US Army Corps
of Engineers
New York District

Multivariate Benthic Community Analysis
Norton Basin/Little Bay Restoration Project

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Prepared for

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Introduction

The goal of the Norton Basin/Little Bay project is to demonstrate the feasibility of habitat restoration via bathymetric recontouring of the Norton Basin/Little Bay complex located in Jamaica Bay, Far Rockaway, New York. In order to accomplish this task, several borrow pits (55-65 ft. deep) located within this area would be filled using dredged material derived from navigation improvement projects within the Port (Barry A. Vittor & Associates, Inc. 2003a). A pilot study was conducted in Norton Basin, Little Bay, and two reference areas located in Jamaica Bay (The Raunt and Grass Hassock Channel) to provide guidelines for Phase I (Baseline Environmental Studies) of the project. Water quality monitoring, hydrodynamic monitoring, characterization of benthic invertebrate communities, SPI surveys, and fish surveys were included in both years (2001 and 2002) of the Phase I study. Phase I of the Norton Basin/ Little Bay bentho invertebrate survey consisted of two seasons of sampling (June and October) during each year involved.

Graphical and univariate statistical analysis of the 2001 and 2002 benthic community data collected from Norton Basin, Little Bay and the reference areas in Jamaica Bay indicated distinct differences in abundance, biomass and taxa richness among stations, with particular regard to depth strata. Recent multivariate analyses (e.g., PCA, CCA) of benthic data and environmental variables indicated dissolved oxygen concentration as a significant predictor of benthic invertebrate abundance and biomass. Additional environmental variables, which were significant predictors of benthic abundance, biomass and taxa richness included water column chlorophyll *a*, phaeophytin and nitrate concentrations (Great Eastern Ecology, Inc. 2003). Following the recommendations of the project interagency technical team, the next step is to focus on species associations within the benthic community, with comparisons among Norton Basin, Little Bay and the reference areas. This report discusses a further multivariate analysis of benthic macroinvertebrate assemblage data from June and October 2001 and 2002 in the Phase I study.

Site Descriptions

The Norton Basin and Little Bay study areas are two dead-end basins located on the north shore of the eastern Rockaway Peninsula, in the Borough of Queens, New York. These embayments are located southeast and south of the Edgemere Landfill,

respectively. Norton Basin has three 45 to 50 ft deep borrow pits that have soft, mud substrates, while there are shallower areas that consist of sandy substrates (Barry A. Vittor & Associates, Inc. 2003 a, b). It has been revealed that along the Norton Basin floor there is extensive debris, small submerged structures, as well as two 30 – 40 ft wrecks (CR Environmental, Inc. 2001). Little Bay has three 60 – 65 ft deep borrow pits that also have soft, mud substrates and shallow areas of the inlet with sandy substrates. The floor of the basin was found to have several 30 – 40 ft wrecks and extensive debris (i.e. tires, pilings, and other structures) (CR Environmental, Inc. 2001). Grass Hassock Channel is a wide, deep tidal channel, which is bounded by Jo-Co Marsh and Silver Hole Marsh to the west and by Conchs Hole Point, the Edgemere Landfill, Norton Basin, and Motts Point to the east. Grass Hassock Channel originates at the confluence of Winhole Channel and Beach Channel (Barry A. Vittor & Associates, Inc. 2003 a, b). The substrate of Grass Hassock Channel is patchy, and includes sand/silt, shell/gravel, extensive *Ampelisca* mats, and dense sponge colonies (CR Environmental, Inc. 2001). The Raunt is a shallow tidal channel, which passes in a northeasterly direction through Little Egg Marsh, Big Egg Marsh, and Yellow Bar Hassock before terminating at Goose Pond Marsh, in the community of Broad Channel, Queens, New York. The bottom sediments of the Raunt are predominantly sands and silts, with seasonally dense mats of sea lettuce (*Uva lactuca*) and extensive beds of tube-dwelling amphipods in the upper reaches. The lower reach of the Raunt has a substrate that consists of a hard sand bottom (CR Environmental, Inc. 2001).

Assemblage Composition Using Cluster and MDS Analysis

Data from similar sampling stations were grouped together for the purpose of statistical analysis. The seven data groups represent the Raunt (7 ft to 25 ft. deep), and Grass Hassock Channel (20 ft. to 50 ft deep) reference areas, the deep areas of Little Bay (over 40 ft. deep), the intermediate depth areas of Little Bay (approx. 30 ft. deep), the deep areas of Norton Basin (over 40 ft. deep), the intermediate depth areas of Norton Basin (20 ft. to 35 ft deep), and the entrance to Norton Basin (10 ft. to 20 ft. deep) (Barry A. Vittor & Associates, Inc. 2003 a, b).

Cluster analysis was performed by calculating the Bray-Curtis similarity coefficient for all pairs of sampling stations, after having transformed (e.g. square root,

ln_e) the original taxa abundances (Clarke and Gorley 2003). Clusters were formed using the group-average linkage method between similarities. Due to limitations of the Primer software, sites with one or fewer animals were excluded from further analysis. A non-metric multi-dimensional scaling (MDS) was then performed on the similarity matrix generated by the cluster analysis. MDS represents sample stations in 2-dimensional space such that the relative distances apart of all points were in the same rank order as the relative dissimilarities of the samples as calculated by the Bray-Curtis coefficients. Points close together in an MDS plot represents sample stations that were very similar in taxa composition and points that were far apart represent very different assemblages (Clarke and Gorley 2003). Cluster analysis and MDS plots comparing June and October were performed for both study years in order to further investigate the Norton Basin and Little Bay biological attributes. The relative abundance of selected taxa (or taxa groups) was overlain as bubble plots on the MDS.

Results

June 2001

The 3 Little Bay stations (LB1-D, LB2-D and LB3-I) had 0 animals and were excluded from the cluster analysis. The remaining stations from June 2001 clustered into 3 groups (Figure 1). The Grass Hassock (GH) and Raunt (R) reference and Norton Basin shallow water stations (NB-S) clustered together, while the Norton Basin deep stations (NB-D) and 1 Raunt station formed outlying clusters. The MDS plot of the June 2001 stations is given in Figure 2. The Norton Basin deep stations (NB-D) and the single Raunt station can be seen as outliers indicating different macroinvertebrate assemblages; the two NB-D stations grouped in the lower left of the MDS plot had only 4 and 6 polychaete species, respectively, while the Raunt and NB-D stations grouped in the upper MDS space were dominated by two species (the gastropod, *Ilyanassa obsoleta* and the polychaete, *Capitella capitata*) or three species (the amphipod, *Ampelisca vadorum* and the polychaetes, *C. capitata* and *Streblospio benedicti*), respectively. The large grouping in the lower right of the MDS plot was comprised of stations dominated by a single taxon (the amphipod, *A. vadorum* for the Grass Hassock and Raunt stations or a complex of benthic taxa for the Norton Basin shallow stations). The relative abundance of the polychaete, *C. capitata*, was overlain on the MDS plot in Figure 3.

October 2001

Two stations (NB5-D and LB2-D) had 0 animals and one station (NB6-D) had one animal and were excluded from the cluster analysis. The remaining stations from October 2001 clustered into 4 groups (Figure 4): the Grass Hassock and Raunt (GH and R) reference stations, the Norton Basin shallow water stations (NB-S), and the Little Bay stations (LB) and the Norton Basin intermediate (NB-I) and deep (NB-D) stations. The Norton Basin intermediate and deep stations (NB-I and NB-D) stations were dominated by a single taxon, the amphipod, *A. vadorum* (93% and 83% of the benthic assemblage, respectively). The Norton Basin shallow water stations (NB-S) had a diverse assemblage of macroinvertebrates with no clear dominant. The Grass Hassock and Raunt stations had high macroinvertebrate densities dominated by a mixed assemblage of amphipods, polychaetes and mollusks. The MDS plot of the stations shows the distinct separation of the Little Bay intermediate (LB-I) and deep (LB-D) stations (less than 6 organisms found at each station) from the remaining stations (Figure 5).

June and October 2001

Four Little Bay (June: LB1-D, LB2-D, LB3-I; October: LB2-D) stations and one Norton Basin station (October: NB5-D) had 0 organisms and one Norton Basin station (October: NB6-D) had one organism and were excluded from the cluster analysis. The stations from 2001 with more than one organism clustered into four distinct groups (Figure 6). One cluster contained all of the Grass Hassock and Raunt reference (GH and R) and Norton Basin shallow water stations (NB-S) for June, while a second cluster contained the same stations for October indicating a seasonal difference in the relative distribution and abundance of macroinvertebrates in the respective assemblages. The remaining two clusters contained the Little Bay and Norton Basin intermediate (LB-I, NB-I) and deep stations (LB-D, NB-D) and one Raunt station. The Little Bay and Norton Basin intermediate and deep stations, as well as one Raunt station, were separated in MDS space from the remaining stations indicating different macroinvertebrate assemblages (Figure 7). An assemblage of four polychaetes, *Mediomastus* (LPIL), *Capitella capitata*, *Polydora cornuta*, and *Streblospio benedicti*, were responsible for the close clustering of the June Norton Basin shallow, Grass Hassock and Raunt stations (Figures 8-11). The polychaete, *Sabellaria vulgaris*, was responsible for the separation of

the October Norton Basin shallow stations (Figure 12). The tubiculous amphipods, *Ampelisca vadorum*, *Monocorophium tuberculatum*, and *Microdeutopus gryllotalpa* were abundant at the Raunt and Grass Hassock stations during both seasons (Figures 13-15).

June 2002

Five Little Bay stations (LB3-D, LB4-D, LB5-D, LB8-D, LB7-I) had 0 organisms and one Little Bay (LB6-D) and one Norton Basin station (NB4-D) had only one organism and were excluded from the cluster analysis. The remaining stations from June 2002 with more than one organism clustered into 5 groups (Figure 16). Five of 7 Norton Basin intermediate depth (NB-I) stations formed a cluster, while all of the Grass Hassock and Raunt reference stations except for the Raunt station, R-2, formed a cluster. The MDS plot of these sites had one large station grouping with a Little Bay station as an outlier (Figure 17). Even within the large station cluster, stations from the same area tended to be closer together indicating similar assemblages. Plots of dominant taxa were overlain on the MDS plot in Figures 18-25. The assemblages at the Grass Hassock (GH) and Raunt (R) reference sites in the upper left MDS grouping were dominated by the tubiculous amphipods, *Ampelisca vadorum*, *Monocorophium tuberculatum*, and *Microdeutopus gryllotalpa* (Figures 18-20). The Norton Basin intermediate (NB-I) sites located in the bottom right portion of the MDS plot were dominated by the polychaete, *Capitella capitata*, while the Norton Basin shallow (NB-S) stations in the lower left of the MDS plot were dominated by the polychaetes, *Polydora cornuta*, *Streblospio benedicti*, and *Sabellaria vulgaris* (Figs 22-24). The assemblage at the Raunt site (R-2) which did not cluster with the remaining reference sites was dominated by the polychaete, *Mediomastus* (LPIL) (Figure 25).

October 2002

Three Little Bay (LB7-I, LB6-D, LB8-D) and one Norton Basin (NB3-I) station had 0 organisms, and two Little Bay stations (LB2-D, LB4-D) had only one organism and were excluded from the cluster analysis. The stations from October 2002 with more than one organism clustered into several groups (Figure 26). Little Bay stations, LB3-D, LB5-D and LB1-I had only 2, 2, and 3 organisms, respectively, and clustered apart from the remaining stations. The Grass Hassock (GH) and Raunt (R) reference stations formed distinct clusters, while the Norton Basin stations were scattered among several clusters

(Figure 26). The Little Bay intermediate (LB-I) and Little Bay deep (LB-D) stations were separated from the remaining stations in the MDS space indicating disparate macroinvertebrate assemblages (Figure 27). The GH, R and NB-S stations were each close together in MDS space indicating relatively similar macroinvertebrate assemblages. Plots of dominant taxa were overlain on the MDS plot in Figures 28-35. The Grass Hassock (GH) stations were dominated by the tubiculous amphipods, *Ampelisca vadorum* and *Monocorophium tuberculatum*, while the R stations were dominated by the tubiculous amphipod, *Microdeutopus gryllotalpa* (Figures 28-30). The polychaetes, *Streblospio benedicti* and *Mediomastus* (LPIL) were abundant at the NB-S, GH and R stations (Figures 31 and 32). The polychaetes, *Sabellaria vulgaris* and *Polydora cornuta*, were most abundant at the Norton Basin shallow (NB-S) stations, while *Capitella capitata* was most abundant at the Norton Basin Intermediate (NB-I) and Raunt (R) stations (Figure 35).

June and October 2002

Eight Little Bay stations (June: LB3-D, LB4-D, LB5-D, LB8-D, LB7-I; October: LB7-I, LB6-D, LB8-D) and one Norton Basin station (October: NB3-I) had 0 organisms, while three Little Bay (June: LB6-D; October: LB2-D, LB4-D) stations and one Norton Basin (NB4-D) station had only one organism and were excluded from the cluster analysis. The remaining stations from June 2002 with more than one organism clustered into several groups (Figure 36). Four stations clustered separately (October: LB1-D, LB3-D, LB5-D; June: LB1-I), but had only 2 or 3 organisms present. The remaining stations tended to cluster by location and depth and secondarily by season (Figure 36). The Little Bay intermediate (LB-I) and Little Bay deep (LB-D) stations were separated from the remaining stations in the MDS space indicating disparate macroinvertebrate assemblages (Figure 37).

Summary

In June 2001, the Norton Basin deep stations (NB-D) had distinct macroinvertebrate assemblages dominated by an assemblage of polychaete species, a gastropod (*Ilyanassa obsoleta*) and a polychaete taxon (*Capitella capitata*), or three taxa (the amphipod, *Ampelisca vadorum* and the polychaetes, *C. capitata* and *Streblospio*

benedicti). The Grass Hassock and Raunt stations were dominated by the tubiculous amphipod, *A. vadorum,*

In October 2001, the Norton Basin intermediate and deep stations (NB-I and NB-D) stations were dominated by the amphipod, *A. vadorum*, while the Norton Basin shallow water stations (NB-S) had a diverse assemblage of macroinvertebrates with no clear dominant. The Grass Hassock and Raunt stations had high macroinvertebrate densities dominated by a mixed assemblage of amphipods, polychaetes and mollusks. There was also a distinct separation of the Little Bay intermediate and deep stations (less than 6 organisms found at each station) from the remaining stations.

In June 2002, stations from the same area tended to be grouped together indicating similar assemblages. The tubiculous amphipods, *Ampelisca vadorum*, *Monocorophium tuberculatum*, and *Microdeutopus gryllotalpa* were abundant at the GH and all but one R reference sites. The Norton Basin intermediate depth (NB-I) stations were dominated by the polychaete, *Capitella capitata*, while the Norton Basin shallow (NB-S) stations were dominated by the polychaetes, *Polydora cornuta*, *Streblospio benedicti*, and *Sabellaria vulgaris*. The remaining R reference sites was dominated by the polychaete, *Mediomastus* (LPIL).

In October 2002, the Little Bay Intermediate and Little Bay Deep stations were separated from the remaining stations in the MDS space indicating disparate macroinvertebrate assemblages. The GH, R and NB-S stations were each close together in MDS space indicating relatively similar macroinvertebrate assemblages. The Grass Hassock (GH) stations were dominated by the tubiculous amphipods, *Ampelisca vadorum* and *Monocorophium tuberculatum*, while the Raunt (R) stations were dominated by the tubiculous amphipod, *Microdeutopus gryllotalpa*. The polychaetes, *Streblospio benedicti* and *Mediomastus* (LPIL) were abundant at the NB-S, GH and R stations. The polychaetes, *Sabellaria vulgaris* and *Polydora cornuta*, were most abundant at the Norton Basin shallow (NB-S) stations, while *Capitella capitata* was most abundant at the Norton Basin Intermediate (NB-I) and Raunt (R) stations.

The majority of stations excluded from analysis for having one or fewer animals were Little Bay stations. These results fit our basic understanding of the habitat conditions at these stations. The Little Bay stations that were included in the analysis

contained few animals in comparison to the reference stations. In October 2002, the reference station clusters were more distinct. The Norton Basin shallow, intermediate, and deep stations were dispersed among the clusters. The June 2001, October 2001, and June 2002 sample groups had a similar pattern of clusters. The reference stations and shallow stations clustered together, with the deep stations either clustering together or being excluded.

The data presented in this study continue to supplement our understanding of the biological attributes of Norton Basin and Little Bay, as there is little data previously available on the ecology of this area. The cluster and MDS analyses separated the Norton Basin, Little Bay and reference stations (Grass Hassock, Raunt) on the basis of depth, season and macroinvertebrate assemblages. These baseline data may be used to develop restoration targets and to establish monitoring protocols and success criteria, should future restoration activities be undertaken in the study area.

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Figure 1. Station dendrogram from the cluster analysis for the Norton Basin stations, June 2001.

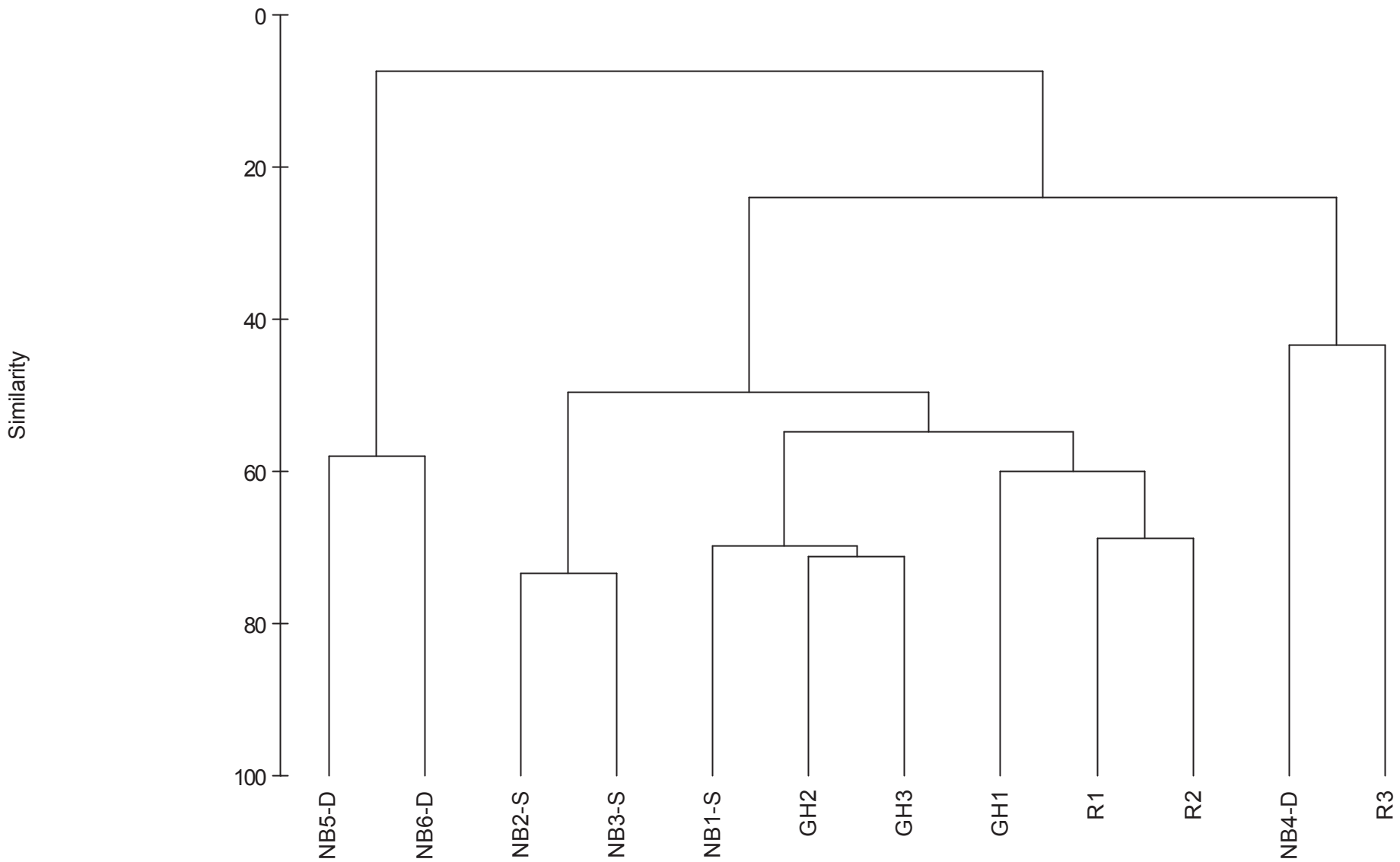

Figure 2. MDS plot of the Norton Basin stations, June 2001.

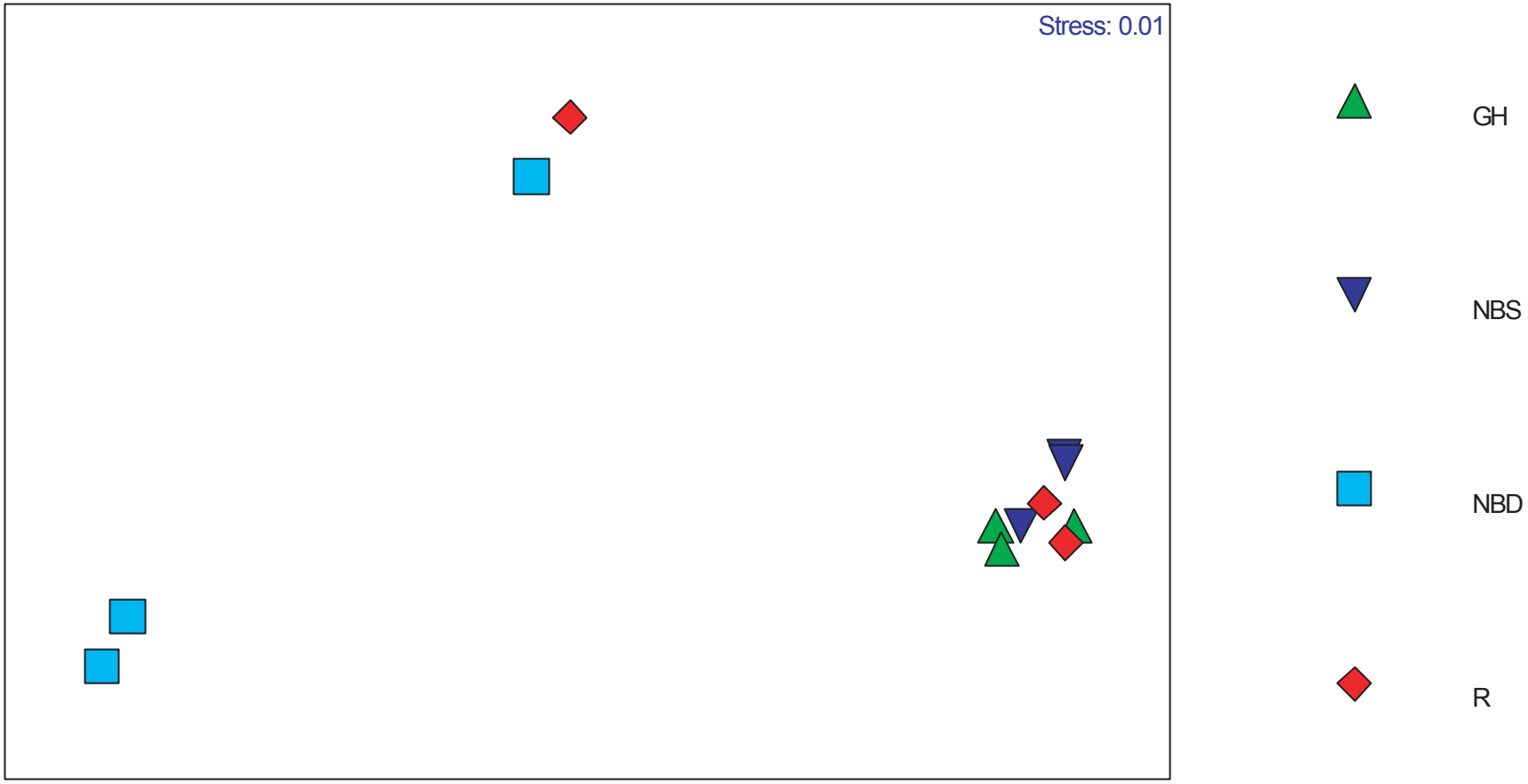

Figure 3. MDS plot and *Capitella capitata* abundance for the Norton Basin stations, June 2001.

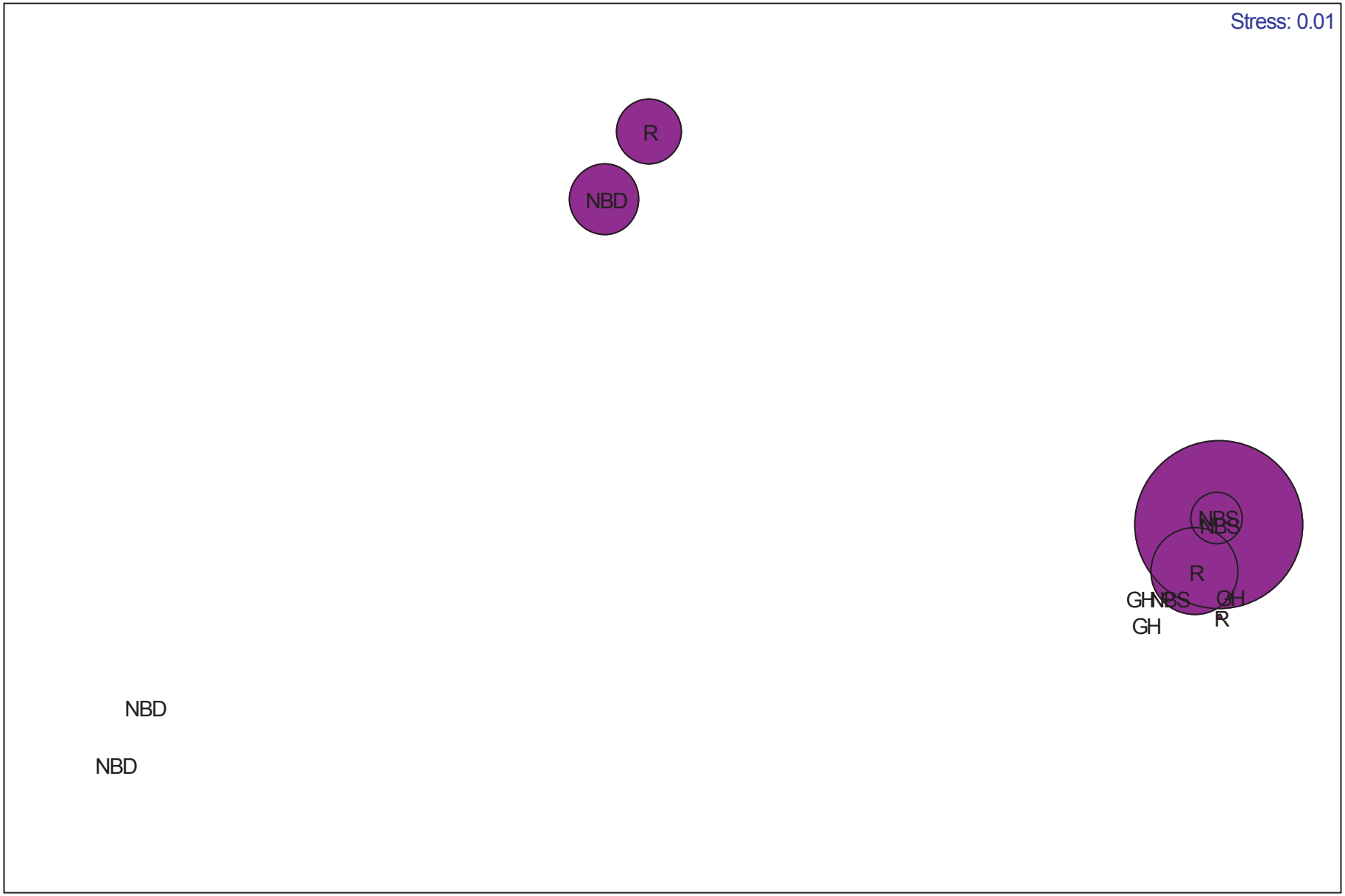

Figure 4. Station dendrogram from the cluster analysis for the Norton Basin stations, October 2001.

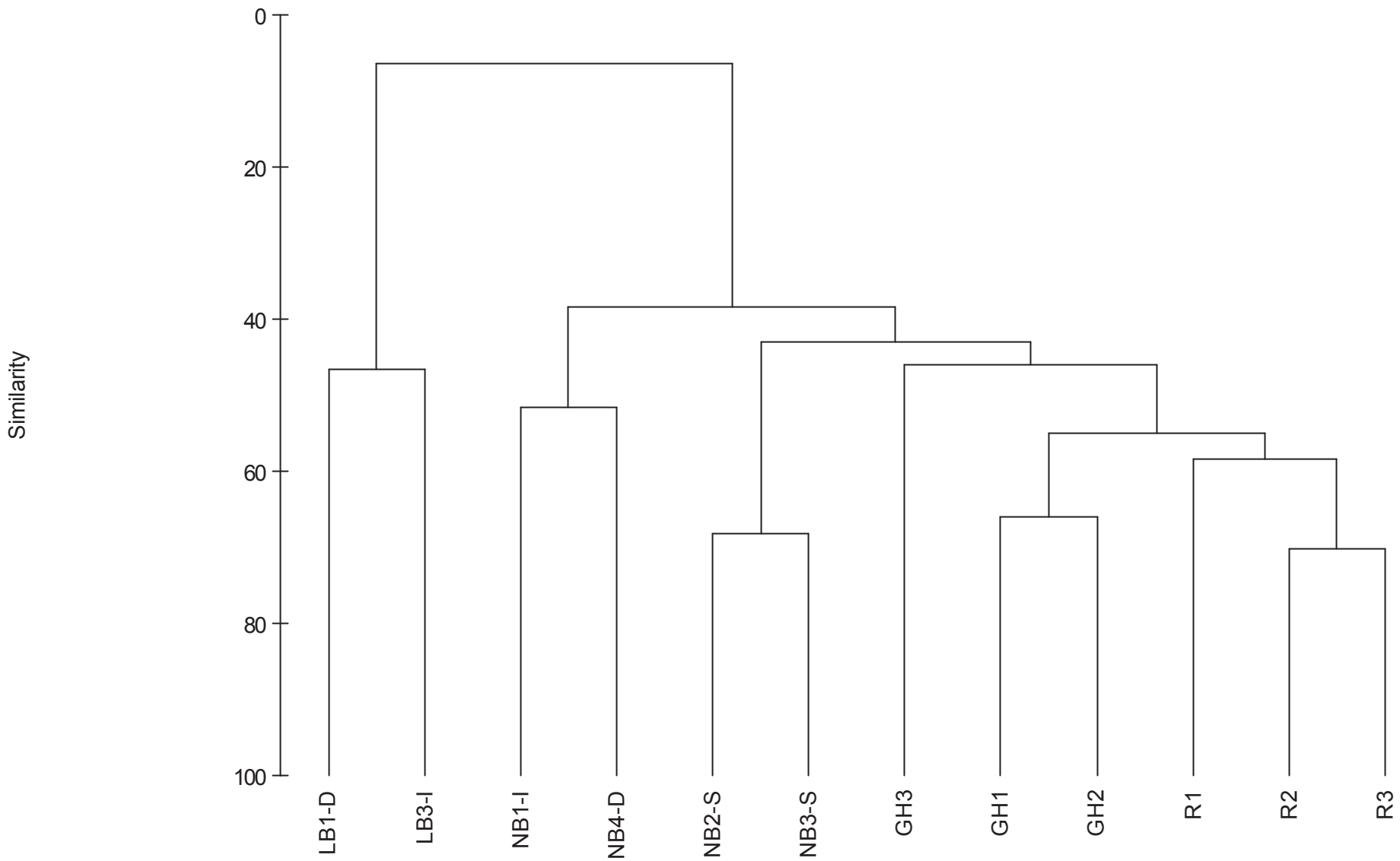

Figure 5. MDS plot of the Norton Basin stations, October 2001.

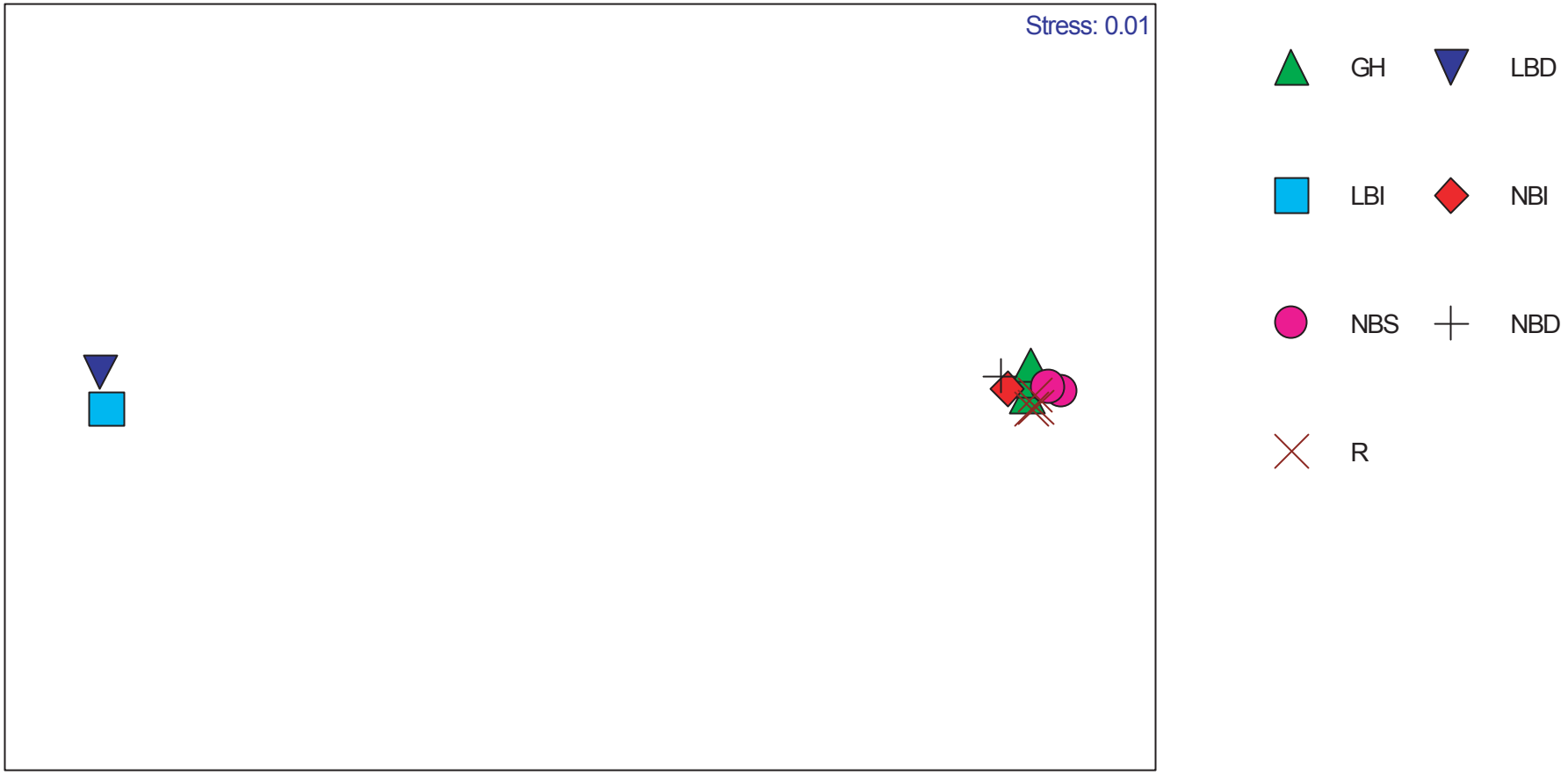

Figure 6. Station dendrogram from the cluster analysis for the Norton Basin stations, June and October 2001.

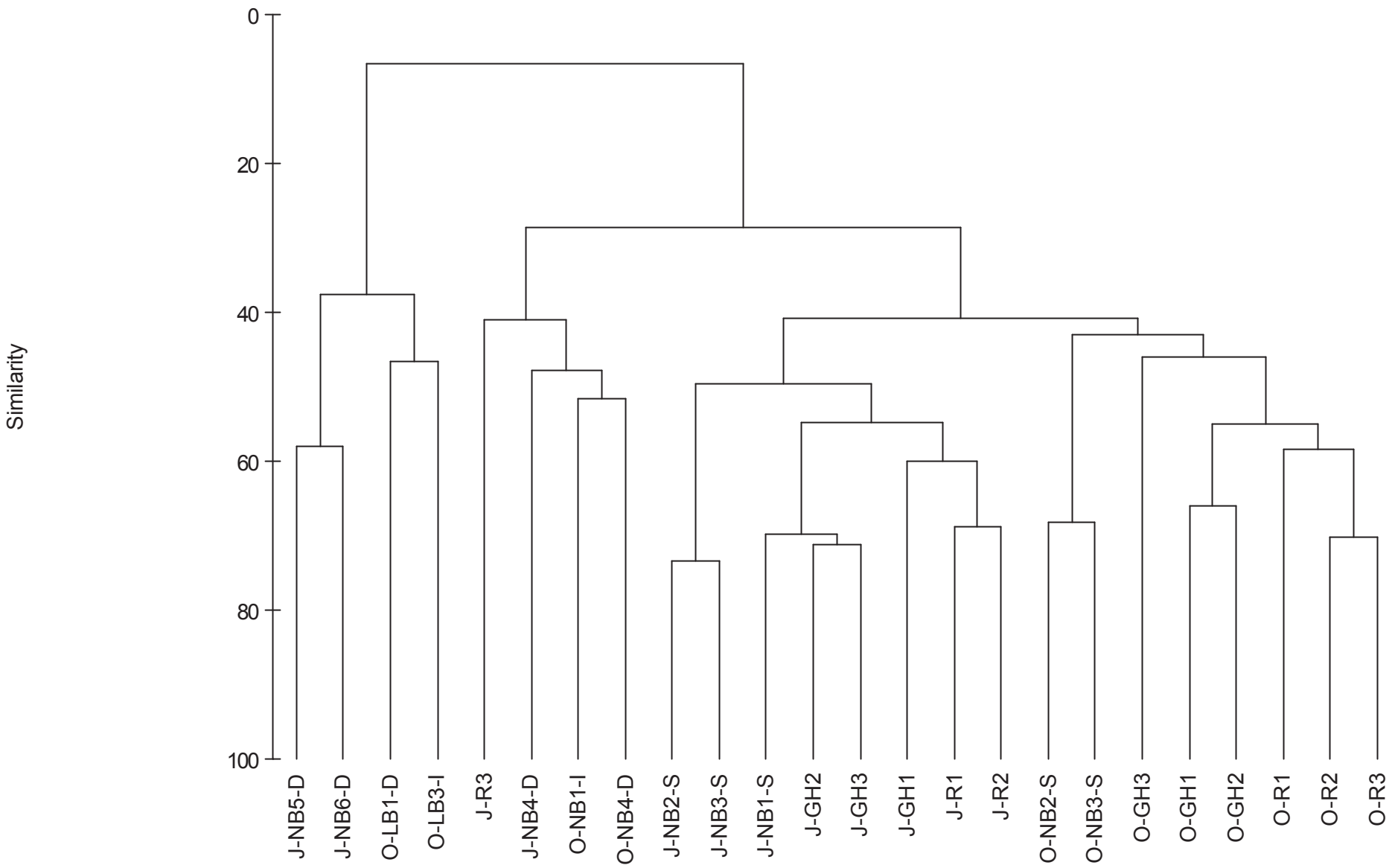

Figure 7. MDS plot of the Norton Basin stations, June and October 2001.

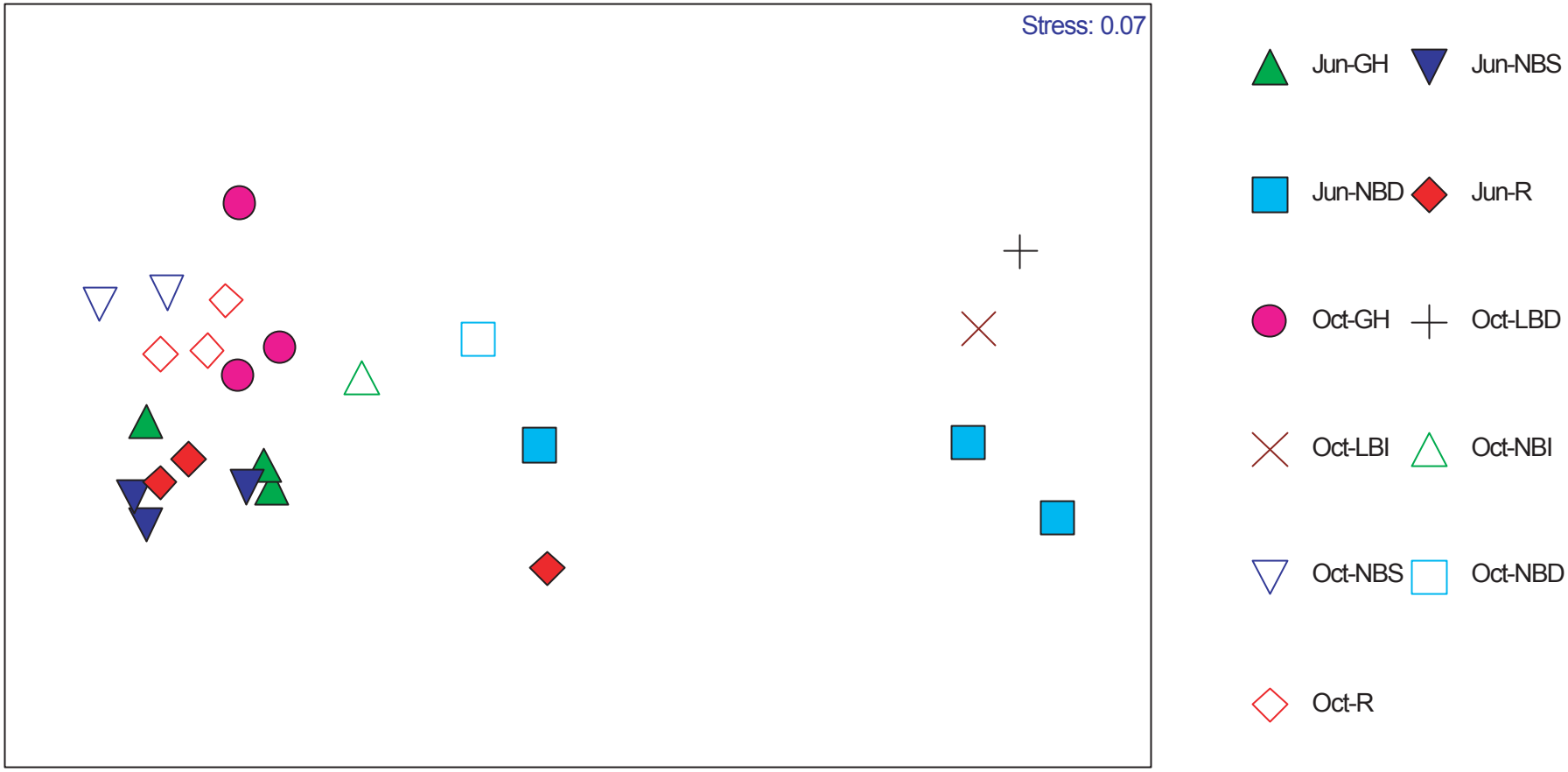

Figure 8. MDS plot and *Mediomastus* (LPIL) abundance for the Norton Basin stations, June and October 2001.

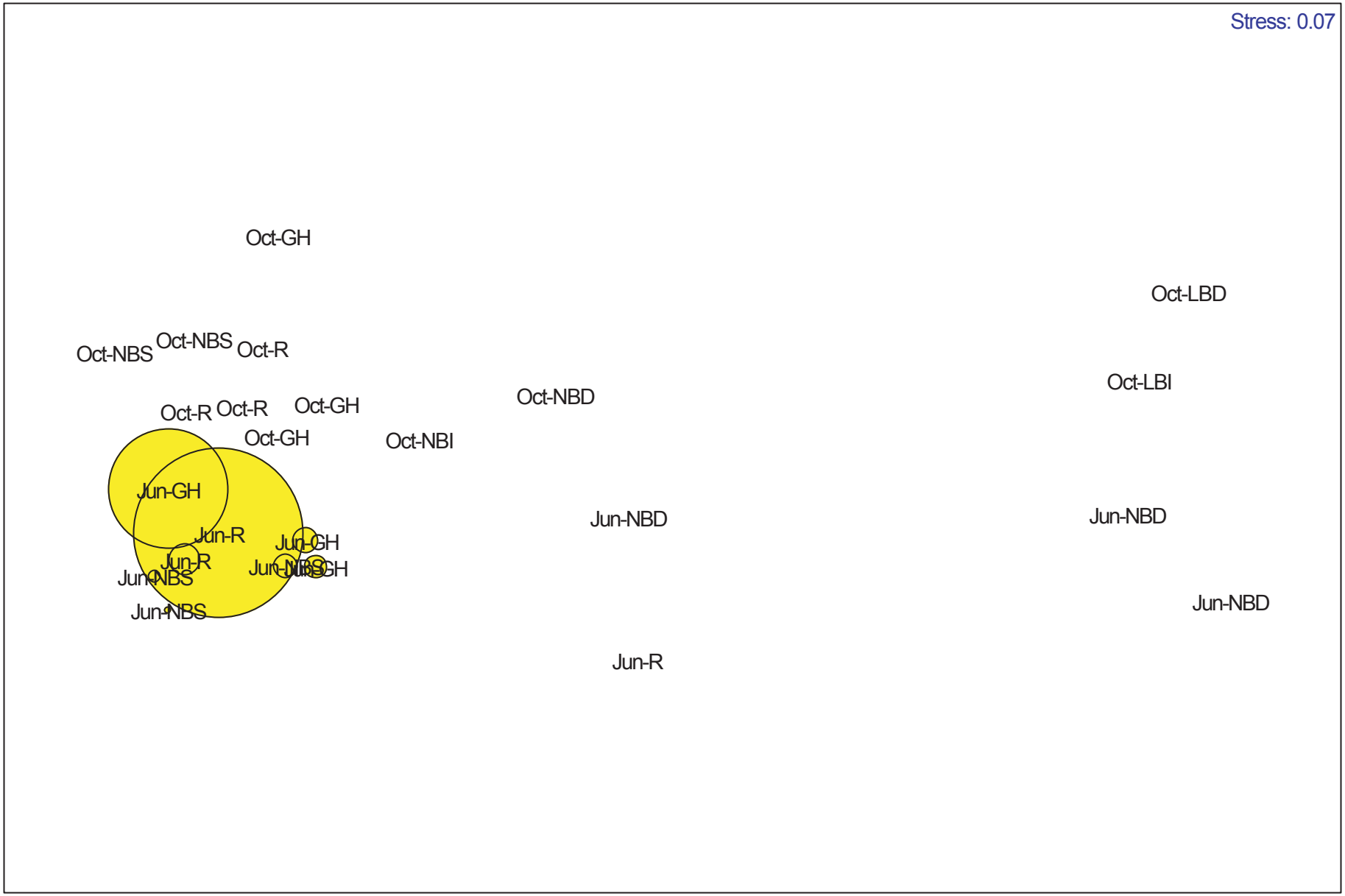

Figure 9. MDS plot and *Capitella capitata* abundance for the Norton Basin stations, June and October 2001.

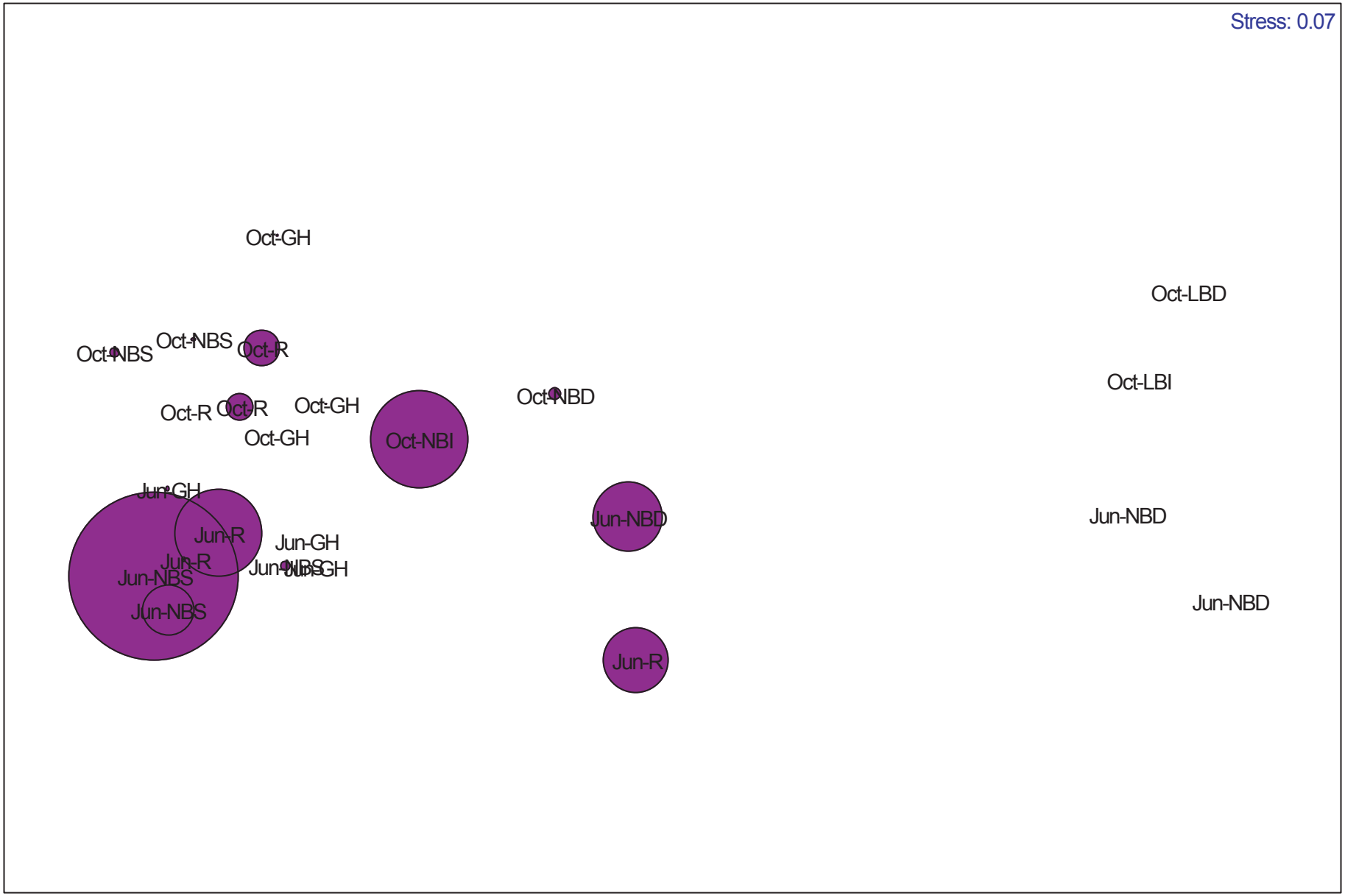

Figure 10. MDS plot and *Polydora cornuta* abundance for the Norton Basin stations, June and October 2001.

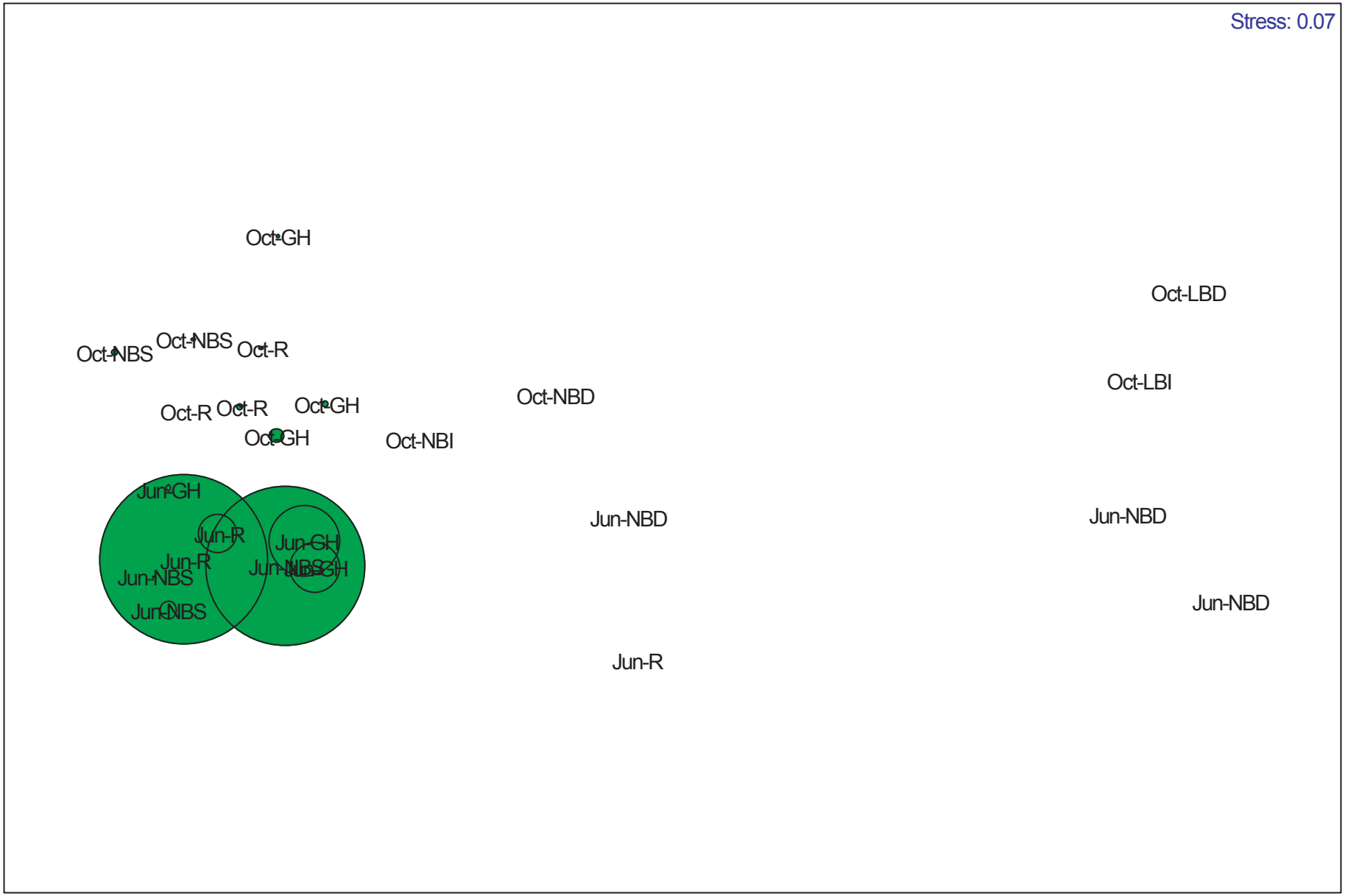

Figure 11. MDS plot and *Streblospio benedicti* abundance for the Norton Basin, June and October 2001.

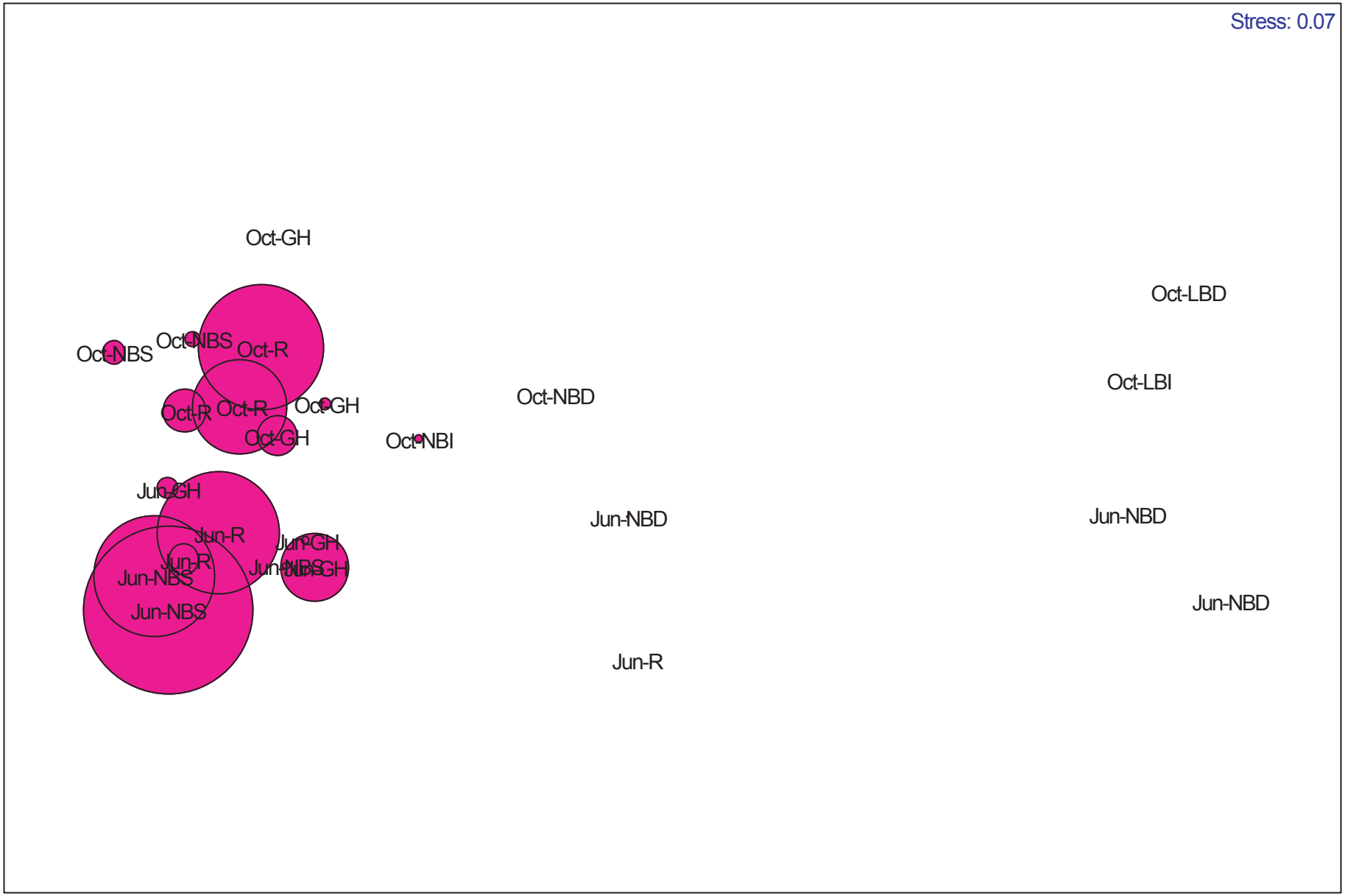

Figure 12. MDS plot and *Sabellaria vulgaris* abundance for the Norton Basin stations, June and October 2001.

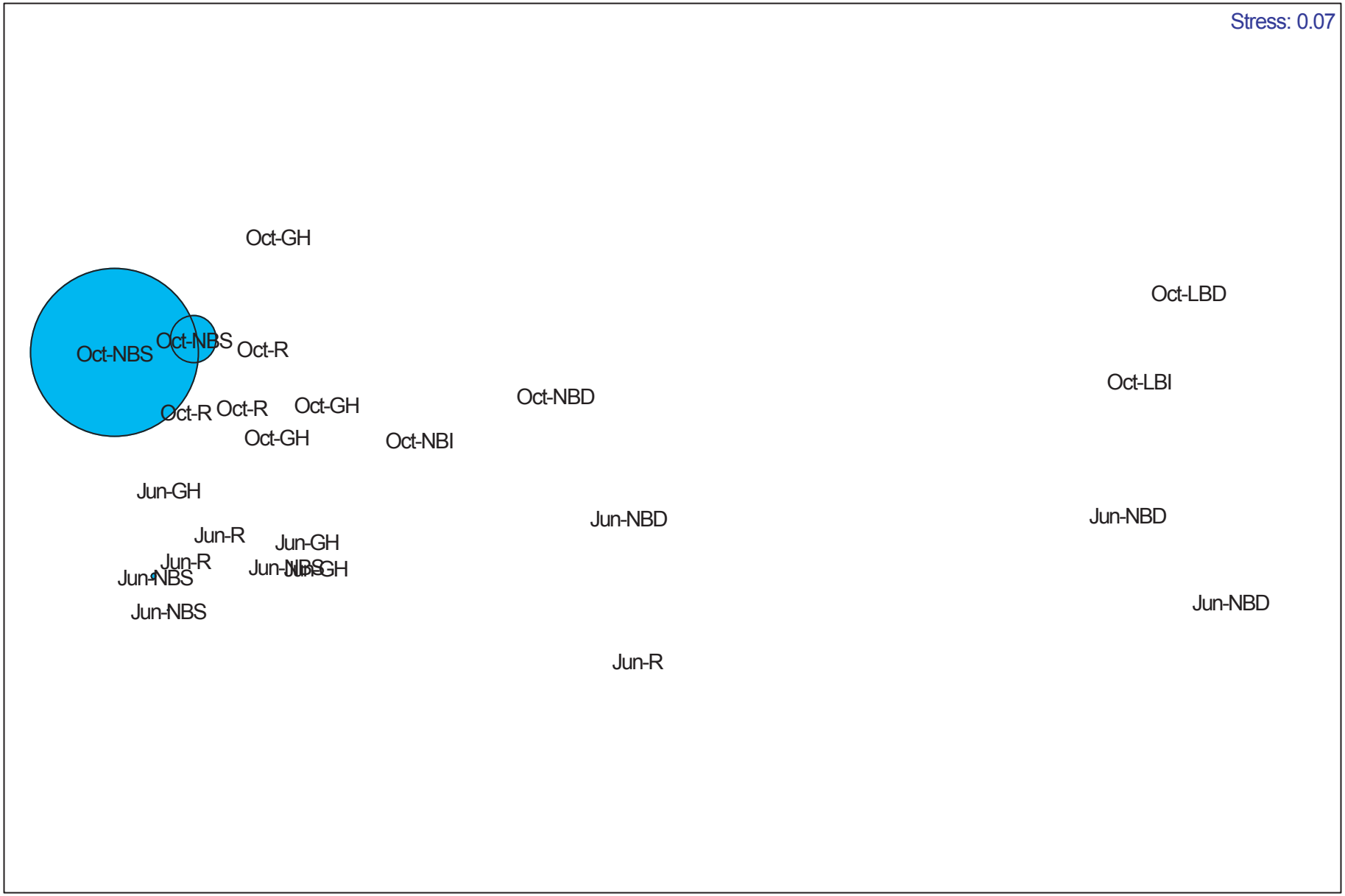

Figure 13. MDS plot and *Ampelisca vadorum* abundance for the Norton Basin stations, June and October 2001.

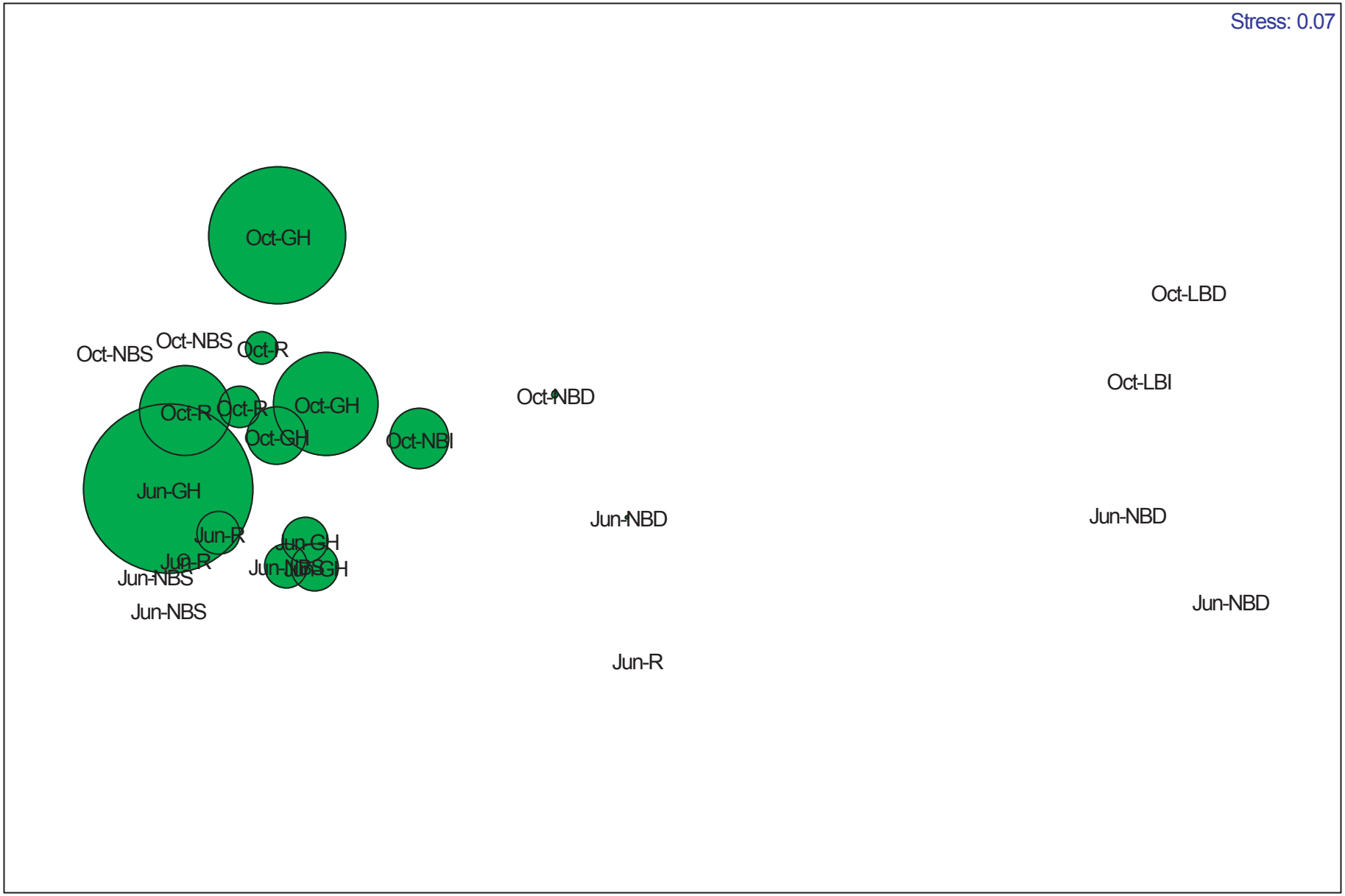

Figure 14. MDS plot and *Monocorophium tuberculatum* abundance for the Norton Basin stations, June and October 2001.

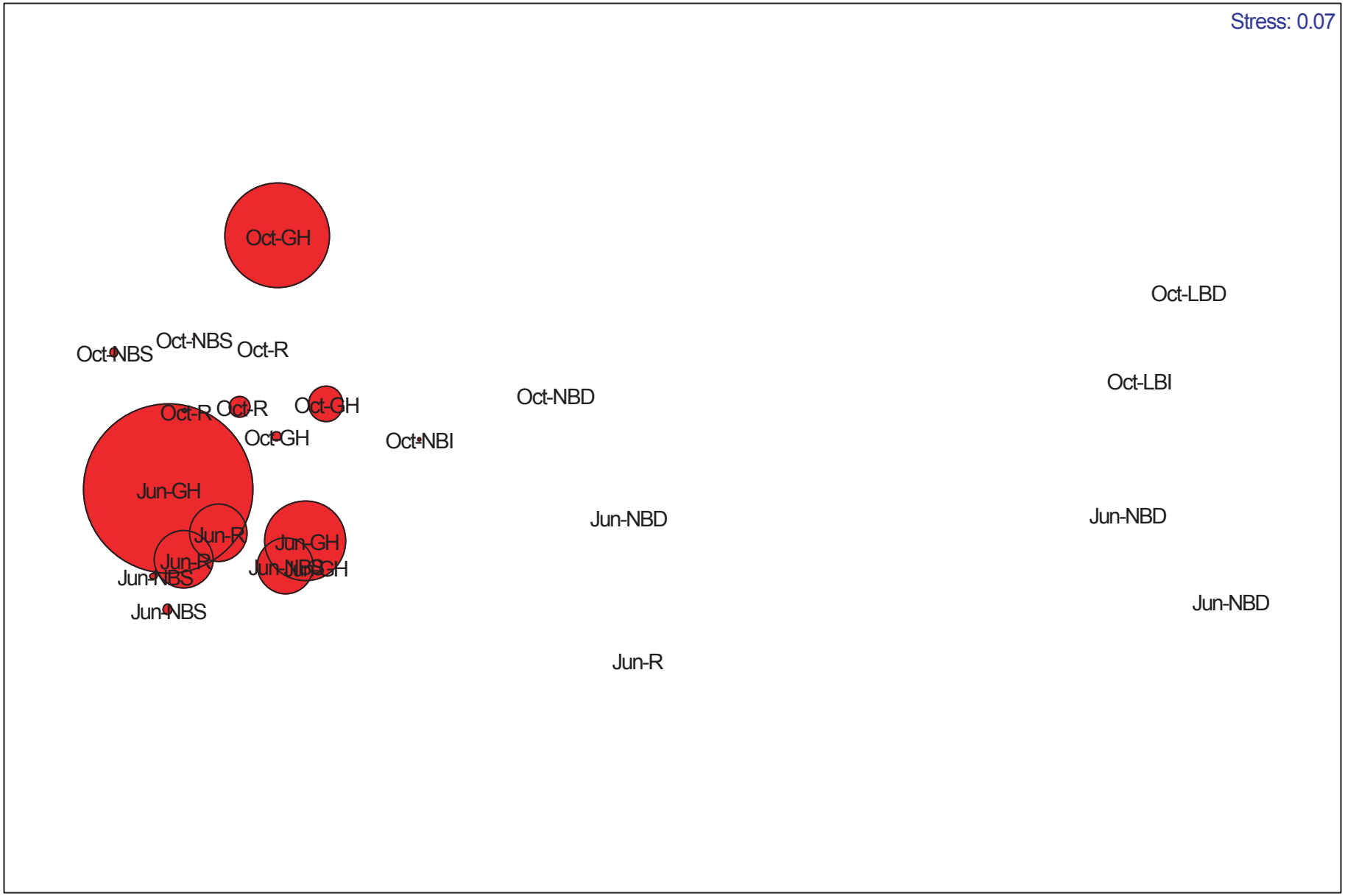

Figure 15. MDS plot and *Microdeutopus gryllotalpa* abundance for the Norton Basin stations, June and October 2001.

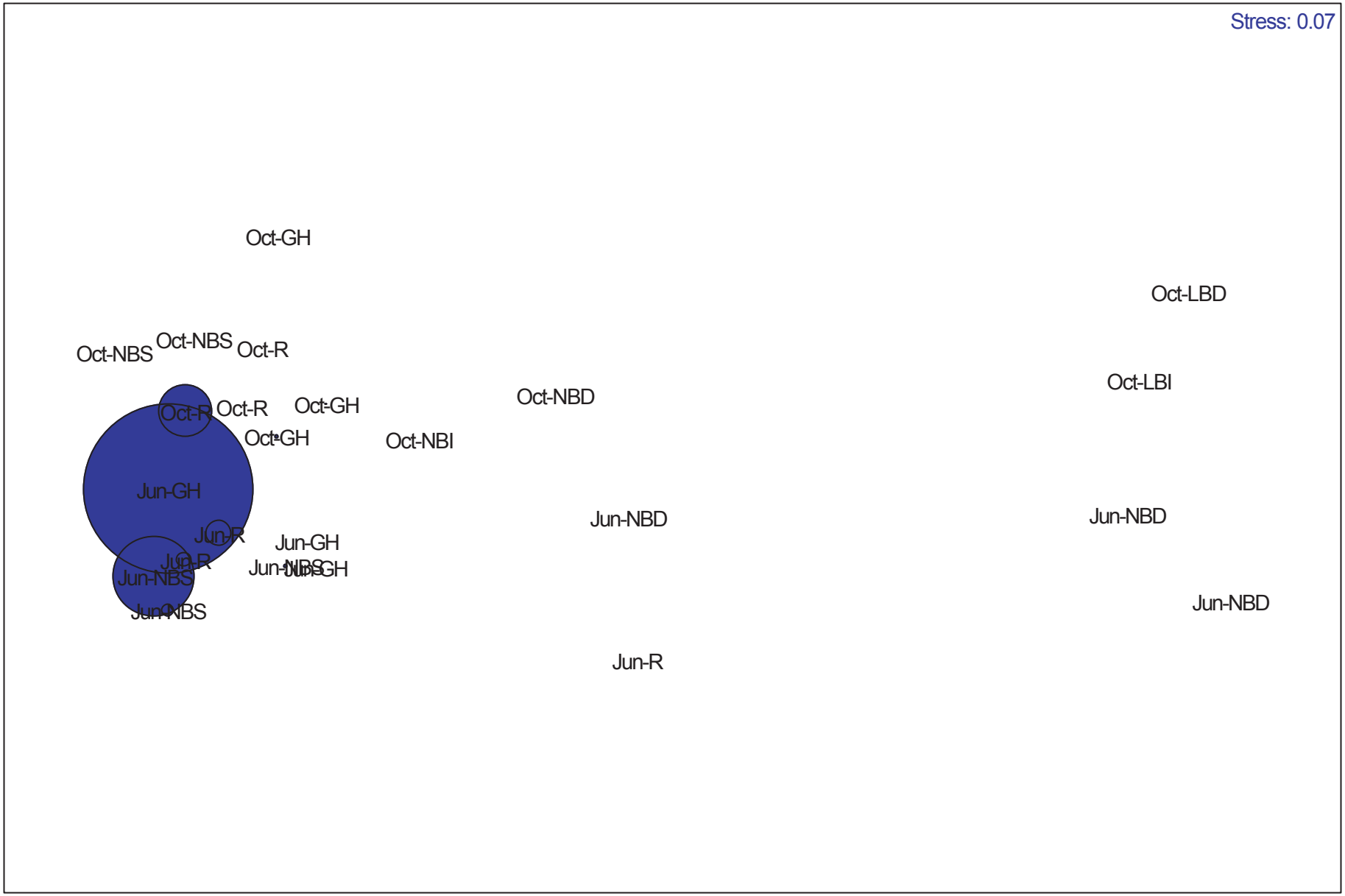

Figure 16. Station dendrogram from the cluster analysis for the Norton Basin stations, June 2002.

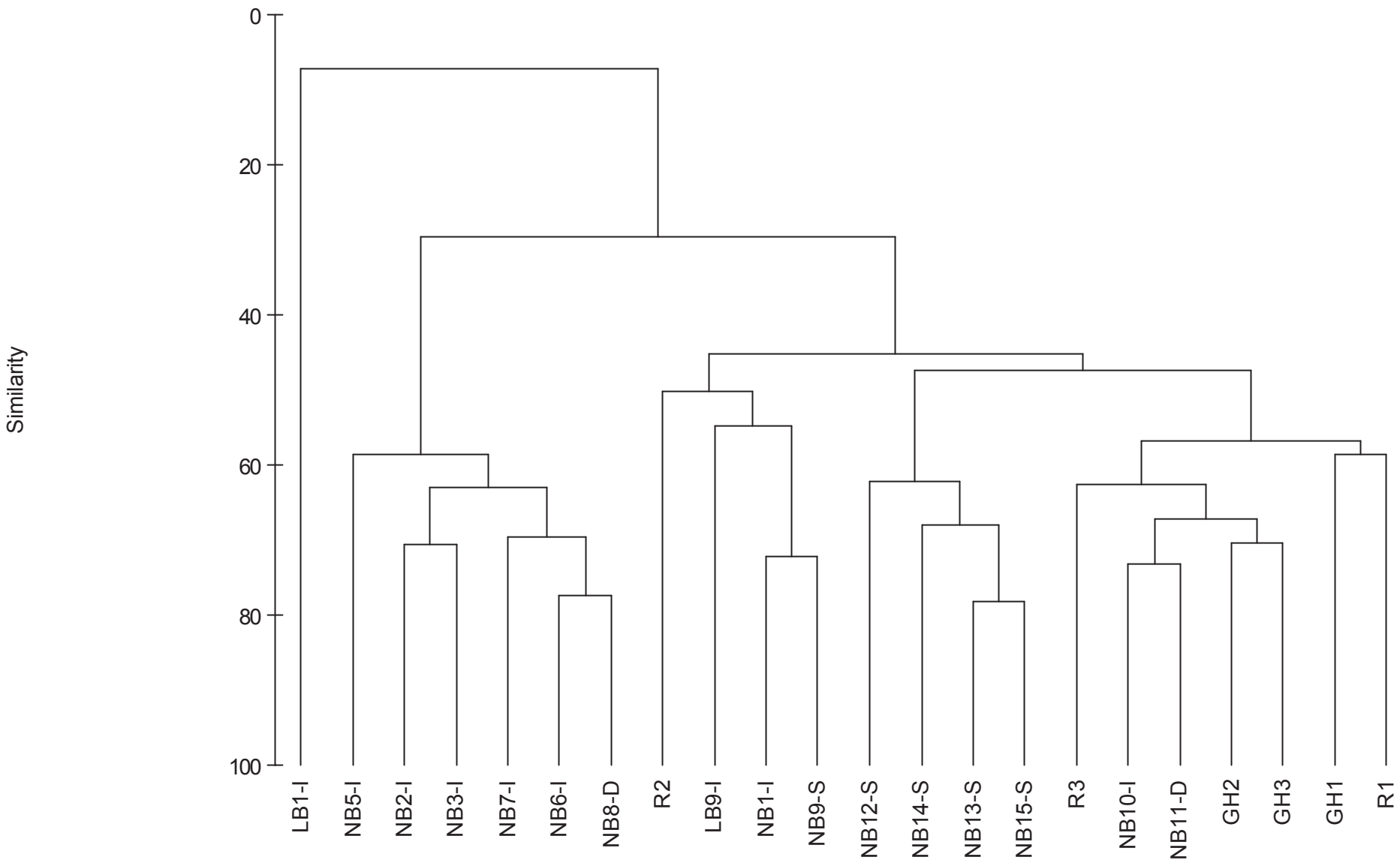

Figure 17. MDS plot of the Norton Basin stations, June 2002.

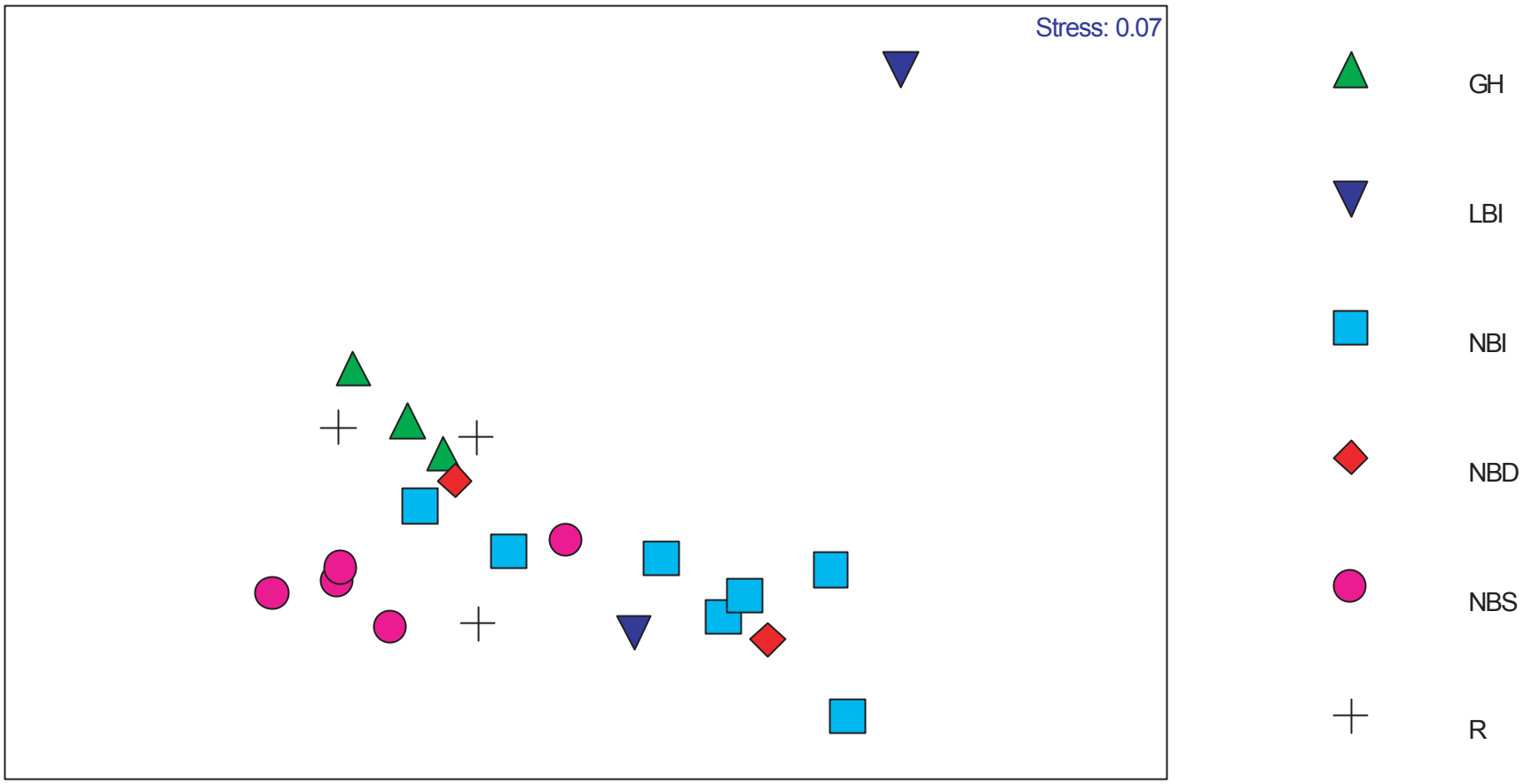

Figure 18. MDS plot and *Ampelisca vadorum* abundance for the Norton Basin stations, June 2002.

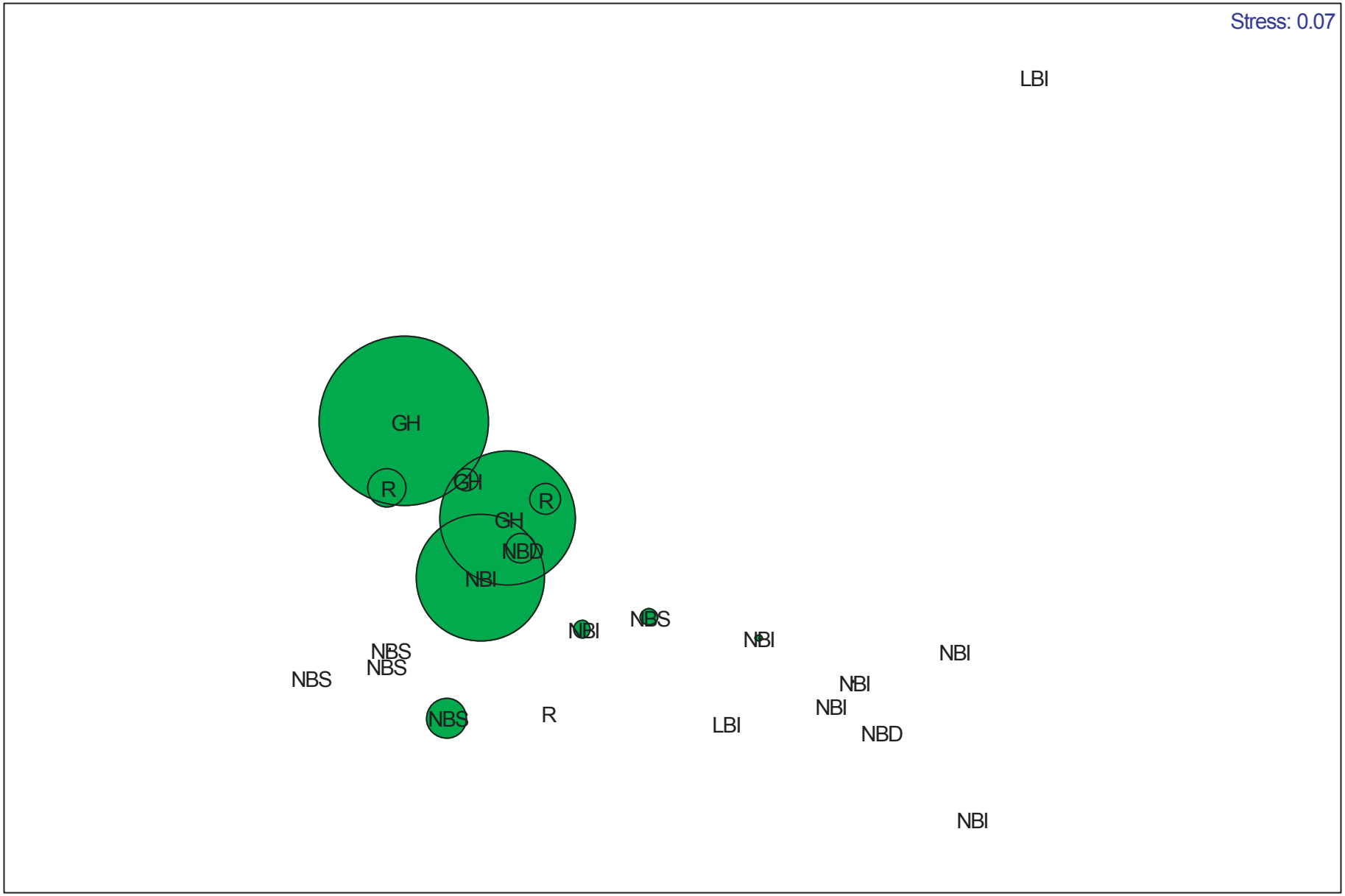

Figure 19. MDS plot and *Monocorophium tuberculatum* abundance for the Norton Basin stations, June 2002.

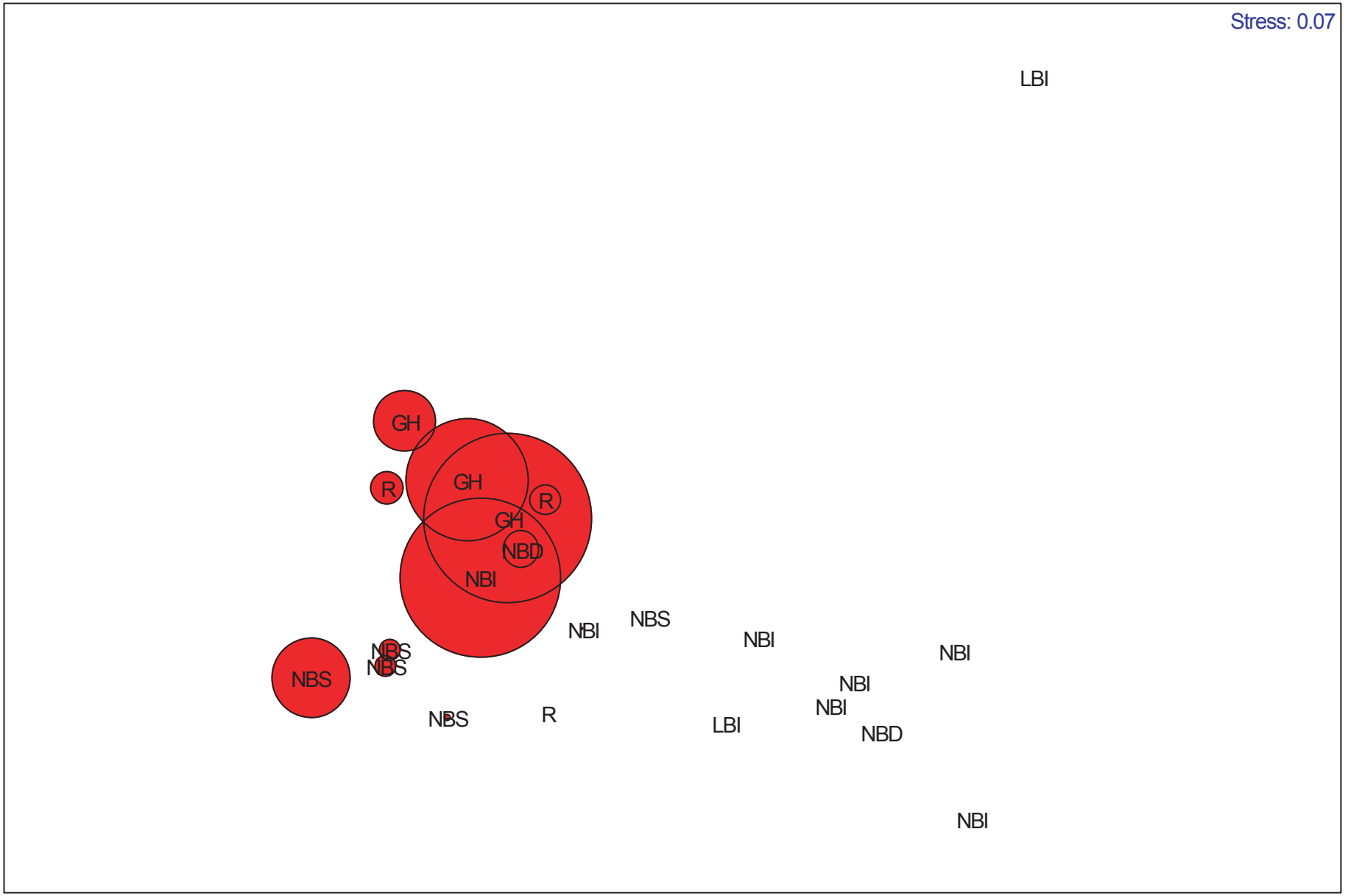

Figure 20. MDS plot and *Microdeutopus gryllotalpa* abundance for the Norton Basin stations, June 2002.

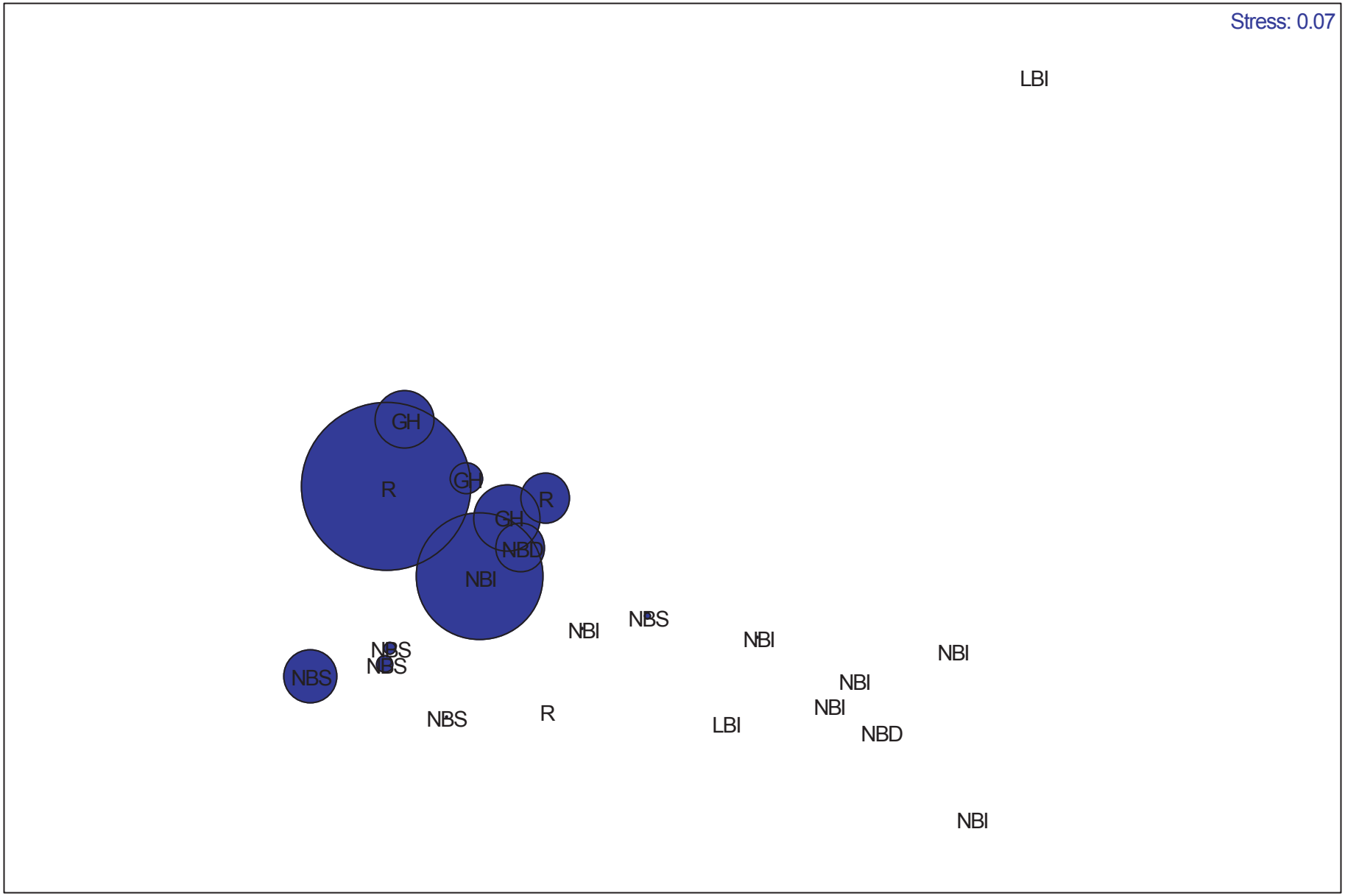

Figure 21. MDS plot and *Capitella capitata* abundance for the Norton Basin stations, June 2002.

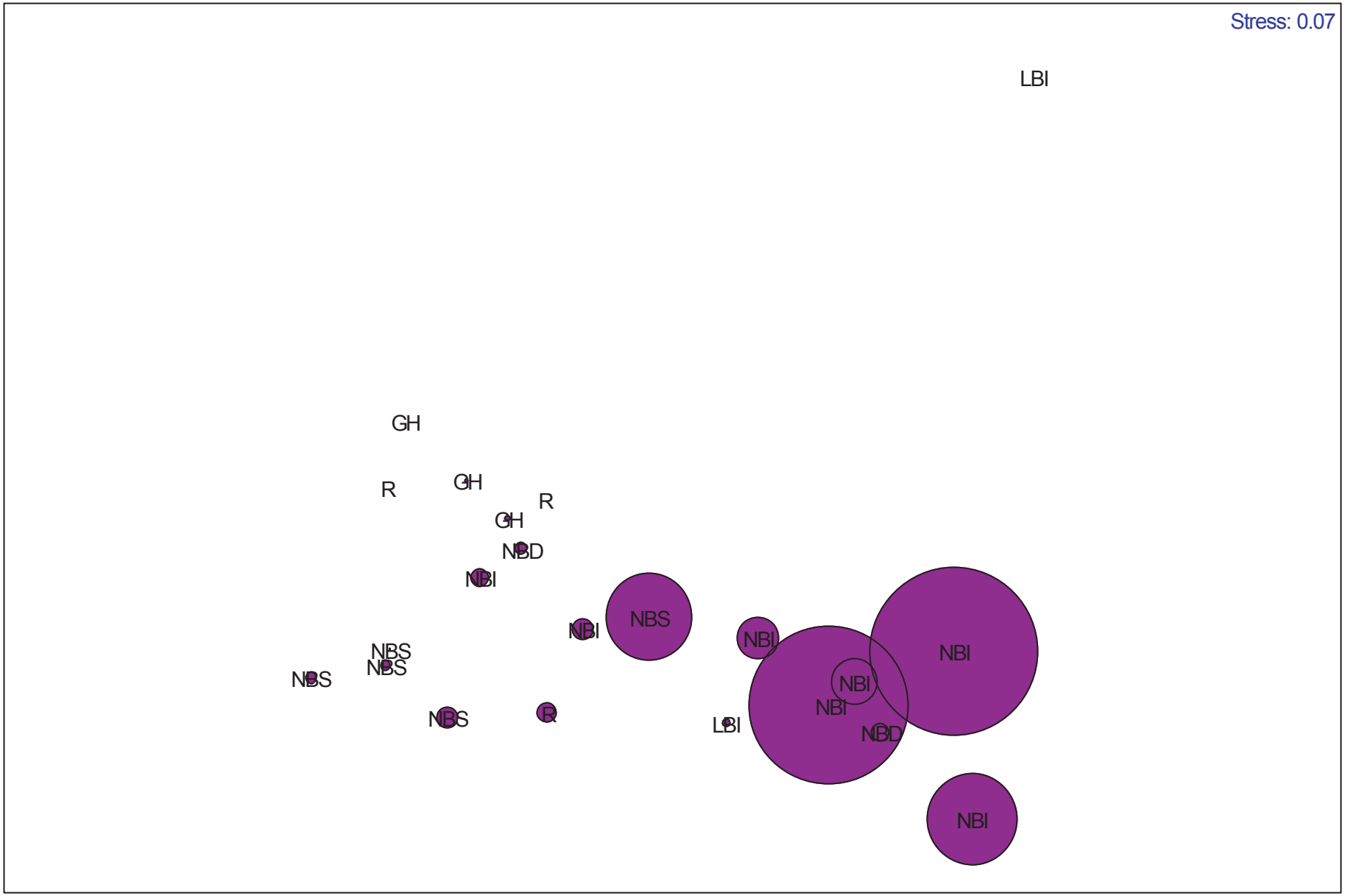

Figure 22. MDS plot and *Polydora cornuta* abundance for the Norton Basin stations, June 2002.

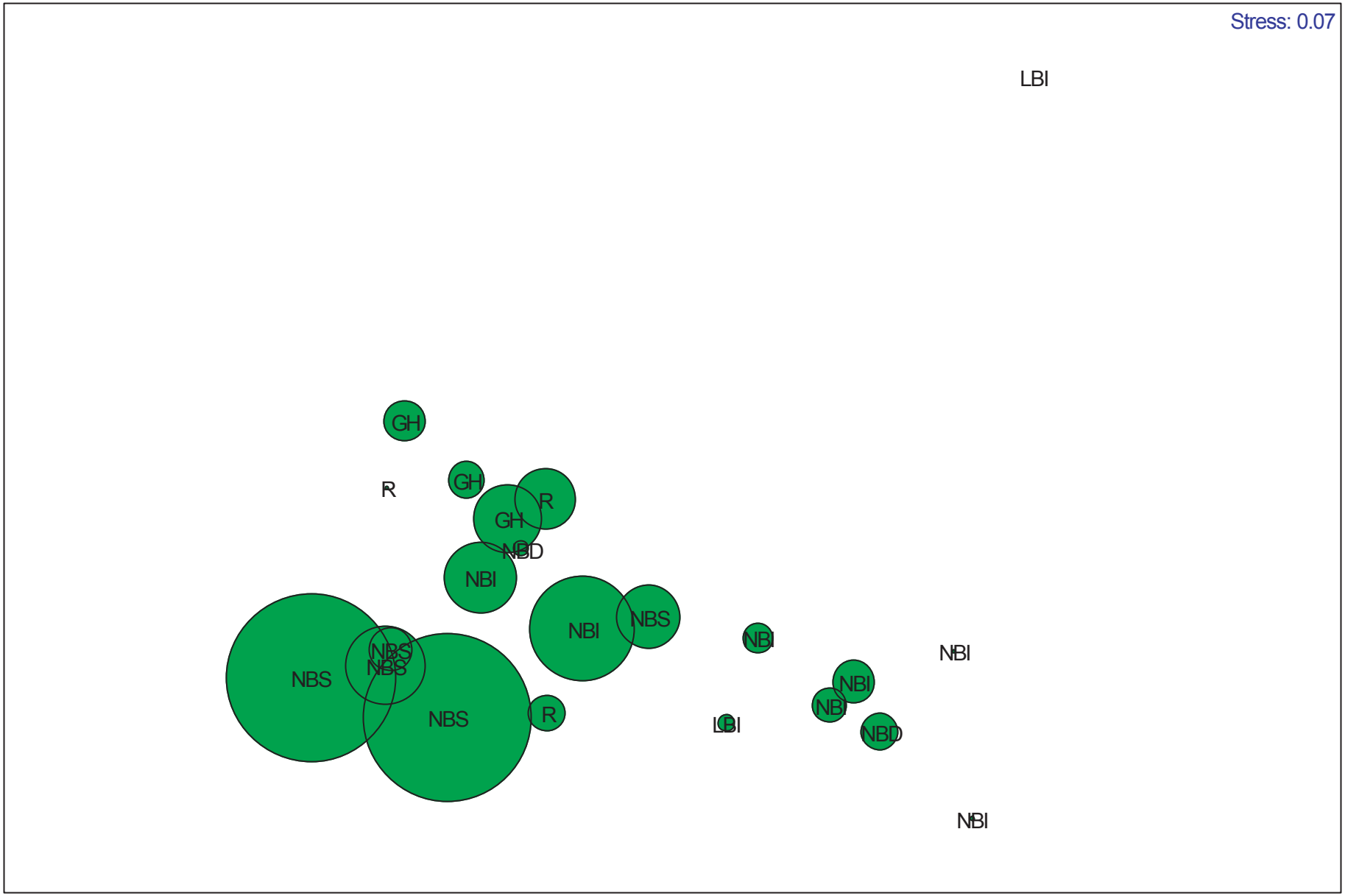

Figure 23. MDS plot and *Streblospio benedicti* abundance for the Norton Basin stations, June 2002.

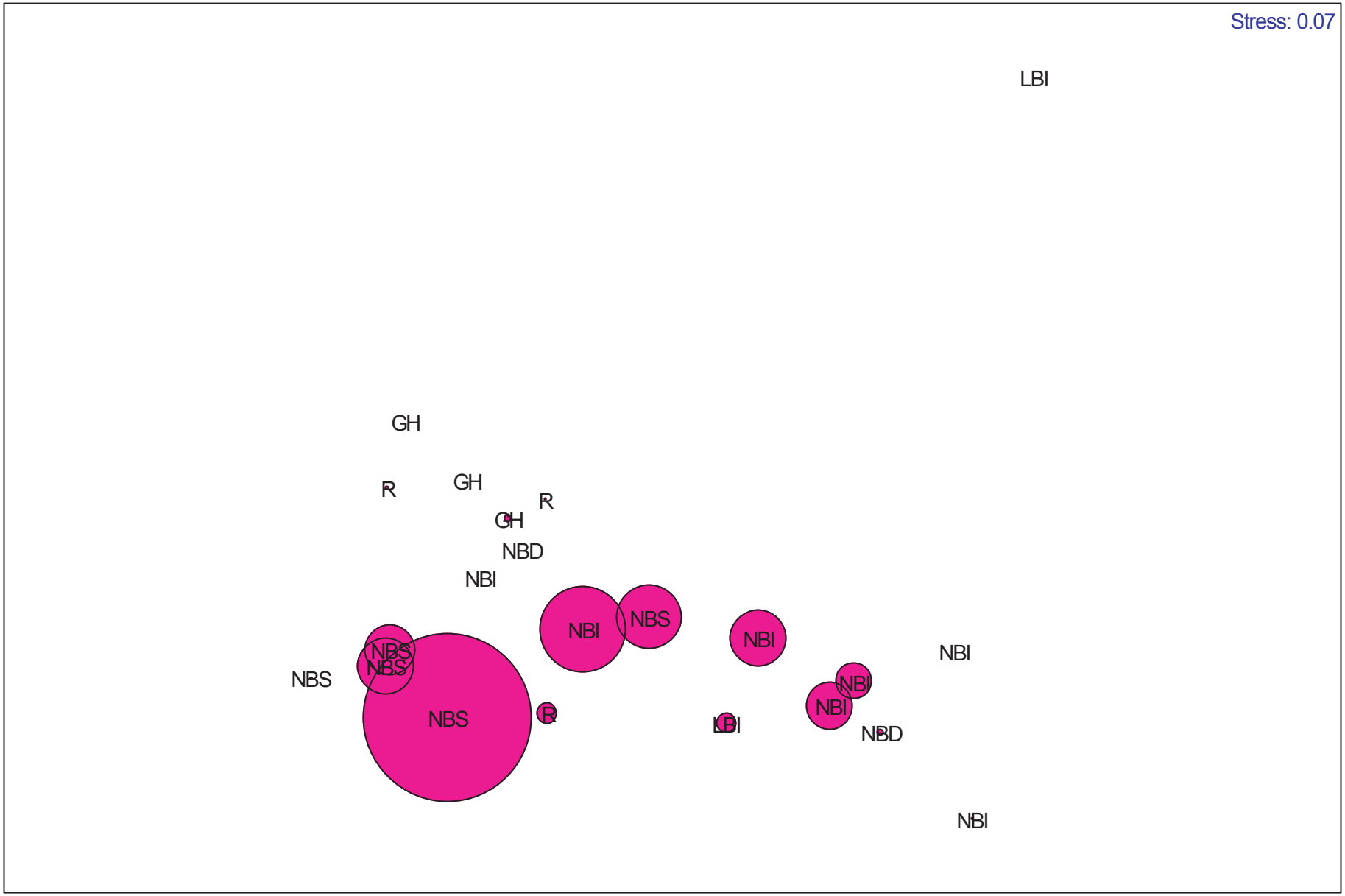

Figure 24. MDS plot and *Sabellaria vulgaris* abundance for the Norton Basin stations, June 2002.

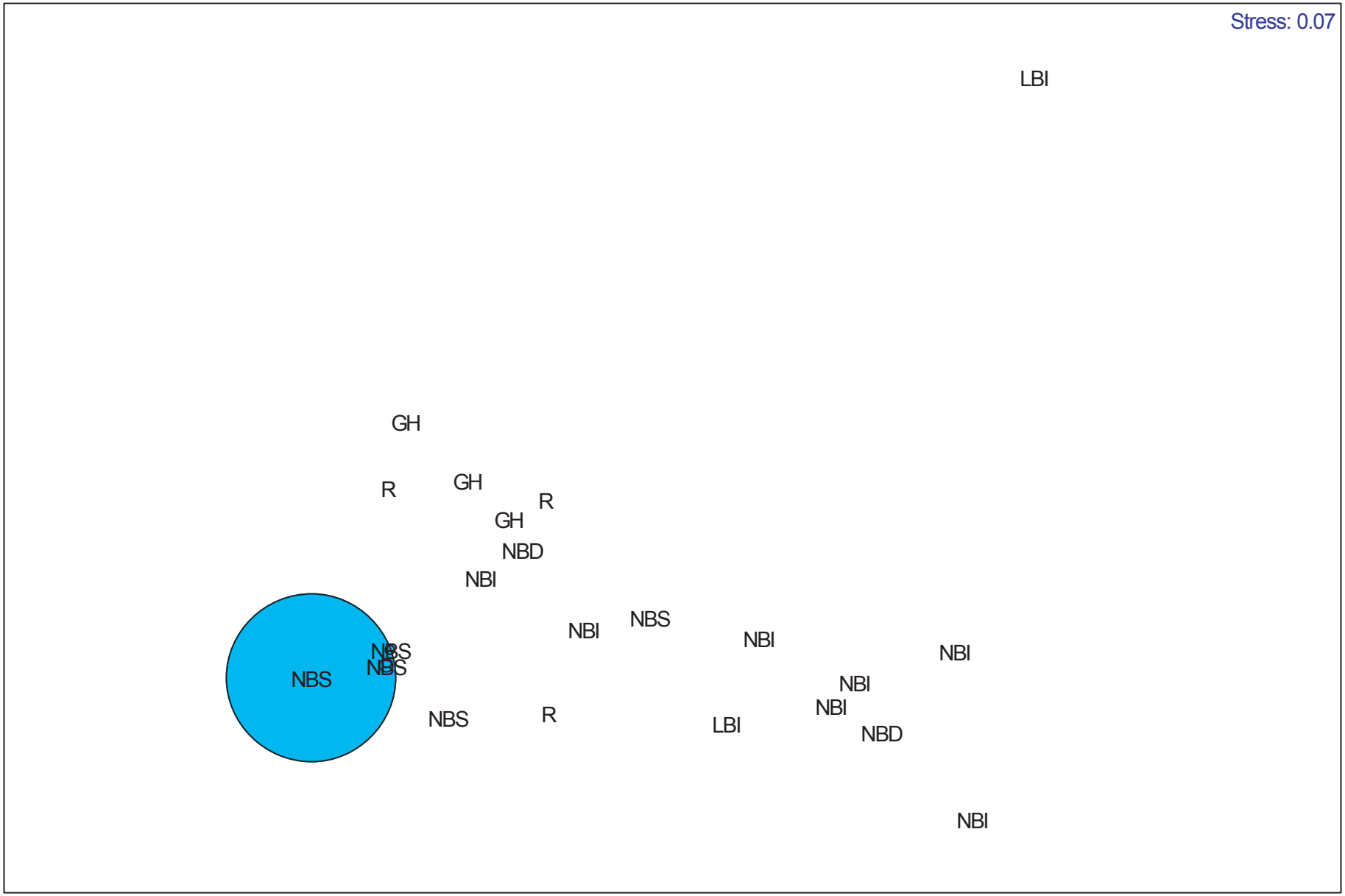

Figure 25. MDS plot and *Mediomastus* (LPIL) abundance for the Norton Basin stations, June 2002.

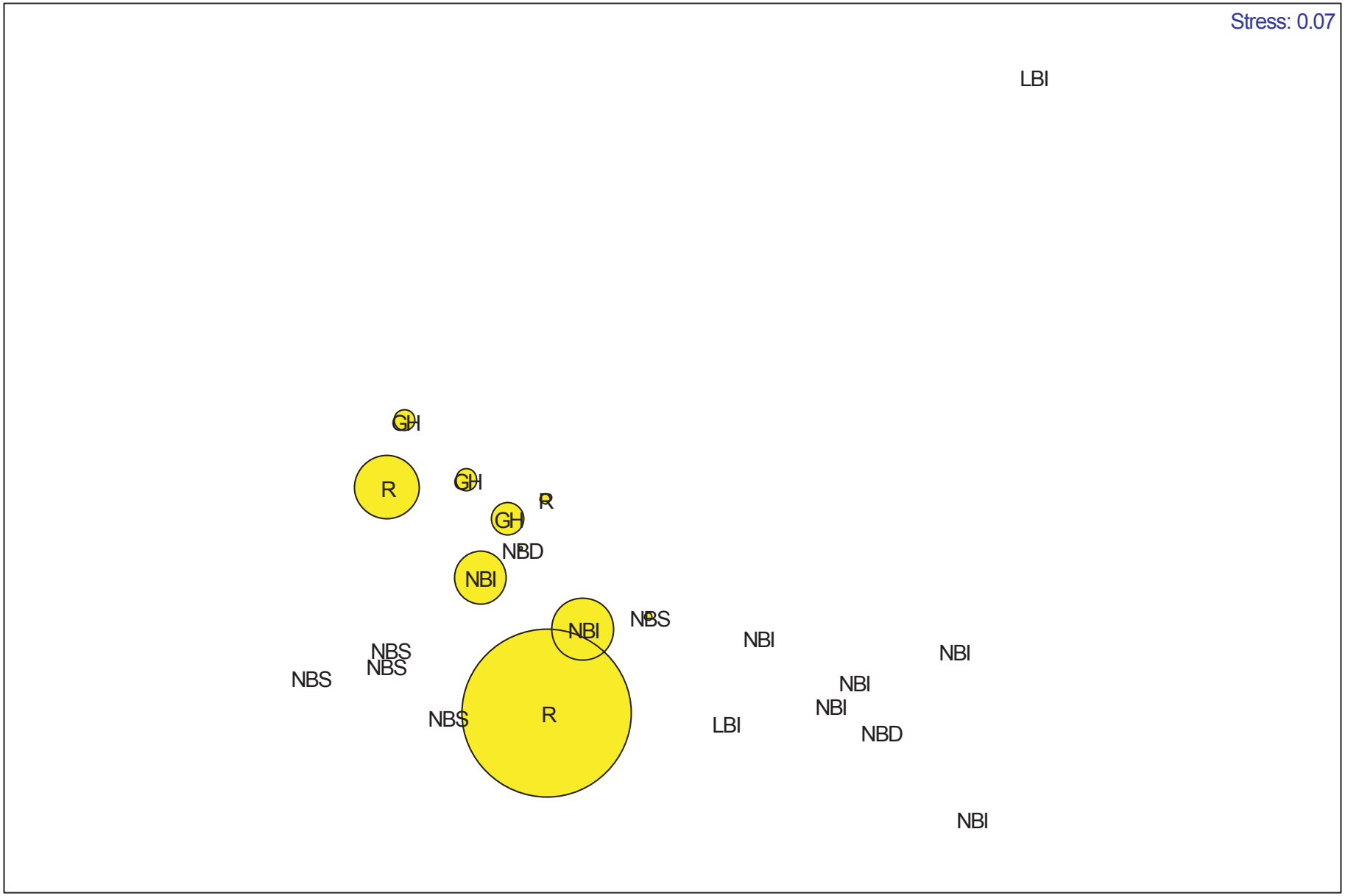

Figure 26. Station dendrogram from the cluster analysis for the Norton Basin stations, October 2002.

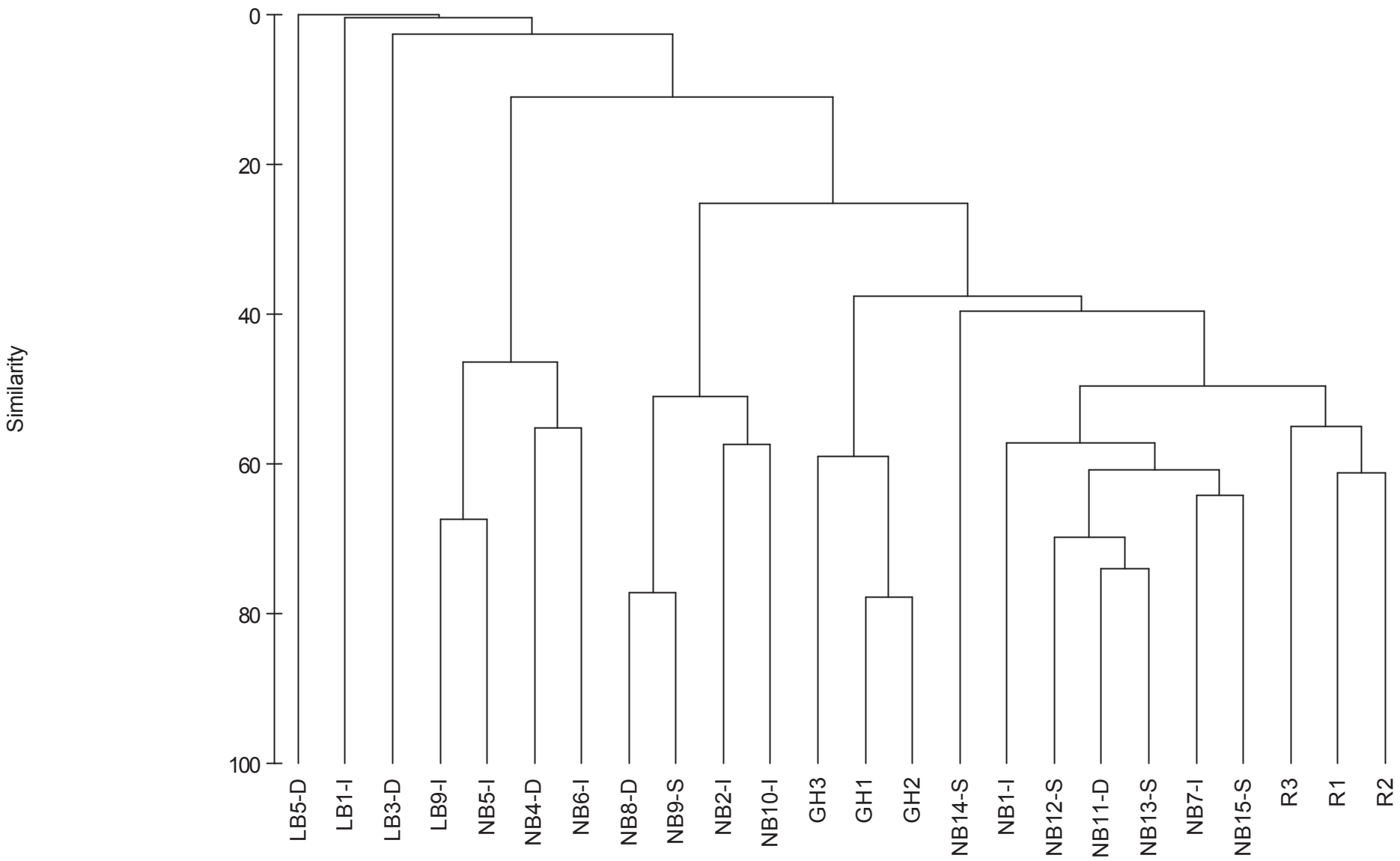

Figure 27. MDS plot of the Norton Basin stations, October 2002.

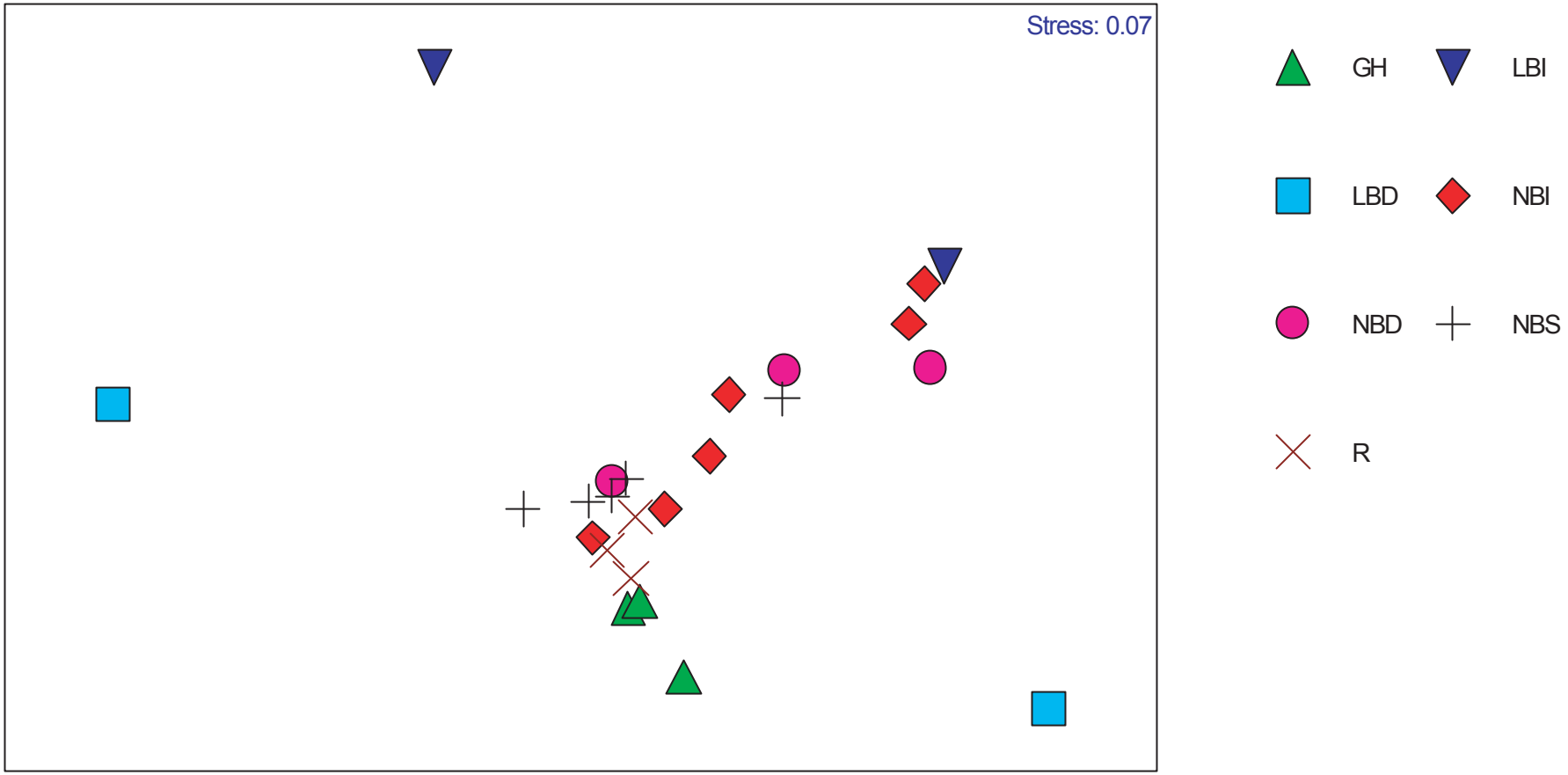

Figure 28. MDS plot and *Ampelisca vadorum* abundance for the Norton Basin stations, October 2002.

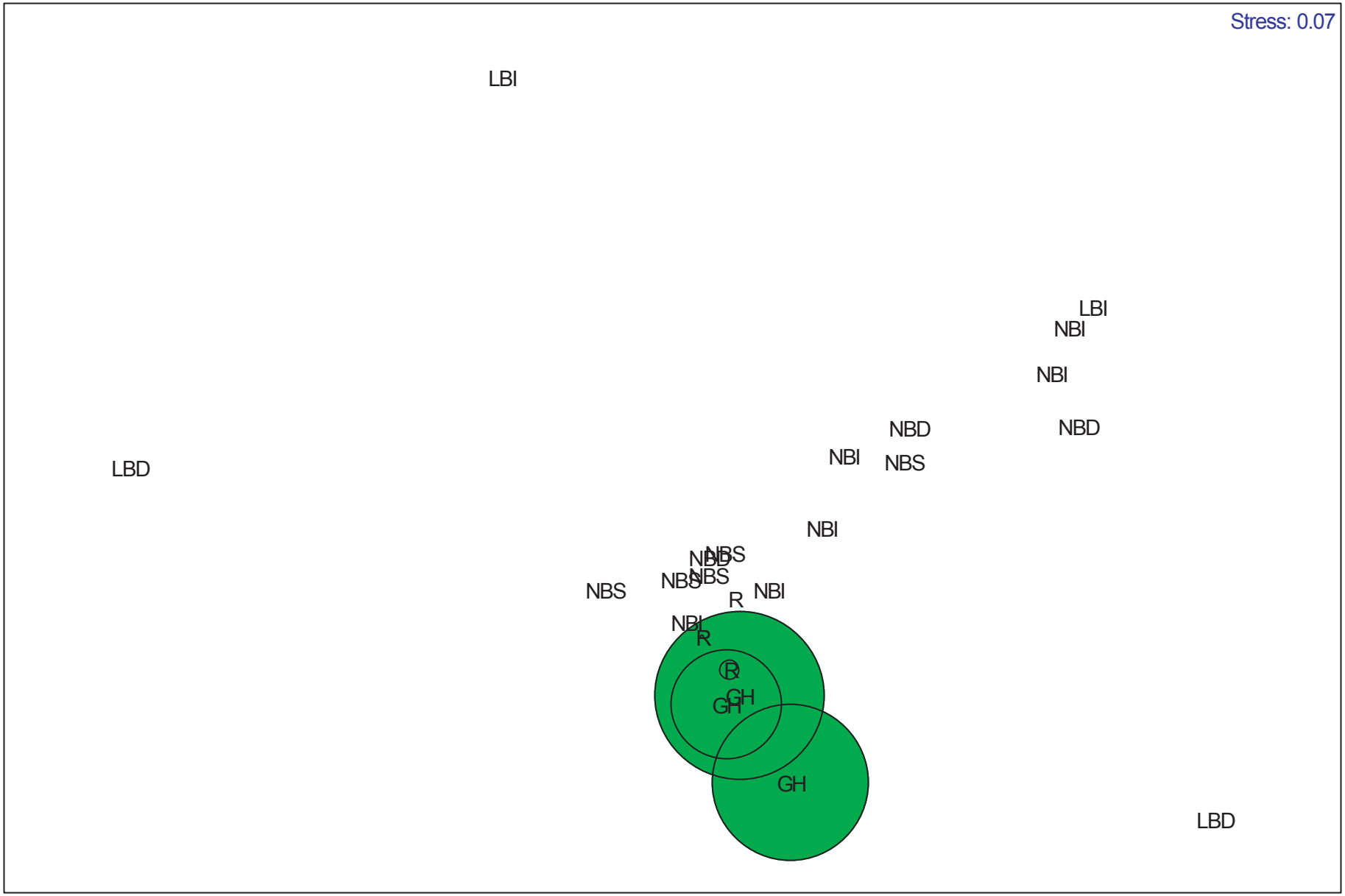

Figure 29. MDS plot and *Monocorophium tuberculatum* abundance for the Nortom Basin stations, October 2002.

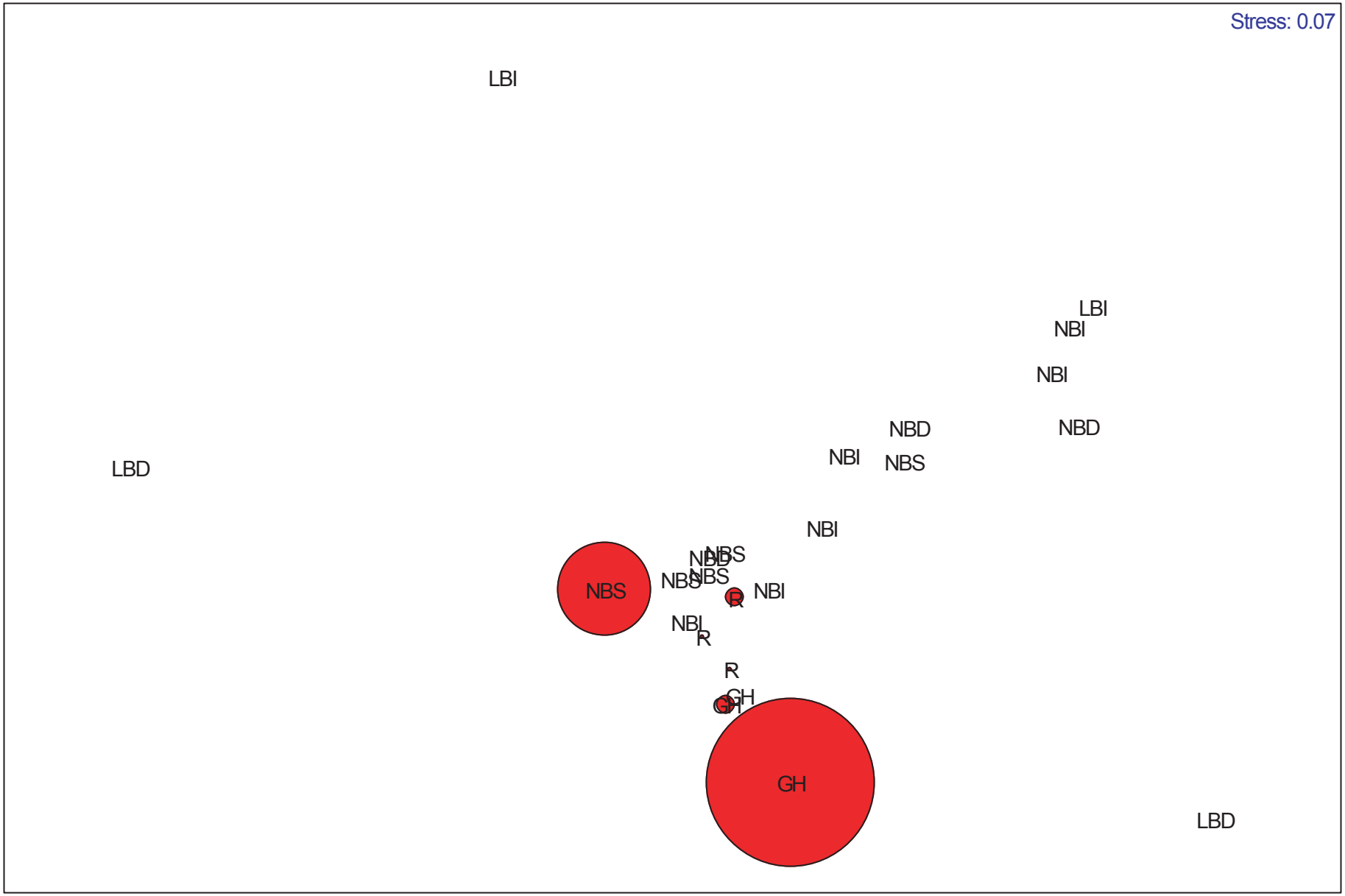

Figure 30. MDS plot and *Microdeutopus gryllotalpa* abundance for the Norton Basin stations, October 2002.

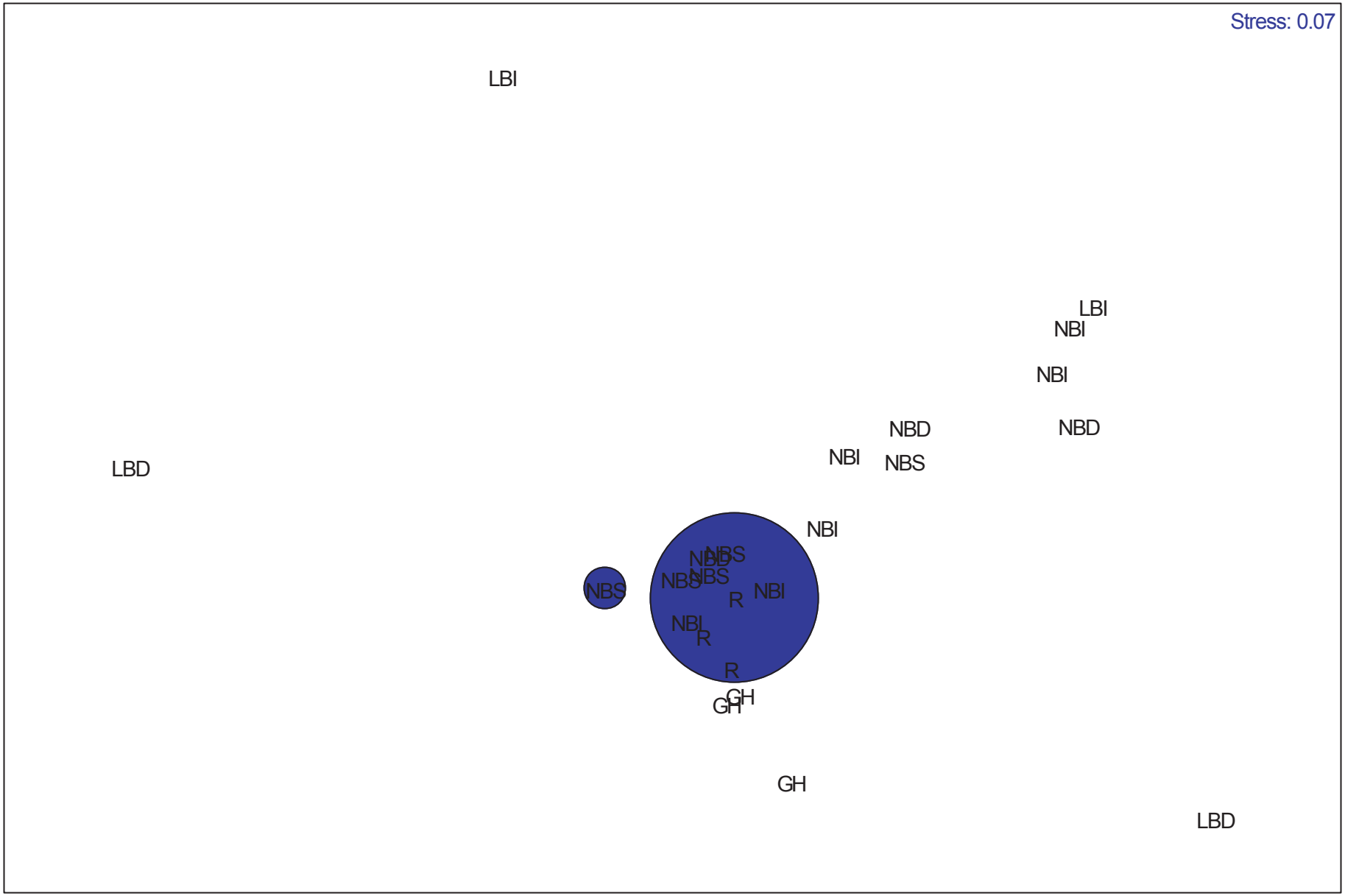

Figure 31. MDS plot and *Streblospio benedicti* abundance for the Norton Basin stations, October 2002.

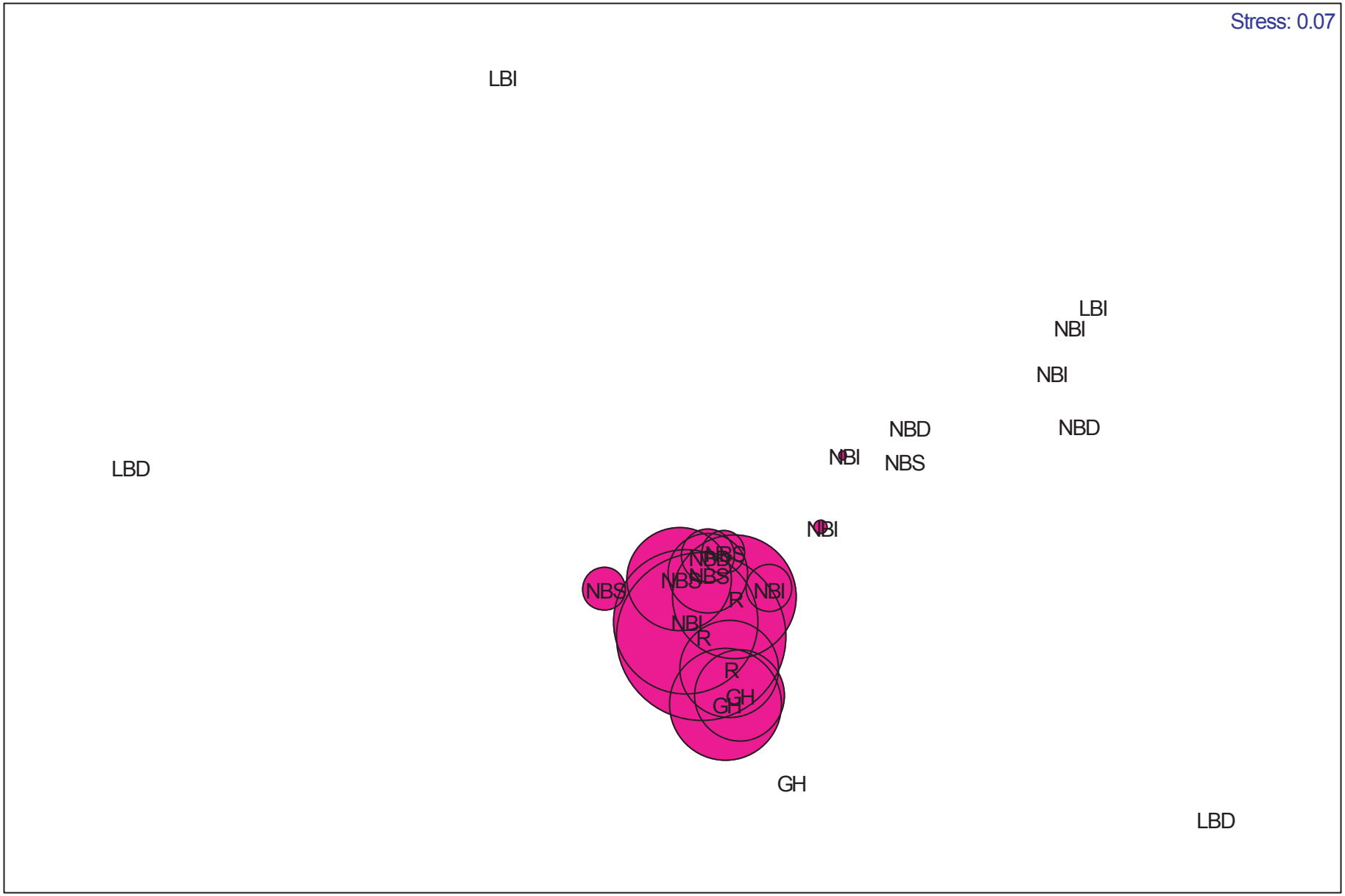

Figure 32. MDS plot and *Mediomastus* (LPIL) abundance for the Norton Basin stations, October 2002.

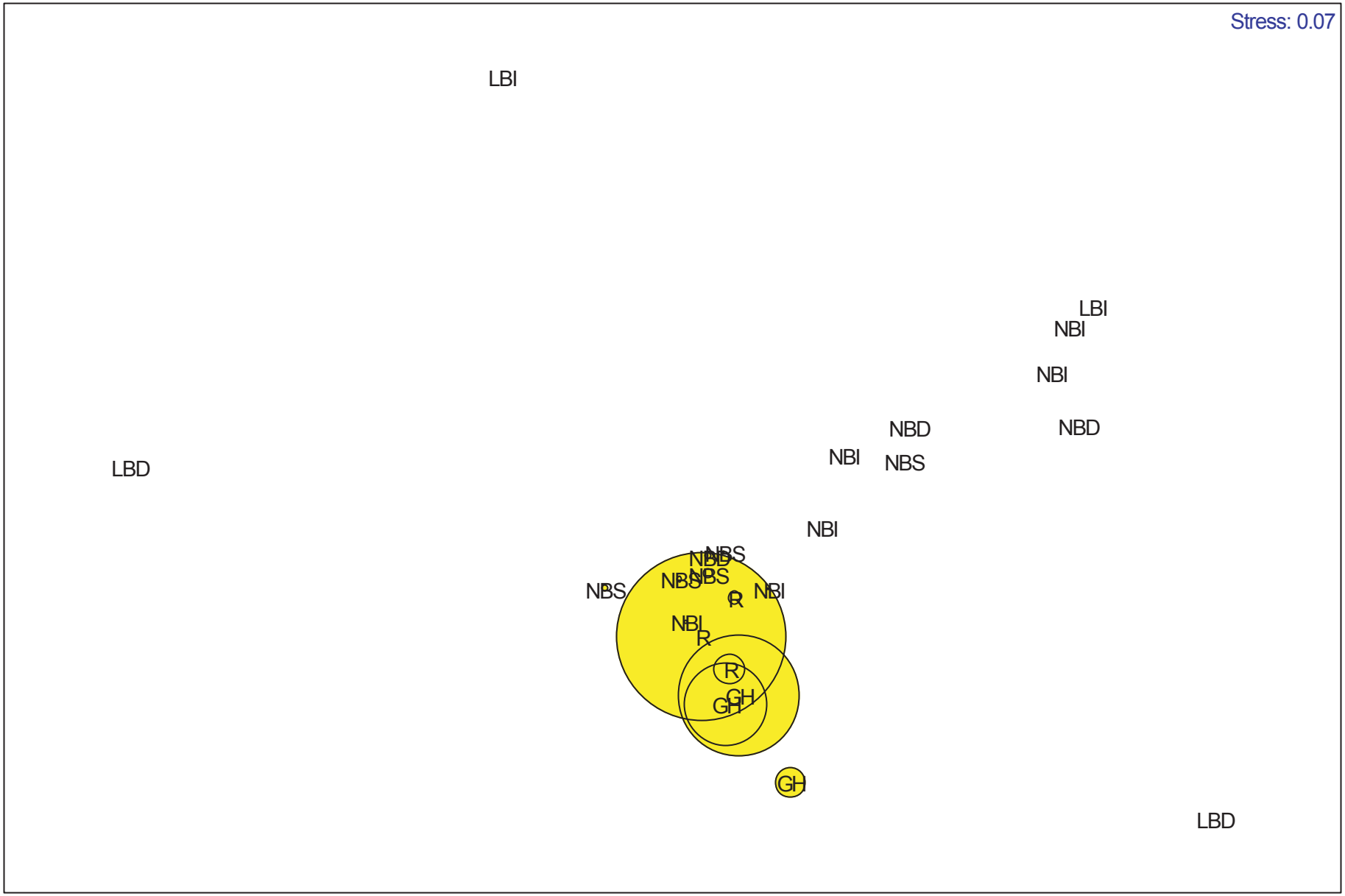

Figure 33. MDS plot and *Sabellaria vulgaris* abundance for the Norton Basin stations, October 2002.

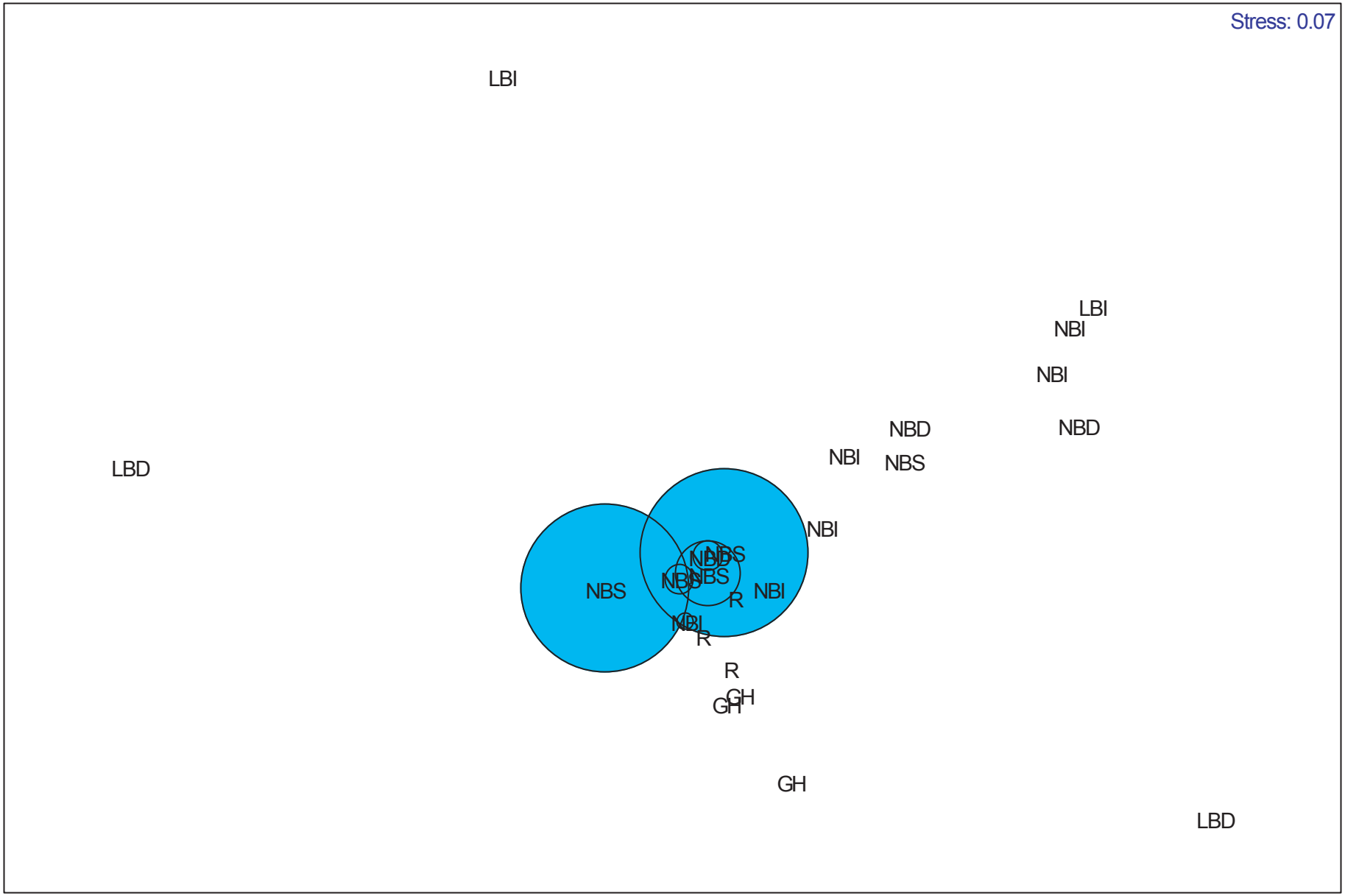

Figure 34. MDS plot and *Polydora cornuta* abundance for the Norton Basin stations, October 2002.

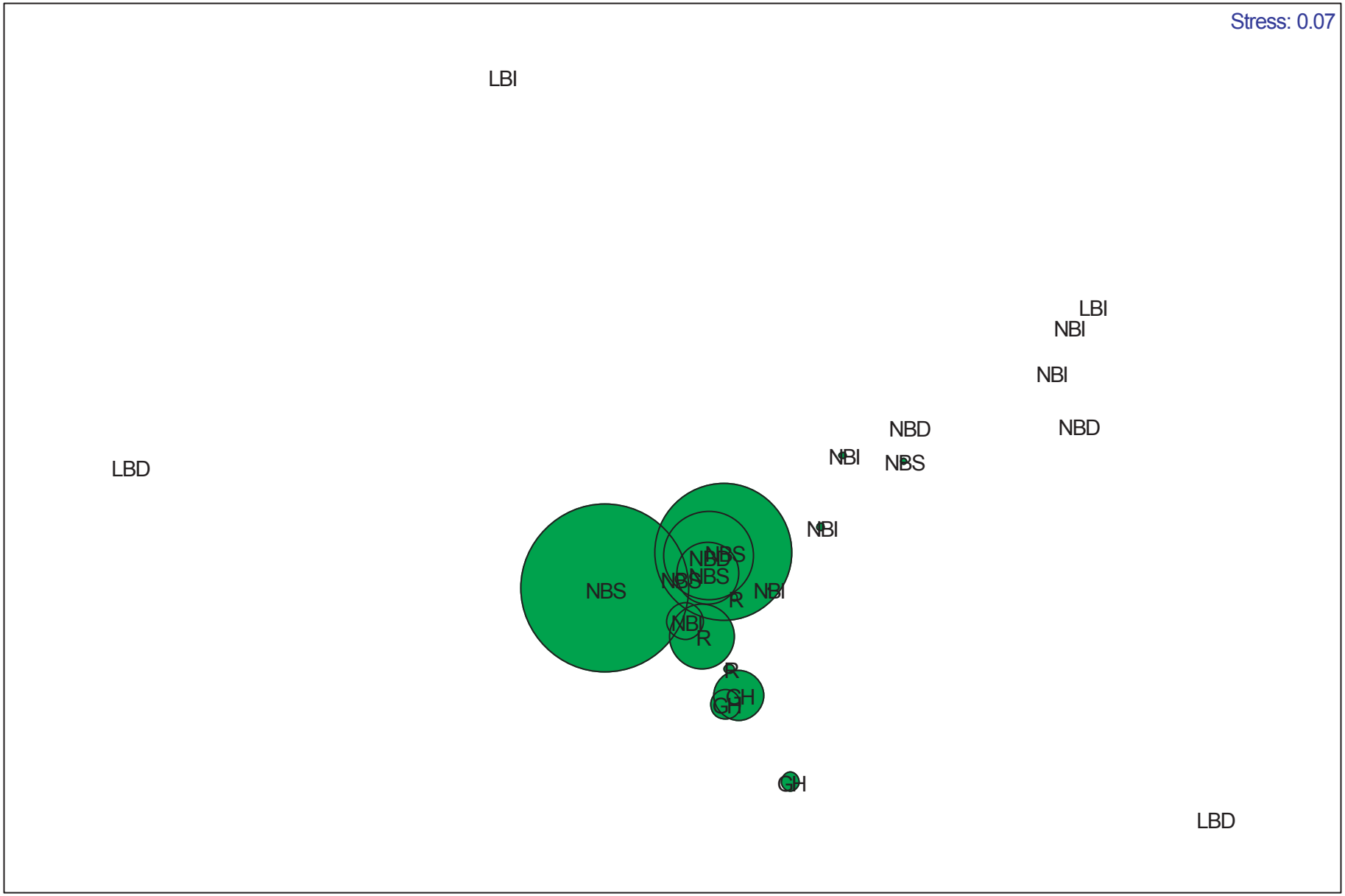

Figure 35. MDS plot and *Capitella capitata* abundance for the Norton Basin stations, October 2002.

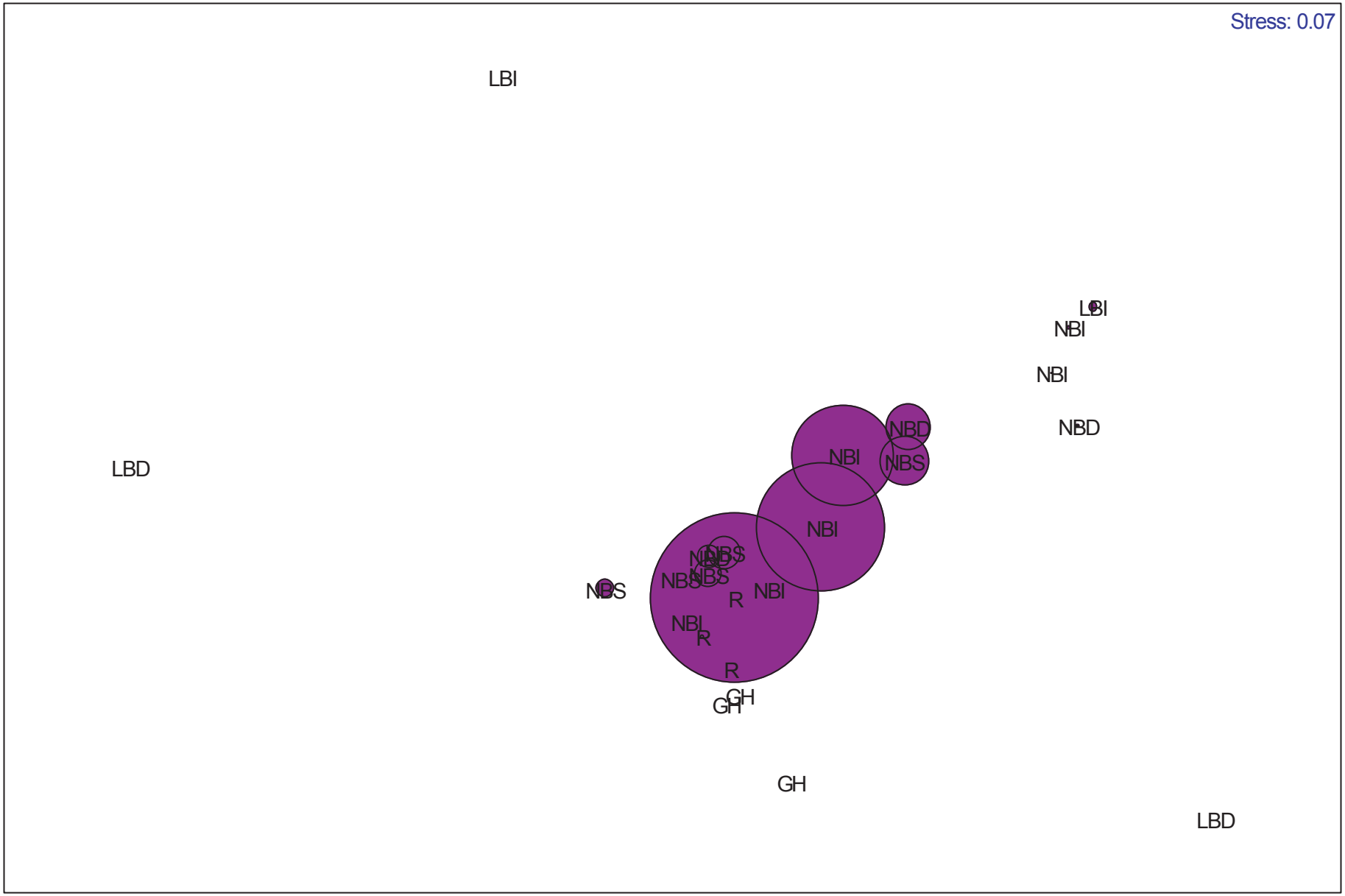

Figure 36. Station dendrogram from the cluster analysis for the Norton Basin stations, June and October 2002.

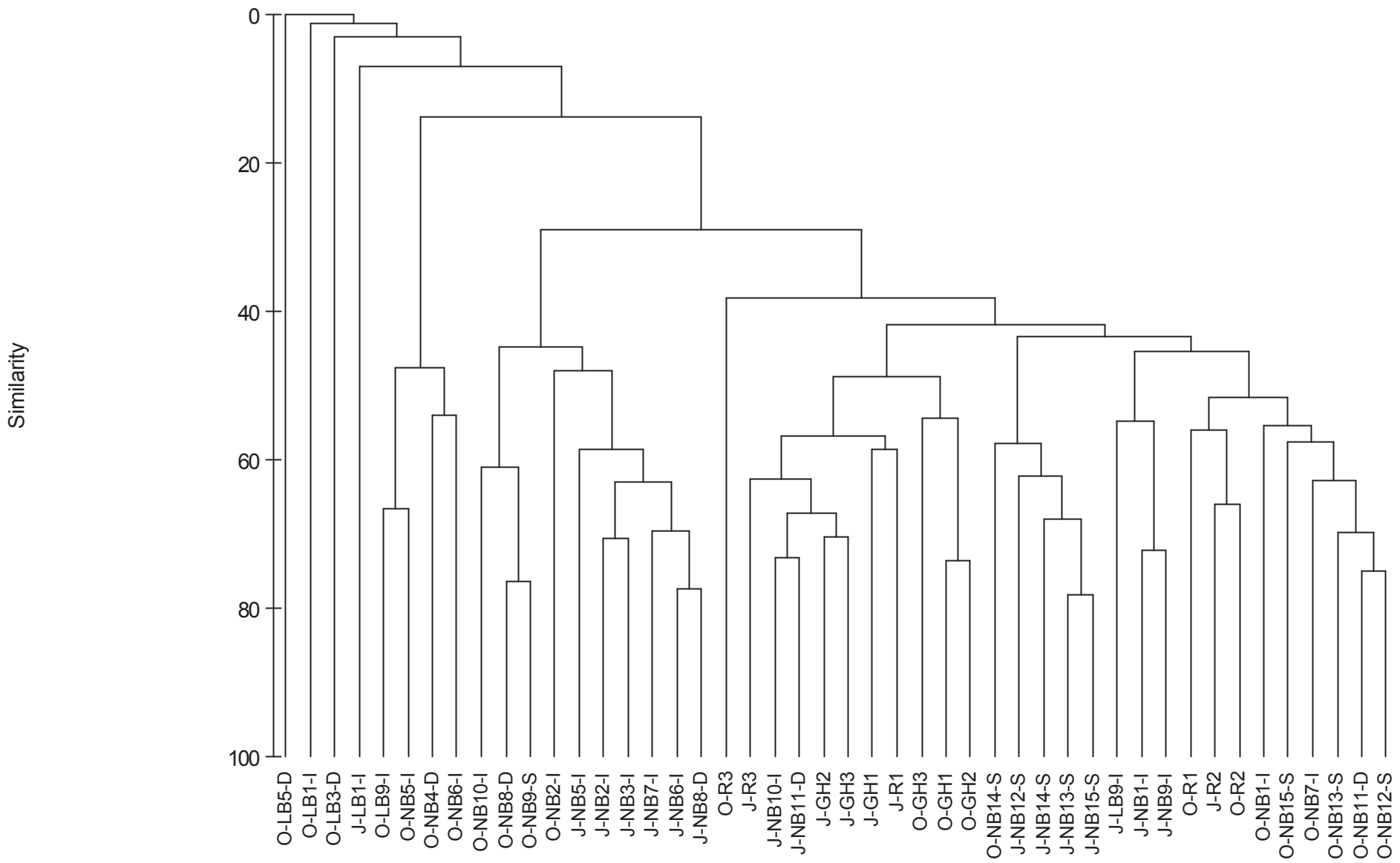

Figure 37. MDS plot of the Norton Basin stations, June and October 2002.