4.4.2.2 Future predictive modelling

Whilst it is outside the scope of this study to develop predictive models along the lines of RIVPACS and AusRivAS, it is likely that this is the most advantageous future direction for the derivation of reference conditions for riverine macroinvertebrates and the RHP in general. Examination of reference site classification on the basis of invertebrate communities suggests that whilst there is a certain degree of agreement between the ecoregion/sub-region approach to classifying sites and the classification of sites based on invertebrate communities, additional factors are coming into play at the level of river type.

Of the predictor variables identified, three (longitude, altitude and distance from source) were catchment variables. These types of variables would relate in some way to ecoregions. Site variables identified included stream width, mean depth of shallow-water habitat (e.g. cobble riffle or bedrock rapid) and vegetation type. Whilst vegetation type also relates to ecoregions, stream width and mean depth of shallow-water habitat variables are site specific and would not be reflected in ecoregions although stream width is likely to be correlated with sub-region to a certain degree. Habitat variables identified as potential predictor variables included substratum composition and, in particular, the percentage of bedrock and percentage of gravel, sand and mud, together with the percentage of SIC/SOOC present at the site. These variables are at Level 3, i.e. river type. Adopting an approach which is based on classification of sites from invertebrate communities, and subsequent examination of environmental variables to determine which variables best discriminate between sites, is likely to provide an objective and robust method for future biomonitoring and data interpretation via the use of established reference conditions. As already mentioned, by ensuring the collection of quality data, the stage is set for future development of predictive models which would facilitate the computerised calculation of degree of impairment of a monitoring site when compared to an expected reference condition.

4.4.3 Separate- versus combined-biotope sampling

As discussed in section 3.3.2, the availability of SASS biotopes for sampling, and whether or not the biotopes are sampled separately or combined into one SASS assessment for the site, may influence SASS results. Biotope-groups used in the analysis are:

- stones-in-current/stones-out-of-current (SIC/SOOC),
- aquatic/marginal vegetation (AQV/MV),
- and gravel/sand/mud (G/S/M).

4.4.3.1 Separate-biotope site classification versus Reference Group classification

Cluster analysis (Figures 4.8, 4.9 and 4.10) and MDS ordinations (Figures 4.11, 4.12 and 4.13) were undertaken at 57 sites for seasonally-combined, invertebrate communities for each biotope-group. Analyses were run separately for each biotope-group such that the resultant site classification could be compared to that obtained for the composite reference community data in which biotope-groups were combined and which generated three Reference Groups and two sub-groups (see Figures 4.5 and 4.6).

Stones-in-current/stones-out-of-current:

- Fifty-three of the 57 sites were at least 60% similar (Figures 4.8 and 4.11).
- Sites from Reference Groups 1 and 2 and sub-group 2a were mixed together.
- Reference Group 3 sites grouped together at 65% similarity (indicated as A on Figures 4.8 and 4.11).
- Three sites from sub-group 3a were outliers together with one site from Reference Group 3 which had 85-90% gravel and sand, 5% SIC/SOOC biotope and very little marginal vegetation.

Aquatic/marginal vegetation:

- Sites from Reference Groups 1 and 2 and sub-group 2a were mixed together at around 50% similarity, although on the basis of dominance, two groups were apparent. The first group (indicated as A on Figures 4.9 and 4.12) was comprised of Reference Group 1 sites and the second (indicated as B) by Reference Group 2 sites.
- With the exception of one sub-group 3a site, all Reference Group 3 sites clustered together at approximately 50% similarity (indicated as C). Three sites from other Reference Groups were also in this group.

Gravel/sand/mud:

- Seven of the 11 Reference Group 1 sites clustered together (50% similarity, indicated as A on Figure 4.10), although the grouping was not clear in the ordination plot (Figure 4.13).
- Sixteen of the 24 Reference Group 2 sites clustered together (58% similarity, indicated as B).
- Reference Group 3 sites grouped together at 55% similarity (indicated as C). Three sites from other Reference Groups were also in this Reference Group.
- The remaining sites were mixed in and amongst the different Reference Groups.

On the basis, therefore, of multivariate analysis, there appears to be a certain degree of agreement between the composite Reference Groups and groups generated when each biotope-group was analysed separately. In all analyses, however, several sites were either separated as outliers or grouped with non-member Reference Groups. In other words the amount of "noise" had increased and groupings were less clear. In terms of future predictive modelling, it may be advantageous to develop models for each biotope-group separately, in addition to a composite Reference Group model, so that the predictive potential and accuracy of each may be assessed.

4.4.3.2 The frequency of occurrence of each SASS taxon amongst biotope-groups

The frequency of occurrence of each SASS taxon amongst the three biotope-groups was calculated using data from final reference sites (n=57) at which all three biotope-groups were sampled and on a per-sampling-occasion basis. This resulted in 122 observations on which to base the frequency data which have been plotted as stacked bar graphs (Figures 4.14 and 4.15). Any taxon present at < 5% of any one biotope-group was excluded from the calculations. Certain taxa are more frequently recorded in one biotope-group, whilst others occurred across two or three biotope-groups. The following generalisations may be made:

- Taxa more frequently occurring in the SIC/SOOC biotope-group (relative % > 50%) included:
  - Plecoptera: Perlidae,
  - Ephemeroptera: Heptageniidae, Leptophlebiidae, Tricorythidae,
  - Coleoptera: Elmidae/Dryopidae, Psephenidae,
  - Trichoptera: Hydropsychidae (2 and 3 types), Philopotamidae, Psychomyiidae,
  - Diptera: Athericidae, Blephariceridae, Muscidae, Tabanidae, Tipulidae,
  - Odonata: Aeschnidae, Libellulidae,
  - other: Hydrachnellae, Brachyura (crabs), Planariidae, Porifera, and
  - Mollusca: Ancylidae.

- Taxa more frequently occurring in the AQV/MV biotope-group (relative % > 50%) included:
  - Coleoptera: Dytiscidae, Gyrinidae, Helodidae, Hydrophilidae,
  - Trichoptera: Hydroptilidae, cased-caddis (2 and 3 types),
  - Diptera: Culicidae, Dixidae,
  - Hemiptera: Belastomatidae, Gerridae, Nepidae, Notonectidae, Pleidae, Veliidae,
  - Odonata: Calopterygidae, Coenagrionidae, Zygoptera (juveniles),
  - Crustacea: Natantia, and
  - Mollusca: Planorbidae.

- Taxa more frequently occurring in the GSM biotope-group (relative % > 50%) included:
  - Ephemeroptera: Baetidae (1 type),
  - Diptera: Ceratopogonidae,
  - Odonata: Cordulidae, Gomphidae, and
  - Mollusca: Sphaeriidae.

- Taxa occurring in all three biotope-groups with approximately equal frequency included:
  - Ephemeroptera: Baetidae (2 and 3 types), Caenidae,
  - Trichoptera: Hydropsychidae (1 type), cased-caddis (1 type),
  - Diptera: Chironomidae,
  - Hemiptera: Corixidae, Naucoridae, and
  - Odonata: Chlorocyphidae

- Taxa occurring in two biotope-groups with approximately equal frequency included:
  - Coleoptera: Hydraenidae (in AQV/MV and GSM),
  - Diptera: Simuliidae (in SIC/SOOC and AQV/MV), and
  - Oligochaeta (in SIC/SOOC and GSM).

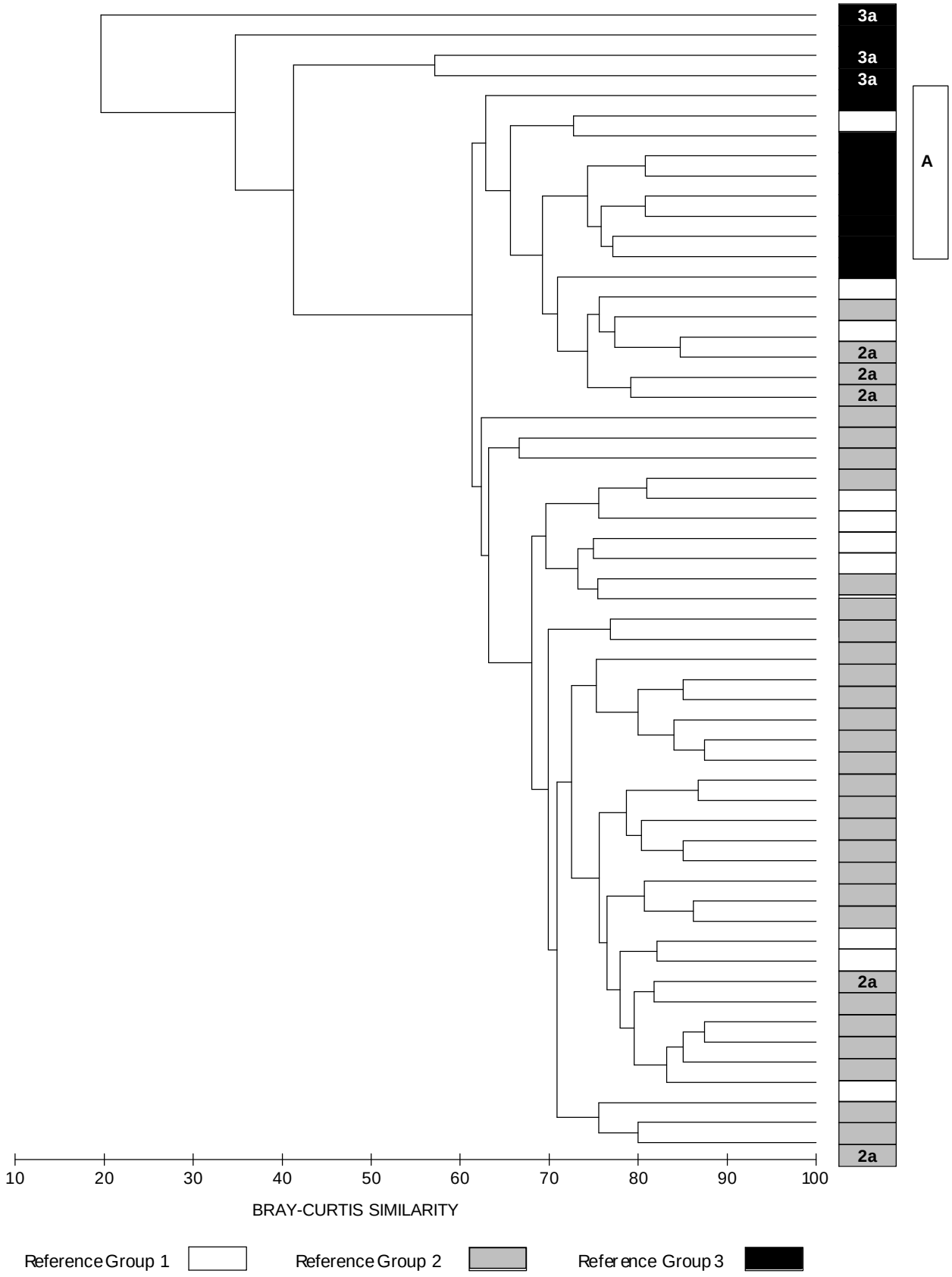

Figure 4.8 Dendrogram showing the classification of 57 reference sites in Mpumalanga based on taxa recorded in the stones-in-current/stones-out-of-current biotope-group. Sites are shaded on the basis of the composite Reference Group classification (Figure 4.5). Sites in sub-groups 2a and 3a are indicated.

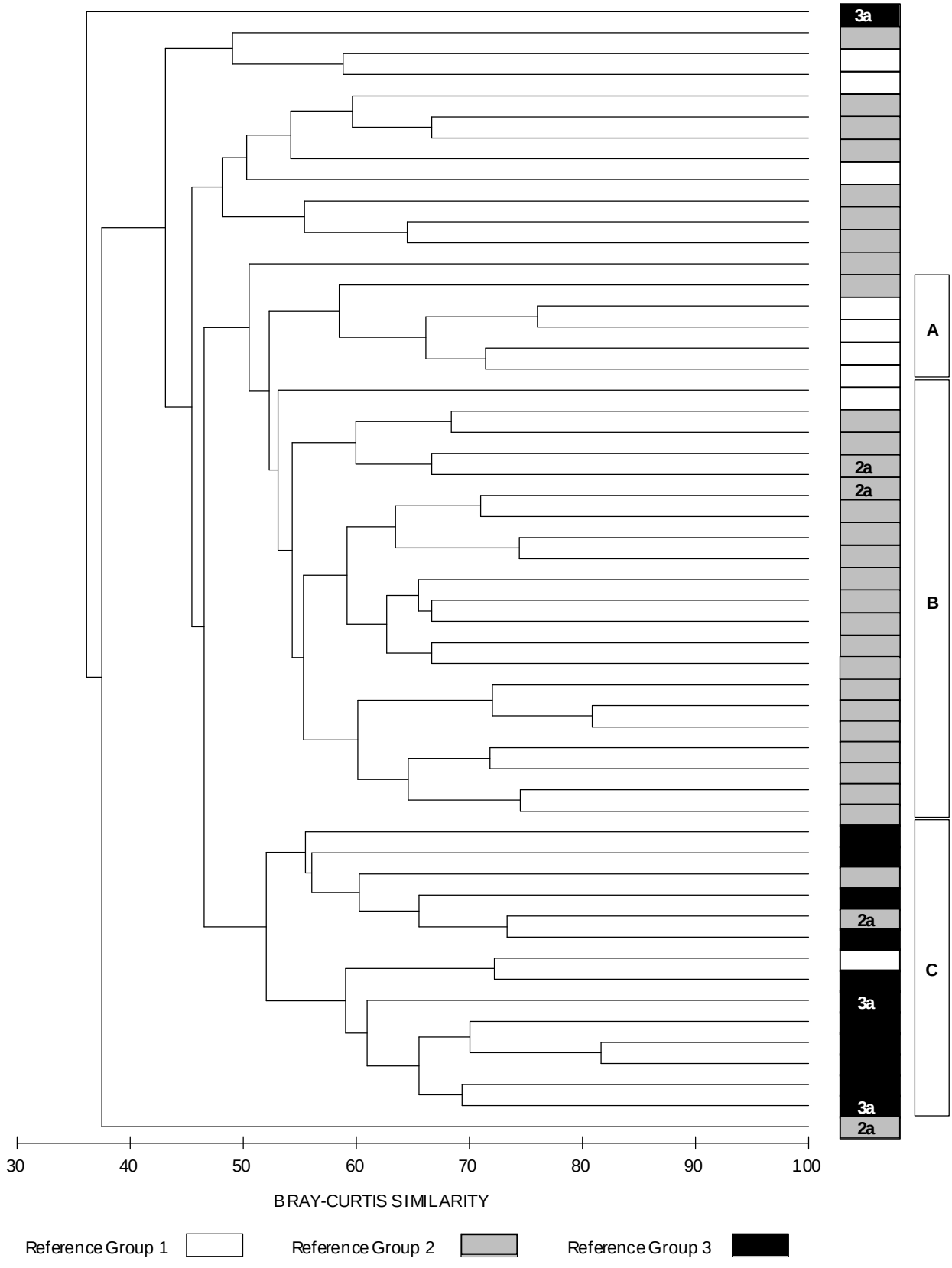

Figure 4.9 Dendrogram showing the classification of 54 reference sites in Mpumalanga based on taxa recorded in the aquatic and marginal vegetation biotope-group. Sites are shaded on the basis of the composite Reference Group classification (Figure 4.5). Sites in sub-groups 2a and 3a are indicated.

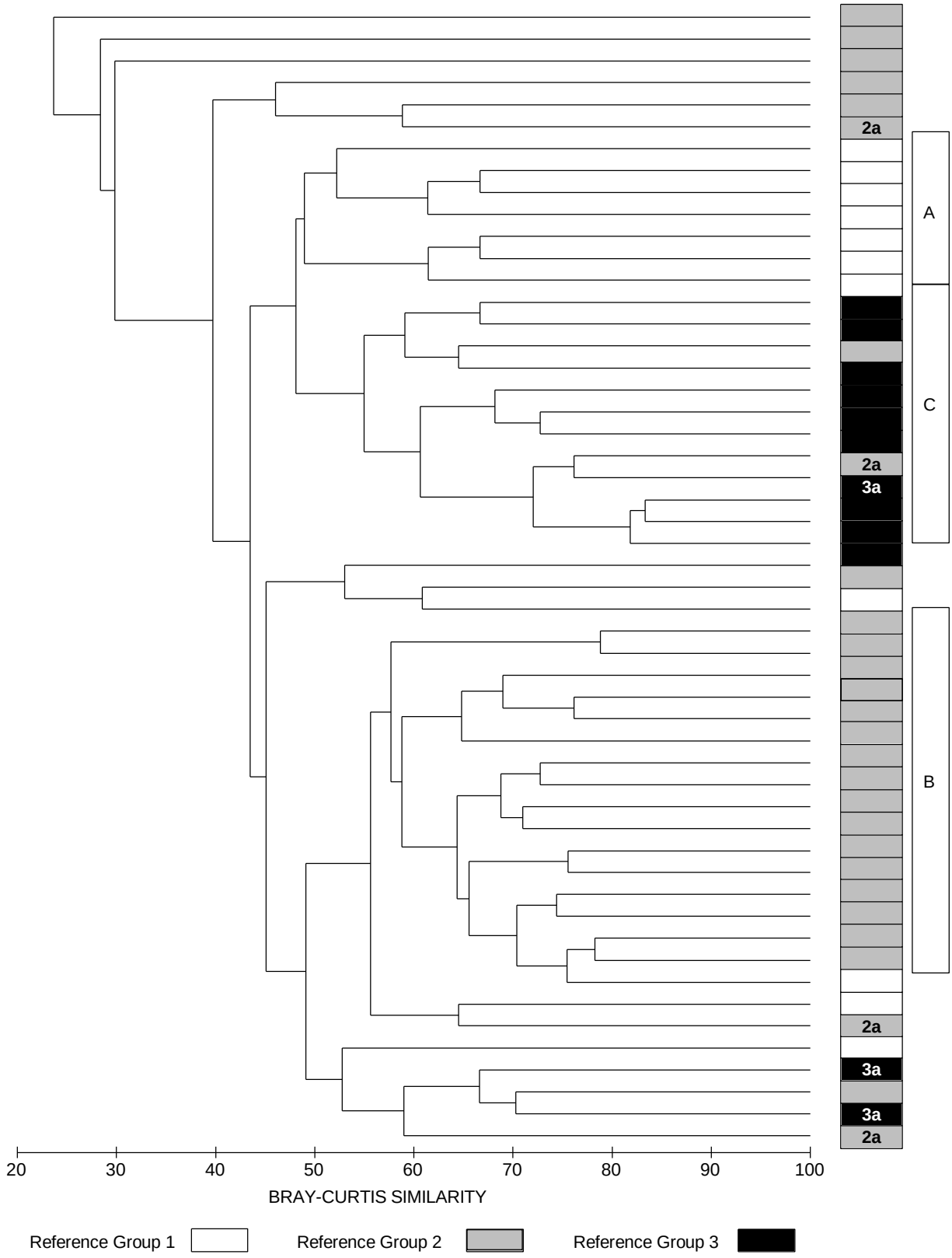

Figure 4.10 Dendrogram showing the classification of 52 reference sites in Mpumalanga based on taxa recorded in the gravel/sand/mud biotope-group. Sites are shaded on the basis of the composite Reference Group classification (Figure 4.5). Sites in sub-groups 2a and 3a are indicated.

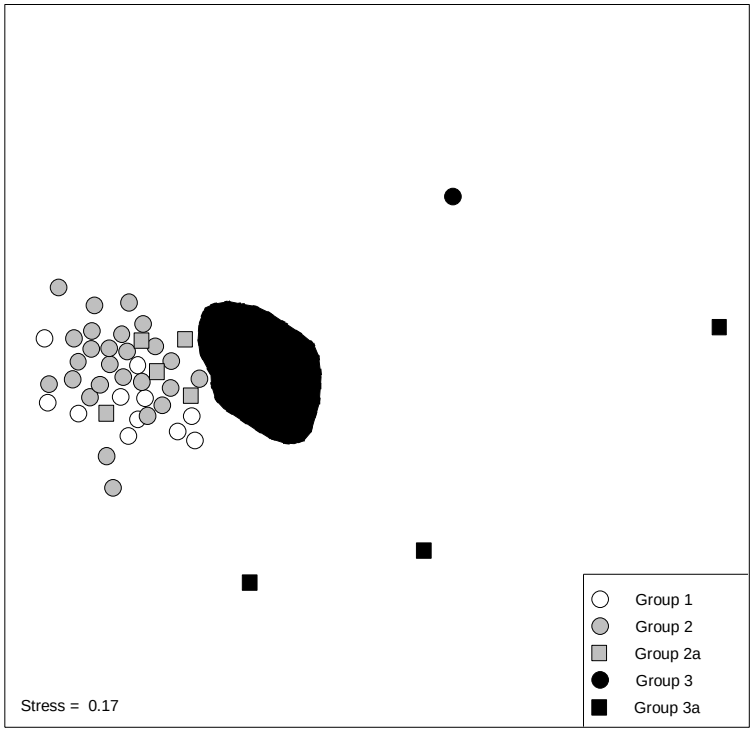

Figure 4.11 Ordination of 57 reference sites in Mpumalanga based on taxa recorded in the stones-in-current/stones-out-of-current biotope-group. Sites are shaded on the basis of the composite Reference Group classification and groups have been outlined manually on the basis of the cluster analysis.

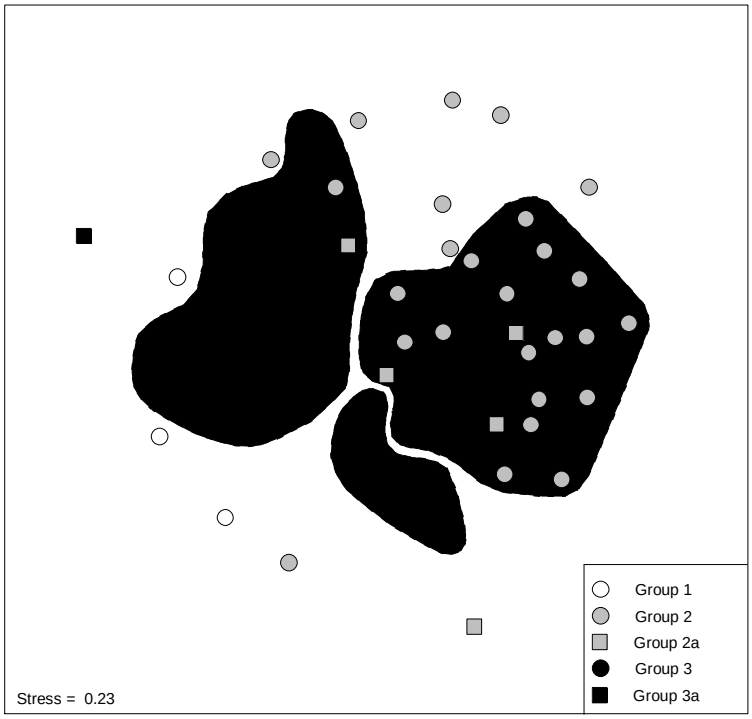

Figure 4.12 Ordination of 54 reference sites in Mpumalanga based on taxa recorded in the aquatic and marginal vegetation biotope-group. Sites are shaded on the basis of the composite Reference Group classification and groups have been outlined manually on the basis of the cluster analysis.

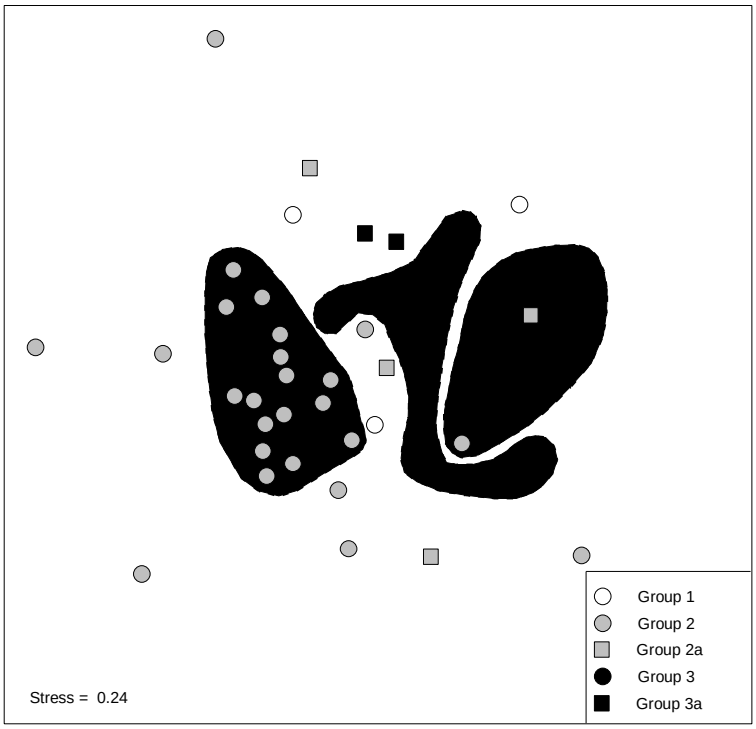

Figure 4.13 Ordination of 52 reference sites in Mpumalanga based on taxa recorded in the gravel/sand/mud biotope-group. Sites are shaded on the basis of the composite Reference Group classification and groups have been outlined manually on the basis of the cluster analysis.