The morphological variations of *Thelypteris palustris* Schott affected by human disturbances in the wetlands of Hokkaido, Japan

（北海道の湿原における人為攪乱に対するヒメシダの形態変異）

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Abstract

Thelypteris palustris Schott is a common wetland fern, establishing often in disturbed swamps, bogs and marshes. *T. palustris* produces dimorphic leaves, i.e., infertile and fertile leaves of which responses to disturbances are likely to be different. These suggest that this fern is used for an indicator species to estimate disturbance intensity, particularly in wetlands that are one of the vulnerable ecosystems. To assess the relationships between the morphological characteristics of *T. palustris* and disturbance intensity, the leaves were measured in four disturbed wetlands in Hokkaido (Uasai, Shizukari, Sarobetsu and Nopporo), Japan, during late summer and early autumn in 2017 and 2018. The measured parameters were: fertility, number of veins (NV), dry weight (DW), frond length (FL), blade length (BL), blade width (W), leaf area (LA) and perimeter of frond (P). Based on these, dissection index (DI), aspect ratio (AR) and leaf mass per area (LMA) were calculated. These parameters were primarily categorized into two types, size (DW, FL, BL, W and LA) and shape (P, DI and AR). NV and LMA were suspended to sort the category. The data were analyzed by logistic regression and principal component analysis (PCA) to estimate variations in morphological parameters between the four wetlands. Anthropogenic disturbance intensities in the wetlands were determined by disturbance rank, based on the neighbor landuse, buffer zone and hydroloy.

Logistic regression indicated that the fertility of leaves was different among the wetlands and was predicted well by DW, BL, LA, DI and LMA. Relationships between NV and fertility differed among the wetlands. PCA showed that the first axis was related to the size, the second axis was to the shape and the third axis was to NV and LMA. The morphology of fertile and infertile leaves from Sarobetsu and infertile leaves from Nopporo were different from those from Utasai and Shizukari. There were significant differences in morphology of fertile leaves between Utasai, Shizukari and Sarobetsu and of infertile leaves among the four wetlands. The disturbance rank was ordered as: Utasai > Shizukari > Sarobetsu > Nopporo. The rank was mostly determined by surroundings and buffer types. The infertile leaves altered the size parameters more than the fertile leaves, showing that the size of infertile leaves was more sensitive to disturbances and its related factors. NV and LMA were suitable indices for the prediction of leaf fertility. Since the LMA was measured by a destructive method, i.e., harvesting, NV was the most suitable parameter to investigate wetland status in relation to human disturbances without wetland destruction. The wetland deterioration and fate should be predicted by the size-class distribution of NV and its related parameters.