American Journal of Plant Sciences, 2013, 4, 2455-2460
Published Online December 2013 (http://www.scirp.org/journal/ajps)
http://dx.doi.org/10.4236/ajps.2013.412305

Scientific Research

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

Olga N. Selivanova, Galina G. Zhigadlova

Kamchatka Branch of the Pacific Geographical Institute, Far Eastern Division of the Russian Academy of Sciences, Petropavlovsk-Kamchatskii, Russia.
Email: oselivanova@mail.ru

Received October 14th, 2013; revised November 16th, 2013; accepted December 1st, 2013

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 1. Examined samples of *Mikamiella ruprechtiana.*

Herbarium sample number	Date of collection	Location of collection	Depth	Fertility state
2695	August 20, 1986	Commander Islands, Mednyi Island, Gladkovskaya Bay	3 - 4 m	vegetative
1532	August 25, 1986	Commander Islands, Bering Island, Lisinskaya Bay	6 - 7 m	cystocarpic
2702	September 11, 1986	Commander Islands, Bering Island, Podutyosnaya Bay	3 m	vegetative
2691	September 19, 1986	Commander Islands, Bering Island, Toporkov Islet	1 m	cystocarpic
1530	August 18, 1987	Commander Islands, Bering Island, Cape Vkhodnoi Rif	Cast ashore	spermatangial
1814	August 4, 1988	Commander Islands, Bering Island, Staraya Gavan' Bay	Cast ashore	cystocarpic
3286	July 17, 1991	Commander Islands, Bering Island, Poludennaya Bay	5 m	cystocarpic
3281	July 4, 1992	Commander Islands, Mednyi Island, Cape Bobrovyie Kamni	5 m	spermatangial
4855	July 27, 2011	South- eastern Kamchatka, Avacha Gulf, Spaseniya Bay	4 - 5 m	vegetative
4856	July 27, 2011	South-eastern Kamchatka, Avacha Gulf, Starichkov Island	16 m	vegetative

Table 2. Examined samples of *Yendonia crassifolia.*

Herbarium sample number	Date of collection	Location of collection	Depth	Fertility state
1898	August 19, 1988	Bering Sea, Karaginskii Gulf, Karaginskii Island, Cape Tonos	Cast ashore	vegetative
4853	August 19, 1988	Bering Sea, Karaginskii Gulf, Karaginskii Island, Cape Tonos	10 m	cystocarpic
2105	August 20, 1988	Bering Sea, Karaginskii Gulf, Cape Kekurnyi	12 - 13 m	vegetative
2111	August 20, 1988	Bering Sea, Karaginskii Gulf, Cape Kekurnyi	19 m	cystocarpic
2050	August 21, 1988	Bering Sea, Karaginskii Gulf, Karaginskii Island	10 m	vegetative
1994	August 22, 1988	Bering Sea, Olyutorskii Gulf, Lavrova Bay	10 m	vegetative
1895	August 28, 1988	Pacific Ocean, Kamchatskii Gulf, Kamenistaya Bay	4 - 5 m	vegetative
1874	October 7, 1988	Bering Sea, Ozernoi Gulf, Cape Yuzhnyi—Cape Dvoinoi	Cast ashore	tetrasporic
1892	October 7, 1988	Bering Sea, Ozernoi Gulf, Cape Yuzhnyi—Cape Dvoinoi	Cast ashore	cystocarpic
4854	July 27, 2011	South-eastern Kamchatka, Avachinskii Gulf, Spaseniya Bay	4 - 5 m	cystocarpic

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-Kamchatskii, Russia.

3. Results and Discussion

As pointed out by different authors [1,5-7,9] *M. ruprechtiana* 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,

Figure 1. *Mikamiella ruprechtiana*, cystocarpic, voucher sample # 1814, scale bar 9 cm.

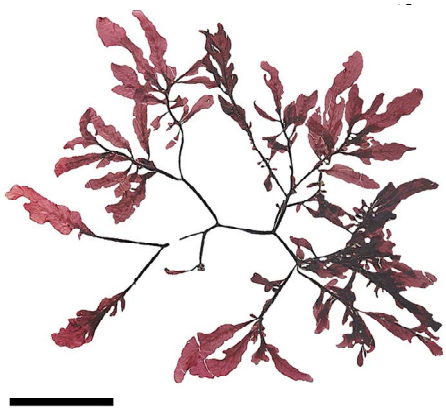

Figure 2. *Mikamiella ruprechtiana,* cystocarpic, voucher sample # 3286, scale bar 8 cm.

Figure 3. *Yendonia crassifolia*, cystocarpic, voucher sample # 2111, scale bar 6 cm.

Figure 4. *Yendonia crassifolia*, vegetative, voucher sample # 1994, scale bar 8 cm.

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

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.

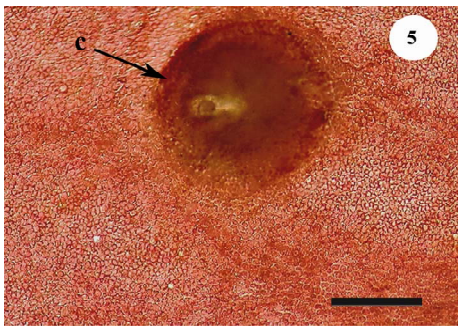

Figure 5. *Yendonia crassifolia*, cystocarp (c) located on the surface of the main blade near veins, voucher sample # 2111, scale bar 200 µm.

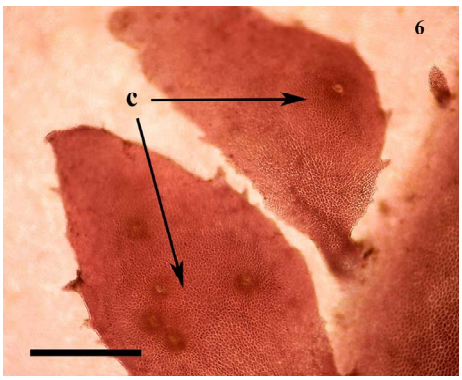

Figure 6. *Mikamiella ruprechtiana*, cystocarps (c) located on the surface of special leaflets, voucher sample # 3286, scale bar 500 µm.

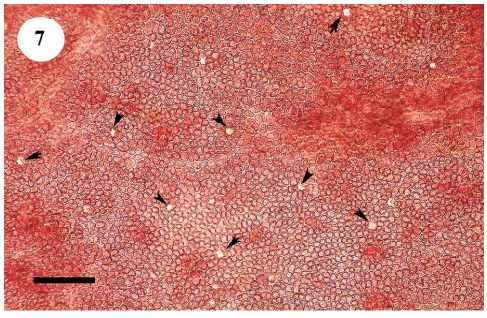

Figure 7. *Yendonia crassifolia*, cystocarpic, surface view of the main blade with abundant light-refracting cells (arrowheads), voucher sample # 2111, scale bar 150 µm.

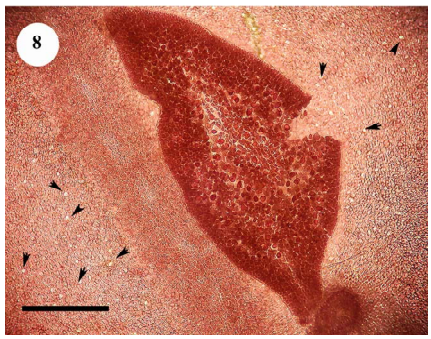

Figure 8. *Yendonia crassifolia*, tetrasporic, surface view of the main blade with abundant light-refracting cells (arrowheads), voucher sample # 1874, scale bar 250 µm.

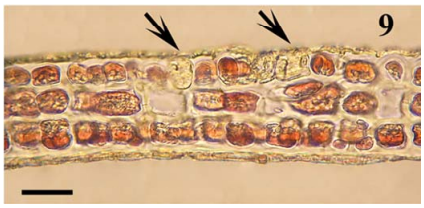

Figure 9. *Yendonia crassifolia*, cystocarpic, cross section of the main blade with light-refracting cells (arrows), voucher sample # 2111, scale bar 25 µm.

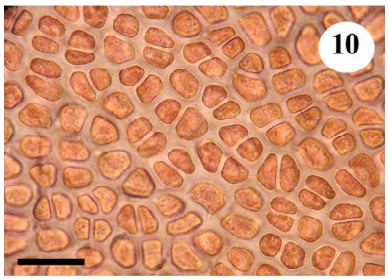

Figure 10. *Mikamiella ruprechtiana*, surface view of the main blade, no light-refracting cells, voucher sample # 3286, scale bar 50 µm.

Figure 11. *Mikamiella ruprechtiana*, cross section of the main blade, no light-refracting cells, voucher sample # 3286, scale bar 50 µm.

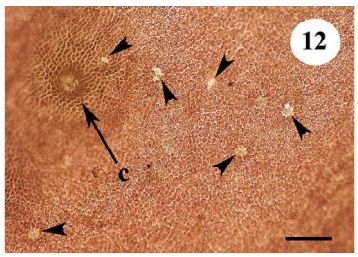

Figure 12. *Yendonia crassifolia* from St. Paul Island (Alaska, USA), surface view showing the presence of light reflecting cells, scale bar 100 µm.

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 in the tissues of the plants is also observed in some species of another morphologically related genus of this family—*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 following 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

[1] L. P. Perestenko, "Krasnye Vodorosli Dal'nevostochnykh Morei Rossii (Red Algae of the Far Eastern Seas of Russia)," "Olga" Publishing House, St. Petersburg, 1996 [for 1994] (In Russian).

[2] M. J. Wynne, "Records and Notes on Alaskan Marine Algae III," *Contributions from the University of Michigan Herbarium*, Vol. 17, 1990, pp. 335-343.

[3] M. D. Guiry and G. M. Guiry, "AlgaeBase. World-Wide Electronic Publication," National University of Ireland, Galway, 2013. http://www.algaebase.org

[4] M. J. Wynne, "Re-Examination of the Type of *Delesseria kurilensis* Ruprecht (Delesseriaceae, Rhodophyta)," *Algae*, Vol. 20, No. 4, 2005, pp. 271-278. http://dx.doi.org/10.4490/ALGAE.2005.20.4.271

[5] M. J. Wynne, "The Current Status of Genera in the Delesseriaceae (Rhodophyta)," *Botanica Marina*, Vol. 26, No. 9, 1983, pp. 437-450. http://dx.doi.org/10.1515/botm.1983.26.9.437

[6] M. J. Wynne, "Marine Algae of Amchitka Island (Aleutian Islands). I. Delesseriaceae," *Syesis*, Vol. 3, No. 1-2, 1970, pp. 95-144.

[7] M. J. Wynne, "*Mikamiella*, a New Genus of Delesseriaceae (Rhodophyta) from the North Pacific," *Bulletin of the Japanese Society for Phycology*, Vol. 25, 1977, pp. 395-402.

[8] H. Kylin, "Zur Nomenklatur Einiger Delesseriaceen," *Fysiografiska sällskapet. Förhandlingar*, Vol. 5, No. 2-3, 1935, pp. 1-5.

[9] A. D. Zinova, "Species Familiae Delesseriacearum (Rhodophyta) in Parte Septentrionali Oceani Pacifici (Representatives of the Family Delesseriaceae (Rhodophyta) in the Northern Part of the Pacific Ocean)," *Novitates Systematicae Plantarum non Vascularium* (*News of Systematics of Spore Plants*), Vol. 2, 1965, pp. 78-97 (In Russian).

[10] M. J. Wynne and J. N. Heine, "Collections of Marine Red Algae from St. Matthew and St. Lawrence Islands, the Bering Sea," *Nova Hedwigia*, Vol. 55, No. 1, 1992, pp. 55-97.

[11] L. P. Perestenko, "De genere *Phycodrys* Kütz. et Pro-

prietatibus eius Notula (The Genus *Phycodrys* Kütz. and Its Characteristic Features)," *Novitates Systematicae Plantarum non Vascularium* (*News of Systematics of Spore Plants*), Vol. 20, 1983, pp. 45-51 (In Russian).

[12] O. N. Selivanova and G. G. Zhigadlova, "*Phycodrys valentinae* sp. nov. (Delesseriaceae, Rhodophyta) with Discussion of Other Species of the *Phycodrys* Genus from the North Pacific," *Russian Journal of Marine Biology*, Vol. 29, No. 4, 2003, pp. 206-215. http://dx.doi.org/10.1023/A:1025424607854

[13] J. Tokida, "The Marine Algae of Southern Saghalien," *Memoirs of the Faculty of Fisheries Hokkaido University*, Vol. 2, No. 1, 1954, pp. 1-264.

[14] E. A. Kardakova-Prejentzoffa (Prezhentsova), "The Seaweeds of Commandor Islands," *Izvestia TINRO*, Vol. 14, 1938, pp. 77-108 (In Russian).

[15] S. Sinova, "The Algae of the Commander Islands," *Trudy Tikhookeanskogo Komiteta* (*Proceedings of the Pacific Committee*), *Academy of Sciences of the USSR*, No. 5, 1940, pp. 165-243 (In Russian).

[16] G. G. Zhigadlova, "Additional Morphological Criterion for Distinguishing Two Close taxa *Mikamiella* Wynne and *Yendonia* Kylin (Delesseriaceae, Rhodophyta)," *Proceedings of International Scientific Conference Modern Problems of Algology*, Rostov-on-Don, 9-13 June 2008, pp. 150-151 (In Russian).