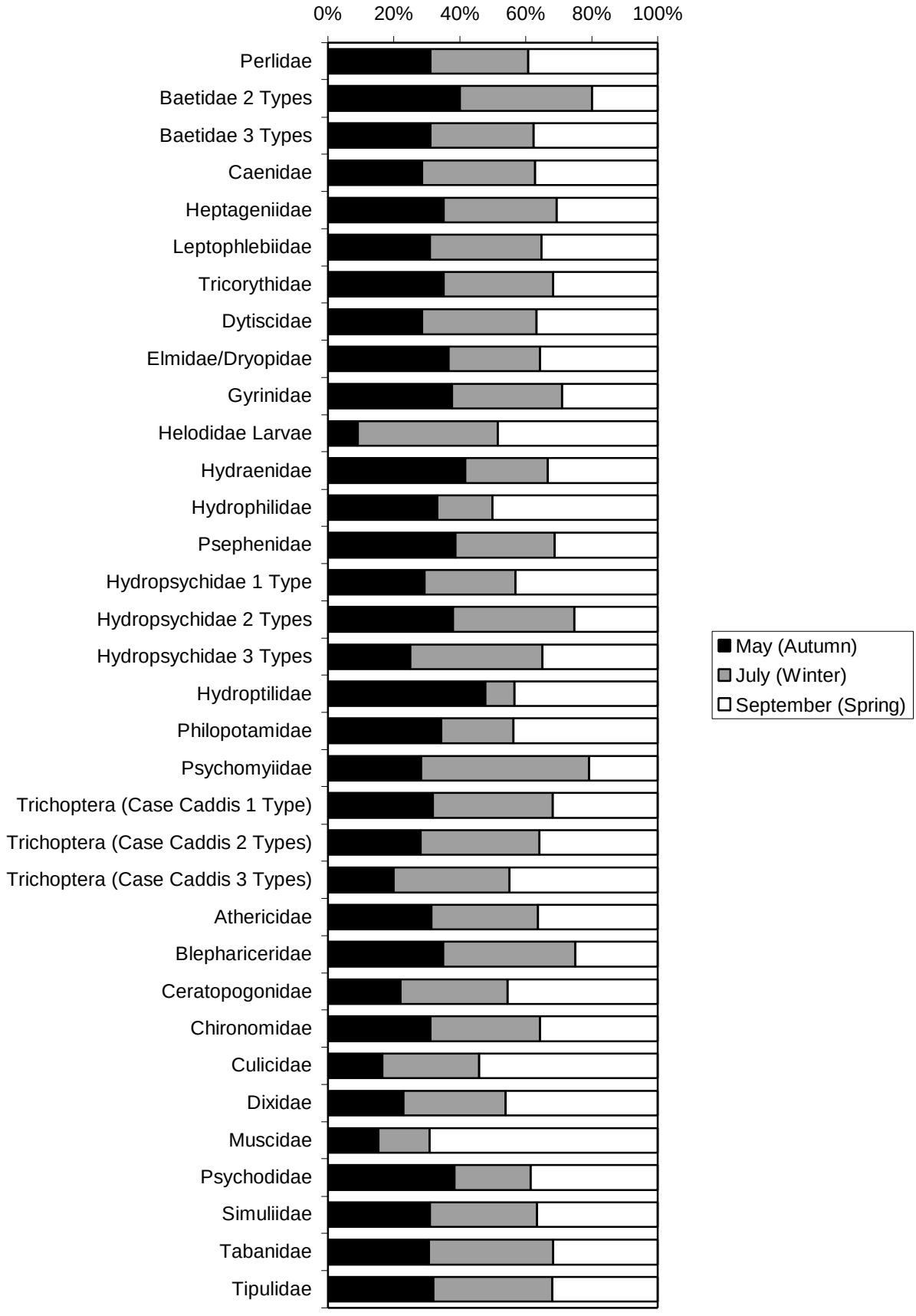

Figure 4.27 **Relative percentage occurrence of each SASS taxon within each month/season. Taxa within the following groups are presented: Plecoptera, Ephemeroptera, Coleoptera, Trichoptera and Diptera.**

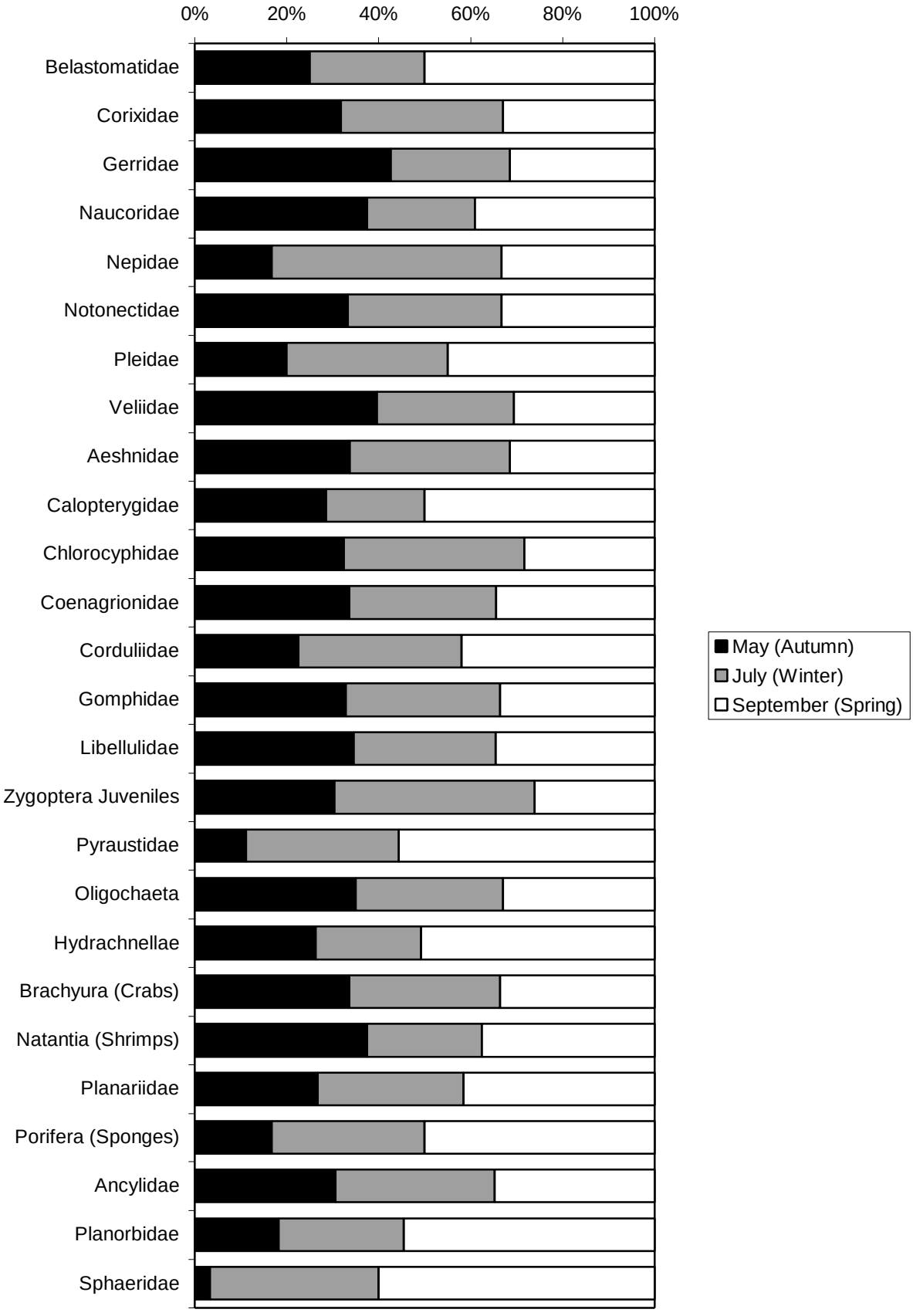

Figure 4.28 Relative percentage occurrence of each SASS taxon within each month/season. Taxa within the following groups are presented: Hemiptera, Odonata, Lepidoptera, Annelida, Crustacea, Platyhelminthes, Porifera and Mollusca.

4.4.4.3 SASS4 Scores, number of taxa and ASPT

Relative percentage contribution

SASS Scores calculated for each season were compared with those calculated from the multiple-season site assessment. Only those sites at which all three seasons were sampled were included in calculations. The percentage contribution of taxa within each season to SASS4 Score, number of taxa and ASPT for a site is given in Figure 4.29. Because certain taxa are found in more than one season the summed percentages from the seasons do not equal 100%. Instead the percentage given for each season is that percentage relative to the total calculated for the site. Because ASPT is calculated by dividing SASS4 Score by number of taxa, subsequent calculation of the percentage contribution of ASPT often resulted in an ASPT greater than 100%.
The mean (+ standard deviation) of the percentage contribution of SASS4 Score, number of taxa and ASPT to SASS Scores for the site are given for each Reference Group. Based on these data:

- Taxa present in autumn constituted 60-75%, 60-74% and 94-102% of the SASS4 Score, number of taxa and ASPT for a site in all Reference Groups.
- Taxa present in winter constituted 62-75%, 64-77% and 96-102% of the SASS4 Score, number of taxa and ASPT for a site in Reference Groups 1, 2 and 3 and sub-group 2a. For sub-group 3a, taxa present winter constituted 42%, 48% and 87% of the SASS4 Score, number of taxa and ASPT for a site. The number of observations for this group is however very low.
- Taxa present in spring constituted 61-75%, 64-76% and 94-100% of the SASS4 Score, number of taxa and ASPT for a site in all Reference Groups.
- SASS4 Scores: the maximum difference in contribution of each season relative to the site was 20% for sub-group 3a, followed by 15% for Reference Group 1. Reference Group 2 and sub-group 2a had ≤ 6% difference between seasons.
- Number of taxa: the maximum difference in contribution of each season relative to the site was 18% for sub-group 3a, followed by 16% for Reference Group 1. Reference Groups 2 and 3 and sub-group 2a had ≤ 8% difference between seasons.
- ASPT: the maximum difference in contribution of each season relative to the site was 7% for all Reference Groups.

Numerical differences in SASS Scores

Percentages were translated to actual values, expressed as the difference between the seasonal SASS Scores and the multiple-season SASS Scores, for each Reference Group separately and for Reference Groups 1, 2 and 3, and sub-group 2a concurrently. Mean, median, standard deviation, minimum and maximum differences in SASS4 Score, number of taxa and ASPT between each season and the multiple-season group are presented in Table 4.11. Examination of results revealed the following:

- *SASS4 Score:* The mean (± standard deviation) difference in SASS4 Score between separate season-groups and the multiple-season group was 76 (± 27) for autumn, 69 (± 29) for winter and 58 (± 19) for spring.
- *Number of taxa:* The mean (± standard deviation) difference in number of taxa between separate season-groups and the multiple-season group was 11 (± 4) for autumn, 10 (± 4) for winter and 8 (± 2) for spring.

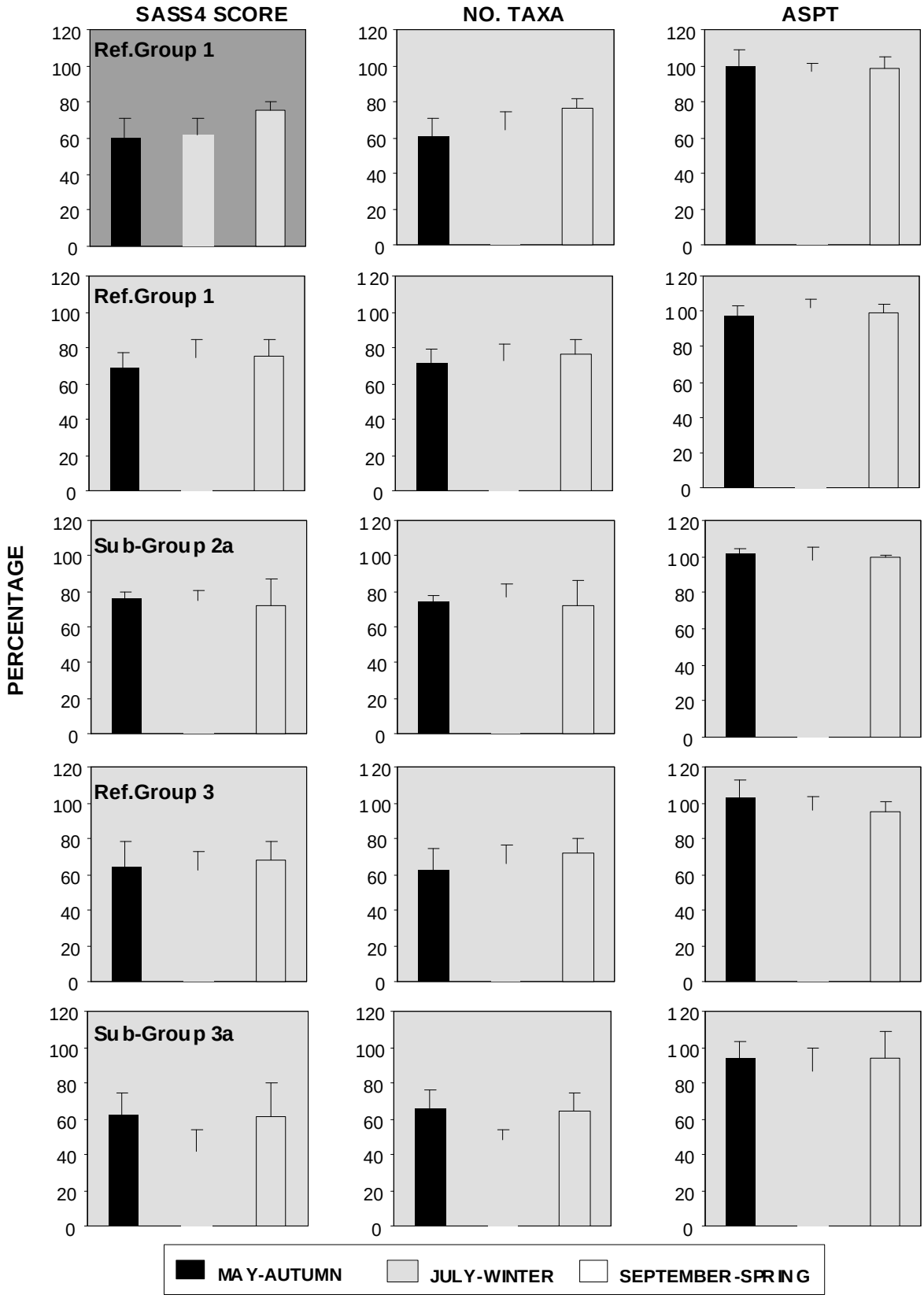

Figure 4.29 **Mean (+ SD) of percentage contribution of SASS4 Scores, number of taxa and ASPT for SASS samples collected in three separate seasons to SASS4 Scores, number of taxa and ASPT calculated for the site, i.e. all three seasons combined. Mean values have been calculated for each Reference Group, including the sub-groups, as follows: Reference Group 1 (n = 11), B = Reference Group 2 (n = 28), C = Sub-group 2a (n = 3), D = Reference Group 3 (n = 7) and E = Sub-group 3a (n = 3).**

- *ASPT:* The mean (± standard deviation) difference in ASPT between separate season-groups and the multiple-season group was 0.10 (± 0.50) for autumn, 0.04 (± 0.42) for winter and 0.10 (± 0.38) for spring.

The differences between seasonal SASS Scores relative to multiple-season SASS Scores was minimal. Of the three seasons, spring SASS Scores were least different to multiple-seasons SASS Scores. Differences in mean and median ASPTs were always ≤ 0.10, again emphasising the importance of ASPT in data interpretation. This is dealt with further in chapter 5.

Table 4.11 Mean, median, standard deviation, minimum and maximum differences in SASS4 Score, number of taxa and ASPT between each season and the multiple-season group. Values are calculated using data from all sites in Reference Groups 1, 2 and 3 and sub-group 2a (n = 53).

	SASS4 SCORE			NUMBER OF TAXA			ASPT		
	AUTUMN	WINTER	SPRING	AUTUMN	WINTER	SPRING	AUTUMN	WINTER	SPRING
Mean	76	69	58	11	10	8	0.10	0.04	0.10
Median	71	63	60	9	9	8	0.01	0.02	0.11
SD	27	29	19	4	4	2	0.50	0.42	0.38
Min	35	6	17	5	2	3	-1.12	-0.87	-0.95
Max	147	132	97	22	20	12	1.15	1.16	1.02

Mean (± standard deviation) and median values

Median and mean SASS Scores for each season were calculated and compared statistically using the Kruskal-Wallis test statistic (H). The SASS4 Score, number of taxa and ASPT values for sites in Reference Groups 1, 2 and 3 and sub-group 2a were incorporated in this analysis. Sub-group 3a was excluded as it was considered substantially different from the other groups with respect to the relative contribution of each season to SASS Scores for the site. Median, 25 and 75 percentiles values, and mean ± standard deviation are given for each season. SASS4 Score and number of taxa were significantly different amongst season ($p < 0.05$, Figure 4.30) and spring had significantly higher median values than autumn for SASS4 Score and number of taxa. ASPT was not significantly difference between seasons.

Additional taxa recorded per season

The number of additional taxa recorded per season was assessed by comparing the number of taxa (mean ± standard deviation) recorded in a single season with the number of additional taxa recorded if a second and then a third season were sampled. Data from final reference sites (n = 57) at which all three seasons were sampled (n = 52) were used for calculations. Analysis was run twice, first with autumn data assessed first (Figure 4.31A) and then with spring data assessed first (Figure 4.31B). Results are as follows:

- If autumn data was assessed first, then the mean number of taxa (± standard deviation) recorded in autumn was 16.5 (± 15.7). Adding winter data resulted in an additional 5.4 (± 4.5) taxa and adding

spring data, an additional 3.5 (± 3.4) taxa.

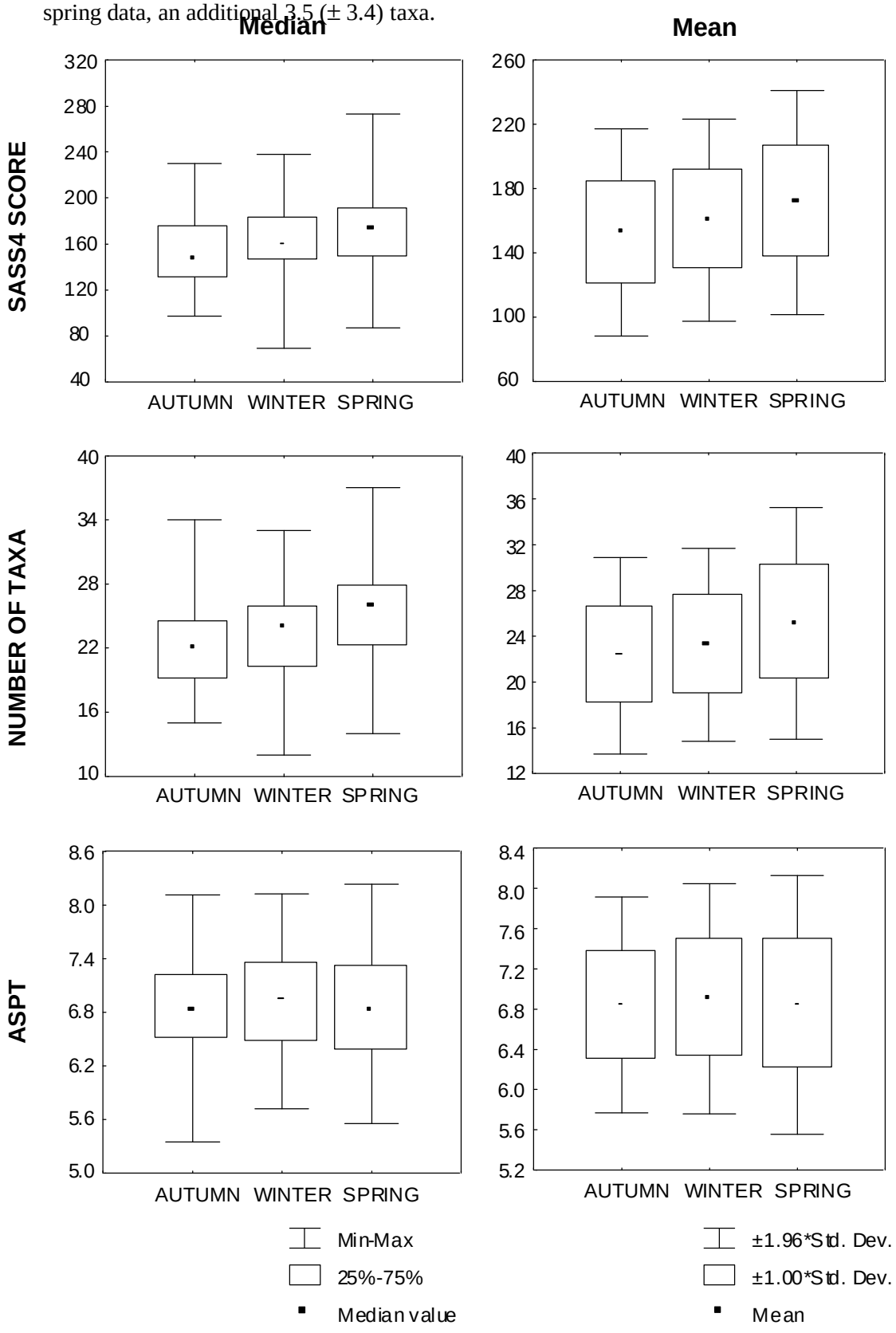

Figure 4.30. Median and mean values for each season: autumn (n = 52), winter (n = 53) and spring (n = 52). Values are calculated from all sites in Reference Groups 1, 2 and 3 and sub-group 2a.

- If spring data was assessed first, then the mean number of taxa (± standard deviation) recorded in spring was 18.4 (± 15.6). Adding autumn data resulted in an additional 4.3 (± 4.0) taxa and adding winter data, an additional 2.7 (± 2.8) taxa.

On this basis, the mean number of taxa recorded in the first season is between 16 and 19, with substantially fewer taxa recorded in subsequent seasons (< 6). Sampling spring first resulted in a higher number of taxa being recorded in the one season. The standard deviation for the single-season assessments were high illustrating that the frequency of occurrence between sites (n = 52) was high, with some taxa only being recorded at a single site with other recorded at > 95% of the sites.

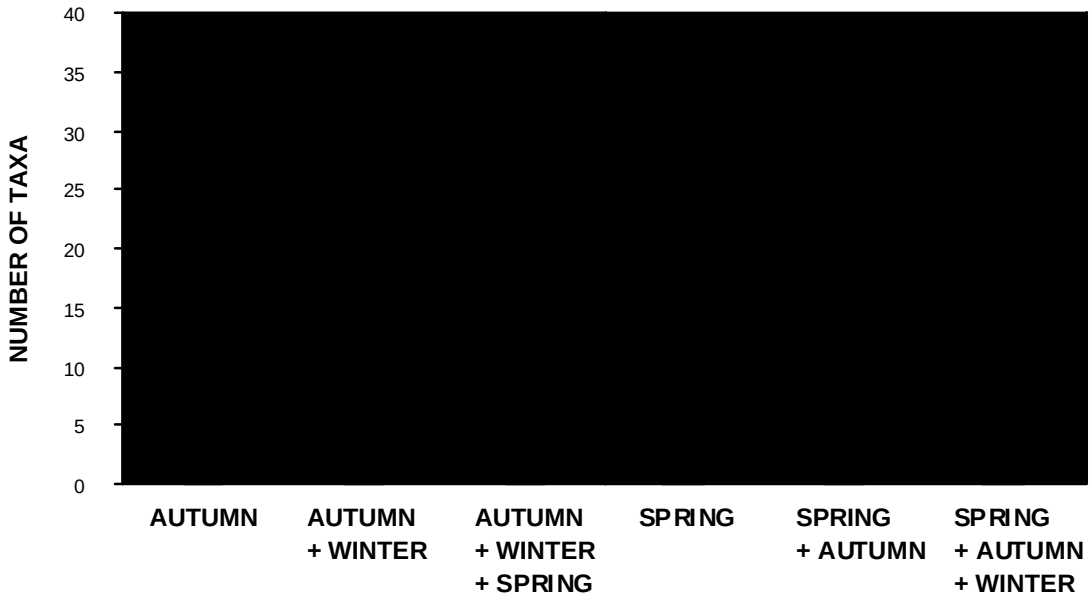

Figure 4.31 Number of taxa (mean ± standard deviation) recorded in a single season, showing the number of additional taxa recorded when a second and third season are included. A: AUTUMN, (AUTUMN+WINTER), (AUTUMN+WINTER+SPRING); B: SPRING, (SPRING+AUTUMN), (SPRING+AUTUMN+WINTER).

4.4.4.3 Summary of seasonal variation in invertebrate communities and SASS Scores

On the basis of the above analyses, single- versus multiple-season sampling is an important consideration when establishing reference conditions for riverine macroinvertebrates and for biomonitoring in general. The following were established:

- Multivariate analysis of single- versus multiple-season faunal samples from reference sites revealed that there was greater differentiation between Reference Groups if site classification was based on more than one seasons. Reference Group 3 sites mostly separated from Reference Group 1 and 2 sites, regardless of whether single- or multiple season data were used for the classification. The distinction between Reference Group 1 and 2 sites was , however, less clear. Site classification based on more than one season would provide a more reliable grouping of sites. Seasonal variation,

however, would need to be taken into account if predictive models were developed in the future, and if necessary, models would need to be developed for each season.

- Most taxa were recorded with relatively similar frequencies across all of the sampling seasons. A few were more frequently recorded in winter or spring. This may have implications for biomonitoring when sampling in undertaken in a single season.
- In terms of SASS4 Score, number of taxa and ASPT, there were minimal differences in the relative percentage contribution of taxa within each season. The maximum differences in the seasonal percentages was 20% for SASS4 Score, whilst ASPT was always <7% difference.
- Translated to actual scores, as opposed to percentages, mean differences in SASS4 Scores between seasons were as high as 76 points. In terms of number of taxa, mean differences were a maximum of 11, whilst ASPT values differed the least between seasons and was ≤ 0.10. This again indicates the importance of using this metric in the interpretation of data.
- SASS4 Score and number of taxa calculated for each season were significantly different amongst seasons and spring had higher median and mean values than autumn. ASPT did not differ significantly between seasons.
- The effect of sampling a site during one, two or three seasons revealed that sampling a single season resulted in the capturing of a mean number of taxa of between 16.5 and 18.4. Sampling a second season added a mean number of taxa between 4.3 and 5.4, and a third season added a mean number of taxa between 2.7 and 3.5.