NMBAQC

NE Atlantic Marine Biological Analytical Quality Control Scheme

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Macroalgae Component - Algal Identification Module Report – RM RT15 2021

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MACROALGAL IDENTIFICATION MODULE REPORT FROM THE CONTRACTOR SCHEME OPERATION –2020-21

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 fifteenth 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 distributed to participating laboratories using file transfer, from which species identification forms were completed and returned for analysis.

Four laboratories subscribed to the macroalgae ring test with all four laboratories submitting results with a total of four participants. Three of the subscribing laboratories were government organisations and one was an independent consultancy. 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 fifteenth 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 fourteen 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 four subscribing laboratories. Round fifteen 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 4 incorrect genus names and 7 incorrect species names, to 38, with one incorrect genus and species name. no one participants correctly identified all species correctly. All participants correctly

identified ten species. Most incorrect species identification were made at the species level with only one 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 fifteen. 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 via file transfer to each participating laboratory, which differed from previous years but considered more efficient. The files 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 file transfer 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-eight will be recorded as MA2812c.

2.3 Macroalgae Ring Test (RM RT15) 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 2021. 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 RT15) specimen photographs were circulated to a total of four laboratories. All four of the laboratories returned data entries with a total of four individual data sets.

Results were distributed to each of the participating laboratories two weeks after data submission. These results are documented in the preliminary results bulletin (RM RT15) 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., *Audouinella infestans* for *Colaconema infestans*
- 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 RT15 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 RT15 contained twenty specimens for identification for which there was a good, albeit varied, level of agreement through all four participants. At the generic level, there were a total of eight differences (from a potential 80) across the four sets of data received from the four participating laboratories (10%). At the specific level, there were a total of fourteen differences (17.5%). The overall % of incorrect species identification was relatively consistent with the previous year.

The differences in species identifications was broadly distributed across several species. The highest number of differences was recorded for species *Acinetospora crinita* (RT1510) with 3 generic and 3 specific differences recorded and accounted for 27% of the overall differences. Species RT1507 resulted in 1 generic and 2 specific differences. Four species resulted in one generic and one specific difference. These included species RT1511 (*Colaconema infestans*), RT1512 (*Monostroma grevillei*),

RT1513 (*Elachista fucicola*) and RT1518 (*Gastroclonium reflexum*). Species RT1520 (*Ulva lactuca*) resulted in 2 specific differences and the remaining differences were recorded as the species level with one specific difference resulting from species RT1504 (*Chaetomorpha linum*), RT1515 (*Gayliella flaccida*) and RT1516 (*Cladophora sericea*).

These results indicate that the incorrect identifications were relatively broadly distributed across all the species with the exception of Acinetopora crinita (RT1510). The remaining differences were also distributed across all three phylum and incorporated a variety of morphological types. In total ten specimens were identified correctly across all participants which is higher than recorded for the previous year.

There were three synonyms used this year with *Audouinella infestans* being accepted for *Colaconema infestans, Ceramium flaccidum* accepted for *Gayliella flaccida*, and *Polysiphonia elongella* accepted for *Carradoriella elongella*. Where these species were only identified to Genus level the synonym was also allowed. All synonyms are accepted for the ring test and receive no scoring penalty.

Two species proved problematic with regards to distinguishing from other morphologically similar species. The photos provided were not sufficient to enable accurate identification. In these instances, the alternative identifications were accepted and they also received no scoring penalty.

The difference between participants' entries and AQC identifications was well distributed across the participants with no participants identifying all species correctly. The overall scores and number of incorrect identifications ranged from two 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
MA2832	38	95
MA2807	37	92.5
MA2810	34	85
MA2812	29	72.5

2.4 Discussion

This is the fifteenth 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 (RT1 through RT14) there was a noticeable decrease in the number of participants making it difficult to make direct comparisons. As per previous years the test included several cryptic and taxonomically challenging species as well as those considered more common. Such genera included *Gayliella sp*. (*Ceramium*), Carradoriella sp. (*Polysiphonia*), *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 *Petalonia fascia* which bears resemblance to *Punctaria sp.* both of which have similar overall structure and morphology. The detailed photographs provided in the test were deemed inconclusive when trying to distinguish the species and as such both *Punctaria plantaginea* and *Punctaria latifolium* were accepted as correct for the purpose of the test. All three species have a flat broad frond of

comparable size and shape, and comparable cell size and shape. Further characteristic would be required, such as reproductive bodies to correctly distinguish the species. *Cladophora sp.* are also notoriously difficult to identify to species level. Many require a number of attributes and characteristics to ascertain a confident and correct identification. *Cladophora sericea* and *Cladophora albida* are also very morphologically similar with comparable cell size, colour, branching pattern and overall form. They can be distinguished by the presence of tapered apical cells in *C. sericea* compared with rounded apical cells of *C. albida.* However, both species exhibit morphological variations that make this characteristic also inconclusive. Therefore, for the purpose of this test *C. albida* was also accepted as a correct identification being indistinguishable from *C. sericea* from the material provided.

Both these contentious species 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, reproductive features and general habitat which can be used to help separate such species.

The most problematic species was *Acinetospora crinita* which is very difficult to identify due to the occurrence of several morphologically similar genera (see table 2 below). This species was misidentified at both the Genus level and Species level with one misidentifying as *Haplospora globosa*, and two further misidentifications as *Hincksia secunda* and *Hincksia ovata*. Only one participant identified this species correctly. Although this species is infrequently recorded and considered relatively rare it possesses some characteristics that enable it to be distinguished from other brown uniseriate filamentous species. This is the presence of right-angled laterals that may be somewhat shorter that other laterals but are clear to see and are not present in other similar brown filamentous forms.

The second most challenging species was *Carradoriella elongella*. This is a synonym of *Polysiphonia elongella* and a Genus that is often difficult to identify to species level. It can be correctly identified by the presence of 4 periaxial cells with cortication particularly evident on the lower portion. The presence of reproductive bodies in the terminal laterals often results in a spiralled appearance of the filaments. It can also be distinguished from *Leptosiphonia fibrillosa* by the presence of a longer basal portion that is absent of laterals generally up to 2cm in length.

Four further species also resulted in misidentifications at both the genus and species level. *Colaconema infestans* was identified as *Epicladia flustrae* they can easily be separated by colour with the forming being a Rhodophyta and therefore red and the latter being a Chlorophyta and green in colour. The difference is clearly visible between the two species. *Monostroma grevillei* was misidentified as *Prasiola stipitata*, the former of which has elongated basal cells not present in the latter. *Elachista fucicola* was misidentified as *Pylaiella littoralis* which is regularly branched unlike the unbranched form of the former. Finally, *Gastroclonium reflexum* was misidentified as *Champia parvula*, which although morphologically very similar they can be distinguished by the length of segments between constrictions. These species can also be separated by their apical form with *Gastroclonium* displaying tapered apices compared with the rounded apices of *Champia*.

Table 2: Summary of differences in identification.

Specimen	Genera	Species	Total differences for 4 returns	
			Genus	Species
RT1501	*Heterosiphonia*	*plumosa*	0	0
RT1502	*Saccharina*	*latissima*	0	0
RT1503	*Corallina*	*officinalis*	0	0
RT1504	*Chaetomorpha*	*linum*	0	1
RT1505	*Taonia*	*atomaria*	0	0
RT1506	*Chondria*	*dasyphylla*	0	0
RT1507	*Carradoriella*	*elongella*	1	2
RT1508	*Ulva*	*intestinalis*	0	0
RT1509	*Halurus*	*flosculosa*	0	0
RT1510	*Acinetospora*	*crinita*	3	3
RT1511	*Colaconema*	*infestans*	1	1
RT1512	*Monostroma*	*grevillei*	1	1
RT1513	*Elachista*	*fucicola*	1	1
RT1514	*Calliblepharis*	*ciliata*	0	0
RT1515	*Gayliella*	*flaccida*	0	1
RT1516	*Cladophora*	*sericea*	0	1
RT1517	*Petalonia*	*fascia*	0	0
RT1518	*Gastroclonium*	*reflexum*	1	1
RT1519	*Fucus*	*ceranoides*	0	0
RT1520	*Ulva*	*lactuca*	0	2
		Total differences	8	14
		Average differences per Genus/ species	0.400	0.700

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. *Gayliella flaccida*, although not misidentified was only identified to species level, using the synonym *Ceramium*, by one participant. The remaining misidentification was for *Chaetomorpha linum* which was identified as *C. melagonium* by one participant. The two species can be easily separated by the size of the cells and the nature of the species whereby the former is often found in tangled masses compared with the solitary form of the latter species.

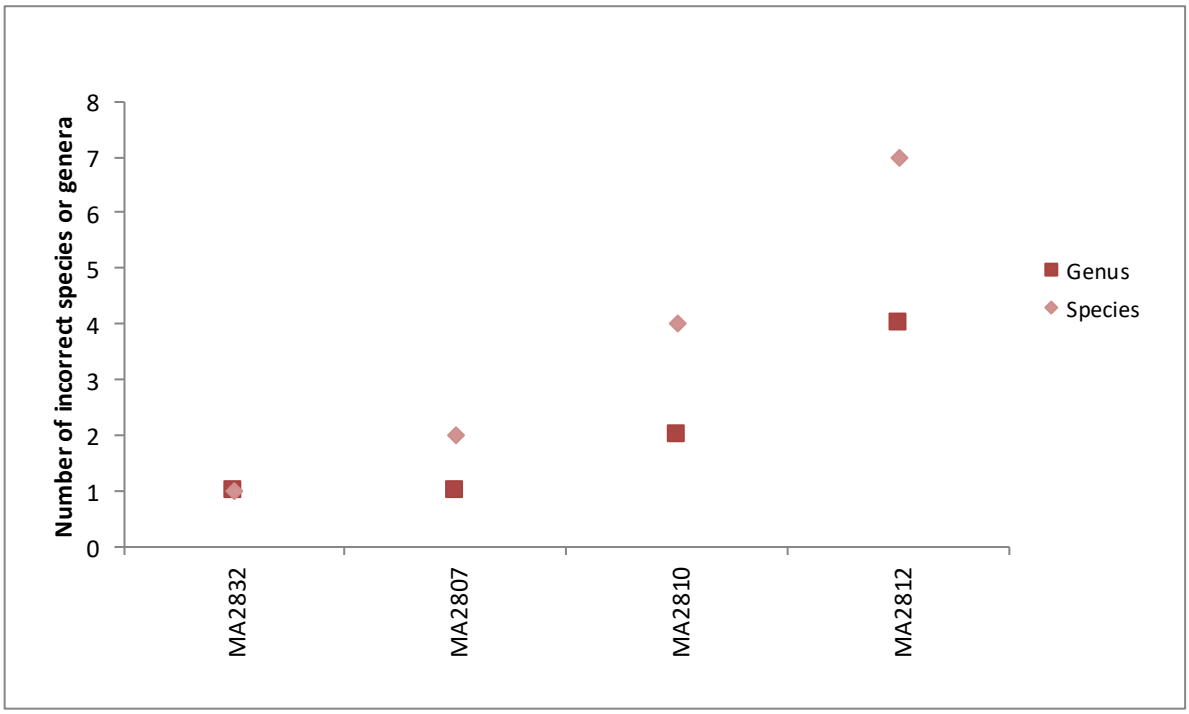

Figure 1: The number of differences from the AQC identification of intertidal macroalgae specimens, for each of the participating laboratories for RT15, arranged in order of increasing number of differences.

There were a higher number of species that were correctly identified by all participants this year compared with the previous (Fig 1). 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 *Ulva fenestrata*.

In the case of *Petalonia* the literature was found in part to be insufficient to aid with correct identification with many contradicting characteristics making it inherently difficult 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.

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 consistent with the previous year albeit with far fewer participants. There were several larger Phaeophyta and Rhodophyta species which are rarely misidentified. However, RT15 also included a variety of rarer, filamentous and difficult species as per previous years which may suggest an increased level of competency. As per previous years, most 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, this year 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 has also resulted in the acceptance of various alternative species identifications as detailed above.

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 fifteenth 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 no incorrect spellings, however one participant used an uppercase letter for both the genus and species, this is only required for the Genus. Participants are urged to take more care prior to submitting results to ensure all names are spelled and typed 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 fifteenth cycle of the macroalgae identification exercise three participants submitted results within the designated timescale. One laboratory was granted one week extension due to unsuccessful file transfers on the commencement date. 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.

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. The start date was postponed by 2 weeks this year due to varying work restrictions due to COVID 19 but will hopefully return to the earlier date in subsequent years.

9. Several species have been requested for inclusion in subsequent tests such as *Gelidium*. 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 photos were considered over exposed and difficult to identify necessary characteristic, or absence of defining characteristics. 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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