A New Criterion for Distinguishing *Yendonia* Kylin and *Mikamiella* M.J. Wynne (Delesseriaceae, Rhodophyta)

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ABSTRACT

An additional morphological criterion is presented to distinguish vegetative samples of the genera *Yendonia* and *Mikamiella* (Delesseriaceae, Rhodophyta). The undescribed earlier feature of *Y. crassifolia* is the presence of abundant light-refracting cells in the tissues of the blades of both fertile and vegetative plants. This feature was never observed in *Mikamiella*, namely, in *M. ruprechtiana*. Additional data amending the description of the genus *Yendonia* are presented.

Keywords: Rhodophyta; Delesseriaceae; *Yendonia*; *Mikamiella*; Morphological Feature

1. Introduction

Marine algae of the family Delesseriaceae are widespread in the Russian Pacific area and represented there by more than 20 genera [1]. There are at least 4 genera among them with similar morphology, especially in their vegetative state: *Congregatocarpus* Mikami, *Neohypophyllum* Wynne, *Mikamiella* Wynne and *Yendonia* Kylin. The main distinctive morphological features of these genera were given by Wynne [2]. The genus *Neohypophyllum* is distinguished from the rest genera by the absence of secondary venation in the vegetative blades. The group including *Congregatocarpus* and *Neohypophyllum* is characterized by irregular arrangement of elongate medullary cells in the midribs, while *Mikamiella* and *Yendonia* have a highly ordered arrangement of rectangular cells. Fertile samples of these algae are distinguished by localization of organs of reproduction: strictly on special proliferations in *Neohypophyllum* and *Mikamiella* and either on proliferations or scattered over the surface of ordinary blades in *Congregatocarpus* and *Yendonia* [2].

Nearly all genera are monotypic, i.e., represented by only one species except for *Mikamiella* that currently is considered to contain two species: *Mikamiella ruprechtiana* (A.D. Zinova) M.J. Wynne (= *Hypophyllum ruprechtianum* A.D. Zinova) and *M. dentata* (M.J. Wynne) M.J. Wynne (= *Hypophyllum dentatum* M.J. Wynne).

The only species of the genus *Neohypophyllum* is *N. middendorffii* (Ruprecht) M.J. Wynne (= *Delesseria middendorffii* Ruprecht) [3].

*Congregatocarpus* also became a monotypic genus after its re-examination by Wynne [4] who synonymized *Congregatocarpus kurilensis* (Ruprecht) M.J. Wynne and *Congregatocarpus pacificus* (Yamada) Mikami and recognized *Congregatocarpus aleuticus* (M.J. Wynne) Perestenko to be invalid name [4], stating that in fact the latter species belongs to the genus *Laingia* Kylin (L. *aleutica* M.J. Wynne).

The genus *Yendonia* previously contained three species: *Yendonia crassifolia* (Ruprecht) Kylin (= *Delesseria crassifolia* Ruprecht), *Yendonia commandorensis* (E.S. Sinova) A.D. Zinova (= *Delesseria commandorensis* E.S. Sinova) and *Yendonia japonica* Nagai. Now all of them are considered to be synonyms, with *Yendonia crassifolia* having priority [1,3]. *Y. crassifolia* resembles *Congregatocarpus kurilensis* in its vegetative state. But in *C. kurilensis* tetrasporangial sori are born on the surfaces of ordinary blades, not on special proliferations arising from the blades as in *Yendonia*. And vice versa, the cystocarps in *Congregatocarpus* are produced on special proliferations born in clusters on the surfaces of ordinary blades, while in *Yendonia* they are produced directly on primary blade surface [2,5]. *Yendonia crassifolia* is superficially most similar to *Mikamiella ruprechtiana*, and both spe-
cies have polystromatic blades which produce branches from the midribs [5]. In both genera the tetrasporangia are produced on special small proliferations. But these two genera can be distinguished by the production of the sexual organs (carpogonia and spermatangia) directly on the ordinary blades in *Yendonia* [6] and only on special proliferations in *Mikamiella* [6,7]. According to Perestenko [1] proliferations bearing tetrasporangia in *Mikamiella* are smaller than those bearing sexual organs.

From the time of publication of the original descriptions of the genera *Yendonia* [8] and *Mikamiella* [7], no new data extending their diagnoses have appeared in the literature. However, identification of the members of these genera, using available descriptions [1,5-7,9,etc.] is sometimes complicated. In this study we tried to find more reliable and constant features for correct identification of these two taxa, represented by both fertile and vegetative samples.

### 2. Materials and Methods

Algae involved in this study were collected by the authors in the western sector of Bering Sea, at the coasts of Eastern Kamchatka and Commander Islands during several expeditions from 1986 till 2011. The studied material contained mostly subtidal samples taken from the depths 1 - 19 m, in addition low intertidal and cast ashore plants were also examined. On the total we examined 53 herbarium samples of *M. ruprechtiana* (10 of them are presented in the Table 1) and 33 samples of *Y. crassifolia* (10 of them are presented in the Table 2).

The material was sectioned free-hand with a razor blade, placed in a drop of fresh water on a glass slide and examined using a light microscope “Olympus CX-31”. The sections were studied unstained. Samples of algae were photographed using “Olympus μ-5010” and “Olympus SZ-20” digital photo cameras. Photomicrographs

<table>
<thead>
<tr>
<th>Herbarium sample number</th>
<th>Date of collection</th>
<th>Location of collection</th>
<th>Depth</th>
<th>Fertility state</th>
</tr>
</thead>
<tbody>
<tr>
<td>2695</td>
<td>August 20, 1986</td>
<td>Commander Islands, Medny Island, Gladkovskaya Bay</td>
<td>3 - 4 m</td>
<td>vegetative</td>
</tr>
<tr>
<td>1532</td>
<td>August 25, 1986</td>
<td>Commander Islands, Bering Island, Lisinskaya Bay</td>
<td>6 - 7 m</td>
<td>cystocarpic</td>
</tr>
<tr>
<td>2702</td>
<td>September 11, 1986</td>
<td>Commander Islands, Bering Island, Podutynaya Bay</td>
<td>3 m</td>
<td>vegetative</td>
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<tr>
<td>2691</td>
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<td>Commander Islands, Bering Island, Toporkov Islet</td>
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<td>cystocarpic</td>
</tr>
<tr>
<td>1530</td>
<td>August 18, 1987</td>
<td>Commander Islands, Bering Island, Cape Vkhodnoi Rif</td>
<td>Cast ashore</td>
<td>spermatangial</td>
</tr>
<tr>
<td>1814</td>
<td>August 4, 1988</td>
<td>Commander Islands, Bering Island, Staraya Gavan’ Bay</td>
<td>Cast ashore</td>
<td>spermatangial</td>
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<tr>
<td>3286</td>
<td>July 17, 1991</td>
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<td>cystocarpic</td>
</tr>
<tr>
<td>3281</td>
<td>July 4, 1992</td>
<td>Commander Islands, Medny Island, Cape Bobrovyye Kamni</td>
<td>5 m</td>
<td>spermatangial</td>
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<tr>
<td>4855</td>
<td>July 27, 2011</td>
<td>South-eastern Kamchatka, Avacha Gulf, Spaseniya Bay</td>
<td>4 - 5 m</td>
<td>vegetative</td>
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<tr>
<td>4856</td>
<td>July 27, 2011</td>
<td>South-eastern Kamchatka, Avacha Gulf, Starichkov Island</td>
<td>16 m</td>
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<th>Location of collection</th>
<th>Depth</th>
<th>Fertility state</th>
</tr>
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<td>1898</td>
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<td>Cast ashore</td>
<td>vegetative</td>
</tr>
<tr>
<td>2105</td>
<td>August 20, 1988</td>
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<td>10 m</td>
<td>cystocarpic</td>
</tr>
<tr>
<td>2111</td>
<td>August 20, 1988</td>
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<td>12 - 13 m</td>
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<tr>
<td>2050</td>
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<td>19 m</td>
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</tr>
<tr>
<td>1994</td>
<td>August 22, 1988</td>
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<td>10 m</td>
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<td>August 28, 1988</td>
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<td>1874</td>
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<td>October 7, 1988</td>
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<td>cystocarpic</td>
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<tr>
<td>4854</td>
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<td>4 - 5 m</td>
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</tbody>
</table>
were made using a DCM-130 digital camera.

The studied material is kept in the unregistered Herbarium of Kamchatka Branch of the Pacific Geographical Institute, Petropavlovsk-Kamchatski, Russia.

3. Results and Discussion

As pointed out by different authors [1, 5-7, 9] *M. rupechtiana* outwardly similar to *Y. crassifolia* differs from the latter in larger sizes. For instance, the maximum height of *Yendonia* from St. Matthew Island is about 20 cm while the plants of *Mikamiella* can reach 50 cm in height [10]. As a result of examination of our collections it is shown that *Mikamiella* ([Figures 1, 2]) is quite comparable in size with *Yendonia* ([Figures 3, 4]). In fact *Yendonia* reaches larger sizes than it was specified earlier and in some cases is even larger than *Mikamiella*. Thus, this feature is not constant and does not help to distinguish these discussed taxa.

The anatomic structure of blades and midribs in the discussed genera are very similar as well as the structure of growing apices. Thus, the only feature for reliable distinguishing of these two genera was considered to be location of their reproductive organs. As was pointed out earlier in *Yendonia*, cystocarps are located on the main blades ([Figure 5]) while in *Mikamiella* they are produced on special small leaflets ([Figure 6]) developed along midribs and some lateral veins. In case of vegetative plants this approach cannot be applied for identification. But we have found data amending the description of the genus *Yendonia* that facilitate distinguishing even vegetative plants of this genus from *Mikamiella* samples. The essential undescribed earlier feature of *Y. crassifolia* is

![Figure 1. Mikamiella rupechtiana, cystocarpic, voucher sample # 1814, scale bar 9 cm.](image1)

![Figure 2. Mikamiella rupechtiana, cystocarpic, voucher sample # 3286, scale bar 8 cm.](image2)

![Figure 3. Yendonia crassifolia, cystocarpic, voucher sample # 2111, scale bar 6 cm.](image3)

![Figure 4. Yendonia crassifolia, vegetative, voucher sample # 1994, scale bar 8 cm.](image4)
the presence of light-refracting cells developing in a considerable number in the tissues of the blades and visible from the surface view (Figures 7, 8) and in cross section (Figure 9). These cells were observed by us in all authentically defined fertile plants of *Yendonia* (Figure 3) as well as in vegetative plants supposed to belong to the genus *Yendonia* (Figure 4). This feature was never observed in *Mikamiella*, namely, such cells are absent in all samples of *M. ruprechtiana* studied by us (Figures 10, 11).

In addition to our material from the Russian Pacific area we also examined a sample of *Yendonia* from St. Paul Island (Pribilof Islands, Alaska, USA) kindly loaned to us by Professor Paul Silva (University of California, Berkeley, USA). This alga also contained light-reflecting cells (Figure 12). It permits to suppose that this feature is typical of the members of the genus *Yendonia* irrespective of their geographical distribution.

Figure 5. *Yendonia crassifolia*, cystocarp (c) located on the surface of the main blade near veins, voucher sample # 2111, scale bar 200 μm.

Figure 6. *Mikamiella ruprechtiana*, cystocarps (c) located on the surface of special leaflets, voucher sample # 3286, scale bar 500 μm.

Figure 7. *Yendonia crassifolia*, cystocarpic, surface view of the main blade with abundant light-refracting cells (arrowheads), voucher sample # 2111, scale bar 150 μm.

Figure 8. *Yendonia crassifolia*, tetrasporic, surface view of the main blade with abundant light-refracting cells (arrowheads), voucher sample # 1874, scale bar 250 μm.

Figure 9. *Yendonia crassifolia*, cystocarpic, cross section of the main blade with light-refracting cells (arrows), voucher sample # 2111, scale bar 25 μm.

Figure 10. *Mikamiella ruprechtiana*, surface view of the main blade, no light-refracting cells, voucher sample # 3286, scale bar 50 μm.

Figure 11. *Mikamiella ruprechtiana*, cross section of the main blade, no light-refracting cells, voucher sample # 3286, scale bar 50 μm.
As a matter of fact, we cannot explain why this diagnostic feature that helps to distinguish samples of two similar genera of the Delesseriaceae (*Mikamiella* and *Yendonia*) was hitherto overlooked by other researchers. However the presence of light-refracting (so-called glandular) cells are observed in *Phycodrys* Kützing. Most abundant glandular cells are observed in *P. vinogradovae* Perestenko et Gussarova in Perestenko [11]. At the same time other species of the genus *Phycodrys* lack these cells, for instance, *P. amchitkensis* Wynne [6] and *P. valentinae* Selivanova et Zhigadlova [12]. It should be noted that this feature is unstable in some species, its variability in *P. rubens* (Hudson) Batters was discussed by Tokida [13]. Still it remains uncertain whether samples of *P. rubens f. quercifolia* (Turner) Newton in Tokida’s interpretation that contained glandular cells and those devoid of them represented one and the same species.

As it is known *Yendonia* was placed in the *Phycodrys* group by Wynne [5,6]. We suppose that the presence of light-refracting cells is inherent for some members of the group (in our case—*Yendonia*) and absent in the others (in our case—*Mikamiella*), and this rule is more constant for *Yendonia* and *Mikamiella* than it is observed in different species within the genus *Phycodrys*.

It is necessary to note that despite long-term research work on the Commander Islands, we did not succeed in finding any plants of *Y. crassifolia* there, while *M. ruprechtiana* was met rather frequently. It is probable that *Yendonia* has disappeared from the flora of this area. It is also not excluded that records on the growth of *Yendonia* on the Commander Islands [14,15] were based on misidentifications. The opposite situation is observed on the coasts of the eastern Kamchatka: *Y. crassifolia* is rather abundant in the Bering Sea, whereas *M. ruprechtiana* was found by us in a small number only in Avacha Gulf (south-eastern Kamchatka) (samples 4855, 4856, Table 1).

4. Conclusion

Thus, in our opinion, it is necessary to make the follow-

ing additions in the diagnostic keys of the genera under discussion: — the presence of light-refracting cells in the blades of *Yendonia* (in both vegetative and fertile plants); — the absence of those in *Mikamiella* [16].

5. Acknowledgements

The authors are very grateful to Professor Michael Wynne (University of Michigan Herbarium, Ann Arbor, Michigan, USA) for critical reading of the draft manuscript. We also express our sincere gratitude to Professor Paul Silva (University of California, Berkeley, USA) for the loan of herbarium samples of *Yendonia* from the eastern sector of the Pacific area.

REFERENCES


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