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Sorella pulchra (Yamada) comb. nov., based on *Erythroglossum pulchrum* Yamada (Delesseriaceae, Rhodophyta)

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Erythroglossum pulchrum Yamada is shown to have *Polyneura*-type procarp structures, consisting of two carpogonial branches and one group of sterile cells on a supporting cell. The type species of the genus *Sorella, S. delicatula* (Gardner) Hollenberg also shows the *Polyneura*-type procarp. Most characteristics of *E. pulchrum are* shared with *Sorella*. It is concluded that *E. pulchrum* should be transferred to *Sorella* as *S. pulchra* comb. nov. The procarp arrangement in illustrations of *Searlesia* Schneider et Eiseman agrees also with that of the *Polyneura*-type. The transfer of *Searlesia subtropica* to *Polyneura* is thus proposed.

Key Index Words: Delesseriaceae—Erythroglossum pulchrum—Polyneura subtropica—*Rhodophyta—procarp structure*—Searlesia—Sorella delicatula—Sorella pulchra—*taxonomy*.

Erythroglossum pulchrum, a species belonging to the red algal family Delesseriaceae, was described by Yamada (1938) based on specimens collected at Hayama, Kanagawa Prefecture and sent from the Biological Laboratory, Imperial Palace. The specimens were all tetrasporophytes. There is no further record of this taxon. Recently, a new collection including female gametophytes was obtained from Kanagawa Prefecture, near the type locality. New information on this collection is presented here, and a comparison is made with the female structures of *Sorella delicatula*, the type species of the genus *Sorella*. It is concluded that *Erythroglossum pulchrum* should be placed in *Sorella*.

Materials and Methods

The specimens of *Erythroglossum pulchrum* were collected by SCUBA diving by S. Arai on 14 January 1988 off Akiya, Kanagawa Prefecture, Pacific central Japan. The plants grew between 3 to 10 meters deep as undergrowths in the *Ecklonia* forest. Specimens of *Sorella delicatula* (Gardner) Hollenberg, collected at Point Loma, California, were kindly provided by Dr. Joan Stewart. The materials were preserved in formalin sea water. Microscopic slides for observation were made by mounting in glycerine after staining with aniline blue. Sections were made by hand with a razor blade. Voucher specimens are deposited in the herbarium of Faculty of Science, Hokkaido University (SAP).

Observations

Erythroglossum pulchrum Yamada

External morphology: Female gametophytes as shown in Figure 1 are similar to the tetrasporangial plants described in the protologue (Yamada, 1938) in external morphology. Figure 2 shows an apical part of the thallus with young cystocarps (cy).

Apical organization: Figure 3 represents a young growing apex. It has an apical cell (a) dividing transversely. Intercalary divisions (i) are recognized in the primary cell row. Young procarps are located near the primary cell row.

Procarp: Procarps of this species are scat-

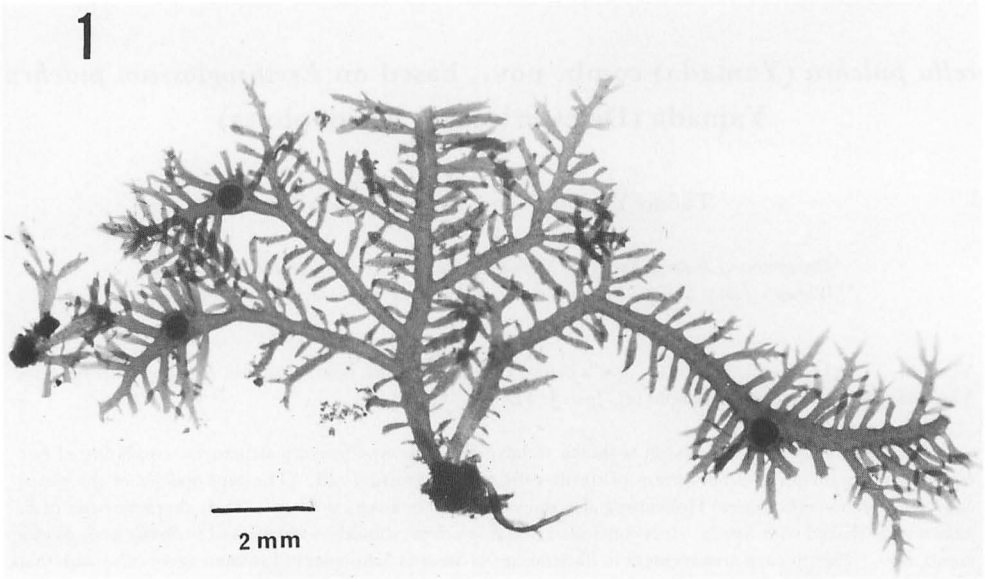

Fig. 1. Female specimen of *Sorella pulchra* (Yamada) comb. nov. collected from Akiya, near Hayama, Kanagawa Prefecture, January 14, 1988.

tered in the apical region of the branches (Fig. 3). They are composed of one group of sterile cells associated with two carpogonial branches originating from the supporting cell (sc). The development of this type of procarp, *Polyneura*-type (Kylin, 1924), is shown in Figures 4–9. Figure 4 indicates that the initial of the supporting cell (sci) cuts off a sterile cell mother cell (stmc) and laterally a mother cell of the first carpogonial branch ($cbmc_1$). The mother cell of the first carpogonial branch divides further (Fig. 5) to form a first cell of carpogonial branch (cb_1) and an initial of carpogonial branch (cbi), and the mother cell of the second carpogonial branch ($cbmc_2$) is cut off from the other side of the supporting cell. These two carpogonial branches are composed of 2 cells in Figure 6 and of 3 cells in Figure 7. At this stage, the sterile cell mother cell undergoes a division and becomes 2 cells (stc). Following two further divisions are shown in Figures 8 and 9. Here the sterile cells form a set of 4 cells and become enlarged with much nutrient material, and attached adjacent to them are the 2 carpogonial branches composed of 4 cells each with a carpogonium bearing a trichogyne (tr). In some cases, a group of sterile cells composed of 8 cells was observed.

Cystocarp: Only one cystocarp usually develops from a group of procarps formed together. Accordingly, a small number of cystocarps developed on an individual. Mature cystocarps measure 480–550 μm in diameter, nearly corresponding to the breadth of branch (Fig. 1). Figure 10 shows gonimoblast filaments in a younger cystocarp, and a cross section of nearly mature cystocarp is given in Figure 11. A large fusion cell (fu) is formed at the base and gonimoblast filaments with short segments radiate from the fusion cell. Carposporangia (ca) are formed in

Fig. 2–11. *Sorella pulchra* (Yamada) comb. nov. 2. A part of frond with young cystocarps. 3. Apex of frond showing apical segmentation and young procarps. 4–9. Stages in development of procarp in surface view. 10. Early stage in development of gonimoblasts. 11. Cross section of a cystocarp. Numerals 1–6, first-order cell row (primary segments produced by an apical cell division); a, apical cell; ca, carposporangium; cb_1, cb_2, cb_3, first, second and third cells of carpogonial branch; cbi, initial cell of carpogonial branch; $cbmc_1$, $cbmc_2$, first and second mother cells of carpogonial branch; cp, carpogonium; cy, cystocarp; fu, fusion cell; gon, gonimoblast; i, secondary cell produced by intercalary division; po, aperture of cystocarp; sc, supporting cell; sci, initial cell of supporting cell; stc, steril cell; stmc, mother cell of steril cell; tr, trichogyne.

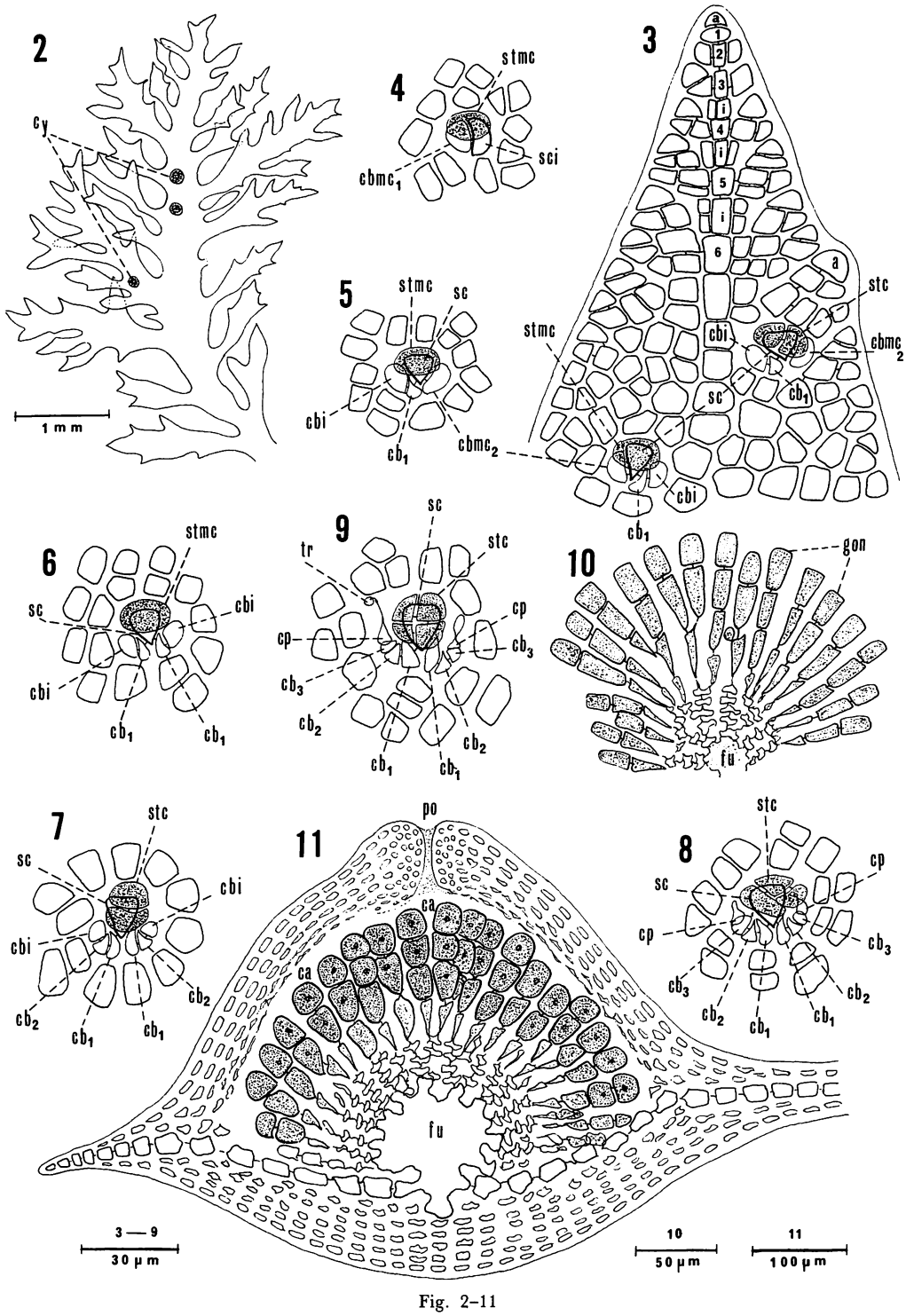
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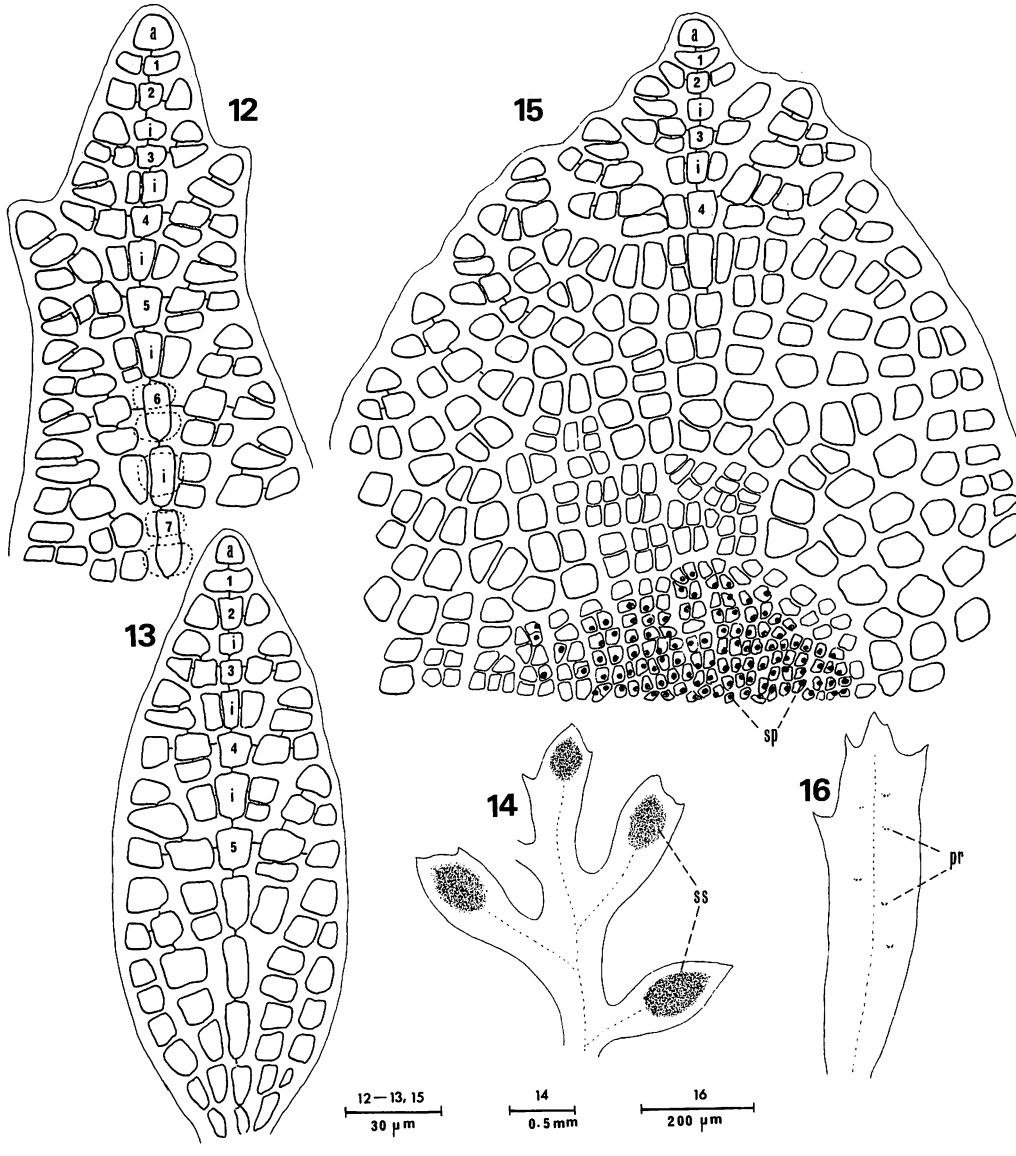
Fig. 2–11



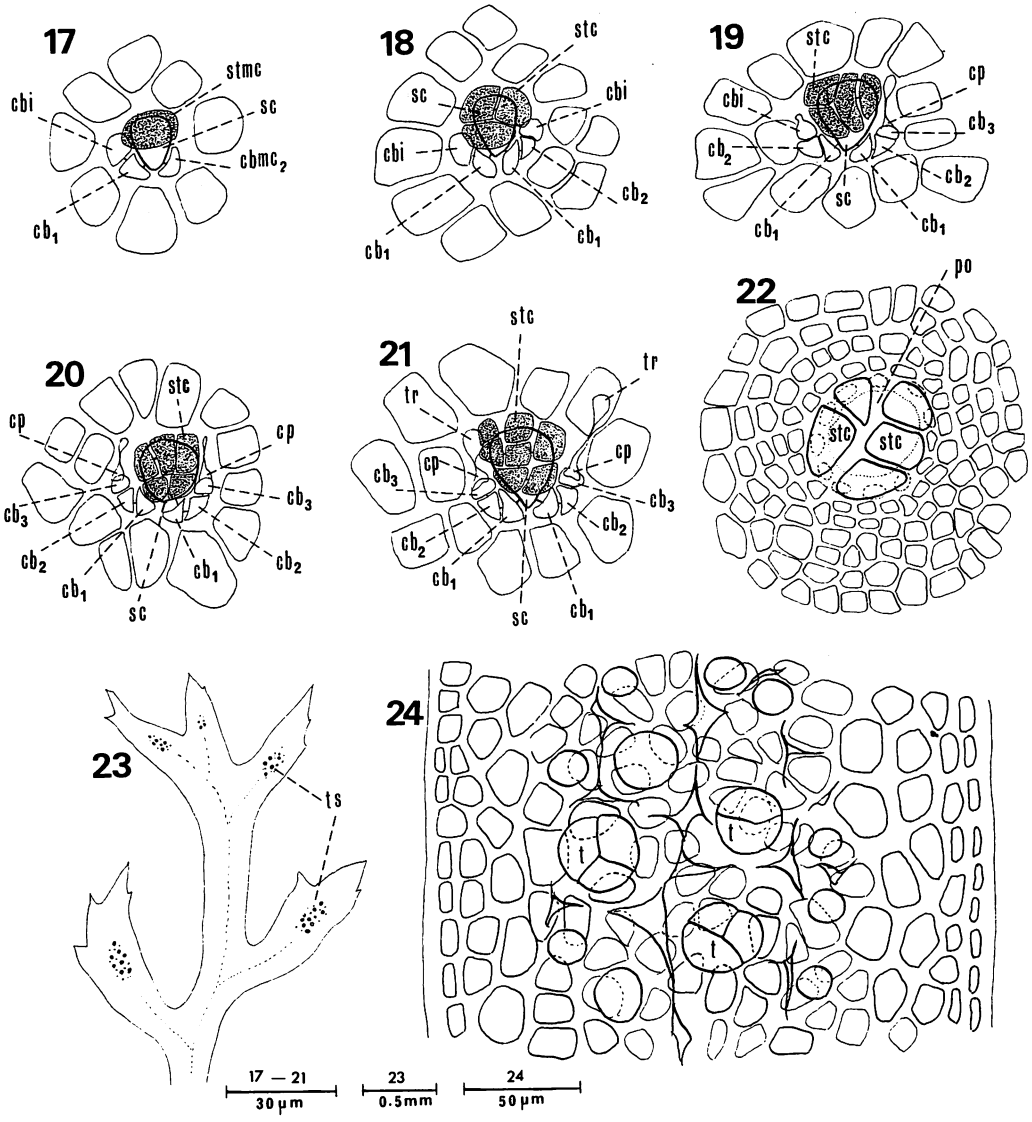
Figs. 12–16. *Sorella delicatula* (Gardner) Hollenberg. 12–13. Apex of frond showing apical segmentation. 14–15. Spermatangial sori (ss). 16. Apical portion of female frond showing the position of procarps (pr). For abbreviations see Figs. 2–11.

short chains on the distal parts of gonimoblasts. Carposporangia are 22–33 × 42–50 μm in size. Cytocarps are hemispherical in shape with an ostiole (po) on the center elevated from the surface of the branch. Because the female plants are decumbent in habit, cystocarps are usually developed on one side of the thallus.

Sorella delicatula (Gardner) Hollenberg

Apical organization: As shown in Figures 12, 13 and 15, this species has a transversely dividing apical cell (a). Intercalary divisions (i) are frequent in the cell rows of first order.

Reproductive structures: Procarps are scattered on the apical part of the branches as shown in Figture 16. Figure 17 represents an early stage in the development of the



Figs. 17–24. *Sorella delicatula* (Gardner) Hollenberg. 17–21. Stages in development of procarp in surface view. 22. Surface view of young cystocarp. 23. A part of frond with tetrasporangial sori (ts). 24. Surface view of tetrasporangial sorus. t, tetrasporangium. For abbreviations see Figs. 2–11.

procarp. Here a supporting cell cuts off a mother cell of sterile cell (stmc) and a carpogonial branch on one side and a mother cell of another carpogonial branch ($cbmc_2$) on the opposite side. The mother cell of sterile cell has divided twice to form a group of 3 cells, although carpogonial branches remain immature (Fig. 18). Figures 20 and 21 show mature stages of procarps with a group of sterile cells containing up to 7 cells and a pair of 4-celled carpogonial branches.

Spermatangial sori are oval to long elliptical in outline and located on the central region of the blade (Fig. 14).

Tetrasporangial sori are formed in similar position as spermatangial sori (Fig. 23). Tetrasporangia are cut off from the primary cells, spherical in shape and dividing tetrahedrally.

Discussion

Hollenberg (1943) established a new genus *Sorella* based upon *Erythroglossum delicatulum* Gardner and named as the type species *Sorella delicatula*. He stated that *Erythroglossum* had tetrasporangial sori formed along the margins of the thallus (Kylin, 1924) and *Sorella* was distinguished from it by the central position of sori. He failed to give detailes of the female reproductive structures. At the same time, he transferred *Erythroglossum repens* Okamura to *Sorella* as *S. repens* (Okamura) Hollenberg. I. Yamada (1971), in his work on the reproductive structure of *S. repens*, verified the characteristics of tetrasporangial and spermatangial sori pointed out by Hollenberg for *Sorella*. He made clear the structure of the procarp in the genus *Sorella* for the first time, showing that *E. repens* had the procarp characteristics of *Polyneura*-type as defined by Kylin (1924), in that the procarps were dispersed on the thallus surface and composed of only one set of sterile cell group and 2 carpogonial branches born on the same supporting cell. Stewart (1977) observed reproductive structures in *S. delicatula*, stating that the procarp organization "appeared similar to those described for *S. repens*" by I. Yamada (1971). We confirmed and showed details of procarp development.

Mikami (1987), after examining the holotype (SAP 048988) and a syntype (SAP 048986) of *Erythroglossum pulchrum* Yamada, recognized that this species had tetrasporangial and spermatangial sori formed on the central area of the branchlets, conforming to the *Sorella*-type. He stated that it was too early to decide the taxonomic status of this species because there was no information on the female plants. But through the observation on the female individuals newly discovered and collected, the procarp of this species is now shown to be of the *Polyneura*-type as demonstrated above.

It is well understood that the type of procarp structure is one of the important characteristics at generic level in this family, in that in a given genus all species have the same type of procarp structure. Among the genera of the Nitophylloideae, the taxa that have been shown to have procarps of *Polyneura*-type organization are *Sorella repens* (Yamada 1971), *S. delicatula* (Stewart 1977 and our observation), *Erythroglossum minimum* (Mikami 1976) and *E. pinnatum* (Mikami 1977), other than the species of *Polyneura*.

In this connection, ***Searlesia*** (Schneider & Eiseman 1979), described from the western Atlantic, was reported to have a procarp structure resembling the *Phycodrys*-type. This type differs principally from the *Polyneura*-type in the posession of 2 groups of sterile cells and a carpogonial branch on a supporting cell (Kylin 1956). From a careful examination of figures given in their paper (figs. 5-11), however, the procarp structure of *Searlesia* is certainly of *Polyneura*-type and not to be interpreted as *Phycodrys*-type. The structure interpreted as the first sterile cell group (stg_1) in their figs. 8 and 9 is none other than the second carpogonial branch, and the second sterile cell group (stg_2) in their fig. 11 is clearly the superimposed image of the carpogonial branch formed on the ventral side of the thallus, i.e. there is only one group of sterile cells. Therefore we conclude that they misinterpreted the procarp structure, especially the relative position of the carpogonial branch and sterile cell group in *Searlesia*. Since the procarp structure of *Membranoptera subtropica* Schneider (Schneider and Eiseman 1979) is here shown to be of the *Polyneura*-type, and characteristics of apical organization and tetrasporangial sori are also the same as those of the genus *Polyneura*, there is no need to establish the genus *Searlesia*, and this species can be accomodated in the genus *Polyneura* as *P. subtropica* (Schneider) comb. nov. (Basionym: *Membranoptera subtropica* Schneider, 1974: 1097; synonym: *Searlesia subtropica*).

In this paper, *Sorella delicatula* (Gardner) Hollenberg, the type species of *Sorella*, is shown to have the procarp structure of *Polyneura*-type.

From the viewpoint of all considered characteristics, *Erythroglossum pulchrum* is concluded to be placed in *Sorella*. Therefore we propose

the following combination:

Sorella pulchra (Yamada) Yoshida et Mikami, comb. nov.

Basionym: *Erythroglossum pulchrum* Yamada 1938: 124. *pl. 24, f. 1.*

Acknowledgements

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吉田忠生*・三上日出夫**：紅藻コノハノリ科クシノハウスベニ

***Sorella pulchra* (Yamada) comb. nov.**

神奈川県葉山沖で新たに採集されたクシノハウスベニの雌性体で，プロカルプが *Polyneura* 型であることが明らかになり，既知の精子嚢斑，四分胞子嚢斑の位置や生長点構造からクシノハウスベニは *Sorella* 属に移すべきであると結論された。これまで知られていなかった *Sorella delicatula* (Gardner) Hollenberg についてもプロカルプが *Polyneura* 型であることを示した。大西洋産の *Searlesia* 属のプロカルプについては原著者等の解釈に誤りがあることを指摘し，その結果この属を認めず，タイプ種は *Polyneura subtropica* とすべきことを提案する。(*060 札幌市北区北10条西 8 丁目　北海道大学理学部植物学教室，**062 札幌市豊平区西岡3-7-3-1 札幌大学女子短大部)