Floral and Ecological Features of *Eriocaulon atrum* Nakai and Its Close-Allies in Yakushima Island, Southern Japan

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*Eriocaulon atrum* and its allied species were studied on Yakushima Island, based on floral and ecological features. *Eriocaulon hananoegoense* Masam., which being known as endemic to Yakushima Island, is not distinguished from *E. atrum*. The occurrence of *E. kiusianum* Maxim. in Yakushima Island is reported for the first time. *Eriocaulon atrum* and *E. kiusianum* have different ecological features.

**Key words:** Eriocaulon, Eriocaulaceae, Yakushima Island.

*Eriocaulon atrum* Nakai is characterized by the connate sepals, the involucral bracts shorter than the head, and the blackish bracts and calyces. In Yakushima Island, *E. atrum* grows in bogs or marsh places in sites at elevations of 1500 m or more. Masamune (1929) was the first botanist who noticed it in Yakushima Island, and determined it as *E. atrum* Nakai. Later he regarded it as an endemic species of the island and named it *E. hananoegoense* (Masamune 1934). Satake (1940, 1941 and 1982) distinguished *E. hananoegoense* from *E. atrum* by the presence of glandular hairs composed of two cells on the outer apical portion of bracts of staminate flowers, the obtuse apex of the median calyx lobe of pistillate flowers and the glabrous receptacle. However, these characters in the other species are insufficient as diagnostic characters because of their instability and variability (Miyamoto and Ohba 2000), and *E. hananoegoense* was treated as the synonym of *E. atrum* by Miyamoto and Ohba (1998), while in Yakushima Island, there is an *Eriocaulon* that is not yet known.

The paper aims to provide floral and ecological features to make clear taxonomic problems of *Eriocaulon* in Yakushima Island.

**Materials and Methods**

Sampling covered 23 populations from five different localities in Yakushima Island, Kagoshima Pref., and in order to clarify taxonomic positions, collections were done at Homan-cho, Fukuoka Pref., Mt. Kirishima, Miyazaki Pref., Mt. Kuju, Oita Pref., Kyushu (Table 1). All materials were collected from 50 × 50 cm quadrates, and they were pressed and dried. In this paper each quadrate is regarded as a single population. Floral morphological features were represented by all flowers in a head of the longest scape in each of all the individuals. They were observed under a binocular microscope with camera lucida. Voucher specimens are deposited in the Herbarium of the
Involucral bract
PBW PCW
Staminate flower
SBW SCW SPW
SL
"¯M"¯wFF
Pistillate flower
Fig. 1. Parts measured: 1) H: Width of head. 2) IL: Length of involucral bract. 3) IW: Width of involucral bract. Pistillate flower. 4) PBL: Length of bract. 5) PBW: Width of bract. 6) PCL: Length of calyx. 7) PCW: Width of calyx. 8) PPL: Length of petal of central part. 9) PPW: Width of petal of central part. 10) PPLL: Mean length of petal of lateral part. 11) PPLW: Mean width of petal of lateral part. Staminate flower. 12) SBL: Length of bract. 13) SBW: Width of bract. 14) SCL: Length of calyx. 15) SCW: Width of calyx. 16) SPL: Length of petal. 17) SPW: Width of petal. 18) SL: Length of the longest scape in each individual.

University of Tokyo (TI).

For investigating variation, measurements and sketches were done in 265 individuals, of which 180 (in 23 populations) were from Yakushima Island, 30 (in two populations) from Homan-cho, 25 (in two populations) from Mt. Kirishima and 30 (in two populations) from Mt. Kuju.

Eighteen floral characters were measured (Fig. 1). Observations were also made of the hairiness of receptacles, calyces and petals of pistillate flowers, and the glandular hairs on bracts, calyces and petals of both staminate and pistillate flowers.

Ecological and individual disposition of *Eriocaulon* was surveyed in a 100 × 20 cm quadrate at Shohananoego moor (alt. 1600 m) in Yakushima Island.

Result

Principal component analysis

The cumulative variance of the first three principal components and loadings of eighteen floral characters are shown in Table 2. The first to third principal components contained 79 % of the total variance. The first component accounted for 66 % of the total variance. Characters with heavy loadings in the first component were all characters except for SL, especially PCL, PPL, PPLL and SCL had loadings above 0.9 (abbreviation indicated in Fig. 1). These characters were length characters in the flower. The second component accounted for 9 % of the total variance. SL loading expressing plant size was heavy in the second component. The third component accounted for 4 % of the total variation, however, all characters had
negative loading.

The scatter diagram of the first principal component to the second (Fig. 2) shows that *Eriocaulon* had wide range of variations both in the first and second components. However, they were clearly segregated two dimensions, of right and left sides by first component. The populations in Yakushima Island (92001, 92002, 92005, 92007, 92014, 92017, 92021, 92023, 92026, 92032, 92033, 92040 and 92048) and Mt. Kuju (92066, 92067) were concentrated on the right side. The Yakushima Island (92002, 92005, 92007, 92015, 92018, 92022, 92027, 92028, 92034, 92036 and 92049), Homan-cho (92108 and 92112) and Mt. Kirishima (92101 and 92102) were concentrated on the left side (Fig. 2).

**Floral morphology**

Figures 3 and 4 show variations of floral features within a single population at Nageishi moor (Fig. 3) and Shohananoego moor (Fig. 4). The number of flowers within a single head varied between 4 and 16. The heads were turbinate (Figs. 3A, 4A). The involucral bracts were apparently shorter than the flowers or nearly the same in length and ovate to elliptic in shape (Figs. 3B, 4B). The shape of bracts on pistillate flowers was ovate to obovate (Figs. 3C and 4C) and that of staminate flowers was oblanceolate (Figs. 3D and 4D).

Calyces in pistillate flowers were elliptic to obovate in shape and those of staminate flowers were oblongolate in shape. The calyces of both pistillate and staminate flowers were always trifid with blackish apices (D, H in Figs. 3, 4). The median calyx lobes were always acute. The median petals of pistillate flowers were apparently clawed (here named clawed type; Fig. 3E) or sessile (named sessile type; Fig. 4E). These were constant and stable in each population. The clawed type occurred in 92001, 92006, 92013, 92014, 92017, 92021, 92023, 92026, 92032, 92033, 92040 and 92048. The sessile type occurred in 92002, 92005, 92007, 92015, 92018, 92022, 92027, 92028, 92034, 92036 and 92049. The corollas of staminate flowers were tubular with a trifid apex. (Figs. 3I, 4I). The petals and calyx of pistillate flowers were hairy (Figs. 3D, E, F) or glabrous to almost glabrous on their abaxial side (Figs. 4D, E, F). The indumenta on receptacles varied from hairy to glabrous. Sometimes glandular hairs were observed on the apical part of the bracts of staminate flowers. *Eriocaulon* from the populations of Mt. Kuju was the clawed type and those from Homan-cho and Mt. Kirishima was the sessile type. Both clawed and sessile types were found in all localities in Yakushima Island.

**Individual disposition of *Eriocaulon* in Yakushima Island**

Figure 5 shows individual disposition in a 100 × 20 cm quadrate. The water depth of...
the moor reached 24 cm. Seventy eight individuals of *Eriocaulon* were found from the marsh to the submerged slopes in the quadrate. The length of scape varied from 4 cm to 24 cm, and 37 individuals of the sessile type varied from 8 cm to 24 cm, while 41 individuals of the clawed type were from 4 cm to 8 cm long (Fig. 5).

**Discussion**

The clawed type and the sessile type are quite distinct and distinguished from one another by the shape of the petals of pistillate flowers. These were distinguishable by the size of flowers. The flowers of the sessile type are smaller than those of the clawed type (Fig. 2, clawed type on right side, sessile type on left side). Both of these types are found in Yakushima Island.

The lectotype (Akanumanohara, Tochigi Pref.) of *E. atrum* Nakai and the lectotype of *E. hananoegoense* Masam. fall within the variation range of the clawed type. While the syntype (Mamushiike, Aichi Pref.) of *E. atrum* and the holotype of *E. kiusianum* Maxim. are of the sessile type (Fig. 2). Satake (1940) distinguished *E. hananoegoense* from *E. atrum* by its acute median calyx lobes on pistillate flowers and sparse, two-celled glandular hairs on the bracts of staminate and pistillate flowers. These characters, however, overlap each other and cannot be used as diagnostic characters.

The lectotype of *E. hananoegoense* is evidently merely a dwarf individual of *E. atrum*. These from Mt. Kuju were also *E. atrum* in having clawed median petals of pistillate flowers. The known distribution range of *E. atrum* is in central and northern Kanagawa Pref. *Eriocaulon atrum* of Mt. Kuju and Yakushima Island reveals disjunctive distribution. The sessile type is *E. kiusianum* Maxim. *Eriocaulon kiusianum* was described from Shimabara, Nagasaki Pref., Kyushu. *Eriocaulon nakasimpanum* Satake is a synonym of *E. kiusianum* Maxim. (Ohba and Miyamoto 1993).

**Taxonomic treatment**


Tochigi Pref., Akanumanohara, Nikko, S. Kodama, Aug. 1910 (TI-lectotype, selected here).


_E. atrum_ Nakai var. glaberrimum (Satake)


The examined specimens were cited in Miyamoto and Ohba (1998).

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References
— and —— 2000. Populational variation of floral
Fig. 6. *Eriocaulon kiusianum* Maxim. in Yakushima Island. 1–3: shallow water habit. 4–5: submerged habit. 6: head. 7: involucral bract. Pistillate flower. 8: bract. 9: calyx. 10: median petal. 11: lateral petals. 12: ovary and stigmas. Staminate flower. 13: bract. 14: calyx. 15, 16: petal and anthers. 17, 18: sheath. 19: cross section of scape. 1, 6–19: Shohananoego (2059). 2: Hananoego (2051). 3: Shikanosawa (2033–1). 4–5: Shohananoego (2047). Scales: a (1 cm) for 1–5, b (1 mm) for 8–11, 13–15, c (0.1 mm) for 19, d, (1 mm) for 6, 7, 17 and 18, e (0.5 mm) for 12 and 16.
宮本 太*, 大場秀章：屋久島産クロイヌノヒゲとその近縁種の花形態および生態的特性

本研究は鹿児島県屋久島に生育するクロイヌノヒゲ* Eriocaulon atrum Nakai とツクシクロイヌノヒゲ E. kiusianum Maxim. について花形態および生育地における生態特性を明らかにした。特産種として屋久島から記載されたヤクシマホウセンサケ hananoegoense Masam. はクロイヌノヒゲの矮小型にすぎないことが明らかになった。また、屋久島の標高1600 m以上の高所にクロイヌノヒゲと同所的に生育する近縁種は、雛花花弁基部が無柄であること、花サイズがクロイヌノヒゲに比べて小さいことで区別できる。これらの分類学的扱いを明らかにするために宮崎県霧島山、大分県久住山および福岡県産の個体群、およびクロイヌノヒゲとツクシクロイヌノヒゲのタイプ標本を含めて比較検討した。その結果、雛花花弁基部が無柄の個体群と霧島および福岡県産の個体群はツクシクロイヌノヒゲと雛花花弁の形態と花サイズが一致することが明らかになった。また大分県久住山の個体群は雛花花弁に柄を有することなどからクロイヌノヒゲであることが明らかになった。屋久島におけるクロイヌノヒゲとツクシクロイヌノヒゲにはすみ分けは見られなかった。しかし、花茎長の長さで両種には明らかな生育地での差異が見られた。ツクシクロイヌノヒゲでは最高24 cmの花茎をもち、頭花は水面上に出していた。それに対しクロイヌノヒゲではその長さは最高8 cmであった。これからのことからツクシクロイヌノヒゲは水深にたいして花茎を伸長させる性質を示すが、クロイヌノヒゲはそのような伸長が見られないことが明らかになった。

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