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FORUM PAPER

Translation of the Braun-Blanquet scale to percent in TURBOVEG can bias diversity metrics

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Abstract

Background: The majority of vegetation plots has been and still is being recorded on ordinal scales, meaning that the values have to be back-transformed to percent for many typical analyses. Little is known about how different back-transformation approaches affect this procedure. While generally the midpoints of the class borders are recommended for back transformation, one of the most widely used back-transformation for the 7-step Braun-Blanquet scale (as the most widely used ordinal scale) is the default back transformation in the software TURBOVEG. Thus, we asked whether this approach possibly biases results. **Case study:** We selected three datasets of different vegetation types recorded with percent and calculated how the use of the 7-step Braun-Blanquet scale with three possible back-transformations (arithmetic and geometric mid-point, TURBOVEG) would have influenced Shannon diversity, Shannon evenness and Simpson diversity. We found small and inconsistent changes for the first two but always substantial increases in case of the TURBOVEG back-transformation. **Conclusions:** The default TURBOVEG translation of the 7-step Braun-Blanquet scale can strongly bias analyses of vegetation plots stored in regional and collaborative databases in the case of cover-based biodiversity metrics, but likely also for any other analysis that involves species cover. It should thus be avoided.

Keywords

Biodiversity metric, Braun-Blanquet scale, European Vegetation Archive (EVA), ordinal scale, percent cover, species cover, sPlot, transformation, TURBOVEG, vegetation-plot database

Background

Vegetation plots are by far the most used sampling method in vegetation science (plant community ecology), and visually estimated cover of the superficial plant parts is the by far most often used approach to quantify plant importance in a plot (Dierschke 1994; Peet and Roberts 2013; Bruelheide et al. 2019). Cover refers to the percent fraction of a vegetation plot that all individuals of one species together occupy in their vertical projection (Dengler et al. 2008). However, traditionally vegetation ecologists mostly used ordinal cover scales rather than direct percent estimates (Bruelheide et al. 2019). The latter became more prominent only recently (Dengler et al. 2016; Dengler and Dembicz 2023). Numerous scales have been developed and applied in different regions of the world (Dierschke 1994; Peet and Roberts 2013), but the various variants of the Braun-Blanquet scale are most widely used globally (Bruelheide et al. 2019). In the European Vegetation Archive (EVA; Chytrý et al. 2016), as of March 2026, 56% of the 2,328,036 plots were recorded with a variant of the so-called Braun-Blanquet scale (I. Knollová, database

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manager, pers. comm.). Among the 1,055,178 plots from the 21st century, variants of the Braun-Blanquet scale still prevailed with 34%, while other ordinal scales accounted for 7%, direct percent for 30% and presence/absence for 29% of the plots (I. Knollová, pers. comm., 12 June 2026).

In the last edition of his textbook, Braun-Blanquet (1964) proposed four variants of his scale, namely one with five steps and three with six steps (see Dengler and Dembicz 2023). Interestingly, instead of these original variants, mostly 7-step-variants or less frequently 9-step variants are used and attributed to Braun-Blanquet. The 7-step variant uses the ordinal categories r, +, 1, 2, 3, 4 and 5, while in the 9-step variant, the category 2 is split into 2m, 2a and 2b (Wilmanns 1998; van der Maarel and Franklin 2013). What apparently most researchers using one of these two scales are not aware of is the fact that none of them has a generally agreed definition of its categories, but numerous variants exist that differ in smaller or bigger aspects (see Dengler and Dembicz 2023 and Table 1, for some major examples). Particularly challenging are combined cover-abundance variants where the lower categories are defined by the number of individuals and the higher categories by cover (e.g. versions by Westhoff and van der Maarel (1973) and Pfadenhauer (1997) in Table 1 or van der Maarel and Franklin 2013); such a combination of criteria precludes a proper back-translation (Dengler and Dembicz 2023).

The second challenge comes from the fact that for any numerical analysis the ordinal categories must be back-translated into a numeric scale (van der Maarel 1979; Podani 2006; Dengler and Dembicz 2023). Since this double translation – from visually estimated percent to an ordinal scale and from the ordinal scale to a probable cover value (or another numeric value related to cover) – introduces avoidable additional errors to the data, ordinal scales have been criticized and the use of direct percent estimates has been recommended instead (Dengler et al. 2016; Dengler and Dembicz 2023; Dembicz and Dengler 2025). The most widely used approach for back-translation is the arithmetic midpoint of the class borders (Braun-Blanquet 1964; Dierschke 1994; Tremp 2005; Podani 2006). However, it has also been suggested to use the geometric midpoint (Dembicz and Dengler 2025) or not to back-transform to percent cover but to a pseudo-logarithmic scale from 1 to 7 (9), sometimes called ordinal transform values (OTVs; Tremp 2005; van der Maarel 2007). All these approaches are plausible, and Dembicz and Dengler (2025) showed that, contrary to their expectations, neither the geometric mean nor the arithmetic mean was systematically superior. However, there is a fourth way of back-transforming the 7-step Braun–Blanquet scale of which most researchers are probably unaware, although it appears to be the most widely used solution globally. This is the variant that is built-in as default into TURBOVEG (Hennekens and Schaminée 2001; the translation table is reproduced in Dengler and Dembicz 2023). Since TURBOVEG is the by far most used vegetation database program globally and underlies the two largest international vegetation-plot databases, European Vegetation Archive (EVA; Chytrý et al. 2016) and its global counterpart "sPlot" (Bruelheide et al. 2019), and most users likely do not question or change the default settings, these are ubiquitous in vegetation ecological analyses. The problem is that the in-built back-translations do not match any of the three mentioned logical approaches. While for three of the categories, the translation corresponds to the (rounded) arithmetic class mid-points, this is not the case for the four others (Table 1). Specifically, the two lowest categories (r, +) are translated to significantly too high cover values, "2" is translated to 13% instead of the mid-point of 15% and "4" to 68% instead of the mid-point of 62.5%.

Dembicz and Dengler (2025) showed that ordinal scales generally introduce biases in analyses of cover-based biodiversity metrics. Specifically, they found that the 7-step Braun-Blanquet scale, both with arithmetic and with geometric mid-point transformation performed slightly worse than direct percent estimates, while the Londo scale and the Hult-Sernander-Du Rietz scale, both with lower resolution for the small cover values, performed much worse. Since the default transformation of TURBOVEG shows the strongest deviations from the two other transformations for "r", "+" and "1", we expect that this could lead to significant biases in biodiversity metrics.

Table 1. Four variants of the (6) 7-step Braun-Blanquet scale with their definitions. The first variant and the last variant are pure cover scales, while the second and third variants are combined cover-abundance scales.

Category	Braun-Blanquet (1964, p. 39, lower table)		Westhoff and van der Maarel (1973)		Pfadenhauer (1997)		Bergamini et al. (2025)	
	Min. cover %	Max. cover %	Min. cover %	Max. cover %	Min. cover %	Max. cover %	Min. cover %	Max. cover %
r	NA		1 or few individuals		1–3 individuals		>0	0.1
+	>0	1	>0	5	>0	1	>0.1	1
			AND occasional					
1	>1	10	>0	5	>1	5	>1	5
			AND less abundant to abundant					
2	>10	25	>5	25	>5	25	>5	25
			OR <5% and very abundant					
3	>25	50	>25	50	>25	50	>25	50
4	>50	75	>50	75	>50	75	>50	75
5	>75	100	>75	100	>75	100	>75	100

To demonstrate and quantify this effect, we thus used the same data as in Dembicz and Dengler (2025) and added the TURBOVEG transformation.

Case study

For the case study, we used the same three datasets as Dembicz and Dengler (2025); details are provided therein. Dataset A has 32 100-m² plots of a wide range of subalpine and alpine habitats in Switzerland, dataset B 171 10-m² plots from dry grasslands in the inneralpine valleys of Switzerland and dataset C 60 10-m² plots from grasslands across the moisture gradient on the Swedish island of Gotland (Suppl. materials 1–3). In all plots the cover of the species was estimated in percent (A: only vascular plants, B and C: all terricolous taxa). We then simulated the numerical values for analysis if the recording would have been done with the 7-step Braun-Blanquet scale (version of Bergamini et al. 2025; see Table 1) and subsequently back-translated with one of the three approaches shown in Table 2 and Figure 1. Then we calculated for each plot different diversity indices with direct percent estimation and the three scenarios with the 7-step Braun-Blanquet scale. For this purpose, we selected three of the most widely used biodiversity indices (Maurer and McGill 2011), Shannon diversity, Shannon evenness (Pielou index) and Simpson diversity (1 – *D*). Finally, for each combination of dataset and diversity metric, we compared the mean diversity values with those recorded using direct percentage cover (considered to be the closest approximation to the true values) using paired *t*-tests and visualised the results with boxplots. The analyses were conducted in R (ver. 4.5.2; R Core Team 2025) with the package vegan (ver. 2.7-3; Oksanen et al. 2026). The R code is provided in Suppl. material 4.

We found that all three diversity metrics were substantially and consistently higher when using the default back-translation of TURBOVEG compared to when the true (original) values were used (Figure 2). The average increases were about 0.7 units for Shannon diversity and 0.2 units for Shannon evenness, corresponding to an increase of approximately 30%. For Simpson diversity, the increase on average was smaller with about 0.1 unit, corresponding to roughly 10%, which is because the true Simpson diversity values were above 0.8 and thus already close to the theoretical maximum of 1.0. For all three diversity metrics, the detected distortions were as large as those reported by Dembicz and Dengler (2025) for the Hult–Sernander–Du Rietz 5-step scale in the same datasets. By contrast the mean metrics did not change significantly or only minimally when using either arithmetic or geometric back-translation (Figure 2), while even then the biodiversity ranking of plots was strongly altered (Dembicz and Dengler 2025).

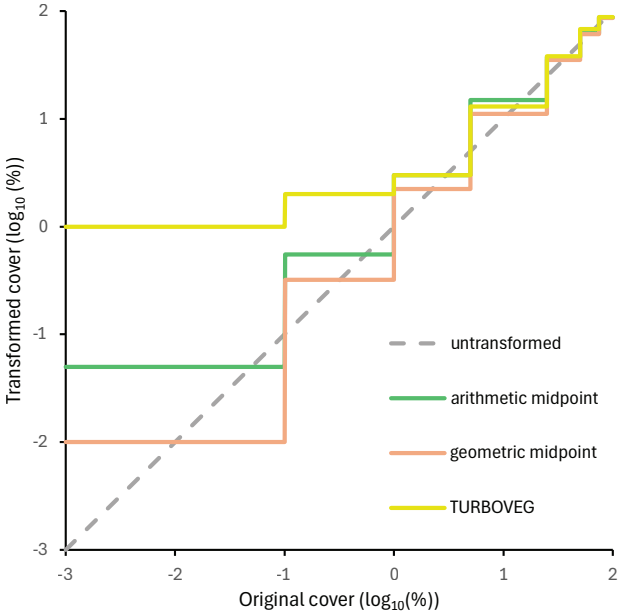

Figure 1. Visual comparison of the effects of the three back-translation options for ordinal cover values for the 7-step variant of the Braun-Blanquet scale used in this paper (for details of the settings, see Table 2). While using direct percent estimates leads to a smooth 1:1 line, any ordinal transformation leads to a "step function".

The reasons for these distortions can be understood from Figure 1. While the back-translated values are symmetrically spread on both sides of the true values for the geometric midpoints and almost so for the arithmetic midpoints, the situation is different for the TURBOVEG

Table 2. Definition of the categories of the 7-step Braun-Blanquet scale and three widespread back-translations into a numeric scale, (a) the arithmetic midpoints of the ranges, (b) the geometric midpoint of the ranges and (c) the default values in TURBOVEG (Hennekens and Schaminée 2001). The two replacements with midpoints are based on the class definitions by Bergamini et al. (2025) as in Table 1 and the assumption that the smallest cover value used is 0.001% (corresponding to 1 cm² or one small seedling/annual in 10 m²).

Category	Min. cover %	Max. cover %	Replacement with arithmetic midpoint	Replacement with geometric midpoint	Default replacement in TURBOVEG
r	>0	0.1	0.05	0.01	1
+	>0.1	1	0.55	0.32	2
1	>1	5	3	2.24	3
2	>5	25	15	11.18	13
3	>25	50	37.5	35.36	38
4	>50	75	62.5	61.24	68
5	>75	100	87.5	86.60	88

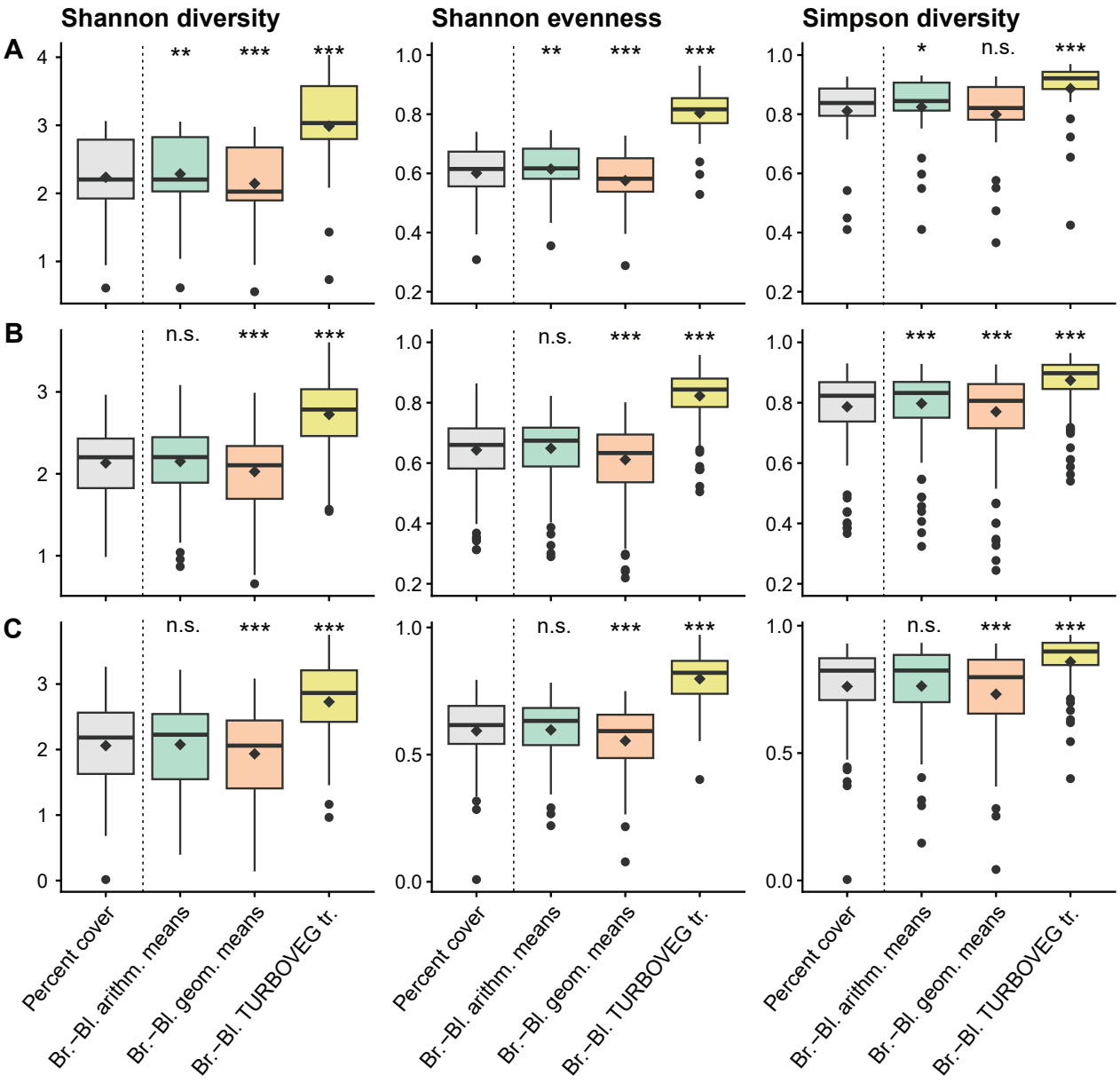

Figure 2. Effect of three different back-translations of the 7-step Braun-Blanquet scale on three diversity metrics in three exemplary datasets in comparison to the original percent values. The significance levels are from paired *t*-tests with Bonferroni correction.

back-translation. For all cover values below 3%, the TURBOVEG default assigns higher cover values compared to those observed in reality, with the differences increasing as cover decreases. Since in typical plant communities, 50% or more of all species have less than 3% cover (see Suppl. materials 1–3), it is evident that such default settings must create significant biases.

Discussion

Here, we showed with typical datasets that the use of the default TURBOVEG back-translation for the 7-step Braun-Blanquet scale introduces substantial error in analyses of cover-based biodiversity metrics, such as Shannon diversity, Shannon evenness and Simpson diversity. If data stored using the default Braun-Blanquet 7-step scale are combined with data that were recorded in percent or have been properly back-transformed, for example when using data from EVA (Chytrý et al. 2016) or sPlot (Bruelheide et al. 2019), erroneous conclusions may result. For example, regions or time periods in which the use of the Braun-Blanquet scale prevails over direct percentage estimates may be erroneously perceived as more diverse than regions or time periods that were predominantly recorded with direct percentage estimates. Moreover, the effect size of bias due to the TURBOVEG default translation is large compared to diversity differences that are often considered as ecologically meaningful. Danko et al. (2026) reported differences in Shannon diversity of < 0.1 and in Shannon

evenness < 0.05 as statistically significant and ecologically relevant in a vegetation change study, while Fenesi et al. (2023) considered a decrease of 0.25 in Shannon diversity as relevant in a neophyte impact study.

It is important to note that in TURBOVEG the translation tables do not contain defined minimum or maximum cover values for the cover categories. In theory, a definition of the 7-step Braun-Blanquet scale might exist where "r" is defined as >0% to 2% - and then the back-translation of "r" to 1% as currently in the TURBOVEG default would be correct. However, then the back-translations of "+" to 2% and "1" to 3% would not be correct. We do not know why default back-translation values in TURBOVEG are as they are and why they have not been corrected since the early days of the program (Hennekens and Schaminée 2001). It might be that the program originally only allowed integer values for percent cover and the programmer thus used 1%, 2% and 3% as the best possible approximation at that time (now TURBOVEG supports one decimal place). The translation of "2" into 13% and "4" into 68% might have been unintentional. Fortunately, in TURBOVEG databases the ordinal cover values are stored and thus users are not forced to work with the default back-translations, but they can modify them.

The distortions introduced by the back-translations are not the only source of error in vegetation plot data. There is a large body of evidence that vegetation plots involve also numerous other errors, such as misidentifications, incomplete species lists (overlooked species or species not superficially present due to phenology) and errors in cover estimates (Archaux et al. 2006; Boch et al. 2022; Morrison et al. 2024). The degree of such errors depends on the experience of the surveyors, the complexity of the vegetation and methodological settings, but it is impossible to avoid them completely (Archaux 2009; Morrison et al. 2024; Riedel et al. 2024). Importantly, these other errors cannot be removed post hoc from data stored in vegetation-plot databases. By contrast, the errors caused by the misleading default back-translation in TURBOVEG can easily be avoided even in data that have been sampled decades before. In our view, avoidable sources of bias should be minimised wherever possible, particularly when the errors involved are systematic rather than random.

Given the concise format of a Forum paper, we refrained from analysing the situation specifically for the TURBOVEG version of the 9-step Braun-Blanquet scale ("Braun-Blanquet new"). However, it is self-evident that the same problems will occur, as the replacement values for "r", "+" and "1" are identical. TURBOVEG (and hence EVA and sPlot) also do not differentiate between pure cover-based versions of the Braun-Blanquet scale and cover-abundance versions (where "r", "+" and "1" are distinguished not by cover, but by the number of individuals); there is only a single scale for both. While cover-abundance versions are generally problematic as they introduce additional challenges of how to translate abundance to cover (as the same number of individuals on a given area can mean different cover values depending on the size of the plants), the general problem highlighted here remains unaffected by this issue: the TURBOVEG default introduces bias into the cover values of all species with less than 3% cover.

While we did not test the effects of the TURBOVEG default translation on other response variables than the three diversity metrics, it is evident that any analysis that relies on cover values and not only on presence-absence information will be affected, albeit not necessarily to the same degree. This means that analyses of species richness and of the presence of individual species are unaffected, while studies of other diversity metrics (e.g. Hill numbers), most functional and phylogenetic diversity metrics, community-weighted means of traits, cover changes of individual species or cluster analyses and ordinations based on dissimilarity matrices will be biased.

Conclusions

With this contribution, we aimed to highlight that something like "the 7-step Braun-Blanquet scale" as often cited in the literature does not exist. First the scale was not published by Braun-Blanquet (1964) himself (and it is also unclear who the true originator is). Second, this is not a fixed scale but exists with significant variation. Furthermore, we sought to raise awareness about the effects of the different methods of back-translating the 7-step Braun-Blanquet scale to a numerical scale for statistical analyses. We found that while the midpoint transformation (be it with arithmetic or geometric midpoint) is reasonable (but worse than having recorded percent cover from the start), the default back-translation of TURBOVEG can cause serious distortions. To reduce such problems in the future, we recommend the following steps:

(1) For new data preferentially use direct percent cover – from our experience, after a short transition period, it does not cost more time in the field but avoids all the problems associated with ordinal scales.
(2) When sampling own data based on a variant of the Braun-Blanquet scales (or any other ordinal scale), explicitly document in the methods how each ordinal category was defined and, when storing the data in TURBOVEG, carefully select or define a translation table that reflects your approach.
(3) When analysing data recorded on ordinal scales retrieved from a collaborative database, choose and document the back-translation function carefully. You do not have to use the standard interpretation that you receive, for example, from EVA and sPlot, but you can and should overwrite it where appropriate. Note that in standard exports from sPlot all ordinal cover and cover-abundance scales are misleadingly coded as percent, i.e. you need to explicitly ask to get also the information on the scale used in the field.

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

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The idea of the study was conceived by JD and ŁK. The writing was led by JD, the statistical analysis was conducted by ID, while all authors checked, revised and approved the manuscript.

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Data availability

The data and R code underlying this article are provided in the Supporting Information to this article.

Supplementary material

Supplementary material 1
Anonymised dataset A (*.csv).
Link: https://doi.org/10.3897/VCS.198373.suppl1

Supplementary material 2
Anonymised dataset B (*.csv).
Link: https://doi.org/10.3897/VCS.198373.suppl2

Supplementary material 3
Anonymised dataset C (*.csv).
Link: https://doi.org/10.3897/VCS.198373.suppl3

Supplementary material 4
R code used for the analyses (*.R).
Link: https://doi.org/10.3897/VCS.198373.suppl4