Memoranda Soc. Fauna Flora Fennica 88: 22–26. 2012

Dryopteris carthusiana var. *enigmatica var. nov.*, a new taxon from Finland

Harri Harmaja

Botanical Museum, Finnish Museum of Natural History, P.O. Box 7, FI-00014 University of Helsinki, Finland. E-mail: harri.harmaja@gmail.com

The new variety *Dryopteris carthusiana* var. *enigmatica* Harmaja (Dryopteridaceae) is described on the basis of a collection from rich brook side forest in southern Finland. Var. *enigmatica* differs from var. *carthusiana* through the smaller fronds, sori, sporangia and spores, the shorter stomata, and a different perispore. The size of the spores and the length of the stomata of var. *enigmatica* suggest that the taxon might be diploid.

Introduction

My field trips and other observing on *Dryopteris* plants during a half century in southern Finland revealed unexpected much morphological variability, especially within *D. carthusiana*, *D. expansa*, and *D. filix-mas* and — to a lesser degree — in *D. dilatata*. Only a part of this variability appears to be known previously. The present contribution treats one item, a deviating stand of *D. carthusiana* that — after consulting the literature and a comparison with selected material (see below) — is judged to represent a taxon of its own. The taxon will be described as *D. carthusiana* var. *enigmatica* Harmaja. Due to its characters it might be worth of a higher taxonomic rank, but the varietal rank was chosen as it is only known from one stand.

Material and methods

Five leaves that were picked out from the small stand comprise the type and only collection of var. *enigmatica*.

The Finnish and other collections of *D. carthusiana* (Vill.) H.P.Fuchs from its whole range, filed in the Botanical Museum (H) of the Finnish Museum of Natural History as well as in Herb. Harri Harmaja, were screened macroscopically. To detect possible additional specimens of var. *enigmatica*, and also for comparison, selected specimens of *D. carthusiana* were further subjected to a more thorough analysis of the sori, and eleven specimens from Finland — listed below — were also analyzed as to spore and stomata characters. No specimens of var, *enigmatica* were detected, but valuable information about the variability of var. *carthusiana* was acquired to be incorporated in the knowledge presented in the literature.

The spore characters and the length of the stomata were studied under the light microscope in water mounts of dried leaves. The spore measures are given as including the perispore. In var. *enigmatica*, the spores of all five leaves of the collection and the stomata of the holotype leaf and one leaf of the isotype were examined.

The collection of var. *enigmatica* is far too old to be analyzed with flow cytometry for the ploidy level.

Finnish specimens of Dryopteris carthusiana var. carthusiana in Herb. Harri Harmaja examined for spores and stomata

1. V. Karjalohja, Suurniemi, 20.VII.2011
2. V. Lohja, Osuniemi, 6680:3329, 23.VII.1992
3. V. Lohja, Osuniemi, 6680:3329, 23.VII.1992 (morph with large sori)
4. V. Lohja, Torhola, 6686:3326, 17.IX.2008
5. V. Lohja, Torhola, 6687:3326, 26.VIII.2009
6. V. Lohja, Torhola, 6687:3326, 20.VII.2011 (3 leaves)
7. V. Lohja, Vanhakylä, 6694: 3343, 24.IX.2008 (a spore from this specimen is shown in Fig. 3b in the present paper)
8. U. Lohja, Kokkila, 21.VII.1992
9. U. Lohja, Lieviö, 10.VIII.2011
10. U. Tuusula, Kirkonkylä, 10.X.1990
11. U.Tuusula, Kirkonkylä, 10.X.1990 (morph with large sori)

Dryopteris carthusiana var. ***enigmatica*** Harmaja, *var. nov.*

Dryopteridis carthusianae var. carthusianae satis similis. Ab ea praecipue differt foliis, soris, stomatis (38–55 µm longis) et sporis (30–45 × 25–32 µm) minoribus non nec perisporio dissimili.

Type: FINLAND. Nylandia (Uusimaa, N/U): Lohja, Lieviö, E corner, brookside between the boundaries of Vihti and Siuntio municipalities, WNW of Mustamäki. A small stand in the mixed herb-rich forest on the W bank of the brook, at the margin of a forest thinning. Finnish national grid (YKJ): 6690:3351 [60°17.7′ N, 24°18.1′ E (WGS84)], alt. c. 57 m a.s.l., 22 September 1992 *Harri Harmaja* (Holotype: H 823477, isotype H 823478).

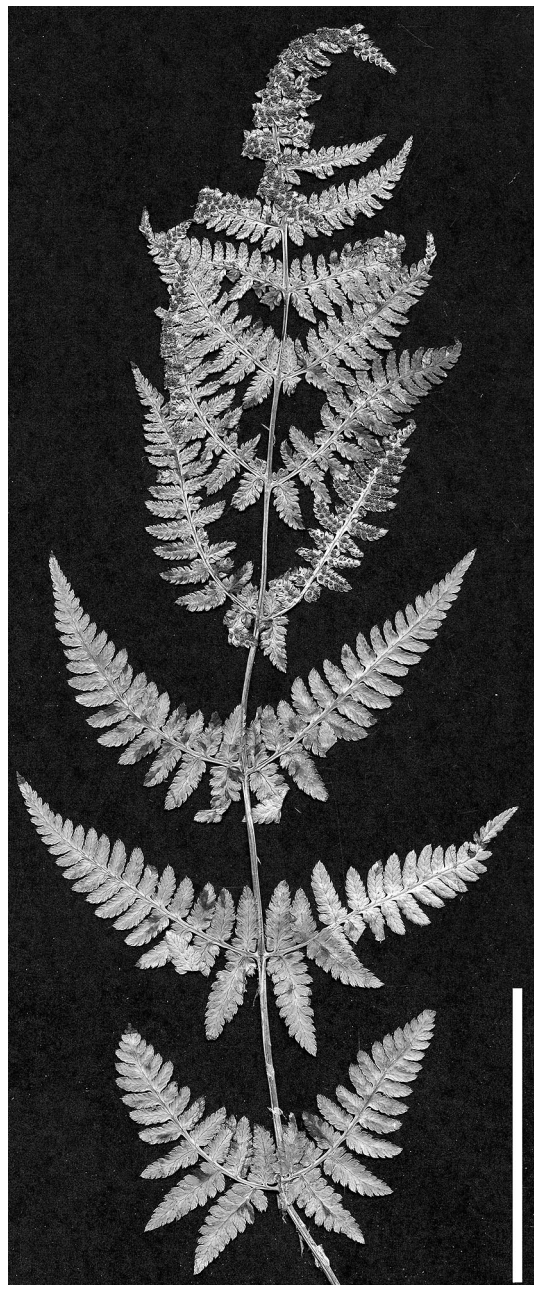

Fig. 1. *Dryopteris carthusiana* var. *enigmatica*: blade of holotype leaf. Scale bar = 5 cm.

Leaves 30–40 cm long. *Petiole* 35–55 % of the leaf length, blackish at base; scaly throughout, densely so at base; scales up to 7 mm long, ovate, acute, tan, without darker stripe, with entire margins, glabrous. *Blade* (Fig. 1) 15–25 × 7–10 cm, fairly light green, ovate – lanceolate, bipinnate – pinnatifid, tripinnate at base. *Blade surfaces*, especially the lower one, with scattered small, narrow scales and moniliform trichomes along veins; glands probably lacking. *Pinnae* triangular below, linear upwards; pinnae of third lowest pair longest; basal basiscopic pinnule 1.5–2.0 × 0.7–1.0 cm, larger than basal acroscopic pinnule, longer than adjacent pinnule; margins of adjacent 3rd degree pinnae usually touching or slightly overlapping; pinnule margins serrate; ultimate segments shortly aristate. *Sori* absent from the pinnae of two or three lowest pairs, in two rows in pinnules, 0.4–0.8 mm in diam. *Indusia* reniform,

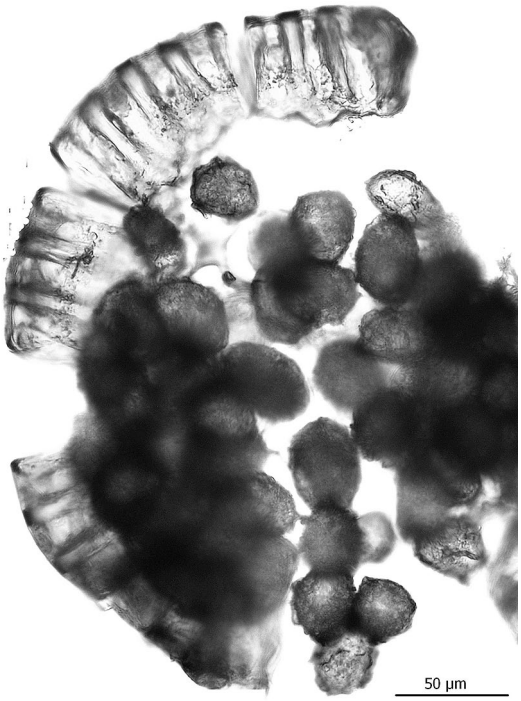

Fig. 2. *Dryopteris carthusiana* var. *enigmatica*: a dehisced sporangium with released spores (holotype).

in mature sori (due to shrivelling in age?) small, inconspicuous and only partly covering the sorus; glands lacking. *Sporangia* (Fig. 2) glabrous, most probably containing 64 (anyway, many more than 32) spores. *Sporangiasters* always present, fairly numerous, resembling aborted sporangia (unless actually the latter are concerned?), very shortly stipitate and thus hiding under the mature sporangia, eglandular. *Stomata* abaxial, 38–55 µm long. *Spores* (Figs. 2, 3a) 30–45 × 25–32 µm; perispore fairly pale brown, inflated with folds, ridges and obtuse conical warts of variable width and up to c. 5 µm high, fairly sparsely beset with spinules up to c. 0.5 µm high.

Habitat. The stand of *D. carthusiana* var. *enigmatica* grew in half-shade in a mixed, rich brookside forest. The area belongs to the southern boreal bioclimatic zone (Ahti et al. 1968). Dominating tree species were *Picea abies* and *Betula pendula*; *Alnus incana* and *Populus tremula* occurred elsewhere in the brookside valley. The vegetation was luxurious; among common species, the following ones were observed by me during several trips: *Carex rhynchophysa, Corylus avellana, Dryopteris carthusiana*, *D. expansa* s. str. (the common morphotype of Finland), *D. expansa* cf. var. *pseudospinulosa, D. expansa* morph (frond sharing some features of *D. dilatata*, also remaining dark green until late in the autumn), *D. filix-mas, D.* nothosp. (an unidentified hybrid), *Glyceria lithuanica, Myosotis laxa cf. ssp. laxa, Poa remota* (two morphotypes), *Pulmonaria obscura* (different morphotypes), *Ranunculus* cf. *imitans, Stellaria alsine, Tilia cordata, Viola mirabilis* (for a description of the brook valley and its flora, see also Pykälä 1992).

Discussion

Due to incomplete observation under collecting, the characters of the rhizome of the new taxon are unknown. Likewise, it remained unstudied whether the leaves in a rosette are monomorphic or dimorphic and whether they overwinter or not.

D. carthusiana var. *enigmatica* resembles *D. carthusiana* var. *carthusiana*, differing in the following respects: the fronds of the former are smaller, the leaf lamina (Fig. 1) is slightly less dissected, the sori are smaller, the sporangia are smaller, the stomata are clearly shorter and are situated more densely (however, the material compared is scanty), the spores (Figs. 2, 3a) are smaller, the perispore is paler brown, the wings of the perispore are lower, the folds and swellings of the perispore are generally narrower (partly comprising obtuse conical warts, or tubercles), and the spinules of the perispore are smaller, sparser, often indistinct. In *D. carthusiana*, the sori measure 0.8–2.0 mm in diam. (depending on the number of functional sporangia), the stomatal length is distributed within 50–85 µm (varying somewhat with collection; according to Tryon & Britton 1966, the amplitude is 44–68 µm), the spores (Fig. 3b) are c. 45–65 × 32–40 µm in size and possess a dark brown perispore with wide wings that are up to c. 10 µm high and distinct spinules up to c. 2 µm long in (Britton 1972, Crane 1953, Sorsa 1964, Widén et al 1967; my own observations).

The size (actually, the volume) of the spores is well known to be commonly positively correlated with the ploidy level in related species of

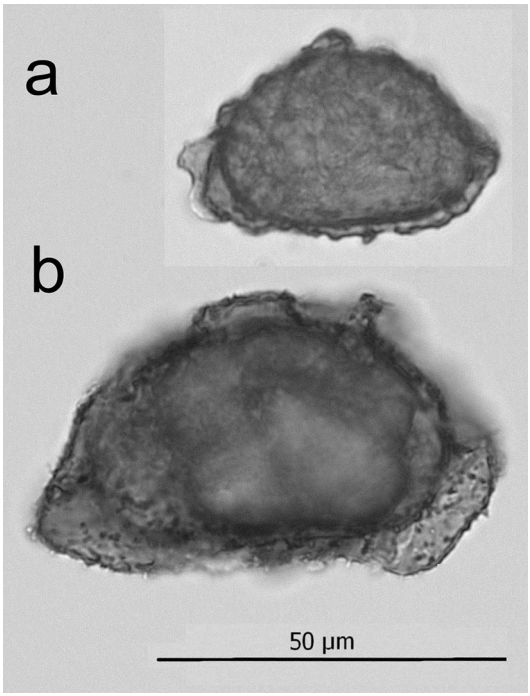

Fig. 3. An average spore. — a: *Dryopteris carthusiana* var. *enigmatica* (holotype). — b: *D. carthusiana* var. *carthusiana* (Finland, Lohja, Vanhakylä, Lehtikallio, 24.IX.2008 *Harmaja*; Herb. H. Harmaja).

vascular plants, including ferns (Barrington et al. 1986, Pryer & Haufler 1992, Quintanilla & Escudero 2006, Thomson & Alonso-Amelot 2002, Whittier & Wagner, Jr. 1971). In *Dryopteris*, this can be seen, for instance, when comparing the spore drawings of Crane (1953, 1956) and the ploidy levels of the respective species given in Montgomery & Wagner, Jr. (1993; this rule has exceptions: the diploid *D. expansa* of this species group possesses large spores according to e.g., Widén et al. 1967 [as *D. assimilis* S.Walker] and my own observations). Consequently, *D. carthusiana* var. *enigmatica* may be diploid as its spores are clearly smaller — their size being close to that of the diploid *D. intermedia* (Crane 1953) — than those of typical *D. carthusiana* (var. *carthusiana*) which is tetraploid.

The same correlation is very common concerning the length of the stomata and the ploidy level (Barrington et al. 1986, Bureš et al. 2003, Thomson & Alonso-Amelot 2002, Harmaja 2012).

Even a third difference would possibly point towards var. *enigmatica* being diploid: its stomata are more densely situated per area unit of the epidermis (Mishra 1997, Beck et al. 2003).

Lastly, a difference in the size of the sporangia may be useful in species level taxonomy and may be positively correlated with the ploidy level in related species (Harmaja 2012).

D. carthusiana and *D. cristata* of Eurasia and North America are allotetraploids. The identity of their parents has been under active study for some time. According to the ”semicristata hypothesis”, one parent — of both species or of *D. cristata* only — would be a hypothetical species *D. ”semicristata”* that may be either extinct or alive but as yet undiscovered: Fraser-Jenkins (2001), Stein et al. (2010), Ekrt et al. (2010), Juslén et al. (2011), Sessa et al. (2012).

Interestingly, the leaf morphology of *D. carthusiana* var. *enigmatica* is fairly astonishingly similar to the illustration showing an estimated frond of *D. ”semicristata”* (drawing presented in the poster of Kuhn & Werth 1990, reproduced as Fig 5C in Stein et al. 2010).

The new variety is only known from this site in southernmost Finland. Despite of later searches in the area, it was not found again (the original site was near to the margin of a cut area, and since then the landscape has changed somewhat following reforestation). Most probably *D. carthusiana* var. *enigmatica* has additional occurrences somewhere. Its main distribution may lie eastwards of Finland in areas that are less thoroughly known floristically than Fennoscandia and that have a more continental climate. *Carex rhynchophysa, Glyceria lithuanica* and *Poa remota* that are listed as accompanying species above, possess more or less eastern distributions in Europe. Moreover, several occurrences — partly discovered by the present author — of *Carex pediformis* ssp. *rhizodes*, likewise preferring rather continental climate, are known nearby.

References

Ahti, T., Hämet-Ahti, L. & Jalas, J. 1968: Vegetation zones and their sections in northwestern Europe. — Ann. Bot. Fennici 5: 169–211.

Barrington , D.S., Paris, C. A.& Ranker, T. A. 1986: Systematic inferences from spore and stomate size in the ferns. — American Fern J. 76: 149–159.

Beck, S.L., Dunlop, R.W. & Fossey, A. 2003: Stomatal length and frequency as a measure of ploidy level in black wattle, Acacia mearnsii (de Wild). — Bot. J. Linnean Soc. 141: 177–181. http://onlinelibrary.wiley.com/doi/10.1046/j.1095-8339.2003.00132.x/pdf

Britton, D.M. 1972: Spore ornamentation in the Dryopteris spinulosa complex. — Canadian J. Bot. 50: 1617–1621 + Pls. 1–4. http://www.nrcresearchpress.com/doi/abs/10.1139/b72-198

Bureš, P., Tichý, L., Wang, Y.-F. & Bartoš, J. 2003: Occurrence of Polypodium ×mantoniae and new localities for P. interjectum in the Czech Republic confirmed using flow cytometry. — Preslia 75: 293–310.

Crane, F.W. 1953: Spore studies in Dryopteris, I. — American Fern J. 43: 159–169. http://www.jstor.org/stable/1545717

Crane, F.W. 1956: Spore studies in Dryopteris. III. — American Fern J. 46: 127–130. http://www.jstor.org/stable/1545732

Ekrt, L., Holubová, R., Trávníček, P. & Suda, J. 2010: Species boundaries and frequency of hybridization in the Dryopteris carthusiana (Dryopteridaceae) complex: A taxonomic puzzle resolved using genome size data. — American J. Bot. 97: 1208–1219. http://www.amjbot.org/cgi/reprint/97/7/1208

Fraser-Jenkins, C.R. 2001: Dryopteris stanley-walkeri Fras.-Jenk., the missing diploid common-ancestor of D. carthusiana and D. cristata (Pteridophyta: Dryopteridaceae). — In: Pande, P C. & Samant, S. S. (eds.), Plant diversity of the Himalaya (Prof. Y.P.S Pangtey commemoration volume). Gyanodaya Prakashan, Nainital, 119–152.

Harmaja, H. 2012: The oldest record of Polypodium interjectum in Sweden, with notes on the variability of P. vulgare. — Ann. Bot. Fennici 49: 13–20.

Juslén, A., Väre, H. & Wikström, N. 2011: Relationships and evolutionary origins of polyploid Dryopteris (Dryopteridaceae) from Europe inferred using nuclear pgiC and plastid trnL–F sequence data. — Taxon 60: 1284–1294.

Kuhn, C. & Werth, C.R. 1990: Reconstructive illustration of an extinct fern, Dryopteris semicristata, from its hybrid derivatives. — American J. Bot. 77 (Suppl,): 109.

Mishra, M.K. 1997: Stomatal characteristics at different ploidy levels in Coffea L. — Ann. Bot. 80: 689–692. http://aob.oxfordjournals.org/content/80/5/689

Montgomery, J.D. & Wagner, W.H.Jr. 1993: Dryopteris Adanson. — In: Flora of North America Editorial Committee (eds.), Flora of North America North of Mexico 2. New York & Oxford, 280–288. http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=110995

Pryer, K.M. & Haufler, C.H. 1992: Isozymic and chromosomal evidence for the allotetraploid origin of Gymnocarpium dryopteris (Dryopteridaceae). — Systematic Bot. 18: 150–172. http://www.jstor.org/sici?sici=0363-6445%28199301%2F03%2918%3A1%3C150%3AIACEFT%3E2.0.CO%3B2-K

Pykälä, J. 1992: Lohjan kunnan arvokkaat lehdot. — Lohjan kunnan ympäristönsuojelulautakunta, julkaisu 3/92: 1–158 + 1–20.

Quintanilla, L.G. & Escudero, A. 2006: Spore fitness components do not differ between diploid and allotetraploid species of Dryopteris (Dryopteridaceae). — Ann. Bot. 98: 609–618. http://aob.oxfordjournals.org/content/98/3/609.full.pdf+html

Sessa, E., Zimmer, E.A. & Givnish, T.J. 2012: Reticulate evolution on a global scale: A nuclear phylogeny for New World Dryopteris (Dryopteridaceae). — Mol. Phyl. Evol. (In press) http://dx.doi.org/10.1016/j.ympev.2012.05.009

Sorsa, P. 1964: Studies on the spore morphology of Fennoscandian fern species. — Ann. Bot. Fennici 1: 179–201.

Stein, D.B., Hutton, C., Conant, D.S., Haufler, C.H. & Werth, C.R. 2010: Reconstructing Dryopteris "semicristata" (Dryopteridaceae): Molecular profiles of tetraploids verify their undiscovered diploid ancestor. — American J. Bot. 97: 998–1004. http://www.amjbot.org/cgi/reprint/97/6/998

Thomson, J.A. & Alonso-Amelot, M.E. 2002: Clarification of the taxonomic status and relationships of Pteridium caudatum (Dennstaedtiaceae) in Central and South America. — Bot. J. Linnean Soc. 140: 237–248. DOI: 10.1046/j.1095-8339.2002.00089.x

Tryon, R. & Britton, D.M. 1966: A study of variation in the cytotypes of Dryopteris spinulosa. — Rhodora 68: 59–92.

Widén, C.J., Sarvela, J. & Ahti, T. 1967: The Dryopteris spinulosa complex in Finland. — Acta Bot. Fennica 77: 1–24.

Whittier, D. P. & Wagner, W. H. Jr. 1971: The variation in spore size and germination in Dryopteris taxa. — American Fern J. 61: 123–127.