NMBAQC

NE Atlantic Marine Biological Analytical Quality Control Scheme

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Macroalgae Component - Algal Identification Module Report – RM RT14 2020

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MACROALGAL IDENTIFICATION MODULE REPORT FROM THE CONTRACTOR SCHEME OPERATION –2019-20

1 Introduction

To enable correct water quality classification and good management decision-making, quality control of biological data is a high priority. This extends through all biological elements including macroalgae and seagrass. Good quality control ensures consistency of data being reported for management purposes, and for macroalgae and marine angiosperms this has been driven primarily by the requirements of the Water Framework Directive. This QC scheme aims to facilitate improvements in biological assessment whilst maintaining the standard of marine biological data. The scheme should help to ensure consistency between analysts with improved confidence in ecological quality status.

The North East Atlantic Marine Biological Analytical Quality Control (NMBAQC) Scheme addresses several issues relating to macroalgae and seagrass data, this report focuses on one of these:

- The identification of macroalgae species

This is the fourteenth year in which the identification of intertidal macroalgae has been included as an element of the NMBAQC scheme, with the format following that of previous years. Test material was labelled and distributed to participating laboratories using previously employed procedures, from which species identification forms were completed and returned for analysis.

Six laboratories subscribed to the macroalgae ring test with all six laboratories submitting results with a total of eleven participants. Four of the subscribing laboratories were government organisations and two were independent consultancies. To ensure consistency between scheme years, each participating laboratory was assigned the same laboratory code as in previous years except where a laboratory was new to the scheme. Individual codes may, however, change slightly due to variations in individual participants. Due to the nature of the exercise there was no limit on the number of participants per lab.

Currently this scheme does not specify a definite qualifying performance level, and NMBAQC ring tests may be treated as training exercises. However, a pass rate of 80% is suggested as an indicator of good performance, which may be used by competent monitoring authorities for internal monitoring of performance. Ring tests offer a means of assessing personal and laboratory performance from which continued training requirements may be identified or from which improvements in current field and laboratory procedures may be addressed.

1.1 Summary of Performance.

This report presents the findings of the macroalgae identification component for the fourteenth year of operation within the National Marine Biological Analytical Quality Control (NMBAQC) Scheme. This component consisted of a single macroalgae exercise the analytical procedures of which remained consistent with round thirteen of the scheme (RM RT14). The results for the exercise are presented and discussed with comments provided on the overall participant performance.

Images of twenty macroalgae specimens were distributed to the six subscribing laboratories. Round fourteen of the ring test produced a good degree of agreement between identifications made by participating laboratories and initial identification as made by Wells Marine. The ring test tried to incorporate a variety of common and more challenging species including some microscopic and epiphytic species.

The level of performance between laboratories and participants varied, with scores ranging from 29, with 5 incorrect genus names and 6 incorrect species names, to 40, with all species correctly identified. All participants correctly identified nine species. Most incorrect species identification were

made at the species level with three species showing considerably difficulty at both genus and species levels. Overall the level of identification was relatively consistent with the previous year with a high level of knowledge of the common species and increased knowledge of the more challenging and unusual species.

2 Summary of Macroalgae Component

2.1 Introduction

There was one module for the macroalgae identification component for scheme year fourteen. This module is described in full below to include details of distribution and logistics, completion of test result forms and full analysis and comparison of final submitted results.

2.2.1 Logistics

The test material was distributed on CD to each laboratory with labelling and distribution procedures following those of previous years. Each disc contained the full identification module including photos and additional habitat, geographical, textural, and size details from which to identify specimens as well as description of methods and data submission forms. Participants were given six weeks to complete the test and return the results. There were no restrictions on the number of participants per laboratory.

Email has been the primary means of communication for all participating laboratories subsequent to the initial postal distribution of test material.

2.2.2 Analysis and Data Submissions

A prepared results sheet was distributed with the exercise instructions to standardise the format in which the results were submitted as per previous years. All returned data was done so in Excel and has been stored and analysed in this format. In this and previous scheme years slow or missing returns for exercises lead to delays in data processing data, reporting and feedback of results, therefore reminders were distributed two weeks before the exercise deadline.

2.2.3 Confidentiality

To preserve the confidentiality of participating laboratories, each participant is allocated a four-digit laboratory code from which they can identify their results. These codes are randomly assigned. The initial letters (MA) refer to the scheme this is followed by the scheme year which refers to the year in which the NMBAQC scheme original commenced, the final two digits represent the laboratory. For those laboratories where multiple submissions were provided the four-digit code is followed by a letter allocated to each participant of that laboratory. For example, participant c from laboratory twelve in scheme year twenty-seven will be recorded as MA2712c.

2.3 Macroalgae Ring Test (RM RT14) Module

2.3.1 Description

This training module enables the inter-laboratory comparisons of participants' ability to correctly identify macroalgae taxa and whether errors may be attributed to inadequate keys, lack of reference material or incorrect use of satisfactory keys.

One set of photographs of twenty specimens was distributed in January 2020. The specimens included a range of Chlorophyta, Rhodophyta and Phaeophyta and a mix of macroscopic and microscopic

specimens from a variety of habitats including epilithic, epiphytic and endozoic species. There were several photographs per taxon showing different aspects of the alga and its habitat. Some supplementary information on habitat, zonation, geographical location, general size, texture, and any additional information considered vital for correct identification, was included.

2.3.1.1 Preparation of the Sample

Each specimen was to be identified through several in-situ, macroscopic and microscopic photographs. In total a minimum of five photographs was used for each specimen collected by Wells Marine for this exercise. Specimen photographs were obtained from a range of surveys from around the coast of the UK. Photographs were selected to sufficiently represent each specimen including in-situ (where possible), overall structure, branching patterns, cellular arrangements and cell contents making sure to include key characteristics for accurate identification. Scale bars were included where appropriate. Attempts were also made to ensure a high quality of photographs primarily focusing on clean specimens with sharp photographs.

Using a photographic test is considered a more practical means of testing macroalgal identification skills than preserved samples. These are known to lose colour rapidly and cell contents may become distorted making key characteristics more difficult to distinguish. Equally, fresh samples would not last a sufficient period to enable identification. It may also be difficult to obtain sufficient numbers of more unusual taxa for distribution to all laboratories.

2.3.1.2 Analysis Required

The participating laboratories were required to identify each of the macroalgae specimens from the photographs provided. Additional information should also be submitted including brief notes, information on keys used or possible problems with identification or quality of photograph provided. Expressing the level of confidence of identification should also be detailed, as this can aid in results of any disputes and in the preparation of reports. Participating laboratories were permitted to submit multiple data entries for each exercise to maximise results and allow sufficient comparisons of data entries. The protocol for circulating and completing the module followed that of previous years with six weeks allowed for the identification and submission of results.

2.3.2 Results

2.3.2.1 General Comments

The scheme has taken on the same format as previous years; this includes the format of the test and method of data analysis and scoring. The macroalgae ring test can act as a training aid in the identification of species allowing those difficult taxa to be revealed and further identifying problematic areas.

For this current round of the scheme (RM RT14) specimen photographs were circulated to a total of six laboratories. All six of the laboratories returned data entries with a total of eleven individual data sets.

Results were distributed to each of the participating laboratories four weeks after data submission. These results are documented in the preliminary results bulletin (RM RT14) which detailed individual scores and highlighted incorrect identifications, miss-spellings and use of synonyms. The bulletin also outlined reasons for identification discrepancies by comparing incorrect species and genus names with those of the AQC with the aid of photographs to pick out key characteristics.

2.3.2.2 Analysis and Scoring of Data Returns

Laboratories returned lists of their species identifications within the format provided; these were compared against AQC identification as determined by Wells Marine to assess the number of differences. The method of data comparison was achieved by comparing both the genus and species names and identifying where these differed with the AQC names. Such comparison included differences in spelling or use of a valid synonym for example:

- Use of different synonym for a taxon, e.g. *Enteromorpha prolifera* for *Ulva prolifera*
- Mis-spelling of taxa name, e.g. *Halydris siliquosa* for *Halidrys siliquosa*

Such differences are highlighted, but not considered during calculation of the total number of differences in identification.

Data entries were tabulated (as seen in RM RT14 Preliminary Results Bulletin, Table 2) in order of specimen number and laboratory. The individuals' data entries are only given where they differ from the AQC identification. This includes those entries for which species are spelled incorrectly or where an appropriate synonym is provided, as well as those instances in which the specimen has been identified incorrectly. For those entries in which the participant recorded a synonym or mis-spelling, but for which the identification was consistent with that of the AQC, the name was presented in brackets [species name]. Those entries in which the identification was considered different to the AQC the species or genus name that did not correspond to the AQC was provided in the table. If part or the entire species name entered was correct this was indicated by a dash "-" any incorrect name was included in the table e.g. where *Prasiola stipitata* was identified as *Prasiola furfuracea* this would be entered as " – *furfuracea*".

The data entries for an individual scored one point where the entry was consistent with that of the AQC. For instance, where text other than a dash "-" or a bracketed name [name] is provided no score was given. This includes differences at both genus and species level, although species can be considered a largely independent value (where the generic identification was incorrect then the species identification would also be incorrect). Therefore, where the full genus and species name was correct a score of two would be given; where either genus or species name was incorrect a score of one would be given. The method of scoring applied to those species in which a correct identification was provided and included those instances where synonyms were used, or species/genus names spelled incorrectly.

2.3.2.3 Ring Test Results

RM RT14 contained twenty specimens for identification for which there was a good, albeit varied, level of agreement through all nine participants. At the generic level, there were a total of twenty-nine differences (from a potential 220) across the eleven sets of data received from the six participating laboratories (13.18%). At the specific level, there were a total of fourty differences (18.18%). The overall % of incorrect species identification was relatively consistent with the previous year.

The differences in species identifications could be attributed primarily to several taxa which showed the highest number of incorrect identifications at both the genus and species level. The highest number of differences was recorded for species *Eudesme virescens* (RT1415) with 8 generic and 8 specific differences recorded. Species RT1404 (*Anotrichium furcellatum*) resulted in 5 generic and 6

species differences and species RT1416 (*Dumontia contorta*) resulted in 6 generic and 6 species differences. However, these three species only accounted for 57% of differences. Therefore, more than 50% of the differences in species identification could be attributed to just three species. Four species (*Pseudendoclonium dynamenae, Gracilaria gracillis, Rhodothamniella floridula* and *Laurencia obtusa*) showed differences at both the genus and species level. The remaining four species of Codium tomentosum, Bryopsis plumosa, Cladophora hutchinsiae and Ulva prolifera only showed between 1 and 2 differences at the species levels. These results indicate that the incorrect identifications were confined to a limited number of species albeit these were distributed across all three phylum and incorporated a variety of morphological types. In total nine specimens were identified correctly across all participants which is higher than recorded for the previous year.

There was only one synonym used this year with *Audouinella floridula* being accepted for *Rhodothamniella floridula*. Some participants still used the old spelling of *Pilayella* which is now *Pylaiella.* All synonyms are accepted for the ring test and receive no scoring penalty. *Pseudendoclonium dynamenae* and *Laurencia obtusa* had incorrect spellings but this did not affect the scoring.

The difference between participants' entries and AQC identifications was well distributed across the participants with one participant identifying all species correctly. The overall scores and number of incorrect identifications ranged from zero to eleven which is consistent with the previous year. A pass rate of 80% (which equates to a total score no lower than 32) is suggested as an indicator of good performance, but above 70% is still considered acceptable. These levels may be used by competent monitoring authorities for internal monitoring of performance. All participants managed to identify the species to a level considered acceptable (Table 1).

Table 1: Participants final scores and overall pass mark.

Lab Code	Total Score	Pass Mark
MA2735	38	95
MA2710	38	95
MA2714a	30	75
MA2714b	35	87.5
MA2714c	31	77.5
MA2714d	31	77.5
MA2707	38	95
MA2712a	30	75
MA2712b	29	72.5
MA2703a	40	100
MA2703b	31	77.5

2.4 Discussion

This is the fourteenth macroalgae identification ring test as circulated through the NMBAQC scheme, with early exercises being essentially trials of the methodology. Although the results were broadly comparable with those of previous years (RT12 and RT13) there was a noticeable increase in the level of agreement between participating laboratories and the AQC when compared with RT13. As per previous years the test included several cryptic and taxonomically challenging species as well as those considered more common. Such genera included *Anotrichium sp*., *Cladophora sp*. and *Ulva sp*., which are notoriously difficult to identify to species level. Other species proved troublesome due to morphological similarities to other species such as *Eudesme virescens* which bears resemblance to *Mesogloia sp. which is also gelatinous in texture, with similar overall structure and morphology. Dumontia contorta* can also been easily misidentified due to confusions with other morphologically similar species such as *Chondria capillaris,* therefore it can be very difficult to tell these species apart from each other. These genera require an increased depth of knowledge on the cellular attributes, which can be remarkably similar between species, as well as other characteristics, such as overall texture, which can be used to separate such species.

Table 2: Summary of differences in identification.

			Total differences for 11 returns	
Specimen	Genera	Species	Genus	Species
RT1401	*Plumaria*	*plumosa*	0	0
RT1402	*Cystoclonium*	*purpureum*	0	0
RT1403	*Codium*	*tomentosum*	0	2
RT1404	*Anotrichium*	*furcellatum*	5	6
RT1405	*Saccorhiza*	*polyschides*	0	0
RT1406	*Pseudendoclonium*	*dynamenae*	2	2
RT1407	*Gracilaria*	*gracilis*	2	4
RT1408	*Pylaiella*	*littoralis*	0	0
RT1409	*Ascophyllum*	*nodosum*	0	0
RT1410	*Bryopsis*	*plumosa*	0	2
RT1411	*Vertebrata*	*lanosa*	0	0
RT1412	*Choreocolax*	*polysiphoniae*	0	0
RT1413	*Fucus*	*vesiculosus*	0	0
RT1414	*Rhodothamniella*	*floridula*	2	2
RT1415	*Eudesme*	*virescens*	8	8
RT1416	*Dumontia*	*contorta*	6	6
RT1417	*Cladophora*	*hutchinsiae*	0	2
RT1418	*Laurencia*	*obtusa*	4	4
RT1419	*Pelvetia*	*canaliculata*	0	0
RT1420	*Ulva*	*prolifera*	0	2
		Total differences	29	40
		Average differences per Genus/ species	1.450	2.000

Average number of differences for both genera and species was lower than last year which were 1.45 and 2.0 respectively.

The most problematic species was *Eudesme virescens* which is very difficult to identify due to the occurrence of morphologically similar genera. This species was misidentified at both the Genus level and Species level with most misidentifying as *Mesogloia vermiculata* or *Mesogloia*, with one participant identifying as *Sauvageaugloia divaricata* (of which *Mesogloia* is also a synonym). Three participants correctly identified this species which was based primarily on its uniform width of branching throughout, compared with the irregular axis of *Mesogloia sp.* which displays constrictions, thickenings and swellings. Other challenging species included *Gracilaria gracillis* which was misidentified by two participants as *Gracilariopsis longissimi*. In this instance the latter species is not considered cartilaginous as the description indicated and is generally much longer and stringier in form. The other incorrect identification (Gracilaria dura) was not accepted as common to UK coastlines and is more typically located in Southern Europe.

In the case of Gracilaria and Eudesme the literature was found in part to be insufficient to aid with correct identification with many contradicting characteristics making it inherently different to correctly identify such species. This merely highlights the need for more descriptive and up to date identification guides especially where the northern and southern limits of species are moving due to climate change.

Four further species also resulted in several misidentifications. *Anotrichium furcellatum* was incorrectly identified as *Halurus flosculosus*, *Aglaothamnion byssoides*, *Aglaothamnion feldmanniae* and *Callithamnion corymbosum*. *Anotrichium furcellatum* could be distinguished from these other species by varying characteristics including the branching patterns and size of cells. Such small filamentous species as these prove problematic every year due to the wide range of morphologically similar species. *Dumontia contorta* was also misidentified for *Chondria capillaris, Pterocladiella capillacea* and *Polyides rotundas*. These species could also be separated by their branching patterns with *Dumontia contorta* being sparsely and irregularly branched. *Rhodothamniella floridula* was confused for *Rhodochorton purpureum*, the latter of which lacks multiple chloroplasts and the distinctly visible pyrenoids as seen in the former. *Laurencia obtusa* was also misidentified for *Osmundea sp*. and *Chondrus crispus*. The confusion with *Osmundea sp*. is acceptable as *Laurencia* was once the synonym for many *Osmundea* species. In this instance the species details provided with the ring test indicated *Laurencia obtusa* to have a stoloniforous base which distinguishes it from some *Osmundea sp*. *Chondrus crispus* is situated in the same intertidal zone but is very flattened with dichotomous not seen in *Laurencia obtusa*.

Certain issues arose with a few species. *Pseudendoclonium dynamenae* was identified by two participants as *Epicladia flustrae.* However, this species is endozoic on bryozoans and not on hydroids as seen with *Pseudendoclonium*. The remaining misidentification were at the species level only. *Ulva sp.* and *Cladophora sp.* are always contentious species with many morphological similar species within the genera. Key characteristics to look for in these species are the branching patterns as well as cell size and arrangement. However, these are notoriously difficult to identify with many characteristics crossing over several species within the genus. *Bryopsis plumosa* was incorrectly identified by two participants as *B. hypnoides* which can be differentiated by their flattened or spiralled branching. *Codium tomentosum* was also misidentified as *C. vermilara* and *C. fragile*. The presence of mucronate utricles or scarred and flattened utricles are key characteristics for distinguishing species within this genus.

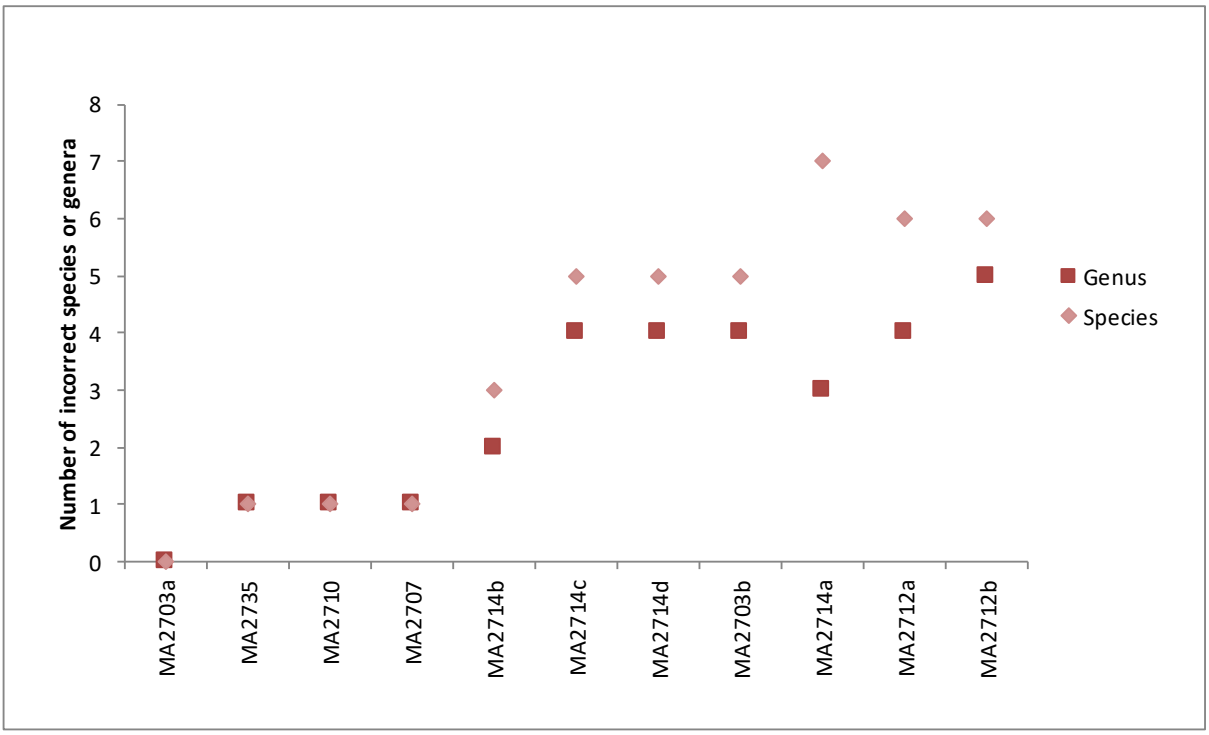

Figure 1: The number of differences from the AQC identification of intertidal macroalgae specimens, for each of the participating laboratories for RT14, arranged in order of increasing number of differences.

There were a higher number of species that were correctly identified by all participants this year compared with the previous. Some of these were species that are less commonly recorded or identified, often relying on the presence of a host species. This is a good indication that the identification process or use of keys is relatively effective with misidentifications occurring at the highest level.

It is apparent that many participants are consulting with photos and descriptions from Algaebase. This is a highly valuable source of information particularly with regards to the current taxonomic status of algae. However, species descriptions are not always as detailed as those within the natural History Museum series or other identification guides and include species from broader locations. It is hugely important to stay aware of current global shifts in species locations, but it is also important to be aware of those species common to the UK shores so as not to get confused with morphologically similar species, such as with *Gracilaria dura*.

In some instances, it was unclear which keys or guides were used by participants to identify the species. This information can be vital to determining if the guide descriptions were insufficient to correctly identify the species or if the photographs provided were insufficient. Additionally, it is recognised that some keys require revision, but this is not within the scope of NMBAQC. However, current developments and taxonomic changes to species should be considered during future field surveys using the correct and most recent identification descriptions, where possible, for verification.

The range of results was improved since last year with the total number of misidentifications fewer. There were several more commonly and large Phaeophyta species included in RT14 which are rarely misidentified. However, RT14 also included a variety of rarer and difficult species as per previous years which may suggest an increased level of competency. As per previous years, many misidentifications occurred at the species level, which is often reliant upon the smallest of variations in characteristics to separate species. This may also suggest that there is an increased level of competency at the genus level which showed proportionally fewer misidentifications than previous years.

As intended by the scheme these tests aim to challenge participants and assist with training by stimulating the use of various keys and increasing familiarity with taxonomic terminology. Further, it allows problem taxa to be identified stimulating areas for inclusion in workshops and targeting such taxa within future exercises. Photographs used within the ring tests may be retained within the participating laboratories for future reference, with some descriptions allowing the comparison of taxonomically similar species.

At this time the use of a photographic test is considered the most effective means of testing macroalgal identification skills. Preserved samples are known to rapidly to lose colour with cells becoming distorted making key characteristics more difficult to distinguish. Equally, fresh samples would not last a sufficient period to enable identification. However, it is possible that some photographs were not considered to be of sufficient quality or contain sufficient characteristics to correctly identify the specimens despite all efforts. This may have attributed to some misidentifications with some of the more cryptic species.

It is accepted that using fresh samples can be much easier to identify than photographs, however it must also be appreciated that even when using fresh specimens, it is not always possible to see certain characteristics, such as unique branching patterns and cell contents or perhaps it was not possible to retain the holdfast. Some features may be masked by excessive debris or diatoms or the specimen may be too small or partly deteriorated. Other issues arise where species show high degrees of morphological variation. All these factors would have to be considered in the field as well as within such ring tests as this and while all attempts are made to ensure perfect specimen material this is not always possible. It is equally difficult to find microscopic epiphytes and endophytes, much less be able to clearly see the cell contents and branching patterns and capture a still of such fundamental characteristics. However, it is considered important for the personal development of participants to be challenged with such species.

3 Conclusions and Recommendations

1. The fourteenth macroalgae ring test exercise was implemented successfully and completed by all participating laboratories with a general agreement of the format. All feedback has been reviewed and will be considered for subsequent exercises; such feedback is encouraged to enable the protocols to be refined.

2. The tests are distributed with a spreadsheet of additional species information such as geographic location of species, height found on the shore and habitat preferences. This year there was better uniformity in terms of habitat, morphological or textural information being provided. A more

detailed spreadsheet was provided during the current ring test to include such information for all species in a clear and concise manner and included the following characteristics:

i. Specimen number
ii. Geographic location from where species was collected
iii. Zonation/height at which the species was located
iv. Habitat preferences
v. Overall texture e.g. gelatinous, cartilaginous, hairy
vi. General size of species
vii. Host species where relevant
viii. Number of photos provided and magnification levels
ix. Any relevant additional information

It has been evident this year that this additional information provided significant assistance with the identification, aiding with eliminating possible confusions between potential species identifications so will continue to be included in the future. It is important that all participants utilise this additional information to assist with correct identifications.

3. The high range of performance levels within this ring test provided evidence of a high range of proficiency. However, there were still a number of cryptic and microscopic species included within the test to challenge participants. There are, naturally, several problematic areas but this is to be expected, as some taxa are inherently more difficult than others. The errors occurring were at both the generic and specific level and within all three divisions, Rhodophyta, Phaeophyta and Chlorophyta. Many of these errors occurred due to confusions with taxonomically and morphologically similar species which share similar characteristics and are therefore hard to separate. Such species will be noted for possible future workshops and will be targeted in future exercises.

4. There were still some incorrect spellings; therefore, participants are urged to take more care prior to submitting results to ensure all names are spelled correctly. It is also important that the species names, including subsp. be appropriately entered into the spreadsheet to avoid confusion. Where there is limited confidence in the final identification it should be remembered that this scheme does not specify a definite qualifying performance level, and NMBAQC ring tests should be treated as training exercises. Ring tests offer a means of assessing personal and laboratory performance from which continued training requirements may be identified. In practice, it is likely that additional expertise would be consulted where the level of confidence in species identification is questionable.

5. Several data spreadsheets were also not fully completed, often missing out the keys or guides that were used. This may seem trivial information but can help identify where the participant has been misled with the keys or help explain how or why an alternative identification was reached. For future ring tests it is requested that the data spreadsheets be completed in full, including level of confidence in the identification. Participants should include the authority alongside taxon names, as this also aids in the analysis of returns.

6. All laboratories are encouraged to keep all test photographs within a reference collection. This has several benefits particularly with regards to improving identification ability, training new staff and maintaining consistency of identification between surveys and staff. This reference collection should also be extended through to literature to ensure current keys are used with up to date nomenclature. A list of identification works will be given on the NMBAQC website. However, this

is not exhaustive, and does not necessarily include unpublished keys provided at workshops unless specifically authorised by the key's author.

7. During this fourteenth cycle of the macroalgae identification exercise all participants submitted results within the designated timescale. Within future ring tests all laboratories should continue to submit results within the requested deadlines as detailed at the beginning of the exercise. Reminders will continue to be distributed two weeks prior to the completion of the exercise and in the case of very late submissions at the deadline. Emails will also be distributed to inform laboratories that the ring test material has been posted and expected date of arrival although this may be difficult with some laboratories outside of the UK. However, all attempts will be made to ensure all laboratories receive the material by the test commencement date.

8. There is now good consensus over the time of year for the test with the slightly earlier distribution of this years' test allowing the results bulletin and final report to be distributed before the sampling season. There has also been no further comment on the amount of time provided for the test, so this has been taken as acceptable.

9. Several species have been requested for inclusion in subsequent tests such as foliose and lower sublittoral species. All attempts will be made to include such species and cover the requirements of the participants.

10. There was a general agreement from participants that this years test was consistent in terms of difficulty compared with previous tests with a similar number of challenging species. There was a general agreement that the overall quality, detail and use of photographs was considered acceptable with most participants. Some species were thought to be mucky and damaged making identification more challenging. Although all attempts are made to produce clear and unambiguous photos this is also the nature of identification and the species. Not all species collected are the perfect example with many species showing broad ranges of morphological variation, this is the case for all specimens collected in the field. Future tests will endeavour to produce increased clarity, particularly of key characteristics and inclusion of transverse sections, where appropriate, in subsequent tests to aid with correct identification and use of guides and keys. It is hoped that recommendations from previous tests have been taken on board and that for most species enough photos and key characteristics were provided for correct and confident identification. However, it must be recognised that even when looking at fresh specimens not all such characteristics may be present, e.g. reproductive structures. No staining is currently used, and this shall remain for the following test. All attempts will be made in the future to ensure that sufficient material is provided, allowing correct identification to species level.

If anyone has further comments on this, or disagrees with any of the interpretation, please pass forward your comments to Dr Emma Wells (emma@wellsmarine.org). This ring test is continually being refined to ensure it provides the best opportunity to test macroalgae identification skills, so all suggestions and comments are welcomed.

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