1300 m 11.ix.2006 leg. Bisio [CBi]; 1 ♂Val Varaita Ballatori (Melle) 1300 m 7.v.2007 leg. Bisio [CBi]; 1 ♂1 ♀♀Col Bicocca Elva CN 2000 m 8.v.1983 leg. Bisio [CBi]; 1 ♀Val Varaita CN V. di St. Veran (Chianale) 2200–2300 m 1.vii.2005 Bisio [CBi]; 5 ♂♂1 ♀Val Maira (CN) Vallone del Preit Marmora 1700 m 21.5.1990 L. Bisio [CBi]; 4 ♂♂1 ♀Val Maira (CN) Grange Resplendino (Pratorotondo) 1900 m 31.v-20.viii.1993 L. Bisio [CBi]; 6 ♂♂3 ♀♀Val Maira (CN) Mt. Pelvo d'Elva 2300 m 7.vii.1993 leg. Bisio [CBi]; 1 ♂Val Pellice (CN) Grange della Gianna (Villar Pellice) 1800 m 17.v.1992 leg. Bisio [CBi]; 2 ♂♂Val Pellice (TO) M. Servin (Angrogna) 1500 m 31.v.2000 leg. Bisio [CBi]; 5 ♂♂Val Pellice (To) Alpe Chiabreassa (Villar) 1700 m 27.vi.2001 Bisio [CBi]; 1 ♂Val Pellice loc. Villanova (Bobbio) 1250–1400 m 15.v.2000 leg. Bisio [CBi]; 1 ♂Val Pellice rifugio Barbara Lowrie (Bobbio Pellice) 1800 m 25.vi.1991 leg. Bisio [CBi]; 6 ♂♂Valle Po Pian Munè (Paesana) 1500 m 12.v.2008 leg. Bisio [CBi]; 1 ♂Pian della Regina Crissolo (CN) 1800 m 10.vi.1980 leg. Bisio [CBi]; 1 ♂Pian della Regina Crissolo (CN) 1800 m 22.v.1983 leg. Bisio [CBi]; 1 ♂Pian della Regina Crissolo (CN) 1800 m 30.v.1985 leg. Bisio [CBi]; 1 ♂Pian della Regina Crissolo (CN) 1800 m 22.v.1983 leg. Bisio [CBi]; 1 ♂Val Varaita M. Birrone (Frassino) 2100 m 28.ix.1997 leg. L. Bisio [CBi]; 11 ♂♂Val Varaita (CN) Santuario di Valmala 1400–1500 m 26.iv.1997 leg. L. Bisio [CBi]; 2 ♂♂Val Maira Grange Culausa (V. Preit, Marmora) 1900 m 21.v.2007 Bisio [CBi]; 1 ♂Val Varaita Pian Traversagn (Bellino) 2000–2100 m 5.vi.2006 Bisio [CBi]; 3 ♂♂Col del Lupo Chianale (CN) 2300 m 26.viii.1989 leg. Bisio [CBi]; 1 ♂Val Varaita CN V. di St. Veran (Chianale) 2200–2300 m 1.vii.2005 Bisio [CBi]; 4 ♂♂Val Maira (CN) Grange Resplendino Vallone Unerzio (Acceglio) 1959 m 26.v.1992 L. Bisio [CBi]; 13 ♂♂23 ♀♀, Terme Valdieri, Piemonte, fine VII,1903, A. Doderò [MSNG]; 1 ♀, P.N. Alpi Marittime, Terme di Valdieri, Vallone del Valasco, 1500–1700, 29.VI.2009, A. Vigna leg. [MSNG]; 6 ♂♂8 ♀♀, Sampeyre (CN), Becetto, Meire Ruà, m 1600, 1/31.VII.2003, G. Gardini leg. [MSNG, CGi]; 5 ♂♂ 4 ♀♀, Sampeyre (CN), Becetto, Meire Ruà, m 1250, b. misto, 27.IV/27.V.2002, G. Gardini leg. [MSNG]; 18 ♂♂16 ♀♀, Alpi Cozie merid., Chianale, 1850 m, 17.VI.68, A. Vigna leg. [MSNG, CGi]; 2 ♀♀, Alpi Cozie, Vallone d. Agnello, 2400–2500, 8.VIII.74 [MSNG]; 1 ♀, Alpi Cozie, Colle dell'Agnello dint., 2400, 14.VII.83 [MSNG]; 7 ♂♂1 ♀, Alpi Cozie, Val.e Pian Traversagn, 2000–2350, 1.VII.77, A. Vigna leg. [MSNG, CGi]; 1 ♂, Alpi Cozie, Sant. Valmala, Passo S. Pietro, 1352 m, 5.VIII.2014, A. Vigna leg. [MSNG]; 1 ♀, Alpi Marittime, Ferriere (Bersezio), 1850, 22.VII.84, A. Vigna

leg. [MSNG]; 1 ♂2 ♀♀, Alpi Marittime, Vallone del Puriac, 1850–2150, 8.VII.87, A. Vigna leg. [MSNG]; 5 ♂♂2 ♀♀, Alpi Marittime, Vallone di Pontebernardo, 1550, 13.VII.84, A. Vigna leg. [MSNG, CGi]; 44 ♂♂70 ♀♀, Alpi Marittime, Vallone di Pontebernardo, 1650, 12.VII.85, A. Vigna leg. [MSNG, CGi]; 1 ♂, Alpi Marittime, Vallone di Pontebernardo, 1700, 10.VIII.91, A. Vigna leg. [MSNG]; 1 ♀, Alpi Marittime, Vallone di Pontebernardo, 1700, 1.V.97, A. and G. Vigna leg. [MSNG]; 27 ♂♂46 ♀♀, Alpi Marittime, Prati d. Vallone (Scoiettas), 1800, 12.VII.84, A. Vigna leg. [MSNG, CGi]; 1 ♂, Alpi Marittime, Sambuco dint. 1800 m, M. Vaccia, Vallone di Soberan, 23.VIII.2006, A. and G. Vigna leg. [MSNG]; 8 ♂♂2 ♀♀, Alpi Marittime, abetina M. Vaccia, m 1800, 6.VI.92, A. and G. Vigna leg. [MSNG, CGi]; 1 ♂, Alpi Marittime, abetina M. Vaccia, m 1300, 12.VI.98, M. Mei and E. Piattella leg. [MSNG]; 1 ♂, Alpi Marittime, abetina M. Vaccia, m 1300, 23.V.99, A. Vigna leg. [MSNG]; 1 ♀, Alpi Marittime, Vallone S. Anna Vinadio, m 1400, 16.VIII.91, A. Vigna leg. [MSNG]; 2 ♂♂1 ♀, Alpi Marittime, Vallone S. Anna, rio S. Anna, m 1400, 18.VI.99, E. Piattella leg. [MSNG, CGi].

**Description of male genitalia:** Median lobe of aedeagus (Figure 12a,b), in lateral view, slightly and regularly curved from base to apex. Apical blade subrectilinear; the basal part of median lobe subcylindrical, uncompressed and unexpanded; in dorsal view, not preapically expanded. Apical blade, in dorsal view, moderately long and sub-triangular, symmetrical, rounded at tip. Apical ostium dorsal, not turned at sides. Right paramere, in lateral view (Figure 12d), long, leaf-shaped. Male invaginated segment large, ovoidal and elongate (Figure 12c).

**Comparative diagnosis:** The comparison is made with the two geographically closest species: *complanatus* and *simonisi* **n. sp.** *P. erythrocephalus* is distinguishable from *P. simonisi* **n. sp.** and *P. complanatus* by the clearly transverse pronotum (distinctly more elongated in *simonisi* **n. sp.** and *complanatus*). Moreover, in *erythrocephalus*, as well as in *complanatus*, the sides of the pronotum are posteriorly straight, whilst they are distinctly sinuate in *simonisi*. The elytral intervals are convex in *erythrocephalus* (and in *complanatus*) and flat in *simonisi* **n. sp.** The head is larger in *erythrocephalus* than in *simonisi*. The first protarsomere, in males, is two times longer than wide (three times in *complanatus*, four times in *P. simonisi* **n. sp.**). The median lobe of the aedeagus is large and slightly curved compared to *complanatus* and larger and less curved compared to *simonisi*. The IX segment invaginated in the male is far larger than in *simonisi* and *complanatus*.

**Taxonomic note:** *P. sexualis* was described from the same areas [60]. The comparison made to the K. and J. Daniel type highlights the conspecificity of *erythrocephalus* and *sexualis*. For reasons of priority, the taxon must be called *erythrocephalus* Bassi, 1834.

**Distribution:** We know *P. erythrocephalus* from the Cottian Alps, between the Chisone Valley and Grana Valley.

**Ecology:** *P. erythrocephalus* is usually found under stones in *Fagus* forest or in damp and cold places, often along the edge of snowfields.

### 3.3.7. *Platynus simonisi* **n. sp.** Giachino, Casale, Allegro (Figure 9c)

<http://zoobank.org/urn:lsid:zoobank.org:act:1928D35E-FC87--403B-B3DC-75AFBC7BB6DB>

**Type locality:** Italia, Piemonte, Forno di Coazze (TO), Miniera di Garida, m 1085

**Holotype:** ♂, Italia, Piemonte, Forno di Coazze (TO), Miniera di Garida, m 1085, 12.X.2019, M. Isaia leg. [CGi].

**Paratypes:** 1 ♀, same data, [CGi]; 5 ♂♂3 ♀♀, Italia, Piemonte, Coazze (TO), 2.VII.1978, A. Simonis leg. [CAL, CGi]; 1 ♂, Coazze (TO), Borgata Bosio, 28.IV.2021, leg. Simonis [CSi]; 7 ♂♂, Val Sangone, Cave di Calce (Forno), 19.V.2021, legit Simonis [Cal, CGi, CSi]; 2 ♂♂, Coazze (TO), B.gta Bosio, 25.V.2021 [CGi]; 1 ♂, Coazze (TO), B.gta Bosio, 23.X.2020/28.IV.2021, trapp. prof., leg. Simonis [CSi]; 1 ♂, Forno di Coazze, cave di calce, 19.V.2021, da trappola di profondità messa il 19.IX.2020, leg. Simonis [CSi]; 15 ♂♂6 ♀♀, Forno di Coazze, cave di calce, 19.IX.2020/19.V.2021, leg. P.M. Giachino [CAL, CGh, CGi, MSNG]; 2 ♀♀, Piemonte, Val Chisone, Fenestrelle, 8.VI.1952, B. Bari [CGi]; 1 ♂1 ♀, Italia, Piemonte, Val di Susa (TO), Monpellato, m 900, IV.1983, P.M. Giachino leg. [CGi]; 2 ♂♂2 ♀♀, Italia, Piemonte, Val di Viù, Molar, m 800, 19.VI.1981, P.M. Giachino leg. [CGi]; 1 ♂, Italia,

Piemonte, Val di Lanzo (TO), Col del Lys, IV.1983, P.M. Giachino leg. [CGi]; 1 ♂, 1 ♀, Italia, Piemonte (TO), Giaveno, B. Tora, MSS, V/23.VIII.1989, A. Casale leg. [CCa, CGi]; 1 ♀, Val di Susa (TO), Colle del Lys, m 1200, 2.IX.78, Casale [CCa]; 3 ♂♂, Val Chisone, Pra Martino, 24.V.78, A. Casale [CCa]; 1 ♀, A. Cozie, Giaveno, Alpe Colombino, m 1300, 1.V.79, Casale [CCa]; 2 ♀♀, Val Chisone (TO), Perrero, Gran Truc, m 1000–1500, 11.VI.78, Casale [CCa]; 2 ♂♂, Parco Orsiera Rocciavré, Val Sangone (TO), m 1600, 21.V.2008, R. Viterbi legit [CAL]; 2 ♂♂, 4 ♀♀, Parco Orsiera Rocciavré, Val Sangone (TO), Selley-Colle Roussa, 18.VI.2013, R. Viterbi legit [CAL]; 1 ♂, Parco Orsiera Rocciavré, Val Sangone (TO), m 1400, 19.VIII.2007, R. Viterbi legit [CAL].

**Description:** L: ♂♂ 12.0–12.3 mm, ♀♀ 13.3–13.5 mm. T: ♂♂ 11.4–12.1 mm, ♀♀ 12.1–12.8 mm. Dorsal surface black, shiny; femora, tibiae, tarsomeres, antennae, palpi and labrum black-reddish; mandibles black. Head with two reddish spots, more or less distinct.

Head large, longer than wide. Frontal impressions deep, anteriorly subrectilinear, posteriorly widely divergent, smooth and shorter than supraorbital carina; vertex delicately punctate. Temples rectilinear; eyes large and convex. Neck constriction distinct, without evident step (as in *P. complanatus*). Antennae short, not reaching the middle of elytra.

Pronotum wider than long, cordiform (PW/PL = 1.1 ♂♂, 1.2 ♀♀), with maximum width at level of anterior third and minimum width at basal angles. Sides gently and regularly arcuate anteriorly, sub-rectilinear posteriorly from half-length, slightly sinuate before base; anterior margin slightly concave, fore angles prominent. Basal angles obtuse and not prominent, with blunt apex. Basal post-angular seta present. Disk with mid longitudinal line well impressed and base distinctly punctate. Lateral furrows wide, hollowed and punctate, posteriorly confluent in the basal impressions, which are wide, long, well impressed and punctate.

Elytra oval, slightly elongate (EL/EW 1.4 ♂♂, 1.5 ♀♀), with maximum width at middle; shoulders largely rounded. Elytral striae well impressed and impunctate; intervals nearly flat. Two discal setae on the second stria, the first at half-length of elytra, the second at base of apical sixth.

Legs long and robust. First protarsomere, in male, 4 times longer than wide. Onychium ventrally with two rows of 3–4 long setae.

**Description of male genitalia:** Median lobe of aedeagus (Figure 12e,f) in lateral view slightly and irregularly curved from base to apex, with apical part less curved. Apical blade sub-rectilinear; basal part of the median lobe sub-cylindrical, uncompressed and unexpanded; in dorsal view, preapically expanded on the left side. Apical blade, in dorsal view, moderately long and sub-triangular, symmetrical, rounded at tip. Apical ostium dorsal, not turned on the sides. Right paramere in lateral view (Figure 12h) long, leaf-shaped. Male invaginated segment small, oval and elongate (Figure 12g).

**Comparative diagnosis:** *P. simonisi* n. sp. is distinguishable from *P. erythrocephalus* by the non-transverse pronotum (distinctly more transverse in *erythrocephalus*). Moreover, in *erythrocephalus*, as well as in *complanatus*, the sides of pronotum are posteriorly straight, whilst they are distinctly sinuate in *simonisi*. Elytral intervals are flat in *simonisi* n. sp. and convex in *erythrocephalus* and *complanatus*. The head is larger in *erythrocephalus* than in *simonisi* n. sp. The first protarsomere, in males, is four times longer than wide (two times in *erythrocephalus*, three times in *complanatus*).

The median lobe of the aedeagus is small and more curved than in *complanatus* and *erythrocephalus*. The IX invaginated segment in males is smaller than in *erythrocephalus* and *complanatus*.

**Etymology:** We are pleased to dedicate this interesting species to our friend Antonio Simonis, who provided us with the material he collected 45 years ago, on which we first identified the new species.

**Distribution:** We know *P. simonisi* n. sp. from the Sangone Valley, where it is found in the surroundings of Coazze (TO). We know this species is also from the Susa and Lanzo Valleys, to the north, and the Chisone Valley to the south. At Perrero (Chisone Valley), *P. simonisi* n. sp. is sympatric with *P. erythrocephalus*.

**Ecology:** *P. simonisi* n. sp. was collected by traps in abandoned mines and in MSS (Superficial Subterranean Habitat) with black humus or directly in *Fagus* and *Castanea* forests on schistose rocks facing north.

### 3.3.8. *Platynus peirolerii* Bassi, 1834 *sensu novo*

**Type locality:** Piedmont, M. Viso, près des sources du Pò (*patria errata*)

**Lectotype:** ♂, *Platynus Peirolerii* Bassi, D. Peiroleri, Alps (white by hand); 5 (white, printed); Lectotypus ♂ *Platynus peirolerii* Bassi, 1834, P.M. Giachino, A. Casale, G. Allegro des. 2022 Coll. Spinola [MRSN].

**Other material:** 1 ♀, *Platynus Peirolerii* Bassi, D. Peiroleri, Alps, Coll. Spinola [MRSN]; 2 ♂♂ 2 ♀♀, *Platynus Peirolerii* Bassi Pedemont 1627, Coll. De Breme [MRSN]; 1 ♂ 1 ♀, Alpi Marittime, 1800, Vallone Maladecia, 17.VII.1985, A. Vigna leg. [MSNG]; 1 ♂ 1 ♀, Alpi Marittime, 1850, Vallone Maladecia, 18.VII.1985, A. Vigna leg. [MSNG]; 2 ♀♀, Alpi Marittime, 1850, Vers. W P.ta Maladecia, 2.VIII.1989, A. Vigna leg. [MSNG]; 1 ♀, Alpi Marittime, 2400 m, Colle della Lombarda dint., 24.VI.2004, E. Piattella leg. [MSNG]; 1 ♂ 2 ♀♀, Alpi Marittime, 2400 m, Colle della Lombarda dint., 24.VI.2004, E. Piattella leg. [MSNG]; 1 ♂ 2 ♀♀, Alpi Marittime, 2350 m, Colle d. Lombarda, 24.VI.77, A. Vigna leg. [MSNG]; 2 ♂♂ 1 ♀, Alpi Marittime, 2400 m, Colle della Lombarda dint., 22.VI.2005, E. Piattella leg. [MSNG]; 1 ♂ 1 ♀, Alpi Marittime, 2400 m, Colle della Lombarda dint., 24.VI.2004, M. Mei leg. [MSNG]; 2 ♀♀, Alpi Marittime, 2400 m, Colle della Lombarda dint., 24.VI.2004, A. Vigna leg. [MSNG]; 1 ♂ 1 ♀, Alpi Marittime, 2400 m, Colle della Lombarda dint., 22.VI.2005, A. Vigna et al. leg. [MSNG]; 1 ♀, Piemonte, S. Anna di Vinadio, 13.VII.58, A. Vigna [MSNG]; 3 ♀♀, Italia, Piemonte, Vinadio (CN), Val. S. Anna, m 1300, 10.VII.1987, P.M. Giachino leg.; 1 ♀, Alpi Marittime, 2000, Vallone Maladecia, 18.VII.1985, A. Vigna leg. [MSNG]; 4 ♀♀, Alpi Marittime, V.S. Anna, Colle di Sant'Anna, 2200–2300 m, 21.VI.2001, A. Vigna leg.; 1 ♂, Italia, Piemonte (CN), 1 ♀, Piemonte, V. Infernotto, Valdieri (CN), Gr. Salamandra sup., m 1110, 11.V.2017/22.IX.2017, Chiappetta, Isaia, Mammola leg. [CGi]; Alpi Marittime, Colle Ciriegia, bunker poco oltre confine, 24.VI.2015, Isaia-Mammola leg. [CGi]; 1 ♂ 1 ♀, Alpi Liguri, Colle di Tenda, 15.VII.1978, m 1900, R. Poggi [MSNG]; 1 ♀, Alpi Liguri, dint. Colle di Tenda, 4.VII.1999, m 2000, R. Poggi [MSNG]; 2 ♂♂ 7 ♀♀, Alpi Maritt., Certosa di Pesio, VII–VIII.1910, A. Dodero [MSNG]; 1 ♀, Terme Valdieri, Piemonte, fine VII, 1903, A. Dodero [MSNG]; 1 ♀, Val Pesio, Ghiliani [MSNG]; 1 ♂ 1 ♀, Limone Piem., Colla Piana, 6 e 11.V.1915, A. Baliani [MSNG]; 1 ♂, Val Pesio, fine VIII.1907, A. Dodero [MSNG]; 1 ♀, Alpi Marit., 11.VIII.1972, Col Finestre, m 2000, I. Mercati leg. [MSNG]; 1 ♀, Alpi Marittime, Vallone Finestra, m 2200, 20.VII.66. Osella leg. [MSNG]; 1 ♂ 1 ♀, Alpi Marittime, Vallone Finestra, m 2200–2450, 10.VIII.72. A. Vigna leg. [MSNG, CGi]; 1 ♂, Alpi Marittime, Cima Salauta, m 2160, 8.VII.1958, A. Vigna [MSNG]; 1 ♀, Alpi Liguri, Col di Tenda, C. Becco, 26.VIII.1999, m 2000, A. Vigna leg. [MSNG].

**Redescription:** L: ♂♂ 13.0–14.5 mm, ♀♀ 13.5–14.8 mm. T: ♂♂ 12.7–14.2 mm, ♀♀ 13.1–14.5 mm. Dorsal surface reddish-piceous, shiny; femora, tibiae, tarsomeres, antennae, palpi, labrum and mandibles concolorous. Head with two reddish spots, more or less distinct.

Head large, longer than wide. Frontal impressions deep, sub-rectilinear and slightly divergent, nearly smooth and shorter than supraorbital carina; vertex smooth. Temples rectilinear; eyes large and convex. Neck constriction evident, without any distinct step. Antennae long, not reaching the middle of the elytra.

Pronotum wider than long, slightly cordiform (PW/PL = 1.2 ♂♂ ♀♀), with maximum width at about middle and minimum width at basal angles. Sides gently and regularly arcuate anteriorly, sub-rectilinear at basal half, not sinuate before base; anterior margin slightly concave, fore angles very scarcely prominent. Basal angles obtuse and not prominent, with rounded apex. Basal angular seta absent. Disk with mid longitudinal line well impressed and base distinctly punctate. Lateral furrows very wide, hollowed and punctate, posteriorly confluent in the basal impressions, which are wide, long, well impressed and punctate.

Elytra ovoidal, slightly elongate (EL/EW 1.4 ♂♂ ♀♀), with maximum width at posterior third; shoulders widely rounded, not distinct. Elytral striae well impressed and delicately



punctate; intervals nearly flat. Two discal setae on the second stria, the first at half-length of elytra, the second at base of apical fourth.

Legs long and robust. First protarsomere, in male, 2.5–3.0 times longer than wide. Onychium ventrally with two rows of 3–4 long setae.

**Description of male genitalia:** Median lobe of aedeagus (Figure 13e,f), in lateral view, slightly and regularly curved from base to apex; in dorsal view, with preapical part not sinuate. Apical blade sub-rectilinear; basal part sub-cylindrical, uncompressed and unexpanded. Apical blade, in dorsal view, long and sub-triangular, symmetrical, rounded at tip. Apical ostium dorsal, not turned at sides. Right paramere, in lateral view (Figure 13h), long, leaf-shaped. Male invaginated segment narrow, not semi-circular (Figure 13g).

**Comparative diagnosis:** The comparison is made with the two geographically closest species: *occitanus* n. sp. and *maritimus* n. sp. *P. peirolerii sensu novo* has a much smaller pronotum than *maritimus* n. sp. and *occitanus* n. sp., with posteriorly sub-rectilinear sides at the basal third. The male invaginated segment is large, ovoidal, elongated, and narrower than in *occitanus* n. sp. The median lobe of the aedeagus is of the same size in the three species but more regularly curved in *peirolerii sensu novo*. The apical blade, in the dorsal view, is less narrow and acute in *peirolerii sensu novo* than in *occitanus* n. sp. and *maritimus* n. sp.

**Distribution:** The Maritime Alps (Vallone di Maladecia, Colle della Lombarda, Vallone di Sant’Anna di Vinadio, Valle Gesso, Col di Tenda, Val Pesio).

**Ecology:** *Platynus peirolerii sensu novo* was collected directly under stones in damp and cold places, often along the edge of snowfields. In its distribution area, it is sympatric with *P. occitanus* n. sp. and *P. maritimus* n. sp.

**Taxonomic note:** In the Spinola Collection at MRSN, there are one ♂ and two ♀♀ labelled “*Platynus Peirolerii* Bassi, D. Peiroleri, Alps”, each of them with a number from three to five [56]. Specimen four, a female in bad condition, is a *P. occitanus* n. sp., while specimens three (a female without head) and five (a male with the abdomen destroyed by *Anthrenus* sp.) are *P. peirolerii*. In the de Breme collection at MRSN, there are four specimens (two ♂♂ and two ♀♀) labelled “*Platynus Peirolerii* Bassi Pedemont 1627”. All these specimens are *P. peirolerii*. One of these, a male labelled as n 14, was extracted and drawn by AC in 1978 (Figure 10c), but these specimens do not belong to the type series [56]. In the original description [58], the author, evidently, makes an error, saying that this species comes from M. Viso area, where, instead, *P. erythrocephalus* is widespread. On the other hand, as recently clarified by [56], in the catalog of the Peiroleri Collection, the place of origin of *P. peirolerii* is specified in “Alpes du Vaudier (=Valdieri) en Juillet”.

### 3.3.9. *Platynus maritimus* n. sp. Giachino, Casale, Allegro (Figure 9a)

<http://zoobank.org/urn:lsid:zoobank.org:act:3E186C75--6B61--4629-A2B9--46CC33D936D1>

**Type locality:** Italia, Piemonte (CN), Val Pesio, Sotto Camosciere.

**Holotype:** ♂, Italia, Piemonte (CN), Val Pesio, Sotto Camosciere, 5.VII.1984, P.M. Giachino leg. [CGi].

**Paratypes:** 1 ♀, same data [CGi]; 1 ♀, Piem., Val Pesio, M. Costa Rossa, 7.VII.1941, m 2200, B. Bari leg. [CGi]; 1 ♂4 ♀♀, Italia, Piemonte (CN), Valle Ellero, Cima Kars m 1950, 30.VI.2014, P.M. Giachino leg. [CGi]; 2 ♂♂1♀, Italia, Piemonte (CN), Valle Ellero, Pian Marchisio, m 1600, 15.VI.2013/30.VI.2014, P.M. Giachino leg. [CGi]; 1 ♂, Alpi Marittime, dint. Viozene, VII-1939, B. Bari [CGi]; 1 ♂, Piem., Val Pesio, sottern. Certosa, 4.7.1941, B. Bari [CGi]; 3 ♂♂, Piem., Val Pesio, M. Marguareis, m 2000, 5.VII.1941, B. Bari [CGi]; 3 ♂♂3 ♀♀, Italia, Alpi Marittime, Cima Becco Rosso, m 2000, vt. Nord, 20.VII.1970, O. Cantamessa [CGi]; 2 ♂♂, Italia, Alpi Marittime, Cima Becco Rosso, m 1950, vt. Nord, 12.VII.1969, O. Cantamessa [CGi]; 1 ♀, Italia, Piemonte, (CN), Limonetto, m 1600, dint. Gall. Napoleone, 2.XI.1987, Giachino [CGi]; 1 ♂2 ♀♀, Italia, Piemonte, Frabosa Sottana, (CN), Abisso Artesinera 197 Pi/CN, 28.VI.2008, Isaia leg. [CGi]; 1 ♂, Piemonte (CN), Artesina, m 1600, 26.VI.1982, leg. B. Bari [CGi]; 3 ♂♂, 5 ♀♀, S. Giacomo Entracque (CN), Nevaio, m 1700, 25.VII.1996, G. Allegro legit [CAL]; 1 ♂, 1 ♀, M. Argentera (CN), Lago del Chiotas,

m 2500, 22.VII.1996, G. Allegro legit [CAL]; 2 ♂♂, Entracque (CN), Rifugio Soria, m 1900, 22.VII.1997, G. Allegro legit [CAL]; 1 ♂, 1 ♀, Entracque (CN), Gorge della Reina, m 1100, 21.VII.1997, G. Allegro legit [CAL]; 2 ♂♂, 2 ♀♀, M. Marguareis (CN), Rocche Biecai, m 2000, 7.VIII.2001, G. Allegro legit [CAL]; 1 ♂, Chiusa Pesio (CN), Pian delle Gorre, 8.V.2005, G. Allegro legit [CAL]; 1 ♂, 1 ♀, Valle Pesio (CN), Colle del Duca, m 1800, 27.VI.2010, G. Allegro legit [CAL]; 1 ♂, Val Pesio (CN), M.te Besimauda, Gias Pravine, m 1950, 18.VI.2011, G. Allegro legit [CAL]; 1 ♀, Val Grana (CN), Monterosso Grana, 14.VIII.1987, P.M. Giachino legit [CAL]; 1 ♂1 ♀, Italia, Piemonte, Valdieri, Vall. S. Anna, m 1800, 3.VIII.89, leg. A. Casale [CCa]; 1 ♂5 ♀♀, Italia, Piemonte, Col di Tenda, P.ta Becco, m 2000, 6.VIII.89, leg. A. Casale [CCa]; 2 ♂♂3 ♀♀, Italia, Piemonte, Col di Tenda, m 1900, 7.VIII.88, leg. A. Casale [CCa]; 3 ♂♂ 3 ♀♀, M. Marguareis, Piaggia Bella, m 2200, 20.VI.72, Casale [CCa]; 2 ♂♂, Val Casotto, CN m 1300, 23.V.71, Casale [CCa]; 1 ♂, Alpi Mar. CN, Prato Nevoso, m 1500, 20.V.79, Casale [CCa]; 3 ♀♀, Alpi Liguri, Marguareis, Carsene, m 2200, 10.VIII.80, Casale [CCa]; 2 ♀♀, Italia, Piemonte, V. Stura Demonte, Rif. Talarico, m 1700, 28.VI.84, A. Casale leg. (CCa); 1 ♂ 1 ♀, Italia, Piemonte, Monterosso Grana (CN), 21.V.86, leg. A. Casale (CCa); 3 ♀♀, Alpi Liguri, Colle di Tenda, 15.VII.1978, m 1900, R. Poggi [MSNG]; 1 ♂, Alpi Liguri (CN), Colle di Tenda, 19.VI.1982, m 1800, R. Poggi [MSNG]; 1 ♂1 ♀, Alpi Liguri, Val Casotto (CN), m 1400, 30.V.1981, R. Poggi [MSNG]; 2 ♀♀, Alpi Liguri, Alta Valle Ellero (CN), Rocce del Biecai, m 1900, 7.VI.1998, R. Poggi [MSNG]; 3 ♂♂2 ♀♀, Alpi Liguri (CN), Colle dei Signori, m 2100, 4.VII.1999, R. Poggi [MSNG, CGi]; 1 ♂3 ♀♀, Alpi Liguri (Francia), dint. Testa Ciaudon, m 2100, 4.VII.1999, R. Poggi [MSNG]; 4 ♂♂, Alpi Liguri, dint. Colle di Tenda, 4.VII.1999, m 2000, R. Poggi [MSNG, CGi]; 5 ♂♂3 ♀♀, AlpiLiguri, Alta V. Ellero, Passo delle Saline (CN), 2.VI.2003, R. Poggi [MSNG, CGi]; 8 ♂♂4 ♀♀, Alpi Liguri, Colle di Tenda(CN), Vallone Cabanaira, m 2000, 24.VI.2008, R. Poggi [MSNG, CGi]; 1 ♀, Alpi Cozie (Demonte), Vallone dell'Arma (CN), Colle dei Morti m 2400, 30.VI.2013, R Poggi [MSNG]; 2 ♂♂1 ♀, Terme Valdieri, Piemonte, fine VII,1903, A. Dodero [MSNG]; 1 ♂2 ♀♀, Valle Pesio, 16.VII.1911 [MSNG]; 19 ♂♂30 ♀♀, Piemonte, Alta Val Grana, VI.43, Binaghi; 29 ♂♂15 ♀♀, Piemonte, Alpi Mar. Viozene, Col del. Saline, 14.6.1937, G. Binaghi [MSNG]; 13 ♂♂7 ♀♀, Alpi Lig., V. Tanarello, M. Saccarello, 16.6.951, G. Binaghi [MSNG]; 3 ♂♂3 ♀♀, Alpi Maritt., Certosa di Pesio, VII-VIII.1910, A. Dodero [MSNG]; 1 ♀, Garessio, 9.VII.91 [MSNG]; 2 ♀♀, Limone Piem., Colla Piana, 6 e 11.V.1915, A. Baliani [MSNG]; 6 ♂♂4 ♀♀, Alpi Maritt., Val Pesio, VII.914, C. Mancini [MSNG]; 2 ♂♂4 ♀♀, Alpi Maritt., Val Pesio, C. Mancini [MSNG]; 2 ♂♂, Italie, Alpes de Tende, VII.1921 [MSNG]; 1 ♂, Marguareis, 6.09, C. Mancini [MSNG]; 12 ♂♂10 ♀♀, P.N. Alpi Marittime, Praiet, dint. Gias della Sciula, 1600–1700, N 44°08'37.9" E 007°22'34.3" 1.VII.2010, G. Vigna leg. [MSNG, CGi]; 1 ♂, Alpi Marittime, Prinardi-Murenz, 1500 m, 26.IV.2011, G.and A. Vigna leg. (NSNG); 1 ♂, P.N. Alpi Marittime, Terme di Valdieri, Vallone del Valasco, 1500–1700, 29.VI.2009, A. Vigna leg. [MSNG]; 1 ♀, Alpi Marit, 11.VIII.1972, Col di Tenda, m 2000, I. Mercati leg, [MSNG]; 4 ♂♂1 ♀, Piem. (CN), Santuario di Valmala, 22.IV.1980, leg. L.Bisio [MSNG, CGi]; 4 ♂♂2 ♀♀, Piemonte (CN), Val Ellero, 18.V.1986, Bisio leg. [MSNG]; 2 ♂♂, Piem. (CN), Certosa di Pesio, 1000 m, 16.IV.1981, Bisio leg. [MSNG]; 1 ♀, Artesina (CN), M. Mondolè m 1300, 15.VI.1976, G. Parodi [MSNG]; 4 ♂♂, Alpi Maritt., p.ta Marguareis, Rifugio Garelli, 16–17.VI.1973, leg. G. Gardini [MSNG, CGi]; 1 ♂, Alpi Liguri, m 1700, pend. Sud Cima Ciuaiera, 12–14.VII.976, leg. G. Gardini [MSNG]; 1 ♂2 ♀♀, Colle di Tenda, 29.VI.1967, R. Poggi [MSNG]; 1 ♀, Alpi Liguri, Valle delle Saline, m 1800, 24.VII.1970, R. Poggi [MSNG]; 1 ♂4 ♀♀Alpi Liguri, Bochín d'Aseo, m m 2292, 20.VII.1970, R. Poggi [MSNG]; 2 ♀♀, Alpi Liguri (CN), Cima d. Colme, m 2000, 5.VIII.1971, R. Poggi [MSNG]; 3 ♂♂2 ♀♀, Alpi Cozie, dint. Passo Gardetta N, m 2000–2150, 22.VII.74, A. Vigna leg. [MSNG, CGi]; 1 ♂1 ♀, Alpi Marittime, fontana sulla strada Ferriere-Bersezio, m 1850, 14.VI.2000, M. Mei lg. [MSNG]; 2 ♂♂1 ♀, Alpi Marittime, Pontebernardo, dint Rifugio Lausa, m 2400, 26.VII.86, A. Vigna leg. [MSNG, CGi]; 3 ♂♂1 ♀, Alpi Marittime, Sambuco, abet. M. Vaccia 1300 m, 19.VII.86, A. and G. Vigna leg. [MSNG, CGi]; 1 ♂2 ♀♀, Alpi Marittime, Sambuco, abet. M. Vaccia 1300 m, 7.VII.87, A. and G. Vigna leg. [MSNG]; 3 ♀♀, Alpi Marittime, Sambuco, abet. M. Vaccia 1300 m, 17.VII.98, A. Vigna leg. [MSNG]; 1 ♀, Alpi Marittime, Sambuco, abet. M. Vaccia 1300 m, 25.VI.1993, A. Vigna leg. [MSNG];

1 ♀, Alpi Marittime, Sambuco, abetine M. Vaccia 1300 m, 9.VI.1998, M.Me E. Piattella leg. [MSNG]; 1 ♂, Alpi Marittime, Sambuco, abetine M. Vaccia 1300 m, 12.VI.1998, M.Me E. Piattella leg. [MSNG]; 2 ♂♂2 ♀♀, Alpi Marittime, Sambuco, abetine M. Vaccia 1300 m, 12.VI.1998, A. Vigna leg. [MSNG]; 1 ♂, Alpi Marittime, Sambuco, abetine M. Vaccia 1300 m, 18.VI.2000, A. and G. Vigna leg. [MSNG]; 1 ♀, Alpi Marittime, Sambuco, abetine M. Vaccia 1300 m, 24.VI.2003, A. Vigna leg. [MSNG]; 1 ♀, Alpi Marittime, Sambuco, abetine M. Vaccia 1300 m, 22.VI.2004, A. Vigna leg. [MSNG]; 3 ♂♂1 ♀, Alpi Marittime, Vall. Riofreddo, Gias Paur, 6.IV.1995, A. Vigna leg. [MSNG]; 1 ♂, Alpi Marittime, Col Finestra, m 2400, 4.VIII.66. A. Vigna leg. [MSNG]; 3 ♂♂4 ♀♀, Alpi Marittime, Vallone Finestra, m 2200–2450, 10.VIII.72. A. Vigna leg. [MSNG, CGi]; 2 ♂♂4 ♀♀, Alpi Marittime, rifugio Soria, m 2000, 17.VII.1966. [MSNG, CGi]; 3 ♂♂6 ♀♀, Alpi Marittime, V.ne Gesso d. Barra, Garb d. Siula, m 1650–1700, Nevai Gorgia del Gelas, 13.VIII.2008. [MSNG, CGi]; 2 ♀♀, Alpi Marittime, Entracque S. Lucia Gorge, m 1100, 25.VIII.72, Colonnelli leg. [MSNG]; 1 ♀, Alpi Marittime, Cima Salauta, m 2160, 8.VII.1958, A. Vigna [MSNG]; 5 ♂♂11 ♀♀, Alpi Marittime, Cima Salauta, m 2160, 21.VII.1965, A. Vigna [MSNG, CGi]; 1 ♂3 ♀♀, Alpi Marittime, Col di Tenda, 1900, 16.VI.68, A. Vigna leg. [MSNG]; 7 ♂♂3 ♀♀, Alpi Marittime, C. Tenda, Bric Campanino m 1900, 8.VIII.72. A. Vigna leg. [MSNG, CGi]; 3 ♂♂7 ♀♀, Alpi Marittime, C. Tenda, Bric Campanino m 1900, 16.VIII.72. A. Vigna leg. [MSNG, CGi]; 3 ♀♀, Alpi Liguri, Colle dei Signori, m 2100, 13.VIII.67, A. Vigna leg. [MSNG]; 3 ♂♂7 ♀♀, Alpi Liguri, V. Pesio, V. Marguareis, 1200–1300, 25.VI.77, A. Vigna leg. [MSNG, CGi]; 1 ♀, Alpi Liguri, V. Pesio, 1200, 23.VI.69, A. Vigna leg. [MSNG].

**Description:** L: ♂♂10.5–11.2 mm, ♀♀11.0–11.7 m. T: ♂♂10.0–10.8 mm, ♀♀10.6–11.1 mm. Dorsal surface black-reddish, shiny; femora, tibiae, tarsomeres, antennae, palpi, mandibles and labrum black-reddish. Head with two reddish spots, more or less evident.

Head large, longer than wide. Frontal impressions deep, anteriorly sub-rectilinear, posteriorly slightly divergent, anteriorly gently wrinkled and shorter than supraorbital carina; vertex smooth. Temples rectilinear; eyes large and convex. Neck constriction distinct, without any distinct step. Antennae short, not reaching the middle of the elytra.

Pronotum wider than long, cordiform (PW/PL = 1.1 ♂♂), with maximum width at base of the anterior third and minimum width at basal angles. Sides gently and regularly arcuate in the anterior part, gently sinuate before base; anterior margin barely concave, fore angles prominent. Basal angles obtuse and not prominent, with distinct apex. Basal seta absent. Disk with mid longitudinal line well impressed and base not wrinkled. Lateral furrow very wide, hollowed and gently punctate, posteriorly confluent in the basal impressions, which are wide, long, well impressed and punctate.

Elytra ovoidal, slightly elongate (EL/EW 1.4 ♂♂, 1.5 ♀♀), with maximum width at posterior third; shoulders widely rounded, not distinct. Elytral striae well impressed and impunctate; intervals nearly flat. Two discal setae on the second stria, the first at half-length of elytra, the second at base of apical sixth.

Legs long and robust. First protarsomere, in male, 3 times longer than wide. Onychium ventrally with two rows of 3–4 long setae.

**Description of male genitalia:** Median lobe of aedeagus (Figure 13i,j), in lateral view, slightly and irregularly curved from base to apex. Apical blade sub-rectilinear; basal part sub-cylindrical, uncompressed and unexpanded. Apical blade, in dorsal view, long and sub-triangular, symmetrical, moderately turned on left side, and moderately rounded at tip. Apical ostium dorsal, not turned at sides. Right paramere, in lateral view (Figure 13l), long, wide, leaf-shaped. Male invaginated segment narrow, not semi-circular (Figure 13k).

**Comparative diagnosis:** The *P. maritimus* n. sp. pronotum is smaller, less transverse, and less rounded at sides than in *occitanus* n. sp.; it is smaller and less transverse than in *peirolerii sensu novo*. It also differs from *peirolerii* by the most distinct basal angles of the pronotum, and it is not completely blunt as in *peirolerii*. It also differs from *occitanus* n. sp. by the more slender shape of the IX invaginate segment of the male.

**Etymology:** We are pleased to name this interesting species corresponding to the Maritime Alps, where the new species is located.

**Distribution:** The Maritime and Ligurian Alps from Grana Valley to Saccarello Mt.

**Ecology:** *Platynus maritimus* n. sp. Is usually found in *Fagus* forest, under stones in damp and cold places, often along the edge of snowfields. In Ellero Valley, it was collected by traps in a Superficial Subterranean Habitat (MSS), with a commonly used technique [60]. In its distribution area, it is sympatric with *P. peirolerii* and *P. occitanus* n. sp.

### 3.3.10. *Platynus occitanus* n. sp. Giachino, Casale, Allegro (Figure 9b)

<http://zoobank.org/urn:lsid:zoobank.org:act:F7833C05-88A2-4329-A174-71E01AECFD93>

**Type locality:** Italy, Piedmont, Maritime Alps, Collalunga Lakes, m 2400 a.s.l.

**Holotype:** ♂, Valle Stura, Laghi di Collalunga, m 2400, 5.VII.2002, G. Allegro leg. [CAL].

**Paratypes:** 1 ♀, same data. [CGi]; 1 ♂, Alpi Marittime, 2400 m, Lago di Collalunga, 17.VII.86, G. Vigna leg. [MSNG]; 1 ♀, Lago Brocan, Alpes Marit., 5.7.11, 576 [CGi]; 3 ♀♀, Italia, Piemonte, Valdieri/Entraque, L. di Esterate, m 2000, 9.VIII.87, leg. A. Casale [CCa, CGi]; 2 ♀♀, Italia, Piemonte, Valle Stura di Demonte, rifugio Talarico, m 1900, 29.VII.84, leg. A. Casale [CCa]; 1 ♀, Italia, Piemonte, Valdieri, Vall. S. Anna, m 1800, 3.VIII.89, leg. A. Casale [CCa]; 2 ♀♀, Italia, Piemonte, Colle di Tenda/P.ta Becco, m 2000, 6.VIII.89, A. Casale (CCa); 2 ♂♂, Val Gesso, Rif. Soria, m 2200, 30.VII.72, Casale (CCa); 1 ♂, Italia, Piemonte, Valle Stura Demonte, Rif. Talarico, m 1700, 20.VII.84 A. Casale (CCa); 2 ♂♂, Alpi Liguri IM, Cima Marta, m 2000, 17.VI.82, Casale (CCa); 1 ♀, Val Maira, Acceglio (CN), Vallone Traversiera, Grangia Giacomarda, 18.IX.2005, m 2050, R. Poggi [MSNG]; 1 ♀, Alpi Liguri (CN), Colle dei Signori, m 2100, 4.VII.1999, R. Poggi [MSNG]; 1 ♂1 ♀, Alpi Liguri, Colle di Tenda(CN), Vallone Cabanaira, m 2000, 24.VI.2008, R. Poggi [MSNG, CGi]; 2 ♀♀, Piemonte, Alta Val Grana, VI.43, Binaghi [MSNG]; 2 ♂♂, Terme Valdieri, Piemonte, fine VII,1903, A. Doderio [MSNG]; 2 ♀♀, Italie, Alpes de Tende, VII.1921 [MSNG]; 2 ♀♀, Colle della Maddalena, 10.V.78, Giuntelli [MSNG]; 1 ♂, Alpi Maritt., p.ta Marguareis, Rifugio Garelli, 16–17.VI. 1973, leg. G. Gardini [MSNG]; 2 ♀♀, Colle di Tenda, 29.VI.1967, R. Poggi [MSNG]; 1 ♂2 ♀♀, Alpi Cozie, vallone Arma-Valcavera, m 2100–2300, 29.VI.77, A. Vigna leg. [MSNG]; 1 ♂, Alpi Cozie, Cima Ruissas, (Col Valcavera), 2500 m, 9.VI.1998, A. Vigna leg. [MSNG]; 1 ♀, Alpi Cozie, Cima Ruissas, Colle Valcavera, 2400 m, 20.VI.2001, A. Vigna leg. [MSNG]; 1 ♀, Alpi Marittime, Pietraporzio, 1300 m, 26.VI.1997, A. Digiulio [MSNG]; 1 ♂, Alpi Marittime, Vall. Riofreddo, Gias Paur, 6.IV.1995, A. Vigna leg. [MSNG]; 3 ♀♀, Alpi Marittime, Col Finestra, m 2400, 4.VIII.66. A. Vigna leg. [MSNG, CGi]; 1 ♀, Alpi Marittime, Vallone Finestra, m 2200, 20.VII.66. Osella leg. [MSNG]; 1 ♀, Alpi Marittime, Vallone Finestra, m 2200–2450, 4.VIII.66. A. Vigna leg. [MSNG]; 2 ♂♂2 ♀♀, Alpi Marittime, Vallone Finestra, m 2200–2450, 10.VIII.72. A. Vigna leg. [MSNG, CGi]; 1 ♂1 ♀, Alpi Marittime, Cima Salauta, m 2160, 21.VII,1965, A. Vigna [MSNG, CGi]; 2 ♂♂5 ♀♀, Alpi Marittime, C. Tenda, Bric Campanino m 1900, 8.VIII.72. A. Vigna leg. [MSNG, CGi]; 3 ♂♂9 ♀♀, Alpi Marittime, C. Tenda, Bric Campanino m 1900, 16.VIII.72. A. Vigna leg. [MSNG, CGi].

**Description:** L: ♂♂11.8–12.4 mm, ♀♀11.5–12.6 mm. T: ♂♂11.4–12.0 mm, ♀♀11.0–12.2 mm. Dorsal surface black-reddish, shiny; femora, tibiae, tarsomeres, antennae, palpi and labrum black-reddish; mandibles black. Head with two reddish spots, more or less distinct.

Head large, longer than wide. Frontal impressions deep, anteriorly sub-rectilinear, posteriorly slightly divergent, anteriorly wrinkled and shorter than supraorbital carina; vertex smooth. Temples rectilinear; eyes large and convex. Neck constriction evident, without any distinct step. Antennae short, just reaching the middle of the elytra.

Pronotum wider than long, not cordiform (PW/PL = 1.2 ♂♂), with maximum width at about middle and minimum width at basal angles. Sides gently and regularly arcuate from anterior to basal angles, not sinuate before base; anterior margin scarcely concave, fore angles scarcely prominent. Basal angles obtuse and not prominent, with rounded apex. Basal seta absent. Disk with mid longitudinal line well impressed and base distinctly wrinkled. Lateral furrows very wide, hollowed and punctate, posteriorly confluent in the basal impressions, which are wide, long, well impressed and punctate.

Elytra ovoidal, lightly elongate (EL/EW 1.5 ♂♂♀♀), with maximum width at posterior third; shoulders broadly rounded, not distinct. Elytral striae well impressed and impunc-



tate; intervals nearly flat. Two discal setae on the second stria, the first at half-length of elytra, the second at base of apical sixth.

Legs long and robust. First protarsomere, in male, 2.5 times longer than wide. Onychium ventrally with two rows of 3–4 long setae.

**Description of male genitalia:** Median lobe of aedeagus (Figure 13a,b), in lateral view, slightly and regularly curved from base to apex. Apical blade sub-rectilinear; basal part sub-cylindrical, uncompressed and unexpanded. Apical blade, in dorsal view, long and sub-triangular, symmetrical, moderately rounded at tip. Apical ostium dorsal, not turned at sides. Right paramere, in lateral view (Figure 13d), long, wide and leaf-shaped. (Figure 13c). Male invaginated segment wide and oval.

**Comparative diagnosis:** *P. occitanus* n. sp. is easily distinguished by its large pronotum, which is more transverse and regularly rounded forwards and backwards than in *maritimus* n. sp. and *peirolerii*. The apical blade of the median lobe of the aedeagus, in the dorsal view, is narrower and sharper in *occitanus* n. sp. compared to *maritimus* n. sp. and *peirolerii*. The IX invaginated segment is short and wide in *occitanus* n. sp., and it is ovoidal and narrow in *maritimus* n. sp. and *peirolerii*.

**Etymology:** We are pleased to dedicate this interesting species to the historical Occitan Region, where the new species is located.

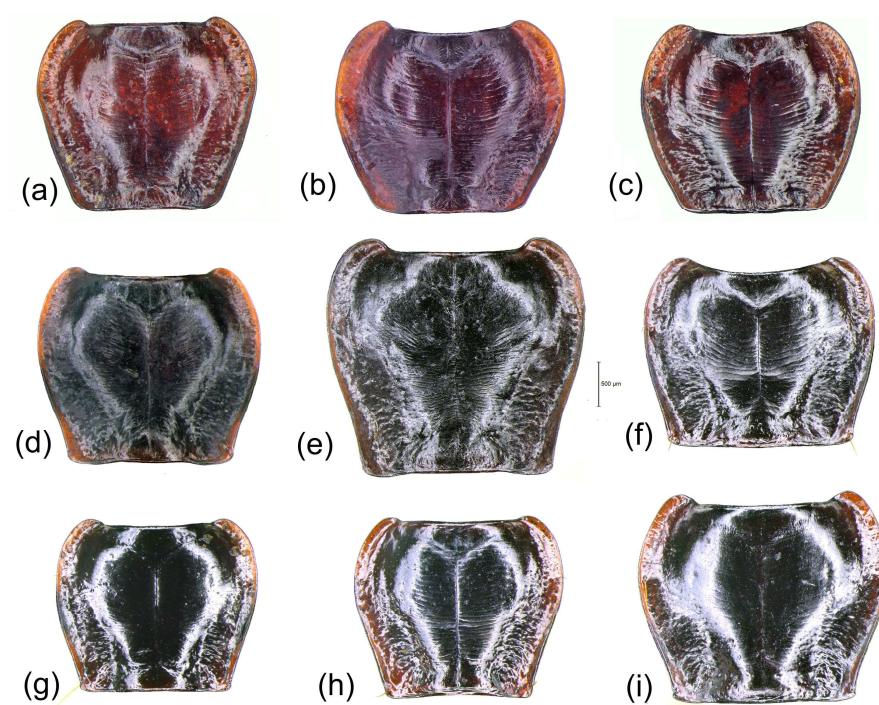
**Distribution:** The Maritime and Ligurian Alps: from the Lakes of Collalunga, Brocan, and Esterate, S. Anna Valley, to Col di Tenda and Cima Marguareis.

**Ecology:** *Platynus occitanus* n. sp. was collected directly under stones in damp and cold places, often along the edge of snowfields. It is sympatric with *P. peirolerii* and *P. maritimus* n. sp in its distribution area.

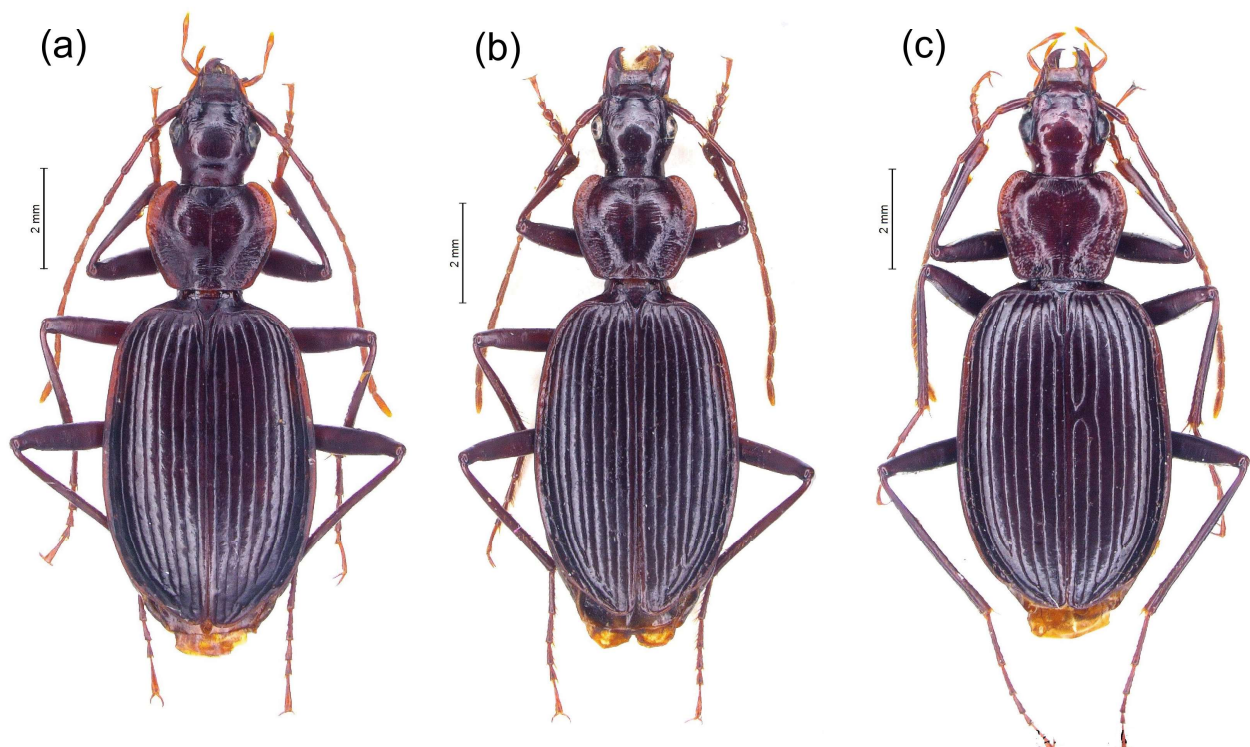
### 3.3.11. Identification Keys of the *Platynus* (species from Italy) (Figures 14–17, Table 4)

1. Winged. Metaepisterna long, markedly narrowed posteriorly. Elytra long and narrow, slightly convex. Piedmont, Lombardy ... ..  
... .. *P. livens* (Gyllenhal, 1810)
- Brachypterous. Metaepisterna wide, scarcely narrowed posteriorly. Elytra oval, flattened ... .. 2
2. Eyes large and markedly protruding. Third antennomere as long as fourth. Body piceous-brown, shiny. Antennae, mouth parts, legs and ventral parts reddish; sides of pronotum as well as of elytra yellowish-brown. Friuli ... ..  
... .. *P. scrobiculatus scrobiculatus* (Fabricius, 1801)
- Eyes moderately small and scarcely protruding. Third antennomere longer than fourth ... .. 3
3. Posterior angles of pronotum obtuse and rounded, without seta. Maritime Alps ... .. 4
- Posterior angles of pronotum usually distinct, with seta. ... .. 6
4. Pronotum larger, more transverse and more rounded at sides. Maritime and Ligurian Alps ... ..  
... .. *P. occitanus* n. sp.
- Pronotum much smaller, less transverse and less rounded at sides ... .. 5
5. Pronotum with sides sub-rectilinear at basal third and basal angles broadly rounded. Maritime Alps ... ..  
... .. *P. peirolerii* (Bassi, 1834) *sensu novo*
- Pronotum with sides slightly rounded at basal third and basal angles narrowly rounded. Maritime and Ligurian Alps ... ..  
... .. *P. maritimus* n. sp. (ex *P. peirolerii* Bassi, 1834)

6. Tarsomeres very long: male first protarsomere 3–4 times longer than wide . . . . .  
 . . . . . 7
  - Tarsomeres shorter: male first protarsomere at most 2.5 times longer than wide . . . . .  
 . . . . . 8
7. Pronotum sides rectilinear at basal half. Male first protarsomere 3 times longer than wide. From Cottian to Lepontine Alps . . . . .  
 . . . . . *P. complanatus* (Dejean, 1828) where *P. complanatus* is sympatric with *P. depressus* (Biella Pre-alps and Western Lepontine Alps), they can be easily distinguished by the ventral setae of onychium, which are more numerous, stouter and present at least from half length of onychium in *P. complanatus*, instead of less numerous, thin and limited to the apical part of onychium in *P. depressus*. Moreover, the maxillary palpi are entirely reddish in *P. complanatus*, whilst the first palpomere is darker than following in *P. depressus*.
  - Pronotum sides slightly sinuate at basal half. Male first protarsomere 4 times longer than wide. Cottian Alps (Sangone Valley) . . . . .  
 . . . . . *P. simonisi* n. sp.
8. Pronotum short, markedly transverse, with sides rectilinear at basal half, anterior edge concave. Body piceous-black with antennae, palpi and tarsomeres reddish. Cottian and Maritime Alps . . . . . *P. erythrocephalus* Bassi, 1834 (= *P. sexualis* K. Daniel & J. Daniel, 1898)
  - Pronotum slenderer, anterior edge rectilinear . . . . .  
 . . . . . 9
9. Sides of pronotum usually slightly sinuate towards basal angles, which are obtuse or nearly right. Palpomeres entirely reddish. Ventral setae of onychium stouter. From Orobian Alps to Lessini . . . . .  
 . . . . . *P. teriolensis* K. Daniel & J. Daniel, 1898
  - Sides of pronotum rectilinear towards basal angles, which are obtuse. First maxillary palpomere darker than following. Ventral setae of onychium absent or very thin and limited to apical part. Pennine and Western Lepontine Alps . . . . .  
 . . . . . 10
10. Pronotum smaller, less transverse, with narrower base. Elytra broadly rounded at sides, with more rounded shoulders. Pennine and W Lepontine Alps . . . *P. depressus* Dejean & Boisduval, 1830
  - Pronotum larger, more transverse, with broader base. Elytra less rounded at sides with more distinct shoulders. W Lepontine Alps (between Vigizzo Valley and Val Grande) . . . *P. vignai* n. sp.



**Figure 14.** Pronotum of *Platynus* species: (a) *P. maritimus* n. sp.; (b) *P. occitanus* n. sp.; (c) *P. peirolerii sensu novo*; (d) *P. complanatus*; (e) *P. simonisi* n. sp.; (f) *P. erythrocephalus*; (g) *P. depressus*; (h) *P. vignai* n. sp.; (i) *P. teriolensis*.



**Figure 15.** Habitus of *Platynus* species: (a) *P. occitanus* n. sp.; (b) *P. peirolerii*; (c) *P. maritimus* n. sp.



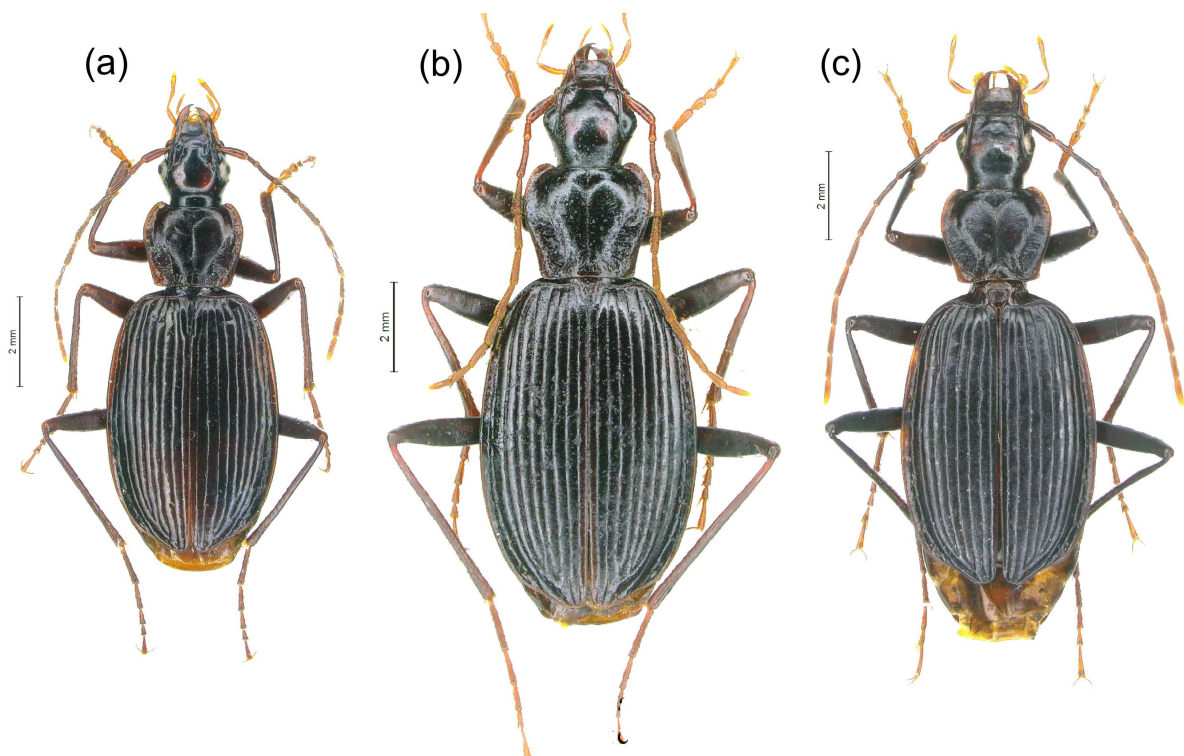


Figure 16. Habitus of *Platynus* species: (a) *P. erythrocephalus*; (b) *P. simonisi* n. sp.; (c) *P. complanatus*.

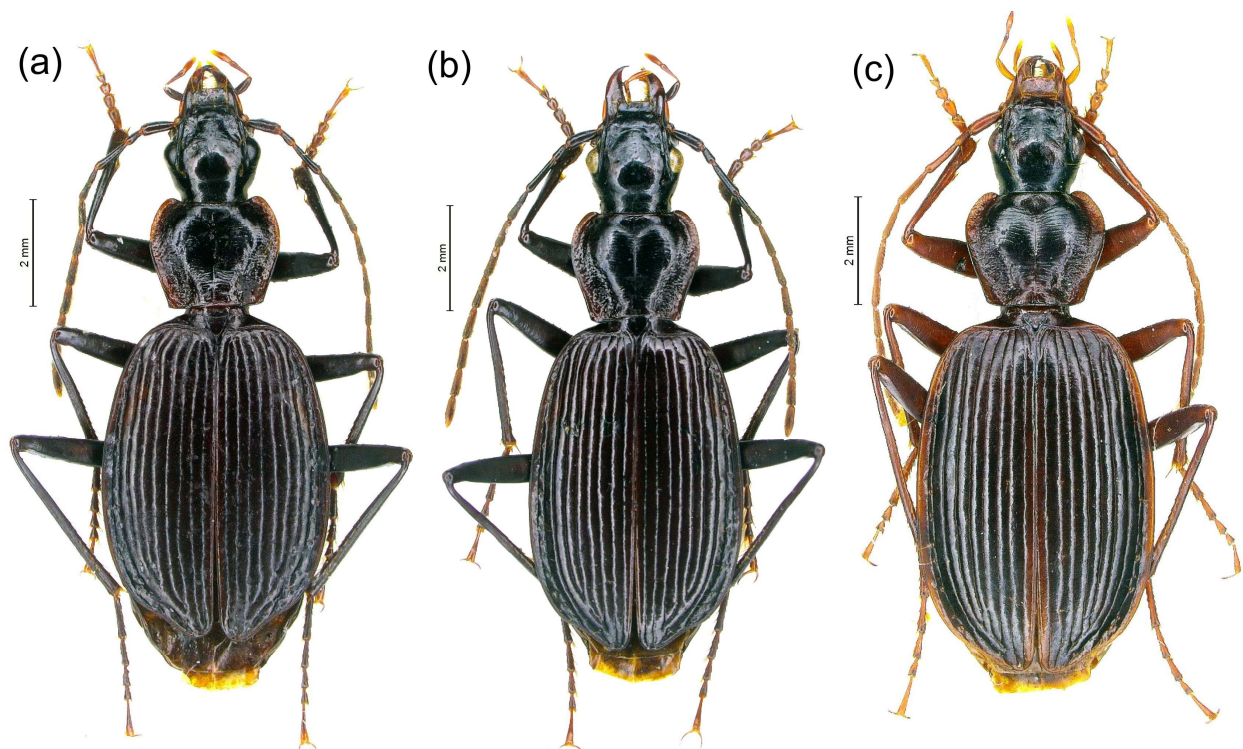


Figure 17. Habitus of *Platynus* species: (a) *P. depressus*; (b) *P. vignai* n. sp.; (c) *P. teriolensis*.



**Table 4.** Ratio between the linear measurements of each species of *Platynus*. In the table, the acronyms correspond to: PL = pronotum maximum length, measured from anterior to the basal angle; PW = pronotum maximum width; EL = elytron maximum length, from shoulder to apex; EW = elytron maximum width; MH = maximum head width across eyes; MF = minimum frons width between eyes.

		PW/PL	EL/EW	MH/MF
<i>Platynus complanatus</i>	♀	1.10	1.40	1.54
	♂	1.20	1.40	
<i>Platynus depressus</i>	♀	1.20	1.50	1.43
	♂	1.10	1.50	
<i>Platynus erythrocephalus</i>	♀	1.20	1.40	1.47
	♂	1.20	1.50	
<i>Platynus maritimus</i>	♀	1.10	1.50	1.50
	♂	1.10	1.40	
<i>Platynus occitanus</i>	♀	1.20	1.50	1.46
	♂	1.20	1.50	
<i>Platynus peirolerii</i>	♀	1.20	1.40	1.41
	♂	1.20	1.40	
<i>Platynus simonisi</i>	♀	1.20	1.50	1.55
	♂	1.10	1.40	
<i>Platynus teriolensis</i>	♀	1.20	1.40	1.38
	♂	1.20	1.50	
<i>Platynus vignai</i>	♀	1.10	1.60	1.35
	♂	1.10	1.50	

#### 4. Discussion

*Platynus* is known as an extremely complicated genus whose taxonomic position is still far from being clarified, although parts of the species have already been revised [47,48]. Furthermore, its specific composition has not been fully evaluated until now, and attempts to relate W Palearctic species have yet to be made. For the *Platynus* genus, we herein tested the use of an integrative approach to detect new taxonomic entities in these ground beetles that inhabit the Alpine arc. The study initially focused on the definition of overall shape variation within the dataset, testing different anatomical traits to uncover even the smallest differences in the structures, often undetected by visual surveys. These specimens were analyzed, identifying different patterns of variation in the examined structures. Clearly, the GM approach cannot define the taxonomic rank of the individuals, it was possible to further evaluate any qualitative characters, as those of genitalia, within and among the suggested agglomerates, by direct observation to ascertain if a specific rank could be assigned to these taxa once the closeness degrees of the specimens (and the patterns of variation within the dataset) were assessed. Hence, we combined qualitative and quantitative methods, corresponding to morphological traits, which suggested a relatively easy research protocol to be managed by examining the species.

We defined the size and shape variation by the GM analysis, which has previously given meaningful results in carabid studies [37–39,61,62]. According to our results, as males and females show marked size and shape differences, sexes must always be examined separately to avoid any identification problems due to sexual dimorphism, even in the cases (as for this genus) where sexual morphological differentiation is barely visible by sight [63].

In detail, the size analysis evidenced that, as expected, females are usually bigger than males, and a significant size-related sexual dimorphism is shown in *Platynus*. This is the most common case not only in Carabidae, but also in the majority of insect species [64]. Among the *Platynus* species, however, the geographically closest species usually show

more significant differences for both sexes, or at least in females. This is the case of, for example, *P. complanatus*, *P. depressus*, and *P. vignai* or of *P. erythrocephalus* and *P. simonisi*. When non-significant differences are detected, as with *P. peirolerii* and *P. erythrocephalus*, species are likely well-separated because they present significant morphological differences in shape (Figure 6, see below for details).

The analysis of the shape variation in the pronotum and right elytron allowed us to define some significant differences among species. For the head, the overall shape variation was far less evident in several species. Although the resulting differences are depicted in both datasets of males and females, the structure patterns of variation in shape are, however, different in both sexes, and the closer (and more similar in features terms) species can be easily identified based on the shape of the chosen anatomical traits.

Furthermore, we also found differences in pattern shape variation among the three examined anatomical traits, likely corresponding to different evolutionary trends: head and pronotum showed a similar variation pattern, while the right elytron gave a lower value of covariation to both former structures in the PLS analysis (Table 3). Although the right elytron had high percent values for the explained overall shape variation in PCA, it could also have a different variation pattern from pronotum and head. These results suggested that more than one evolutionary scenario is possible for these structures, with the head and pronotum sharing similar evolutions, while the elytra have other—and different—trends.

It is likely that further different patterns can be detected by including more anatomical traits. Thus, it is surely more advisable to define the shape variation in each trait separately and then analyze them together. The choice to create a unique point configuration of the whole body size, as done by other researchers [39,65], could likely lead to results in which overall shape variation would not be fully represented.

According to these results, the pronotum is surely the structure that can provide the best species identification, but other body parts can contribute to correct species attribution. To correctly identify species, it does not suffice to examine traits separately, they must also be examined together. Within this framework, it is likely that the inclusion of more anatomical traits, such as mouthparts, to be treated together with those herein proposed, could increase the suggested method's discrimination power. It is particularly advisable to choose traits that have been useful in other coleopteran taxa, such as epipharynx [52,53,66,67].

Despite their large use in coleopteran taxa identification [27,28], in the W Palearctic *Platynus*, the male genitalia are very homogenous at specific levels, particularly the shape of the median lobe is rather similar within these taxa, while the IX invaginated segment shows a higher discriminating value. The female genitalia are characterized by slightly differentiated structures. Hence, they cannot be useful for a correct identification at a specific level but can contribute to define the taxonomic rank and phylogenetic relationships at a higher level (e.g., species group or genus).

However, not only shape but also size contribute here to species identification. Thus, other characters could be included in the dataset. Moreover, the separate characters that could not fully discriminate species (as the genitalia) could be extremely effective when coupled to other characters.

Zoogeographically, the distribution of the three southern species *P. peirolerii*, *P. maritimus* n. sp., and *P. occitanus* n. sp., which have largely overlapped ranges, is of particular interest. This phenomenon of the sympatry of several related species of the same group can be attributed to allopatric speciation by isolation (all these species are brachytherous and montane, subject to isolation at various glacial stages) and subsequent “overlapping” of ranges.

## 5. Conclusions

We are aware that, today, the problems of identifying cryptic species and their mutual affinities can be just as validly addressed by the methods of molecular biology: genetic distances and barcoding for species identification; and molecular phylogenies for mutual

affinities. The results of the present research show how geometric morphometrics can be a valid integrative approach to molecular investigation.

The analysis of *Platynus* from the W Alps following both qualitative and quantitative methods allowed us to not only validate these carabids' known taxonomic composition but also extend present knowledge about this genus by adding four new endemic species to the study area. As part of this framework, the herein proposed geometric morphometric approach proves to be a powerful tool to also evaluate the taxonomies for complicated insect groups, such as *Platynus* species, and helps to define taxonomic entities that would be otherwise unrecognizable. Our findings highlight the peculiar ecological requirements of *Platynus*, whose species are usually found in cold habitats and can thus be affected by global environmental changes.

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**Conflicts of Interest:** The authors declare no conflict of interest.

## References

1. Habu, A. *Fauna Japonica, Carabidae: Platynini (Insecta: Coleoptera)*; Keigaku Publishing Co. Ltd.: Tokyo, Japan, 1978; pp. 1–447.
2. Liebherr, J.K.; Will, K.W. New North American *P. latynus* Bonelli (Coleoptera, Carabidae), a Key to Species North of Mexico, and Notes of Species from the Southwestern United States. *Coleopt. Bull.* **1996**, *50*, 301–320.
3. Bousquet, Y. Description of a new species of *Platynus* Bonelli from the Appalachian Mountains of eastern North America (Coleoptera, Carabidae). *Zookeys* **2012**, *163*, 69–81. [[CrossRef](#)]
4. Liebherr, J.K. The Phylogeny and Revision of the *Platynus degallieri* species-group (Coleoptera, Carabidae: Platynini). *Bull. Am. Mus. Nat. Hist.* **1992**, *214*, 1–115.
5. Schmidt, J. Ein Vorschlag zur Lösung nomenklatorischer Probleme der Gattung *Platynus* Bonelli, 1810 (Coleoptera, Carabidae). *Entomol. Bl. Biol. Syst. Kafer* **2000**, *96*, 9–23.
6. Will, K.W.; Liebherr, J.K.; Maddison, D.R.; Galián, J. Absence asymmetry: The evolution of monorchid beetles (Insecta: Coleoptera: Carabidae). *J. Morphol.* **2005**, *264*, 75–93. [[CrossRef](#)] [[PubMed](#)]
7. Baehr, M. *Platynus lindrothi* sp. n., ein neuer Laufkafer aus den Westalpen. *Dtsch. Entomol. Z.* **1982**, *29*, 11–15. [[CrossRef](#)]
8. Vigna Taglianti, A.; Audisio, P.A.; De Felici, S. I Coleotteri Carabidi del Parco Nazionale della Val Grande (Verbania, Piemonte). *Riv. Piemont. Stor. Nat.* **1998**, *19*, 193–245.
9. Casale, A.; Vigna Taglianti, A. I Coleotteri Carabidi delle Alpi Occidentali e Centro-Occidentali (Coleoptera Carabidae). *Bio-geographia* **1992**, *16*, 331–399.
10. Bisio, L.; Allegro, G. I Coleotteri Carabidi e Cicindelidi della Valle d’Aosta (Italia nord-occidentale) (Coleoptera Carabidae, Cicindelidae). *Mem. Soc. Entomol. Ital.* **2022**, *99*, 81–122. [[CrossRef](#)]

11. Focarile, A. Sulla Coleotterofauna alticola di Cima Bonze m 2516 (Valle di Champorcher), del Monte Crabun m 2710 (Valle di Gressoney) e considerazioni sul popolamento prealpino nelle Alpi nord-occidentali (vers. ital.). *Rev. Valdôtaine D'hist. Nat.* **1975**, *29*, 53–105.
12. Focarile, A. Ecologie et Biogéographie des Coléoptères de haute altitude en Vallée d'Aoste. Reg. Autonoma Valle d'Aosta. *Assessor. Agric. For. Ambiente Nat.* **1987**, *72*, 1–167.
13. Casale, A.; Vigna Taglianti, A. Coleotteri Caraboidei delle Alpi e Prealpi centrali e orientali, e loro significato biogeografico (Coleoptera, Carabaeoidea). *Biogeographia* **2005**, *26*, 129–201.
14. Hock, R.; Rasul, G.; Adler, C.; Cáceres, B.; Gruber, S.; Hirabayashi, Y.; Jackson, M.; Kääb, A.; Kang, S.; Kutuzov, S.; et al. High Mountain Areas. In *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*; Pörtner, H.-O., Roberts, D.C., Masson-Delmotte, V., Zhai, P., Tignor, M., Poloczanska, E., Mintenbeck, K., Alegría, A., Nicolai, M., Okem, A., et al., Eds.; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2019; pp. 131–202. [\[CrossRef\]](#)
15. Gobbi, M.; Ambrosini, R.; Casarotto, C.; Diolaiuti, G.; Ficetola, G.F.; Lencioni, V.; Seppi, R.; Smiraglia, C.; Tampucci, D.; Valle, B.; et al. Vanishing permanent glaciers: Climate change is threatening a European Union habitat (Code 8340) and its poorly known biodiversity. *Biodivers. Conserv.* **2021**, *30*, 2267–2276. [\[CrossRef\]](#)
16. Brighenti, S.; Hotaling, S.; Finn, D.S.; Fountain, A.G.; Hayashi, M.; Herbst, D.; Saros, J.E.; Tronstad, L.M.; Millar, C.I. Rock glaciers and related cold rocky landforms: Overlooked climate refugia for mountain biodiversity. *Glob. Change Biol.* **2021**, *27*, 1504–1517. [\[CrossRef\]](#)
17. Gobbi, M.; Lencioni, V. Glacial biodiversity lessons from ground-dwelling and aquatic insects. In *Glaciers and the Polar Environment*; Kanao, M., Godone, D., Dematteis, N., Eds.; Intech Open, London, UK, 2020. [\[CrossRef\]](#)
18. Stibal, M.; Bradley, J.A.; Edwards, A.; Hotaling, S.; Zawierucha, K.; Rosvold, J.; Lutz, S.; Cameron, K.A.; Mikucki, J.A.; Kohler, T.J.; et al. Glacial ecosystems are essential to understanding biodiversity responses to glacier retreat. *Nat. Ecol. Evol.* **2020**, *4*, 686–687. [\[CrossRef\]](#)
19. Lencioni, V.; Gobbi, M. Monitoring and conservation of cryophilous biodiversity: Concerns when working with insect populations in vanishing glacial habitats. *Insect Conserv. Diver.* **2021**, *14*, 723–729. [\[CrossRef\]](#)
20. Liebherr, J.K. Comparison of Genetic Variation in Two Carabid Beetles (Coleoptera) of Differing Vigility. *Ann. Entomol. Soc. Am.* **1986**, *79*, 424–433. [\[CrossRef\]](#)
21. Liebherr, J.K. Gene flow in ground beetles (Coleoptera: Carabidae) of differing habitat preference and flight-wing development. *Evolution* **1988**, *42*, 129–137. [\[CrossRef\]](#)
22. Hågvær, S.; Gobbi, M.; Kaufmann, R.; Ingimarsdóttir, M.; Caccianiga, M.; Valle, B.; Pantini, P.; Fanciulli, P.P.; Vater, A. Ecosystem birth near melting glaciers: A review on the pioneer role of ground-dwelling arthropods. *Insects* **2020**, *11*, 644. [\[CrossRef\]](#)
23. Ficetola, G.F.; Marta, S.; Guerrieri, A.; Gobbi, M.; Ambrosini, R.; Fontaneto, D.; Zerboni, A.; Poulenard, J.; Caccianiga, M.; Thuiller, W. Dynamics of ecological communities following current retreat of glaciers. *Annu. Rev. Ecol. Evol. Syst.* **2021**, *52*, 405–426. [\[CrossRef\]](#)
24. Negro, M.; Caprio, E.; Leo, K.; Maritano, U.; Roggero, A.; Vacchiano, G.; Palestini, C.; Rolando, A. The effect of forest management on endangered insects assessed by radio-tracking: The case of the ground beetle *Carabus olympiae* in European beech *Fagus sylvatica* stands. *For. Ecol. Manag.* **2017**, *406*, 125–137. [\[CrossRef\]](#)
25. Negro, M.; Casale, A.; Palestini, C.; Rolando, A. Habitat use and movement patterns in the endangered ground beetle species, *Carabus olympiae* (Coleoptera: Carabidae). *Eur. J. Entomol.* **2008**, *105*, 105–112. [\[CrossRef\]](#)
26. Negro, M.; La Rocca, C.; Ronzani, S.; Rolando, A.; Palestini, C. Management trade off between endangered species and biodiversity conservation: The case of *Carabus olympiae* (Coleoptera: Carabidae) and carabid diversity in north-western Italian Alps. *Biol. Conserv.* **2013**, *157*, 255–265. [\[CrossRef\]](#)
27. Tarasov, S.; Genier, F. Innovative Bayesian and parsimony phylogeny of dung beetles (Coleoptera, Scarabaeidae, Scarabaeinae) enhanced by ontology-based partitioning of morphological characters. *PLoS ONE* **2015**, *10*, e0116671. [\[CrossRef\]](#)
28. Tarasov, S.I.; Solodovnikov, A.Y. Phylogenetic analyses reveal reliable morphological markers to classify mega-diversity in Onthophagini dung beetles (Coleoptera: Scarabaeidae: Scarabaeinae). *Cladistics* **2011**, *27*, 490–528. [\[CrossRef\]](#) [\[PubMed\]](#)
29. Kerman, K.; Roggero, A.; Rolando, A.; Palestini, C. Evidence for male horn dimorphism and related pronotal shape variation in *Copris lunaris* (Linnaeus, 1758) (Coleoptera: Scarabaeidae, Coprini). *Insects* **2018**, *9*, 108. [\[CrossRef\]](#)
30. Qgis Development Team. QGIS 3.26.3. Available online: <https://www.qgis.org> (accessed on 10 December 2022).
31. HISTALP (Historical Instrumental Climatological Surface Time Series of the Greater Alpine Region). Available online: <https://www.zamg.ac.at/histalp/> (accessed on 10 December 2022).
32. Adams, D.C.; Rohlf, F.J.; Slice, D.E. Geometric morphometrics: Ten years of progress following the 'revolution'. *Ital. J. Zool.* **2004**, *71*, 5–16. [\[CrossRef\]](#)
33. Rohlf, F.J. The tps series of software. *Hystrix* **2015**, *26*, 9. [\[CrossRef\]](#)
34. Zelditch, M.; Swiderski, D.; Sheets, D.H.; Fink, W.L. *Geometric Morphometrics for Biologists: A Primer*, 2nd ed.; Elsevier Academic Press: Waltham, MA, USA, 2004.
35. Rohlf, F.J. tpsDig2 v2.31, Open Access Software. 2018. Available online: <https://www.sbmorphometrics.org/> (accessed on 15 November 2022).
36. Rohlf, F.J. tpsUtil v1.82, Open Access Software. 2021. Available online: <https://www.sbmorphometrics.org/> (accessed on 15 November 2022).



37. Palestrini, C.; Roggero, A.; Hernández Nova, L.K.; Giachino, P.M.; Rolando, A. On the evolution of shape and size divergence in *Nebria* (*Nebriola*) ground beetles (Coleoptera, Carabidae). *Syst. Biodivers.* **2012**, *10*, 147–157. [\[CrossRef\]](#)
38. Roggero, A.; Giachino, P.M.; Palestrini, C. A new cryptic ground beetle species from the Alps characterised via geometric morphometrics. *Contrib. Zool.* **2013**, *82*, 171–183. [\[CrossRef\]](#)
39. Benítez, H.A.; Sanzana, M.J.; Jerez, V.; Parra, L.E.; Hernández, C.E.; Canales-Aguirre, C.B. Sexual Shape and Size Dimorphism in Carabid Beetles of the Genus *Ceroglossus*: Is Geometric Body Size Similar Between Sexes Due to Sex Ratio? *Zool. Sci.* **2013**, *30*, 289–295. [\[CrossRef\]](#) [\[PubMed\]](#)
40. Rohlf, F.J. tpsSmall v1.36, Open Access Software. 2021. Available online: <https://www.sbmorphometrics.org/> (accessed on 15 November 2022).
41. Rohlf, F.J. tpsRelw v1.75, Open Access Software. 2021. Available online: <https://www.sbmorphometrics.org/> (accessed on 15 November 2022).
42. IBM. *SPSS Statistic v28*; IBM Corp: Armonk, NY, USA, 2021.
43. Hammer, Ø.; Harper, D.A.; Ryan, P.D. PAST: Paleontological statistics software package for education and data analysis. *Palaeontol. Electron.* **2001**, *4*, 9.
44. Rohlf, F.J. tpsPLS v1.25, Open Access Software. 2021. Available online: <https://www.sbmorphometrics.org/> (accessed on 15 November 2022).
45. Tocco, C.; Roggero, A.; Rolando, A.; Palestrini, C. Inter-specific shape divergence in Aphodiini dung beetles: The case of *Amidorus obscurus* and *A. immaturus*. *Org. Divers. Evol.* **2011**, *11*, 263–273. [\[CrossRef\]](#)
46. Biondi, M.; Urbani, F.; D'Alessandro, P. Endemism patterns in the Italian leaf beetle fauna (Coleoptera, Chrysomelidae). *ZooKeys* **2013**, *332*, 177–205. [\[CrossRef\]](#) [\[PubMed\]](#)
47. Kataev, B.M.; Schmidt, J. Notes on certain Himalayan species of the genus *Trichotichnus*, with description of a new species from Nepal (Coleoptera, Carabidae, Harpalini). *Entomol. Bl. Col.* **2018**, *114*, 263–280.
48. Liebherr, J.K. A Taxonomic Revision of the West Indian *Platynus* Beetles (Coleoptera: Carabidae). *Trans. Am. Entomol. Soc.* **1986**, *112*, 289–368.
49. Liebherr, J.K.; Ivie, M.A. Two New *Platynus* Bonelli (Coleoptera: Carabidae: Platynini) from Nevis and St. Kitts, Lesser Antilles. *Coleopt. Bull.* **2021**, *75*, 59–74. [\[CrossRef\]](#)
50. Schmidt, J. Die Gattung *Platynus* in Kleinasien, mit der beschreibung neuer taxa (Coleoptera, Carabidae). *Fragm. Entomol.* **1996**, *27*, 347–353.
51. Valentine, J.M. Technique in the Preparation of Coleoptera. *J. Elisha Mitchell Sci. Soc.* **1934**, *50*, 255–262.
52. Roggero, A.; Barbero, E.; Palestrini, C. Phylogenetic and biogeographical review of the Drepanocerina (Coleoptera, Scarabaeidae, Oniticeellini). *Arthropod. Syst. Phylogeny* **2015**, *73*, 153–174.
53. Palestrini, C.; Barbero, E.; Roggero, A. The evolution of the mouthpart structures in the Eucraniini (Coleoptera, Scarabaeidae). *Org. Divers. Evol.* **2020**, *20*, 451–465. [\[CrossRef\]](#)
54. Forsythe, T.G. Feeding mechanisms of certain ground beetles (Coleoptera: Carabidae). *Coleopt. Bull.* **1982**, *36*, 26–73.
55. Ball, G.E.; Acorn, J.H.; Shpeley, D. Mandibles and labrum-epipharynx of tiger beetles: Basic structure and evolution (Coleoptera, Carabidae, Cicindelidae). *ZooKeys* **2011**, *147*, 39. [\[CrossRef\]](#)
56. Giachino, F. Lost collections: Preserving historical biodiversity memory. The case of Peiroleri manuscript. *Diversity*, 2022; in print.
57. Schmidt, J. Tribe Platynini Bonelli, 1810. In *Catalogue of Palaearctic Coleoptera. Volume 1. Archostemata—Myxophaga—Adephaga. Revision and Updated Edition*; Löbl, I., Löbl, D., Eds.; Brill: Leiden, The Netherlands; Boston, MA, USA, 2017; pp. 666–668.
58. Bassi, C.A. Description de quelques nouvelles espèces de Coléoptères de l'Italie. *Ann. Soc. Entomol. Fr.* **1834**, *3*, 463–475.
59. Daniel, K.; Daniel, J. Über zwei neue und einige bekannte, ungeflügelte *Platynus*-Arten. *Coleopt. Stud.* **1898**, *2*, 4–23.
60. Giachino, P.M.; Vailati, D. *The Subterranean Environment. Hypogean Life, Concepts and Collecting Techniques*; WBA: Verona, Italy, 2010; Volume 3, pp. 1–130.
61. Benítez, H.A.; Sukhodolskaya, R.A.; Órdenes-Claveria, R.; Vavilov, D.N.; Ananina, T. Assessing the shape plasticity between Russian biotopes in *Pterostichus dilutipes* (Motschulsky, 1844) (Coleoptera: Carabidae) a geometric morphometric approach. *Zool. Anz.* **2021**, *293*, 163–167. [\[CrossRef\]](#)
62. Benítez, H.A.; Sukhodolskaya, R.A.; Avtaeva, T.A.; Escobar-Suárez, S.; Órdenes-Claveria, R.; Laroze, D.; Hernández, R.P.; Vavilov, D.N. Quantifying elevational effect on the geometric body shape of Russian beetle *Carabus exaratus* (Coleoptera: Carabidae). *Zool. Anz.* **2023**, *302*, 30–36. [\[CrossRef\]](#)
63. Jeannel, R. *Faune de France. 39. Coléoptères Carabiques*; I. Lechevalier: Paris, France, 1941; pp. 1–572.
64. Langraf, V.; Petrovičová, K.; David, S.; Ábelová, M.; Schlarmanová, J. Body volume in ground beetles (Carabidae) reflects biotope disturbance. *Folia Oecol.* **2017**, *44*, 114–120. [\[CrossRef\]](#)
65. Benítez, H.; Vidal, M.; Briones, R.; Jerez, V. Sexual Dimorphism and Morphological Variation in Populations of *Ceroglossus chilensis* (Eschscholtz, 1829) (Coleoptera: Carabidae). *J. Entomol. Res. Soc.* **2010**, *12*, 87–95.

66. Palestini, C.; Barbero, E.; Roggero, A. Male horn lack of allometry may be tied to food relocation behaviour in lifting dung beetles (Coleoptera, Scarabaeidae, Eucraniini). *Insects* **2019**, *10*, 359. [[CrossRef](#)] [[PubMed](#)]
67. Roggero, A.; Moretto, P.; Barbero, E.; Palestini, C. The phylogenetic relationships of *Tiaronthophagus* n. gen. (Coleoptera, Scarabaeidae, Onthophagini) evaluated by phenotypic characters. *Insects* **2019**, *10*, 64. [[CrossRef](#)] [[PubMed](#)]

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