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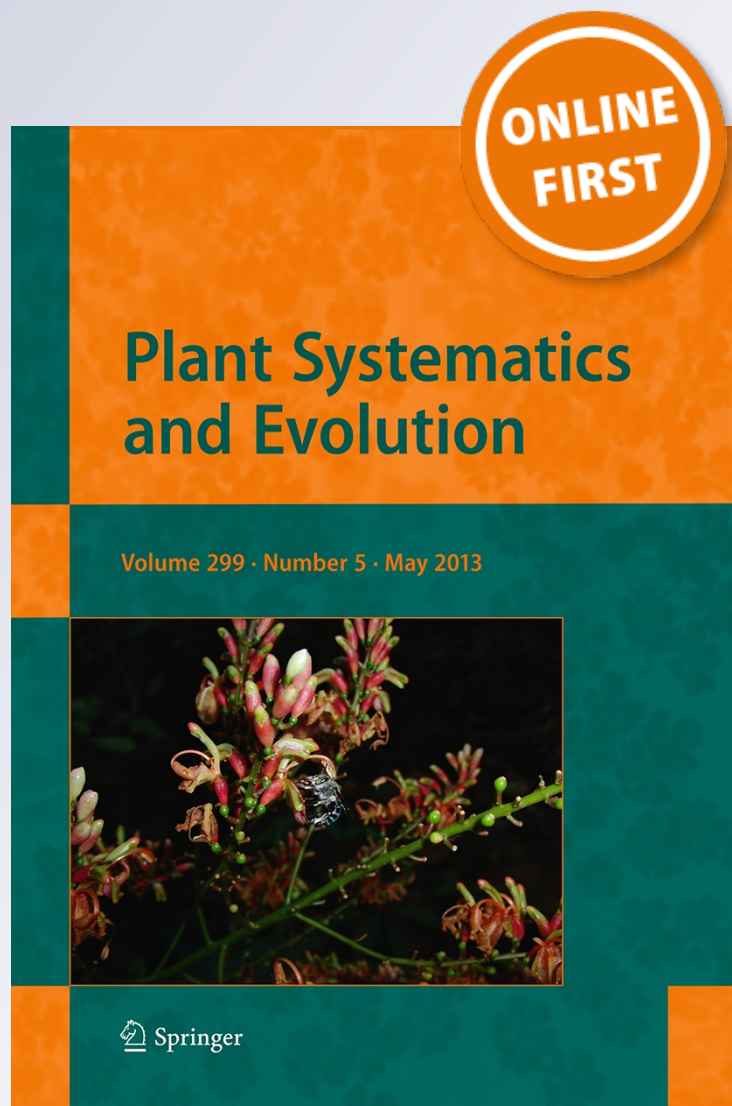
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Multivariate studies of *Ipheion* (Amaryllidaceae, Allioideae) and related genera

Agostina B. Sassone · Liliana M. Giussani · Encarnación Rosa Guaglianone

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Abstract *Ipheion*, as recognized by Guaglianone (Darwiniana 17:159–242, 1972), is a small genus of the family Amaryllidaceae, subfamily Allioideae, tribe Gilliesieae endemic to South America. Since 1800, the species of *Ipheion* were treated under *Beauverdia*, *Brodiaea*, *Milla*, *Nothoscordum*, *Tristagma* or *Triteleia*. Nowadays, some species of *Ipheion* are treated as *Tristagma* and some other under *Nothoscordum*. In this paper, we analyzed the morphological variation among species of *Ipheion* and related genera using a numerical taxonomic approach based on overall similarity, to investigate the intergeneric and infrageneric variations to the circumscribed groups. Based on 141 operational taxonomic units and 51 morphological characters, multivariate analyses were performed. Results showed that *Ipheion* separated into two groups according to Guaglianone's sectional treatment: *Ipheion* sect. *Ipheion* is morphologically more similar to the studied species of *Tristagma*, while *I.* sect. *Hirtellum* can be separated from *Nothoscordum/Zoellnerallium* and from *Tristagma* and allies. These a priori groupings were tested using discriminant and univariate analyses. Diagnostic characters were selected to differentiate groups. Previous taxonomic treatments are discussed and results are also evaluated using additional karyological and geographical data.

Keywords Amaryllidaceae · *Ipheion* · Morphological variation · *Nothoscordum* · *Tristagma* · Multivariate analyses

Introduction

Ipheion Raf. is a small genus of the family Amaryllidaceae, subfamily Allioideae, tribe Gilliesieae (Fay and Chase 1996; Chase et al. 2009). According to Guaglianone (1972), this genus includes eight species restricted to Argentina, Uruguay, southern Brazil and central Chile. *Ipheion uniflorum* (Graham) Raf., the type species, is endemic to the Pampean region (Argentina and Uruguay) despite the fact that it has been introduced in the American continent, Africa, Australia and Europe, as an ornamental species.

Ipheion was first described by Rafinesque (1836) based on *Milla uniflora* Graham, and later treated by Stearn (1943), Traub and Moldenke (1955), Guaglianone (1972) and Crosa (2001). This genus was characterized by Rafinesque (1836) by unifloral inflorescences with white flowers, spathe formed by one bifid bract, staminal filaments independently fused to the perigonial tube and the fruit being a clavate trilocular capsule. However, the taxonomic circumscription of *Ipheion* has been controversial; the species of *Ipheion* were treated under *Milla* Cav. (Graham 1833; Baker 1871; Grisebach 1879), *Tristagma* Poepp (Traub 1963; Ravenna 1967, 2001), *Brodiaea* Sm. (Engler 1887; Baker 1896), *Leucocoryne* Lindl. (Greene 1890), *Nothoscordum* Kunth (Kunth 1843; Baker 1898; Beauverd 1908, 1921; Crosa 1972, 1975b; Ravenna 1967, 1968, 1978; Rodrigues Souza et al. 2010), or *Beauverdia* Herter (1943) (Table 1).

After Rafinesque (1836), the name *Ipheion* was not used again until 1943, when it was accepted by Stearn, who recognized nine species (same species treated as *Beauverdia* by Herter in 1943); however, combinations into *Ipheion* were later done by Traub and Moldenke (1955), who included 23 species with uni and plurifloral

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Table 1 Major taxonomic treatments of unifloral species included in *Ipheion* by Guaglianone (1972)

Guaglianone (1972)	Baker (1871) and Grisebach (1879)	Herter (1943)	Traub and Moldenke (1955)	Traub (1963)	Ravenna (1967, 1968, 1978, 2001)	Crosa (1975b, 2001)
<i>I. uniflorum</i>	<i>M. uniflora</i>	<i>B. uniflora</i>	<i>I. uniflorum</i>	<i>T. uniflorum</i>	<i>T. uniflorum</i>	<i>I. uniflorum</i>
<i>I. sessile</i>	<i>M. sessiliflora</i>		<i>I. sessile</i>	<i>T. sessile</i>	<i>T. sessile</i>	<i>I. sessile</i>
			<i>I. recurvifolium</i>	<i>T. recurvifolium</i>	<i>T. recurvifolium</i>	<i>I. recurvifolium</i>
<i>I. tweedieanum</i>	<i>M. tweedieana</i>	<i>B. tweedieana</i>	<i>I. tweedieanum</i>	<i>T. tweedieana</i>	<i>T. tweedieana</i>	<i>I. tweedieanum</i>
<i>I. vittatum</i>	<i>M. vittata</i>	<i>B. vittata</i>	<i>I. vittatum</i>	<i>T. vittatum</i>	<i>N. vittatum</i>	<i>N. vittatum</i>
		<i>B. lloydiflora</i>	<i>I. lloydiflorum</i>	<i>T. lloydiflorum</i>		
<i>I. setaceum</i>	<i>M. setacea</i>		<i>I. setaceum</i>	<i>T. setaceum</i>	<i>N. setaceum</i>	
<i>I. dialystemon</i>						<i>N. dialystemon</i>
<i>I. hirtellum</i>	<i>M. hirtella</i>	<i>B. hirtella</i>	<i>I. hirtellum</i>	<i>T. hirtellum</i>	<i>N. hirtellum</i> subsp. <i>hirtellum</i>	<i>N. hirtellum</i>
		<i>B. lorentzii</i>	<i>I. lorentzii</i>	<i>T. lorentzii</i>	<i>N. hirtellum</i> subsp. <i>lorentzii</i>	
		<i>B. subssesilis</i>				
<i>I. sellowianum</i>	<i>M. sellowiana</i>	<i>B. sellowiana</i>	<i>I. sellowianum</i>	<i>T. sellowianum</i>	<i>N. felipponei</i>	<i>N. felipponei</i>
		<i>B. felipponei</i>	<i>I. felipponei</i>	<i>T. felipponei</i>		

Genera are abbreviated as follows: *B* *Beauverdia*, *I* *Ipheion*, *M* *Milla*, *N* *Nothoscordum*, *T* *Tristagma*

inflorescences in *Ipheion* and divided the genus in two sections based on the length of the tepal tube: sect. 1, less than 4 mm long and sect. 2, between 4.5 and 39 mm long.; with *I. bivalve* (Lindl.) Traub and *I. uniflorum* as the type species, respectively. Later on, Traub (1963) considered *Ipheion* as synonym of *Tristagma* and transferred to this genus all the species previously treated by Traub and Moldenke (1955). Later, Guaglianone (1972) separated *Ipheion* from *Tristagma*, on the bases of three diagnostic characters: unifloral inflorescences, spathe with one bifid bract or two bracts fused at base, and the presence of humifuse fruits. The last author grouped the species in two sections: sect. *Ipheion* including *I. sessile* (Phil.) Traub, *I. tweedieanum* (Baker) Traub and *I. uniflorum*; and sect. *Hirtellum* Guagl. with *I. dialystemon* Guagl., *I. hirtellum* (Kunth) Traub, *I. sellowianum* (Kunth) Traub, *I. setaceum* (Baker) Traub and *I. vittatum* (Griseb.) Traub. These sections are clearly differentiated by the spathe and the arrangement and fusion of the staminal filaments. Subsequent studies applied different criteria to exclude species from *Ipheion*. For instance, Ravenna (2001) divided *Tristagma* in three sections and included *I. uniflorum* and *I. tweedieanum* into *Tristagma* sect. *Ipheion* (Raf.) Ravenna, while grouped *I. sessile* with species of *Tristagma* in *T.* sect. *Nivella* Ravenna. In turn, Crosa (1972, 1975b) based on karyological and morphological data indicated that *I. hirtellum*, *I. dialystemon*, *I. sellowianum* and *I. vittatum* should be included in *Nothoscordum*, considering that unifloral inflorescences and humifuse fruits are not good characters to differentiate these species from the rest of the species of *Nothoscordum*. Furthermore, section *Hirtellum* and some species of *Nothoscordum* share the same base

chromosome number $x = 5$ and a similar fundamental number (FN) = 16 (Rodrigues Souza et al. 2010); although other species of *Nothoscordum* present a base chromosome number of $x = 4$ (Crosa 1972; Núñez 1990). In addition, the molecular phylogeny of tribe Gilliesieae (Fay et al. 2006) supports the idea that *Ipheion* is poliphyletic, with *I. uniflorum* and *I. sessile* as sister groups of *Tristagma*, while *I. dialystemon* and *I. hirtellum* (Guaglianone 1972) would be nested in *Nothoscordum*.

Zoellnerallium Crosa, which is morphologically related to *Nothoscordum* and differentiated by the reddish color of the inner bulb cataphylls, is also differentiated by the base chromosome number $x = 6$, the morphological type of the epidermal cells of the testa and the morphology and length of the embryo (Crosa 1975a, 2004).

In view of the existing taxonomic complexity of *Ipheion* and related taxa, in this work we tested the circumscription of *Ipheion*, *Nothoscordum*, *Tristagma* and *Zoellnerallium* using a numerical approach. We also used morphological data to further explain the degree of variability among entities. Other source of evidences, such as karyological and geographical data were used to interpret groupings and clarify taxonomic boundaries.

Materials and methods

Selection of taxa and characters

We considered all species of *Ipheion* as accepted by Guaglianone (1972). We also included species of *Nothoscordum*, *Tristagma* and *Zoellnerallium* to account for the variability of

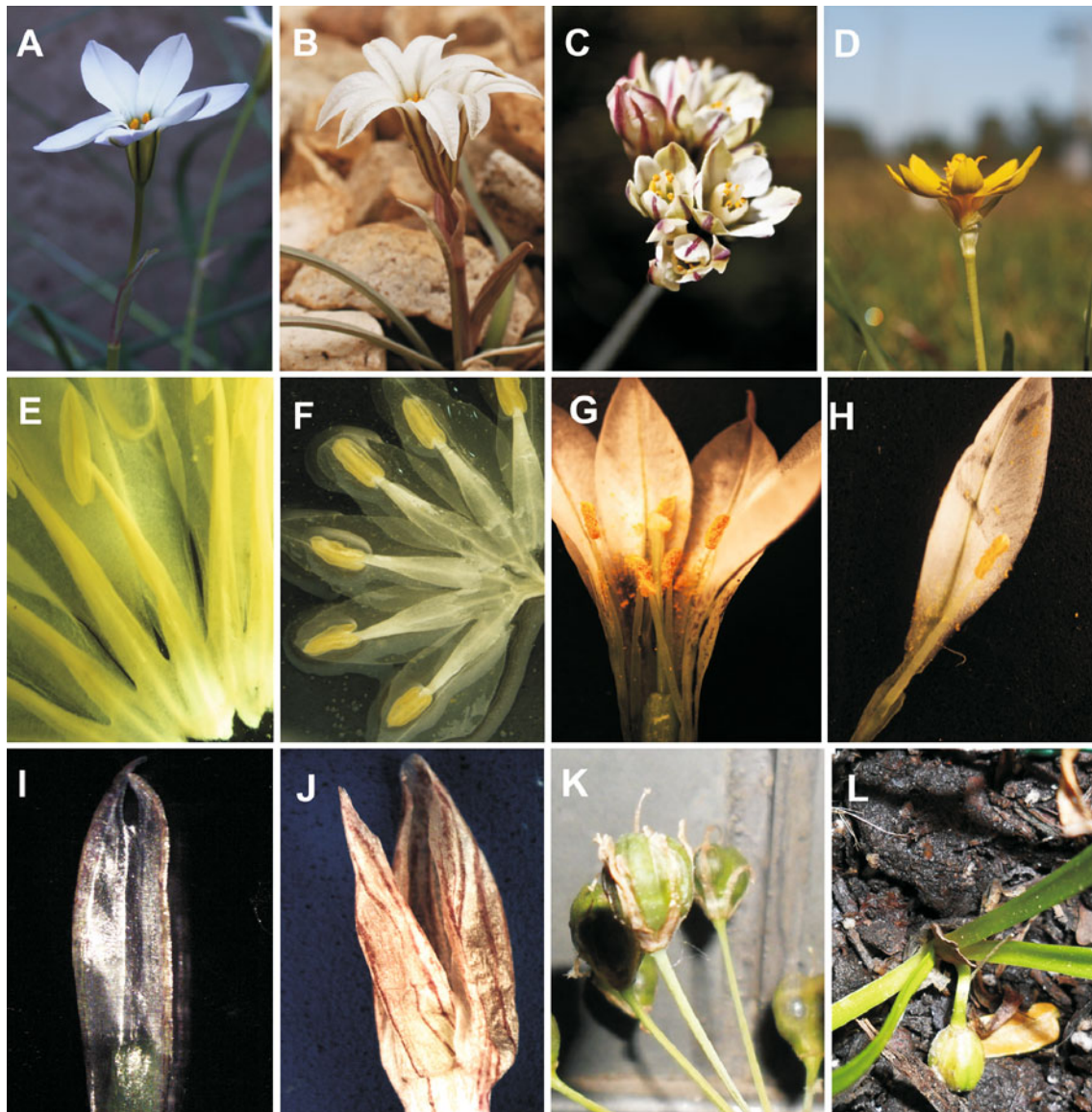


Fig. 1 Plate depicting morphological variability among genera and species in some of the studied characters. **a** *Ipheion uniflorum* (Morrone and Giussani 6217), **b** *Tristagma circinatum* (Zuloaga et al. 12356), **c** *Nothoscordum gracile* (Zuloaga et al. 12205), **d** *I. hirtellum* (Giussani and Morrone 424), **e** *I. hirtellum* (Giussani and Morrone

428), **f** *N. nudicaule* (Giussani and Morrone 446), **g–i** *I. tweedeanum* (Giussani and Morrone 420), **j** *I. sellowianum* (Giussani et al. 466), **k** *N. nudicaule* (Giussani and Morrone 446), **l** *I. sessile* (Giussani et al. 469). See references to character states in Table 2 and text

the genera (Fig. 1). Our sampling encompasses a total of 141 individuals belonging to eight species of *Ipheion*, 11 species of *Nothoscordum*, 9 species of *Tristagma* and one species of *Zoellnerallium*. Characters were measured for each specimen. Measurements were made on an average of five or more herbarium specimens housed at SI or borrowed from the following herbaria: BA, BAB, BAF, CONC, ICN, LIL and MERL (acronyms follow Holmgren et al. 1990). Whenever possible, type specimens of most species of *Ipheion* were also included or measured from on-line images using digital tools available at JSTOR Website (<http://plants.jstor.org>).

Morphological characters were chosen according to general descriptions and taxonomic keys of the species; including diagnostic characters to distinguish species and genera. Measurements on bulbs and flowers were taken on a well-developed bulb or inflorescence, respectively. Leaf blade measurements were taken over the widest region on a well-developed leaf blade. Sixty-one characters were initially examined, and after discarding the uninformative characters (invariable), a total of 51 characters were measured, coded and added to the data matrix for analyses (Table 2).

Table 2 List of characters examined and their coding states

Vegetative characters

1. Type of bulb: (1) simple (2) prolific (with several small bulbs around the principal bulb)
2. Color of cataphyll bulb: (0) whitish (1) reddish
3. Alliaceouse smell: (0) absent (1) present
4. Bulb length, in cm (measured from the base to neck)
5. Bulb width, in cm (measured at the widest region of the bulb)
6. Rhizome: (0) absent (1) present
7. Leaf blade length, in cm
8. Leaf blade width, in mm
9. Leaf blade indumentum: (1) absent (2) present
10. Edge blade indumentum: (1) absent (2) present
11. Ligule (0) absent (1) present
12. Scape length, in cm
13. Scape indumentum: (1) glabrous (2) papillose
14. Neck length, in cm
15. Bract length, in cm
16. Number of bracts: (1) one bifid bract (Fig. 1i) (2) two lanceolate bracts (Fig. 1j)
17. Length of the fused region of bracts or, if one bract, length of bract until division of the bifid apex, in cm
18. Pedicel length (as measured from the bract's base to the tepal's base), in cm

Reproductive characters

19. Type of Inflorescence: (1) unifloral (Fig. 1a, d) (2) bifloral (Fig. 1b) (3) plurifloral, more than two flowers (Fig. 1c)
20. Color of tepals: (1) yellow-yellowish (2) white-cream C (3) blue-light blue (4) pink (5) green.
21. Degree of tepal fusion: (1) fused only at the base (Fig. 1d) (2) fused up to the middle forming a tube around the ovary (Fig. 1a, b)
22. Number of tepals: (1) six (2) eight
23. Length of tepals at the fused region, in cm
24. Outer tepal length, in cm
25. Outer tepal width, in mm
26. Inner tepal length, in cm
27. Inner tepal width, in mm
28. Arrangement of staminal filament: (0) one series (Fig. 1e, f) (1) two series (Fig. 1g)
29. Staminal filament fusion: (1) all fused together at the same level (Fig. 1e, f) (2) all free and fused to the perigon in two series (Fig. 1g) (3) all free and fused to the perigon at different levels
30. Number of stamens: (1) six (2) three fertile stamens + 3 staminoids (3) eight
31. Shape of the staminal filaments: (1) linear (2) awl-shaped
32. Maximum high of the staminal filaments, in mm (measured from the base of the perigonium to the apex of the staminal filaments)
33. Minimum high of the staminal filaments, in mm (measured from the base of the perigonium to the apex of the staminal filaments)
34. Maximum length of the staminal filaments, in mm (measured from the base of the staminal filaments to its apex)
35. Minimum length of the staminal filaments length, in mm (measured from the base of the staminal filaments to its apex)
36. Length of the fused region of the staminal filaments, in mm
37. Maximum width of the staminal filaments, in mm (measured at the middle region of the staminal filaments).
38. Minimum width of the staminal filaments, in mm (measured at the middle region of the staminal filaments)
39. Length of the taller anther, in mm
40. Length of the smaller anther, in mm
41. Maximum width of the anthers, in mm
42. Minimum width of the anthers, in mm
43. Style length including the stigma, in mm
44. Style width, in mm (measured at the middle region of the style)
45. Type of style: (0) single (1) trifid
46. Ovary: (1) stipitate (2) sessile
47. Ovary length, in mm
48. Ovary width, in mm
49. Number of ovules per locule
50. Number of carpels: (1) three (2) four
51. Type of fruit: (0) aerocarpic (Fig. 1k) (1) humifuse (Fig. 1l)

The voucher specimen list used in this study is presented in Appendix 1. The complete data matrix used for numerical analyses is available upon request from the senior author.

Methods of analysis

A set of different methods have been chosen to analyze the taxonomic structure of this group of species, considering that each method itself has its own advantages or drawbacks when grouping; hence they were selected to achieve particular purposes. The principal coordinate analysis was used to faithfully represent distances between major groups, but this method is notorious for falsifying distances between close neighbors (Rohlf 1968). Hence, after exploring major groupings, we used a clustering technique, to reproduce distances between close neighbors faithfully, although this technique shows distortion in the distances among members of larger clusters, i.e., at the base level of the stems (Sneath and Sokal 1973).

Combining both approaches, ordination and clustering methods, we distinguished major groupings of species (i.e. genus level), and tested the clustering of OTUs by species (i.e. species level).

Then, using a selection of quantitative, non-correlated characters, we used a discriminant analysis (DA) to indicate the goodness of a classification using the a priori groupings. Finally, a univariate approach was used to select diagnostic characters that significantly discriminate among the major a priori groups.

Principal coordinates and cluster analyses

In order to describe the morphological variability among species, principal coordinate analyses (PCO, Gower 1966) were performed on partial or total data matrices. Our rationale for using PCO is because this method is recommended for data sets combining quantitative and qualitative characters (Legendre and Legendre 2003) and it is also recommended when missing data are present (Rohlf 1972). PCO was performed on a standard data matrix with variables, subtracting the minimum value of a variable, and dividing it by its range. Then, a double centered matrix was computed based on distances among OTUs (operational taxonomic units), and the eigenvectors were calculated and used to project the specimens in a tridimensional space (Rohlf 1972). This method allowed us to recognize main groups based on morphological similarity. These main groups were separated from the study and new analyses were performed on the remaining OTUs.

In addition, a cluster analysis was performed with the standardized matrix, to investigate distances among OTUs based on the Manhattan distance coefficient, using the

unweighted pair-group method on the arithmetic average algorithm (UPGMA). All analyses were performed using NTSYS-PC version 2.0 (Rohlf 1997).

Discriminant analysis (DA)

Taxonomic groups as defined by PCO were then considered as a priori groupings for discriminant analyses (Sneath and Sokal 1973; Afifi and Clark 1984). Discriminant analysis is a useful method to differentiate between two and more groups of objects with respect to several variables simultaneously. Based on a set of quantitative uncorrelated characters (correlation coefficient, $r < 0.5$), the analysis was used to recognize the percentage of specimens correctly classified on the a priori groups. The DA was performed using STATISTICA 6.0 Edition (StatSoft Inc. 1995).

Univariate analyses

To facilitate the identification of diagnostic characters among the most similar taxonomic groups, significant differences were tested using one-way analysis of variance (ANOVA) for quantitative characters while the non-parametric Kruskal–Wallis test (Sokal and Rohlf 1969) was performed for qualitative characters. The normal distribution of variables and homogeneity of variances among samples were tested using Kolmogorov–Smirnov's test (Tukey 1977) and Bartlett's test, respectively. For those characters not normally distributed, they were transformed using \log_{10} . With the purpose of detecting significant differences between all pairs of groups, Tukey's post hoc comparison and Dunn's test (Glantz 1992) were performed for quantitative and qualitative variables, respectively. The analyses were carried out using STATISTICA 6.0 Edition (StatSoft Inc. 1995), and Infostat (Di Rienzo et al. 2012).

Results

Multivariate analyses

The ordination of all 141 OTUs on the first three principal coordinates shows one group with specimens of *Nothoscordum* and *Zoellnerallium* (group 1) clearly differentiated on the positive extreme of axis I and negative extreme of axis II (Fig. 2). Individuals of *Tristagma*, *Ipheion*, and four specimens of *Nothoscordum* (three specimens of *N. ostenii* Beauverd and the isotype specimen of *N. marchesii* Crosa) were homogeneously distributed in the Euclidean space.

When separating both genera (*Nothoscordum* and *Zoellnerallium*), a new set of analyses was run with specimens of *Ipheion*, *Tristagma* and the four specimens of

Nothoscordum. Two groups of species are seen: (a) *I. uniflorum*, *I. sessile* and *I. tweedieanum* (= *Ipheion* sect. *Ipheion*) together with individuals of *Tristagma* on the negative end of axis I (group 2), and (b) *Ipheion dialyste-*

mon, *I. hirtellum*, *I. sellowianum* and *I. vittatum* (= *Ipheion* sect. *Hirtellum*); this group clearly differentiated on the positive end of axis I and positive end of axis II (group 3) (Fig. 3).

Fig. 2 Tridimensional plot of the first three principal coordinates (PCO) showing the distribution of 141 OTUs based on 51 morphological characters. Circle specimens of all species of *Ipheion* (as Guaglianone 1972); square specimens of *Nothoscordum* with *N. marchesii* (dark grey square) and *N. ostenii* (black square). Grey triangle: specimens of *Tristagma*; and black diamond: specimens of *Zoellnerallium*. Group 1 (rounded) gathers specimens of *Nothoscordum* and *Zoellnerallium* (see text for references)

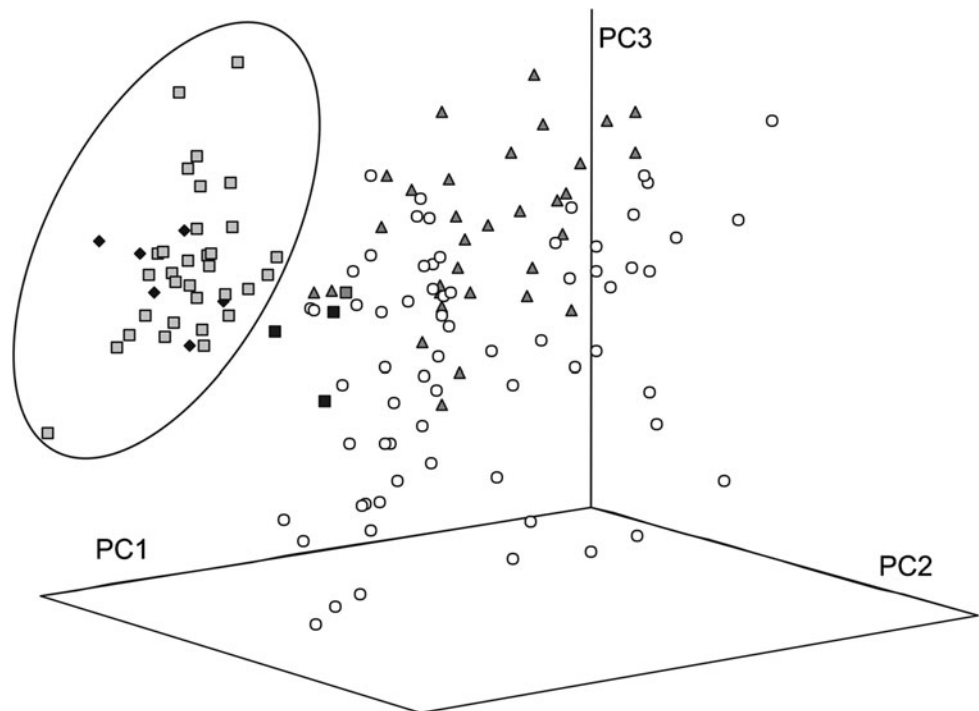
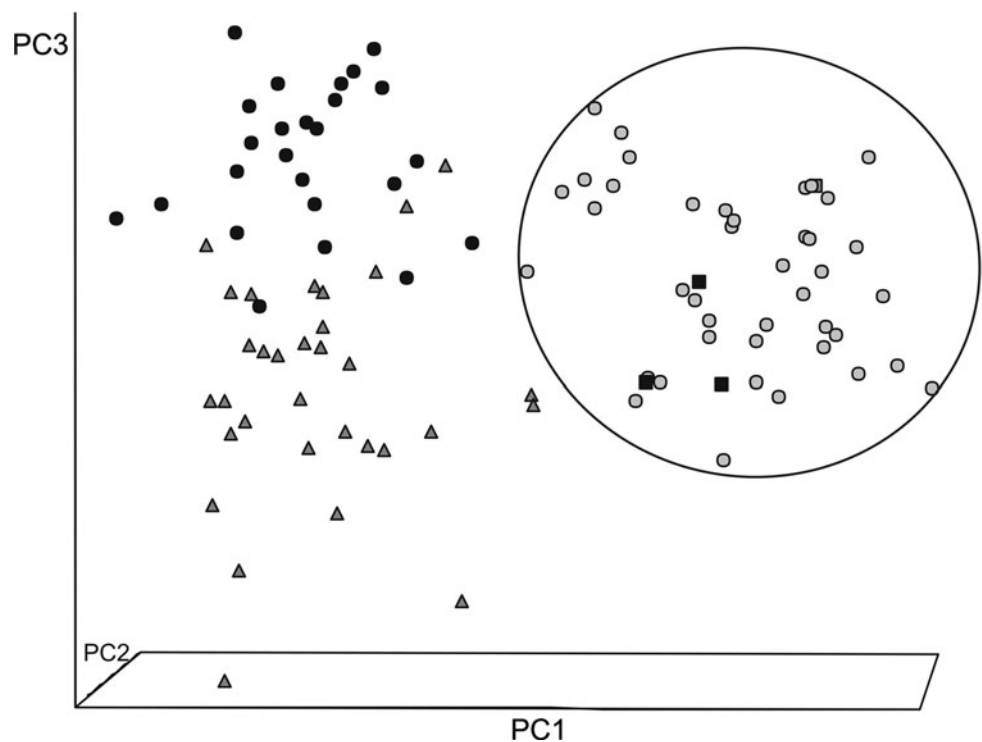


Fig. 3 Tridimensional plot of the first three principal coordinates (PCO) showing the distribution of 102 OTUs based on 51 morphological characters. Group 2: black circle: *Ipheion* section *Ipheion*, Black square: *Nothoscordum marchesii* and *N. ostenii*; and grey triangle: *Tristagma* spp. Group 3 (rounded): grey circle: *Ipheion* section *Hirtellum* (see text for references)

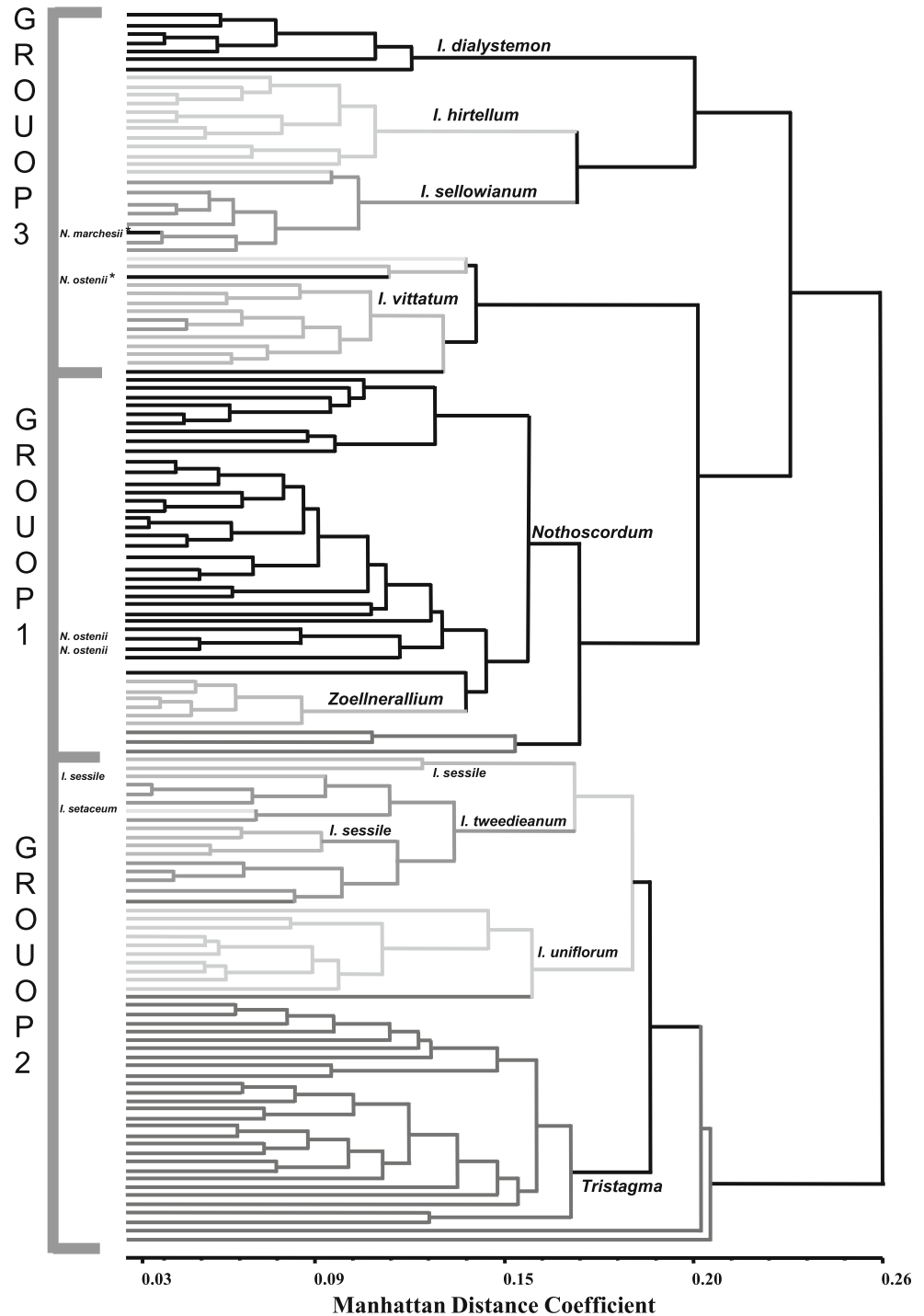


Cluster analysis

As expected from the cluster analysis, similarities among individuals are more accurate than among major groups, hence we only used this method at species level. Specimens were analyzed by cluster analysis based on Manhattan distances to test grouping of individuals into species (Fig. 4). Almost all species of *Ipheion* within

morphological complexes are clearly defined. The exceptions are the specimens of *I. sessile* which separated into two groups; both associated with individuals of *I. tweedeanum*. Other specimens, belonging to *Nothoscordum marchesii* (1) and *N. ostenii* (1), are more similar to species of *Ipheion* than to *Nothoscordum* spp. (Fig. 4), and their taxonomic positions are discussed later in the text.

Fig. 4 Phenogram of all specimens of *Ipheion*, *Nothoscordum*, *Zoellnerallium* and *Tristagma*, based on a Manhattan distance matrix, using the cluster analysis method with UPGMA. Groups 1, 2 and 3 correspond to those obtained with PCO analyses. Scale bar represent Manhattan distance coefficients. * indicates type specimens



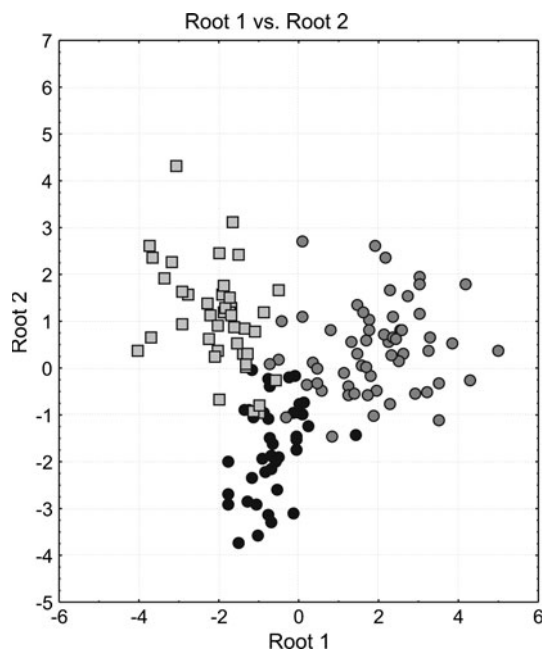


Fig. 5 Distribution of OTUs on the first two canonical variables. Group 1: *Nothoscordum*/*Zoellnerallium* (grey square); group 2: *Ipheion* section *Ipheion*/*Tristagma* (grey circle); and group 3: *Ipheion* section *Hirtellum* (black circle)

Discriminant analysis

Based on PCO, we distinguished three assemblages: group 1: *Nothoscordum* and *Zoellnerallium*; group 2: *Ipheion* sect. *Ipheion* and *Tristagma*; and group 3: *Ipheion* sect. *Hirtellum* (and individuals of *N. marchesii* and *N. ostenii*). Quantitative non-correlated characters were used to discriminate among the three a priori groups indicating that discrimination was highly significant ($p < 0.00001$). A total of 90 % of the individuals appeared to be correctly classified by discriminant functions: 88 % of individuals were correctly organized into group 1, 88 % were classified into group 2, whereas 95 % of individuals were correctly clustered into group 3. The distribution of the OTUs according to the first two canonical variables is seen in Fig. 5.

Univariate analyses

We used the analysis of variance to select diagnostic characters among groups previously defined by PCO and DA. Significant differences were tested among groups by the one-way ANOVA for normally distributed quantitative characters. For qualitative and discrete variables, a non-parametric Kruskal–Wallis analysis was applied. Table 3 shows selected characters representing the most significant differences among groups of the univariate analyses and results of Tukey's and Dunn's comparisons between groups.

Species of the *Nothoscordum*/*Zoellnerallium* complex are clearly distinguished by plurifloral inflorescences, with a spathe formed by two bracts at the base of pedicels, small white-cream or yellow (sometimes pink) flowers, and the longest pedicels. This group presents flowers with the smallest outer and inner tepals ($\bar{x} = 0.86 \pm 0.18$ mm); fruits are aerocarpic when mature. *Ipheion* sect. *Ipheion* and species of *Tristagma* present a well-developed neck ($\bar{x} = 4.13 \pm 2.24$ cm); the inflorescences are usually unifloral (1–5), white or green (pink, blue or purple in a few specimens) flowers. The tepals are fused up to the middle or higher. This group has the largest flowers with the outer and inner tepals about 2.17 ± 0.79 mm long. *Ipheion sessile* is particularly distinctive within the group as this species present the longest tepal tube, partially subterranean, hence with staminal filaments and the style being the longest among all species. Species of *Ipheion* sect. *Hirtellum* are clearly distinguished by having the smallest spherical bulbs, the shortest neck ($\bar{x} = 1.93 \pm 1.18$ cm), and shortest leaves ($\bar{x} = 7.36 \pm 3.88$ cm). The unifloral inflorescences have yellow-yellowish flowers (white in *I. vittatum*), with the tepals fused only at the base. The flowers are subtended by pedicels which are the shortest among groups ($\bar{x} = 0.52 \pm 0.31$ cm), with two lanceolate bracts, and humifuse fruits when mature, they have an average of twelve ovules per locule; staminal filaments are the longest among groups ($\bar{x} = 6.23 \pm 2.12$ mm). Figure 1 illustrates character variation among species of major groups.

Discussion

The circumscription of *Ipheion* and its recognition at the generic rank has been controversial as evidenced by different taxonomic treatments (Table 1) and by the fact that most of the species were transferred to related genera such as *Tristagma* and *Nothoscordum*. Our study indicates that some of the characters historically used to define *Ipheion*, such as unifloral inflorescence, humifuse fruit, and a spathe formed by one, or two fused bracts, were insufficient to group all eight species as previously circumscribed by Guaglianone (1972). The univariate and multivariate analyses showed new associations among species and genera, which were partially in agreement with previous classifications, corroborating the importance of phenetic analyses in the evaluation of taxonomic entities.

Sections of *Ipheion* as proposed in Guaglianone (1972) were recovered in our analyses; nonetheless, these groups were associated by similarity to other taxonomic entities or recognized as independent groups. For instance, *Ipheion* sect. *Ipheion* was associated to species of *Tristagma* (group 2), while *Ipheion* sect. *Hirtellum* (group 3) was identified by morphology as a separate entity from *Nothoscordum*/

Table 3 Quantitative and qualitative characters used to investigate the morphological variation among the following groups: *Nothoscordum/Zoellnerallium* (group 1), *Ipheion* sect. *Ipheion/Tristagma* (group 2), and *I.* sect. *Hirtellum* (group 3)

Character	<i>Nothoscordum/ Zoellnerallium</i> N = 38	<i>Ipheion</i> sect. <i>Ipheion/ Tristagma</i> N = 58	<i>Ipheion</i> sect. <i>Hirtellum</i> N = 45
Qualitative characters			
Alliaceous smell***	0: absent (0–1) A	0: absent (0–1) A	1: present (0–1) B
Type of Inflorescence***	3: plurifloral (1–3) A	1: unifloral (1–3) B	1 unifloral (1–2) C
Color of tepals***	2: white-cream (1–4) A	2: white-cream (2–5) B	1: Yellow-yellowish (1–2) C
Degree of tepal fusion***	1: at the base (1–2) A	2: up to middle (1–2) B	1: at the base (1–1) A
Staminal filament disposition***	0: one series (0–0) A	1: two series (1–1) B	0: one series (1–0) C
Type of fruit***	0: aerocarpic (0–1) A	0: aerocarpic (0–1) B	1: humifuse (1–1) C
Number of ovules per locule***	6 (4–16) A	12 (4–18) B	12 (9–18) C
Number of bracts***	2 (2–2) B	1 (1–2) A	2 (2–2) B
Quantitative characters			
Pedicel length, in cm***	2.33 ± 1.22 A	1.33 ± 1.09 B	0.52 ± 0.31 C
Neck length, in cm***	3.75 ± 2.37 A	4.13 ± 2.24 A	1.93 ± 1.18 B
Outer tepal length, in cm***	0.86 ± 0.18 A	2.17 ± 0.79 B	1.42 ± 0.33 C
Inner tepal length, in cm***	0.85 ± 0.18 A	2.15 ± 0.75 B	1.41 ± 0.33 C
Inner tepal width in mm***	2.04 ± 0.76 B	3.10 ± 1.82 A	3.81 ± 1.57 A
Minimum length of the staminal filaments, in mm***	3.92 ± 1.68 B	3.18 ± 1.51 C	5.12 ± 2.09 A
Length of bracts, in cm***	1.12 ± 0.33 B	1.81 ± 0.64 A	1.18 ± 0.30 B
Length of tepals at the fused region, in cm***	0.20 ± 0.18 B	1.07 ± 0.45 A	0.32 ± 0.36 B
Outer tepal width, in mm**	2.52 ± 1.12 B	3.58 ± 2.10 A	4.12 ± 1.41 A
Maximum anthers width, in mm**	0.57 ± 0.22 B	0.80 ± 0.31 A	0.70 ± 0.28 A
Maximum length of the staminal filaments, in mm***	4.55 ± 1.62 B	4.24 ± 2.03 B	6.23 ± 2.12 A
Length of the fused region of the staminal filaments, in mm*	0.23 ± 0.58 B	0.00 ± 0.00 B	0.86 ± 1.24 A
Bulb width, in cm*	1.24 ± 0.41 A	1.00 ± 0.38 B	1.04 ± 0.34 B
Bulb length, in cm*	1.58 ± 0.61 A	1.49 ± 0.66 AB	1.22 ± 0.39 B
Blade length, in cm*	12.08 ± 6.88 A	9.24 ± 4.72 B	7.36 ± 3.88 AB
Length of the fused region of the bracts, in cm*	0.38 ± 0.51 B	0.66 ± 0.53 A	0.39 ± 0.21 AB
Staminal filaments minimum high, in mm*	5.41 ± 1.98 B	7.85 ± 3.39 A	6.43 ± 1.81 AB
Minimum anther width, in mm*	0.52 ± 0.18 B	0.74 ± 0.32 A	0.64 ± 0.20 AB

Mean value followed by the standard deviation (SD) are shown for quantitative characters; the mode followed by its range are shown for qualitative characters

Asterisks indicate level of significance among groups: * $p \leq 0.05$; ** $p \leq 0.001$; *** $p \leq 0.0001$. Results of the Tukey's and Dunn's pairwise comparison are indicated with letters. Different letters indicate significant differences between groups, $p \leq 0.05$

Zoellnerallium complex (group 1) as much as from *Tristagma* sect. *Ipheion* group (Figs. 2, 3). Molecular studies support the division of *Ipheion*, a genus with questionable monophyly (Fay et al. 2006), but this genus is still in need of a complete sampling to reveal the phylogenetic position of conflictive species.

Ipheion sect. *Ipheion* and *Tristagma* were clearly different from the rest of the entities, this group being characterized by fused tepals forming a tube around the ovary (Fig. 1a, b), the presence of staminal filaments arranged in two series and fused to the tepal tube (Fig. 1g, h), and the color of flowers: white to light blue, pink, green or purple,

but never yellow. *Ipheion* sect. *Hirtellum* was distinguished from the other groups by the length of pedicels (Fig. 1d), tepals, and length of staminal filaments (Fig. 1d, e); and from *Tristagma/Ipheion* sect. *Ipheion* by the presence of tepals fused only at their bases, not forming a tube (Fig. 1d), staminal filaments arranged in only one series (Fig. 1e), and usually by the presence of yellow flowers. It can also be differentiated from *Nothoscordum* and *Zoellnerallium* by the smaller size of vegetative parts of the plant, the length and width of tepals, as well as the presence of humifuse fruits and unifloral inflorescences (Table 3).

In addition, the karyotype formula, the chromosome number, the FN and the chromosome sizes support in part groups recovered in our phenetic analysis. According to Crosa (1972, 1975b) and Rodrigues Souza et al. (2010), *Ipheion* sect. *Hirtellum* and some species of *Nothoscordum* share the base chromosome number ($x = 5$), the FN = 16, a karyotype formula = 3 M + 2 A, and chromosome sizes = 9–18 μm . On the other hand, *Ipheion* sect. *Ipheion* is distinguished by the $x = 6$, FN = 14, mostly acrocentric and the chromosome size varying from 5 to 12 μm (Crosa 1975b, 2004), also differentiated from species of *Tristagma* that share a base chromosome number of $x = 4$, 3 M + 1 A and chromosome size of 11–18 μm (Crosa 1981). *Zoellnerallium*, which is morphologically very similar to *Nothoscordum*, is particularly distinguished by a FN = 32, with mostly acrocentric chromosomes of 4–14 μm and a hypothetically base number of $x = 6$ (Crosa 2004). As suggested by Rodrigues Souza et al. (2010), chromosomal rearrangements, such as Robertsonian translocations may have played an important role in the karyotype evolution of *Ipheion/Tristagma/Nothoscordum/Zoellnerallium* complex representing independent events in the evolution of the group.

When considering morphological variation within species, almost all taxa were recovered as groups by the cluster analysis (Fig. 4). Species within morphological complexes are clearly circumscribed, although it is an exception for *Ipheion sessile*. Clustering analysis supports the idea that OTUs are not correlated with the geographical distribution (Brazil, Chile, Uruguay), and a different association among the specimens analyzed is observed (Fig. 4). On the contrary, Ravenna (2001) pointed out that *Tristagma recurvifolium* (C. H. Wright) Traub and *T. sessile* (Phil.) Traub (in this work both species treated as *I. sessile*) are similar in the length of bracts and the degree of tepals fusion, but they could be differentiated by geographic range and the altitude in which they occur in the wild. The former is native to Uruguay and grows at the sea level, in gently slopes and hills of about 200 m above sea level, while *T. sessile* is native to Chile, inhabiting at 1,200 m of altitude or higher.

Our analyses include the type specimen of *Ipheion setaceum*, collected once in the province of Tucumán,

Argentina. The position of this taxon is not clear; it is seemingly related to *I. tweedieanum* in the cluster analysis (Fig. 4). However, Guaglianone (1972) suggested that this species could be a synonym of *I. vittatum*; the locality of the type specimen would be erroneous for Tucumán, considering that any of the two species are restricted to the Pampean region in Argentina, Brazil and Uruguay.

Only four *Nothoscordum* specimens, belonging to *N. marchesii* (1) and *N. ostenii* (3), appear to be conflictive. *Nothoscordum marchesii*, a recently described species, is morphologically similar to *I. hirtellum* and differs from it in the smaller size of the plant and the yellowish color of the flowers (Crosa 2005). In our analyses, this species resulted very similar to *Ipheion sellowianum* and it was included into *Ipheion* sect. *Hirtellum*. *Nothoscordum ostenii* is another controversial taxon, described by Beauverd in 1908 as a unifloral species. The three specimens included in our study (all bifloral individuals, including an isotype specimen: *Osten* 3611) were associated to different groups. This result probably indicates misidentified vouchers as the isotype specimen of *N. ostenii* appeared similar to *I. sellowianum*.

Nothoscordum izaguirrae Crosa is a recently described species very similar to *N. felipponei* (a synonym of *I. sellowianum*), and mainly characterized by the presence of rhizomes (Crosa 2006). In this work, it was not possible to measure the type specimen but measurements were taken as from the original description. Thus, *N. izaguirrae* grouped within group 3 (*Ipheion* sect. *Hirtellum*) by PCO and included close to *I. sellowianum* in the cluster analysis (Figure not shown).

A major conclusion from this study, results in a good delimitation of the species as taxonomic entities (cluster analysis, Fig. 4), showing that the conflict was at the genus level more than at the species identification. Based on our results and observations conducted to date, *Ipheion* s.l. is not longer sustained. The partition of *Ipheion* into two groups is well supported in our morphological analyses. Based on PCO and DA (Figs. 2, 3, 5), we suggest that *Ipheion* sect. *Ipheion* is more similar to the studied species of *Tristagma* than to the other species of *Ipheion*; while *I. sect. Hirtellum* is clearly distinguished by itself. Based on ANOVAs, a set of diagnostic characters are selected to distinguish *I. sect. Hirtellum* from *Tristagma* + *Ipheion* sect. *Ipheion*, and from *Nothoscordum* + *Zoellnerallium* (Table 3), a spathe formed by two bracts more or less fused at their bases (Fig. 1j), with very short pedicels subtending flowers which are frequently yellow (Fig. 1d) (white in *I. vittatum*), staminal filament in one series, awl-shaped (Fig. 1e), free or fused at their bases, and humifuse fruits.

Results from these studies are just the beginning of a series of works to resolve the taxonomic position of *Ipheion* s.l.; a deeper study on the taxonomy of *Tristagma*

and *Nothoscordum* will help elucidating this issue. If *Ipheion* is recognized as a genus, it would be restricted to *I.* sect. *Ipheion*, and closely related to *Tristagma*, or if recognized under *Tristagma*, it would be a section of it. Taxonomically, we propose to recognize *Ipheion* sect. *Hirtellum* as a separate entity, related to some species of *Nothoscordum* by a basic chromosome number of $x = 5$, the karyotype and the FN (Rodrigues Souza et al. 2010), but clearly distinguished from this genus by seventeen morphological characters (Table 3).

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Appendix 1

Material examined

Species and specimens used in numerical analyses. Voucher specimens are listed following country, state, locality, collector, number and herbarium acronym.

Ipheion dialystemon

ARGENTINA. **Buenos Aires**. Pdo: General Pueyrredón. Sierra de los Padres, a 200 m del Mirador. *Díaz, M.O. s.n.* (SI 26783). Pdo: La Plata. La Plata, alrededores. *Scala, A. C. s.n.* (SI 20065); *Gonnet, in pratis naturalibus non rara. Ragonese, A.M. (Isotype, SI 26130!)*; **Corrientes**. Dpto: Paso de los Libres. Parada Pucheta, vías del F.C. *Scala, A. C. 44* (LIL); **Entre Ríos**. Dpto: Federación. Ruta 14, Chajarí. *Nicora, E. G. 6254* (SI).

Ipheion hirtellum

ARGENTINA. **Entre Ríos**. Dpto: Uruguay. Camino de Colonia Elía a Puerto Campichuelo, 8 km pasando Cnia Elía. *Giussani, L. M. et Morrone O. 428* (SI); Concepción del Uruguay, Estac. Exp. INTA, arrocería. *Ragonese, A. M. s.n.* (SI 26094); Concepción del Uruguay. INTA, arrocería. *Sorarú, S. B. 424* (SI); Concepción del Uruguay, colonia Perfección. *Ragonese, A. M. s.n.* (SI 26100); Ruta Nac. 14. Complejo Termas Concepción. *Giussani, L. M. et Morrone*

O. 424 (SI); Dpto: Federación. Ruta Nac 14. *Giussani, L. M. et Morrone O. 438.* (SI). Dpto: Tala. Rosario del Tala. *Sorarú, S. B. A-16.* (SI); **Corrientes**. Dpto: Curuzú Cuatiá. *Pedersen, T. M. 14553* (SI).

URUGUAY. **Maldonado**. Piriápolis, Cerro Inglés inter saxa, flor aureis. *Osten, C. 5499* (SI); **Montevideo**. Dpto: Lavalleja, Minas, in summo “Monte Arequita”. *Osten 5195 bis (Holotype of Nothoscordum subssesile Beauv, G!)*

Ipheion sellowianum

ARGENTINA. **Distrito Federal**. Parque Lezama. *Dieckmann, J. G. s.n. (Isotype of Tritelleia sellowiana Kunth, SI 20066!)*; **Entre Ríos**. En cultivo jardín botánico de Ezeiza. *Castillo, J.A. s.n. 9* (SI).

URUGUAY. Sin datos. *Felippone, F. 5763* (SI); **Montevideo**. *Felippone, F. 5471* (SI); Cuchilla Pereyra. *Felippone, F. 3493 (Paratype of Nothoscordum felipponei Beauv, SI!)*; **Soriano**. Sin datos. *Gallinal, - 4397* (SI).

BRASIL. **Brasilia**. *Sellow 3664. (Isotype of Tritelleia sellowiana Kunth, K!)*

Ipheion sessile

BRASIL. **Rio Grande do Sul**. Dpto: Caçapava do Sul. Santana do Livramento *Boldrini, I. J. 1570* (ICN).

CHILE. **Región Metropolitana**. Dpto: Chacabuco. Altos de Chicauma, Lampa. *García, N. 4169* (CONC).

URUGUAY. Sin datos. *Felippone, F. 2205 bis*; Cerro. *Felippone, F. 3808* (SI); **Maldonado**. Punta del Este. *Guaglianone, E. R. s.n.* (SI 26507); **Montevideo**. Cerro. *Herter, G. 152 (78457)* (SI); Cerro in Saxosis. *Osten, C. 5221* (SI).

Ipheion setaceum

ARGENTINA. **Tucumán**. 1867. *Tweedie s.n. (Holotype of Milla setacea Baker, K!)*

Ipheion tweedieanum

ARGENTINA. **Buenos Aires**. All found in the fields of Buenos Aires & Banda Oriental. *Tweed s.n. (Holotype of Milla uniflora (Lindl.) Baker var. tweedieana K!)*. **Entre Ríos**. Dpto: Feliciano. Paso Yunque, peladares. *Burkart, A. 25223* (SI); Dpto: Gualeguaychú. Pto. Ruiz. *Burkart, A. 24127* (SI); Arroyo Gualayán, cerca de Gualeguaychú. *Burkart, A. 24129* (SI); Arroyo Gualayán, cerca de Gualeguaychú. *Burkart, A. 24131* (SI); Ruta Nac. 14. Arroyo Gualayán, *Giussani, L. M. et Morrone O. 420* (SI); Dpto: Tala. Rosario del Tala. Los Guachos. *Sorarú, S. B. 125* (SI).

Ipheion uniflorum

ARGENTINA. **Buenos Aires**. Pdo: Avellaneda. Wilde. *Pérez Moreau s.n.* (BA 43219); Pdo: General Alvarado. Miramar, Ruta Nac. 11, camino de Mar del Plata a Miramar. *Morrone, O. et Giussani L. M. 6217* (SI); Pdo: General Pueyrredón. Mar del Plata, Ruta Nac. 11, El Torreón. *Morrone O. et Giussani L. M. 6210* (SI); Mar del Plata. *Valentini, A. 9* (SI); Pdo: Tandil. Cerro de las Ánimas, Cantera de piedra Carba, Cerro Angelica. *Morrone, O. et Giussani L. M. 6250* (SI); Sierras alrededor de la ciudad. *Boelcke, O. 8655*, (SI); Paso del Rey, en quinta. *Guaglianone, E. R. s.n.* (SI 26260); Cerro de la Cruz, La Cascada. *Morrone, O. et Giussani L. M. 6234* (SI); Pdo: Saladillo. Planta urbana. *Múlgura de Romero, M. E. 4587* (SI).

URUGUAY. **Maldonado**. Barra de Maldonado. *Pozner, R. 165* (SI); **Montevideo**. Cerro de Montevideo. *Morrone, O. et Giussani L. M. 6339* (SI); Cerro. *Herter, G. 47A* (LIL).

Ipheion vittatum

ARGENTINA. **Entre Ríos**. Dpto: Uruguay. Al N. de Colonia Elía. *Burkart, A. 26920* (SI); Camino de Colonia Elía a Puerto Campichuelo. *Giussani, L. M. et Morrone O. 431* (SI); Colonia Elía. *Ragonese, A. M. s.n.* (SI 26103). Ruta Nac. 14. Complejo Termas Concepción. *Giussani, L. M. et Morrone O. 425* (SI); Concepción del Uruguay, INTA potrero. *Sorariú, S. B. 412* (SI); Concepción del Uruguay. En el campo entre las gramas. *Lorentz 968*, (*Isotype of Milla vittata* Gris., BAF!). Est. Exp. INTA, arrocera. *Ragonese, A. M. s.n.* (SI 26097). Est. Exp. INTA, *Ragonese, A. M. s.n.* (SI 26096).

URUGUAY. Sin datos. *Felippone, F. 3160* (SI); Sin datos. *Felippone, F. 5940* (SI); **Montevideo**. Cerrito. *Herter, G. 50A* (SI); Cerro Montevideo. *Felippone, F. 3447a* (SI).

Nothoscordum andicolum Kunth

Jujuy. Dpto: Humahuaca. Azul Pampa. *Cabrera, A. L. 27407* (SI).

Nothoscordum arenarium Herter

ARGENTINA. **Córdoba**. San Javier. *Castellano, s.n.* (BA 10360).

URUGUAY. **Colonia**. Parque Forestal Ferrando, alrededores de la ciudad de Colonia. 15 m s.m. *Morrone, O. et Giussani, 6301* (SI).

Nothoscordum bivalve (L.) Britton

ARGENTINA. **Buenos Aires**. Ea. "La Justicia". *Montes, L. 632* (SI); Pdo: Coronel Vidal. Estancia Arroyo Grande de Balcarce sobre ruta 55. *Okada, K. A. 6173* (BAB); **Neuquén**. Dpto: Lácar. San Martín de los Andes. *Gentili, M. 721* (SI); **Entre Ríos** Dpto: La Paz. Yunque, río Guayquiraró. *Burkart 26915* (Cultivado en el invernáculo del Dp. De Agronomía Univ, Nac. Del Sur por *Nuñez, O.*)

MÉXICO. **Durango**. Dpto: Durango. El Carmen, al E, 1.5 km al W del entronque con la carretera 45. *Noriega, J. 16* (SI); El Carmen, al E, bajo puente por terracería. *Noriega, J. 18* (SI).

URUGUAY. Aguas Corrientes, Santa Lucía. *Felippone, F. 6950* (SI).

Nothoscordum bonariense (Pers.) Beauverd

ARGENTINA. **Buenos Aires**. Pdo: Magdalena. Arroyo Juan Blanco. *Giussani, L. M. et Morrone O. 450* (SI).

ARGENTINA. **Entre Ríos**. Dpto: La Paz. Alcaraz. Ruta 127, km 109. *Lartiridge s.n.* (BA 60958).

Nothoscordum gaudichaudianum Kunth

ARGENTINA. **Corrientes**. Dpto: Monte Caseros. M. Caseros, orillas, Uruguay, entre las piedras de la Cachuera. *Nicora, E. G. 6267* (SI); **Entre Ríos**. Dpto: Colón. Palmar cerca de Berdun, arroyo Pons. *Burkart, A. 21681* (SI); Dpto: Gualeguaychú. Camino al Arroyo Gualayán. *Burkart, A. 25695* (SI).

URUGUAY. **Soriano**. Ruta Nac. 2, km 232, camino de Mercedes a Palmitas. *Morrone, O. et Giussani L. M. 6297* (SI).

Nothoscordum gracile (Dryand. ex Aiton) Stearn var. *gracile*.

ARGENTINA. **Misiones**. Dpto: Candelaria. Ruta Prov. 208, 10 km pasando Cerro Corá hacia Cerro Azul. *Morrone, O. 1790* (SI).

Nothoscordum marchesii

URUGUAY. **Rocha**. Parque Nacional de San Miguel, entre el Fuerte San Miguel y el cerro Picudo. *Crosa, O. s.n.* (*Isotype* SI 50357!).

Nothoscordum montevidense Beauverd

ARGENTINA. **Entre Ríos**. Dpto: Concordia. Concordia. *Parodi, L. R. 2331* (BAA); Dpto: Villaguay. Est. Sta. Martha. *Müsch, P. s.n.* (SI 993); **Misiones**. Dpto: Candelaria. Ruta Prov. 208, de Cerro Corá a Cerro Azul. 160. *Zuloaga, F. O. 5773* (SI).

URUGUAY. **Maldonado**. Ruta Interbalnearia n° 11, camino hacia la ruta 10. *Morrone, O. et Giussani L. M.* 6329 (SI); Ruta 60, 44 km de Minas camino a Piriápolis, *Morrone, O. et Giussani L. M.* 6325 (SI); Ruta 9, km 115, de Rocha a el Pan de Azúcar. *Morrone, O. et Giussani L. M.* 6335 (SI); **Montevideo**. Dpto: Montevideo, cerro. *Izaguirre, P. s.n.* (MVFA 2723, SI); **Cerro Largo**. Estancia Perdomo. *Izaguirre, P.* 2356 (SI).

Nothoscordum nudicaule (Lehm.) Guagl.

ARGENTINA. **Entre Ríos**. Dpto: Gualeguaychú. Pasando el Arroyo Gualeyán, km 66 de la Rta Nac 14, a un costado de la ruta. *Giussani, L. M.* 447 (SI); Dto: Villaguay 1 km antes de Paso de la Laguna y cruce con Rta 6. Río Gualeguay. *Giussani, L. M.* 446 (SI); **San Luis**. Dpto: Coronel Pringles. Trapiche. Loc. El Durazno. *Hadid, M.* 52 (MERL).

URUGUAY. **Soriano**. Ruta Nac. 2, José E. Rodo, Pque. Mun. 33 Orientales. *Morrone, O. et Giussani L. M.* 6299 (SI).

Nothoscordum ostenii

URUGUAY. **Montevideo**. Atahualpa. *Herter, W. G. F.* 437 (SI); Cerro de Montevideo. *Hicken 2.* (SI 35125); **Paysandú**. Estancia Lawlor, Molles. *Osten, C.* 3611. (Isotype, SI 61368!)

Nothoscordum punillense Ravenna

ARGENTINA. **Córdoba**. Dpto: Colón. Ascochinga. *Giardelli, M. L.* 61 (SI).

Tristagma sp.

ARGENTINA. **Neuquén**. Dpto: Ñorquín. Copahue. *O'Donell, C. A.* 2092 (LIL).

Tristagma ameghinoi (Speg.) Speg.

ARGENTINA. **Chubut**. Dpto: Escalante. Comodoro Rivadavia. *Kreibohm, E.* 298 (SI); **Neuquén**. Parque Nacional Nahuel Huapi. Ea. Fortín Chacabuco. *Boelcke, O.* 3558 (BAB); **Río Negro**. Dpto: Bariloche. Cerro Otto, filo al lago Gutierrez. *Diem, J.* 1946 (BAB); **Santa Cruz**. Dpto: Río Chico. Estancia La Primitiva. *Cocucci, A. A.* 3675 (SI).

Tristagma atreucoense Ravenna

ARGENTINA. **Neuquén**. Dpto: Lácar. San Martín de los Andes. *Asseguín Sánchez, M. L.* 429 (SI); Dpto:

Minas. Laguna de Atreuco, lomadas. *Boelcke, O.* 11542. (Isotype, SI!)

Tristagma bivalve

CHILE. **V Región de Valparaíso**. ± 15 km NE de Zapallar. *Boelcke, O.* 16833 (BAB); *Werdermann, E.* 6 (SI); Dpto: Valparaíso. Quilpué. *Grandjot, G. F. s.n.* (SI 35380); **X Región de Los Lagos**. Paso Internacional Pino Hachado camino a Liucura. *Morrone, O.* 5516 (SI).

Tristagma circinatum Ravenna

ARGENTINA. **Neuquén**. Andes. Cerro Colohuincul. *Comber, H.F.* 879 (Isotype, K!)

Tristagma malalhuense Ravenna

ARGENTINA. **Mendoza**. Dpto: San Rafael. Co. Nevado, laderas alrededor de la Cienaguita. *Boelcke, O.* 15696 (Paratype, SI!)

Tristagma nivale Poepp.

ARGENTINA. **Chubut**. Ea. Pepita. Lago Fontana. *Soriano, A.* 3950 (BAB); **Mendoza**. Dpto: Luján de Cuyo. Dentro del Centro de Esquí Vallecitos. *Herrera, S. M. E.* 454 (SI); **Neuquén**. Dpto: Lácar. San Martín de los Andes (Pque. Lanín) ladera N de los cerros del valle con exp. al S. *Ruiz Leal, A. A.* 18126 (MERL); **Río Negro**. Dpto: Bariloche. Cima del C° Challhuaco. Ladera pedregosa de exposición E. *Zavala-Gallo, L.* 102 (SI); **Santa Cruz**. Dpto: Güer Aike. Ea. Las Viscachas, Co. sin nombre, ladera E. *Arroyo, S. C. s.n.* (TBPA 2664, BAB); Dpto: Lago Argentino. Estancia Anita, Cerro Huiliche, 2° Laberinto. *Guerrido, C.* 421 (SI); **Tierra del Fuego**. Estancia Los Flamencos. Laguna Miranda, *Goodall, R. N. P.* 2514 (SI).

CHILE. Cord. de Santiago. *Sin colector s.n.* (BAF 7247); **XII Región de Magallanes**. *Donat, A.* 313 (Museo 9270, LIL).

Tristagma patagonicum (Baker) Traub

ARGENTINA. Patagonia. Middleton, *Capt. s.n.* (holotype of *Milla patagonica* Baker, K!); **Chubut**. Dpto: Escalante. Ruta Provincial n° 27 hacia Río Chico a unos 10 km del cruce con la Ruta Nacional n° 3. *Cocucci, A. A.* 3577 (CORD; SI); Campo Escalante. 01/11/1964. *Kreibohm, E.* 174 (LIL); Futaleufú. Esquel. *Burkart, A.* 19153 (SI); Alrededores del Lago Blanco. *Koslowsky, J.* 12430. Dpto: Futaleufú. Cordón. *Kutschker, A.* 149 (SI); **Neuquén**. Dpto:

Zapala. Oeste de Zapala. *Schajowskoy, S. s.n.* (SI 35404); **Río Negro**. Valle río Fayel. *Meyer, T. 9354* (LIL).

Tristagma spegazzinii (Macloskie) Traub

ARGENTINA. **Chubut**. Dpto: Escalante. Campo Escalante. *De Marco de Kreibohm, E. 147* (SI); **Neuquén**. Parque Nacional Lanín, Pampa Hui-Hui. *Eskuche, U. G. 1251* (SI); Dpto: Minas. Laguna de Atreuco. *Boelcke, O.11542* (SI); **Río Negro**. Dto: Bariloche. Cerro Otto, filo al lago Guitierrez. *Diem, J. 1946* (SI).

Tristagma sociale Ravenna

ARGENTINA. **Mendoza**. Dpto: Malargüe. Valle de Las Leñas. *Ruiz Leal, R. A. (Isotype, SI 374521)*

Zoellnerallium andinum (Poepp.) Crosa

ARGENTINA. **Mendoza**. Dpto: Las Heras. Haute Cordillere de Mendoza, Puente del Inca. *Hauman, L. L. 65* (BA); Dpto: Malargüe. Vega del Azufre. *Castellanos, A. 14052* (BA); Dpto: San Rafael. Sierra Pintada. Mina de Uranio "Braulie". *Lagiglia, H.A. 2315* (SI); Hotel Termas del Sosneado. *Zuloaga, F. O. 12378* (SI); Mina San Martín. *Ruiz Leal, A. A. 9705* (MERL); **Neuquén**. Parque Nacional Lanín. Pucara. *Lahitte s.n.* (BA 5443).

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