

**An unexpected record of an African horsetail,
Equisetum ramosissimum Desf. var. *flagelliferum* Milde
(Equisetaceae), from Caucasus**

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Summary: A giant evergreen variety of *Equisetum ramosissimum* Desf. var. *flagelliferum* Milde (subgenus *Hippochaete*), was found and identified by the author in the suburbs of Sochi town, Black Sea shore, Caucasus, Russia, in February 2004. In its gross morphology this variety is characterized by very tall (up to 2–2.5m) perennial aerial shoots, climbing growth form, regular unilateral branching and by very long (up to 45cm) whorled branches which are usually branched too (even to the third extent). It looks very similar to *E. debile* Roxb. (*E. ramosissimum* Desf. subsp. *debile* (Roxb.) Hauke), from the tropics of South-Eastern Asia but differs quite distinctly by particular (individual) endodermis and by multiseriate stomata on the main axis. In their micromorphology and anatomy these Caucasian plants have many resemblances to the tropical South-American species *E. giganteum*, in regular disposition of stomata in 2–4 rows (this is unique and cannot be found among the other species belonging to the subgenus *Hippochaete*) and in quite variable vallicular collenchyma patterns. The whole combination of the features is rare and unusual for *E. ramosissimum* and was found only in several African populations. Up to now, var. *flagelliferum* has been known from South Africa (Natal) and the Canarian Islands (Tenerife Island). Therefore, the finding in Sochi represents the first record for complete Eurasia. It is probably an adventive population, but anyway the finding is important as a proof that *Equisetum* species of quite tropical morphology are able to survive successfully in the temperate zone. That phenomenon could be useful for phylogenetic and paleobotanic reconstructions.

Zusammenfassung: Die riesige, immergrüne *Equisetum*-Varietät *Equisetum ramosissimum* Desf. var. *flagelliferum* Milde (subgenus *Hippochaete*) wurde vom Autor in der Vorstadt von Sochi (Schwarzmeerküste, Kaukasus, Russland) im Februar 2004 gefunden und bestimmt. Grobmorphologisch kann diese Varietät folgendermaßen charakterisiert werden: sehr hohe (2–2,5m), ausdauernde oberirdische Sprosse, kletternde Wuchsform, regelmäßige einseitige Verzweigung und sehr lange (bis 45cm) Wirteläste, die normalerweise bis zum dritten Grad verzweigt sind. Die Pflanzen ähneln *E. debile* Roxb. (*E. ramosissimum* Desf. subsp. *debile* (Roxb.) Hauke) aus den Tropen Südost-Asiens, unterscheiden sich jedoch durch Endodermismerkmale und multiseriale Stomata an der Hauptachse. Die kaukasischen Pflanzen zeigen mikromorphologische und anatomische Ähnlichkeiten zur tropischen, südamerikanischen Art *E. giganteum*. Stomata in 2–4 Reihen (dies ist einmalig und tritt bei den anderen Arten der Untergattung *Hippochaete* nicht auf) und sehr variable Muster des valliculären Kollenchyms. Die Gesamtkombination der Merkmale ist selten und für *E. ramosissimum* unüblich. Sie konnte nur in afrikanischen Populationen gefunden werden. Bisher ist var. *flagelliferum* aus Südafrika (Natal) und den Kanarischen Inseln (Teneriffa) bekannt. Der Fund in Sochi ist der erste für das gesamte Eurasien. Möglicherweise handelt es sich um eine adventive Population, doch ist der Fund insofern wichtig, da er zeigt, dass *Equisetum*-Arten mit tropischer Morphologie auch in temperaten Zonen erfolgreich überleben können. Dieses Phänomen könnte auch für phylogenetische und paläobotanische Rekonstruktionen wichtig sein.

Keywords: Equisetaceae, flora of Russia, new floristic record

A giant evergreen variety of *Equisetum ramosissimum* Desf., characterized by a series of features, which seemed to be very unusual for the species, was found by me in the suburbs of Sochi town, on the Black Sea shore, Caucasus, Russia, in February 2004.

First of all, I was astonished by the size of the plant. One of the two collected samples has an aerial stem about 182cm long, the other one reaches 194cm. The shortest shoot was 155cm long; on the other hand, length of some shoots was more than 2m (but in the thicket of thorny bushes it turned out to be impossible to disentangle those clinging shoots without getting their stems torn). Having observed all the corresponding literature as well as material of *Equisetum* in Russian herbarium collections, I concluded that those giant plants of horsetail had never been collected in Russia (and the former USSR) before (see HAUKE 1962, 1963; ILYIN 1934; MILDE 1867a, 1867b; ZERNOV 2000). The recorded size of the shoots of *E. ramosissimum* is closest to its maximum. According to HAUKE (1963), the maximum for *E. ramosissimum* is 254cm. HAUKE (1963), however, cited no collection and implied that parameters like those recorded by me should be considered as an exception. Indeed, HAUKE (1963) indicated 85cm as an average height of *E. ramosissimum*. Taking into consideration the upper limit of standard deviation, he let it be 125cm. Thus, HAUKE probably did not observe any samples comparable with mine, or at least he had only few of them, even though he was able to obtain the material from all over the world including tropical regions of Asia and Africa.

In addition, these plants were complete undamaged, and their overgrown shoots survived a ten-day spell of snowfall and kept green, safe and sound, even the thin and long whip-formed tops of the main stems.

The growth type of the shoots is very interesting as well. The main stem diameter of the thickest one did not exceed 6mm. These shoots obviously could not stand straight and assumed the climbing growth form with a curved main stem and numerous long branches which were entangled with shoots of *Rubus spp.*, *Rosa spp.*, *Smilax excelsa* and other thorny shrubs (Fig. 1 and Fig. 2). Because of that mess, the lower part of the stem hid in the climbing bushes while the mostly branched upper part rose to the level of 160–200cm. In that thicket the branches of *Equisetum ramosissimum* directed at different angles and wound round the shoots of other plants so densely that they would be partly torn by herbarisation. The irreversible deformation of main stems can be perfectly seen in herbaria (Appendix: Plates 1–4) and even more on photographs (Fig. 3–5).

Unusual growth form corresponds with a peculiar branching of these plants. The main stem branches out beginning at a significant level, ca. 120–150cm, and all the branches are concentrated to a short, ca. 30cm long zone of the stem (Fig. 4). In its natural condition the branching of this horsetail becomes unilateral (so called flag-like form), because most of the branches grow out of the thicket (Fig. 5 and Fig. 7). All the branches are gathered in verticels and are remarkable for their enormous length (up to 45cm). Many of them (Fig. 6), moreover, are branched too (sometimes branching even to the third extent occurs). That phenomenon was quite exceptional for the whole subgenus *Hippochaete*.

Therefore, this record proves to be extraordinary in many ways. The fact of finding a perfectly evergreen sample of *E. ramosissimum* in the suburbs of Sochi is unpredictable itself. Any information about it is absent in literature and there are no such specimens in Russian herbarium collections.

Equisetum ramosissimum Desf. var. *flagelliferum* Milde



Figure 1: *Equisetum ramosissimum* Desf. var. *flagelliferum* Milde. View of the thicket of thorny bushes where the horsetail grows, 26.02.2004.

V. E. SKVORTSOV



Figure 2: *Equisetum ramosissimum* Desf. var. *flagelliferum* Milde. The mess of branches entangled with shoots of other plants, 26.02.2004.

Equisetum ramosissimum Desf. var. *flagelliferum* Milde



Figure 3: *Equisetum ramosissimum* Desf. var. *flagelliferum* Milde. Branching zone of the main stem, 28.02.2004.

V. E. SKVORTSOV

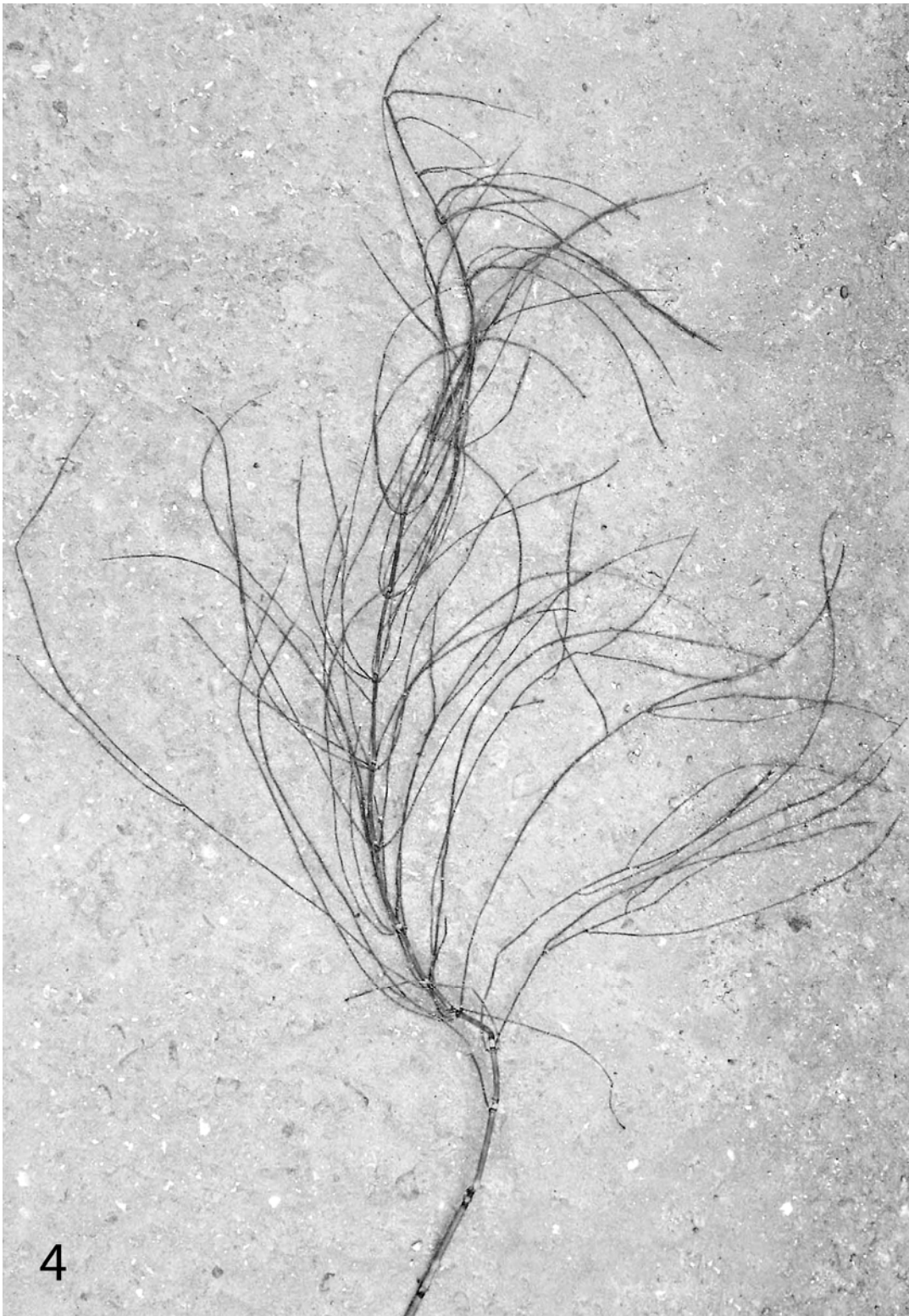


Figure 4: *Equisetum ramosissimum* Desf. var. *flagelliferum* Milde. Unilateral branching, 28.02.2004.

Equisetum ramosissimum Desf. var. *flagelliferum* Milde



Figure 5: *Equisetum ramosissimum* Desf. var. *flagelliferum* Milde. Branching of the lateral branches to the second and third extension, 28.02.2004.

In addition, I could also refer to the personal report of A. S. Zernov, a specialist in flora of North-Western Transcaucasia (ZERNOV 2000), informing that the author had no occasion to find any winter-hardy shoots of *E. ramosissimum* on the Black Sea seashore from Anapa to Tuapse. Taking part in expeditions to the suburbs of Sochi, I could not find evergreen forms

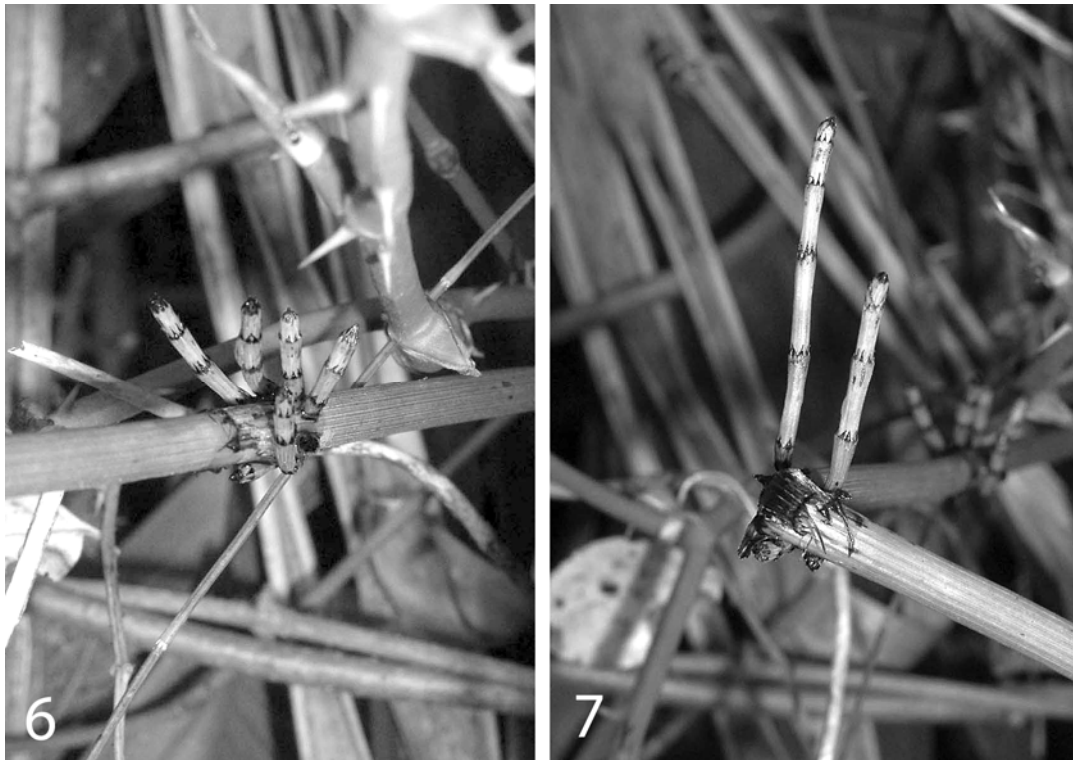


Figure 6 & 7: *Equisetum ramosissimum* Desf. var. *flagelliferum* Milde. 6) The verticil of new branches on an old stem growing unilaterally, 01.05.2004. 7) New branches on an old stem which are supposed to grow very long and branched, 01.05.2004.

of *E. ramosissimum* besides the one mentioned above. That fact is rather significant, because the abundance of populations of *E. ramosissimum* all along the western Black Sea shore presents vast material for observations. The recorded plants from the suburbs of Sochi (their exact location is in a district called Hosta) contrasted with the other populations of that species definitely¹. It was interesting, that no shoot of the plants from Hosta showed a sign of bearing spores before; thus, only second-year shoots probably bear spores.

The position of these plants in taxonomy is the point that special attention should be paid to. A branching type that always follows stem reaching a considerable length, and other details of its morphology described above indicate that the horsetail formed giant shoots as quite a natural process. Their unusual habit, growth form and size link the mentioned plant to evergreen tropical species of *Equisetum*. The latter ones are huge too, and start climbing when they reach the length of shoots that do not correspond with stem diameter. Giant species are widespread in Central and South America (*E. giganteum* L. and *E. myriochaetum* Cham. et Schlecht.) and reach 5–8(10)m height. Besides, there is a species, *E. debile* Roxb., from the tropics of

¹ In beginning of May 2004 I revisited this group of plants and found all the old shoots in a perfect condition. I had a good fortune to catch the moment when they started to grow again forming the regular verticils of branches on the nodes located right below the main branching zone (Fig. 6 and Fig. 7). No doubt these perennial shoots are able not only to persist through the winter but grow normally during two years or more. The new young aerial shoots also were developing in May (Fig. 8).

Equisetum ramosissimum Desf. var. *flagelliferum* Milde



Figure 8: *Equisetum ramosissimum* Desf. var. *flagelliferum* Milde. A young aerial shoot growing at the natural habitat, 01.05.2004.

South-Eastern Asia. At first it was described as a distinct species, but HAUKE (1962, 1963) regarded it as a subspecies of *E. ramosissimum* (*E. ramosissimum* Desf. subsp. *debile* (Roxb.) Hauke). It is not as huge as American species, but it still has shoots up to 4m. Hauke (1963) believes the average length of its main stem to be 120cm (or 155cm, taking into consideration the upper limit of standard deviation). Thus, the size of the plant that I found is even more than that of typical *E. debile*. It is important that the secondary branching is also recorded for *E. debile* and does not characterize American species of *Equisetum*.

However, the external similarity of horsetails is often deceptive. The most significant differences between *E. debile* and *E. ramosissimum* are the number of stomata rows and character of endodermal pattern (MILDE 1867a, 1867b; HAUKE 1962, 1963). *E. debile* has stomata in single lines and particular endodermis (around each of the vascular bundle, so called: individual endodermis). Typical *E. ramosissimum* has one to three rows of the stomata and double common endodermis (external and internal ring around all the vascular bundles). The samples mentioned above have 3 (2–4 in some parts) rows of stomata and a distinct double common endodermis. Thus, in their anatomic structure they are similar rather to *E. ramosissimum* than to *E. debile* in spite of their external resemblance to the latter one. In addition, having scrutinized the problem of correlation between micro- and macromorphological characters of *E. ramosissimum* and those of *E. debile*, HAUKE (1963) resumed that there was no reliable correlation in both cases. Some plants from different areas of the geographical distribution of typical *E. ramosissimum*, for example, Japanese populations, which were recorded by Milde and were referred to as *E. sieboldii* Milde, show close resemblance to *E. ramosissimum* outwardly, have several rows of stomata and, at the same time, an individual endodermis. On the other hand, some samples belonging to different areas of the geographical distribution of *E. debile*, particularly plants

from the tropics of South-Eastern Asia, have stomata in single lines and double common endodermis.

In any case, my plants are not the samples of *E. debile*. A search for corresponding forms among the intraspecific taxa of *E. ramosissimum* Desf. s. str. led me to Milde's "Monographia Equisetorum" (MILDE 1867b). It shows that similar plants were actually recorded as *E. ramosissimum* Desf. var. *flagelliferum* Milde. This is only a variety of *E. ramosissimum* which is marked by the secondary branching (even to the third extent) and by the largest size of its main stem ("caulis longissimus") as well as branches (up to 1.5 foot in length, i.e. up to 45cm exactly). As to the number of stomata cell rows, the variety mentioned above was taken by MILDE (1867b) into the group with two and more rows of stomata, where the plants of mine could be also included.

Thus, validity of their definition is undoubted. This fact is astonishing, because var. *flagelliferum* had been recorded (according to MILDE 1867a, 1867b) only in the south of Africa (Natal) and on Canarian Islands (Tenerife Island). In addition HAUKE (1963: 60) emphasized that South-African forms of *E. ramosissimum* were surprisingly similar to the South-American species *E. giganteum*, in regular disposition of stomata in 2–4 rows (that is unique and is not found among the other species belonging to the subgenus *Hippochaete*) and in quite variable vallicular collenchyma patterns. The plants mentioned above with their 3-row stomata cells and extremely variable vallicular collenchyma seem to correspond to the description adequately. However, we could hardly explain that fact, taking into consideration that the hiatus in the areas of Caucasian and African populations of the species was nearly 5,000km (4,500km between Sochi and Tenerife Island, and 5,500km from Sochi to Natal). It might be an example of adventive plants, but any further details of the event could not be clarified. Anyway, it was HAUKE (1992) who discovered adventive populations of European *E. ramosissimum* in the USA (there are no native wild populations of that species in America). The observed plants had been surviving successfully for 15–20 years, although its area had not been enlarged. Therefore, such records seem to be quite possible. On the other hand, the presence of so unusual wild horsetail populations in Caucasus is still to be discussed. MILDE (1867a, 1867b) mentioned Caucasus as one of the areas of another giant variety, *E. ramosissimum* var. *altissimum* A. Br., though nobody else seemed to be ready to confirm his statement. According to MILDE (1867a, 1867b), shoots of that plant are up 120cm long and can assume the climbing growth form, but its branches were significantly shorter than those of var. *flagelliferum* and never branch out. The last, but not the least, is that *E. ramosissimum* var. *altissimum* has always only one-row stomata and, therefore, would rather be compared with some forms of *E. ramosissimum* from temperate zone of Eurasia.

Thus, the discussed question was still open. Of course, I think that no matter how interesting the finding of a single clone of such an uncommon horsetail was, it still could not allow me to draw a too promising and far-reaching conclusion. As always, some new material needs to be searched for. However, the finding is very important as a proof of subgenus *Hippochaete* species ability to grow in the Western Eurasia in the latitude of 44° N, i.e. in the temperate zone, in spite of the rather tropical size, growth form and phenology of *E. ramosissimum* var. *flagelliferum*. That phenomenon could be useful for phylogenetic reconstructions because of the discussed convergence with *E. giganteum*.

Equisetum ramosissimum Desf. var. *flagelliferum* Milde

Material (Appendix: Plates 1–4)

Equisetum ramosissimum Desf. var. *flagelliferum* Milde: Krasnodar region, Sochi town, Hosta, Samshitovaya str., by the roadside, in the hedge of wild roses, blackberries, laurel and *Smilax excelsa*. leg. V. E. Skvortsov s.n. 27.02.2004 [MW and Herb. Skvortsov].

Acknowledgements

The author expresses his gratitude to N. S. Liksakova (Botanical Institute of Russian Academy of Sciences) for her help in field work. All the published photographs were made by her with the assistance of the author.

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Appendix

Plates 1–4: *Equisetum ramosissimum* Desf. var. *flagelliferum* Milde. The scanned herbarium specimen; several pictures partly overlapping each other. Total length: 180cm. >>

V. E. SKVORTSOV

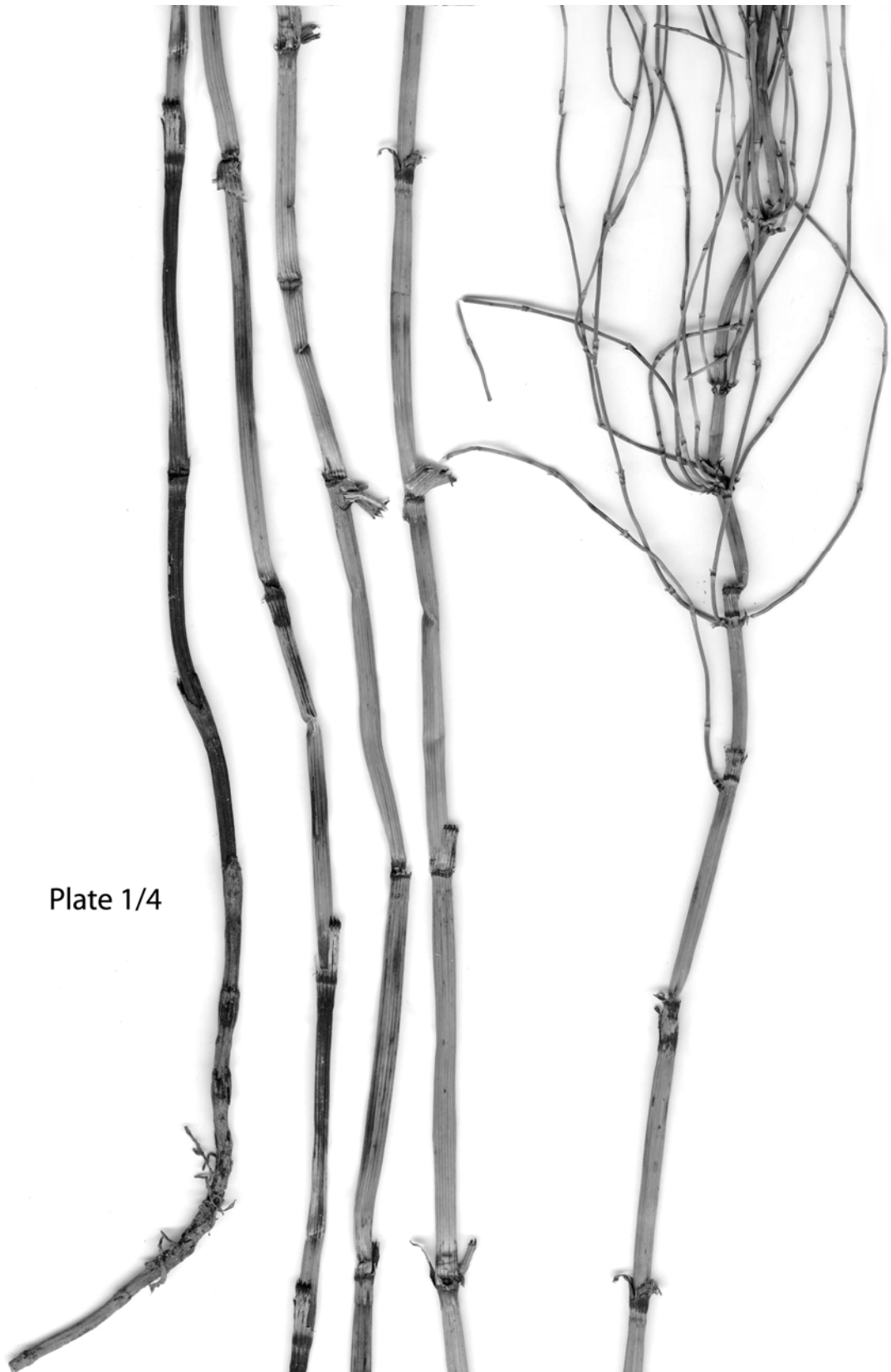


Plate 1/4

Equisetum ramosissimum Desf. var. *flagelliferum* Milde



Plate 2/4

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Plate 3/4

Equisetum ramosissimum Desf. var. *flagelliferum* Milde

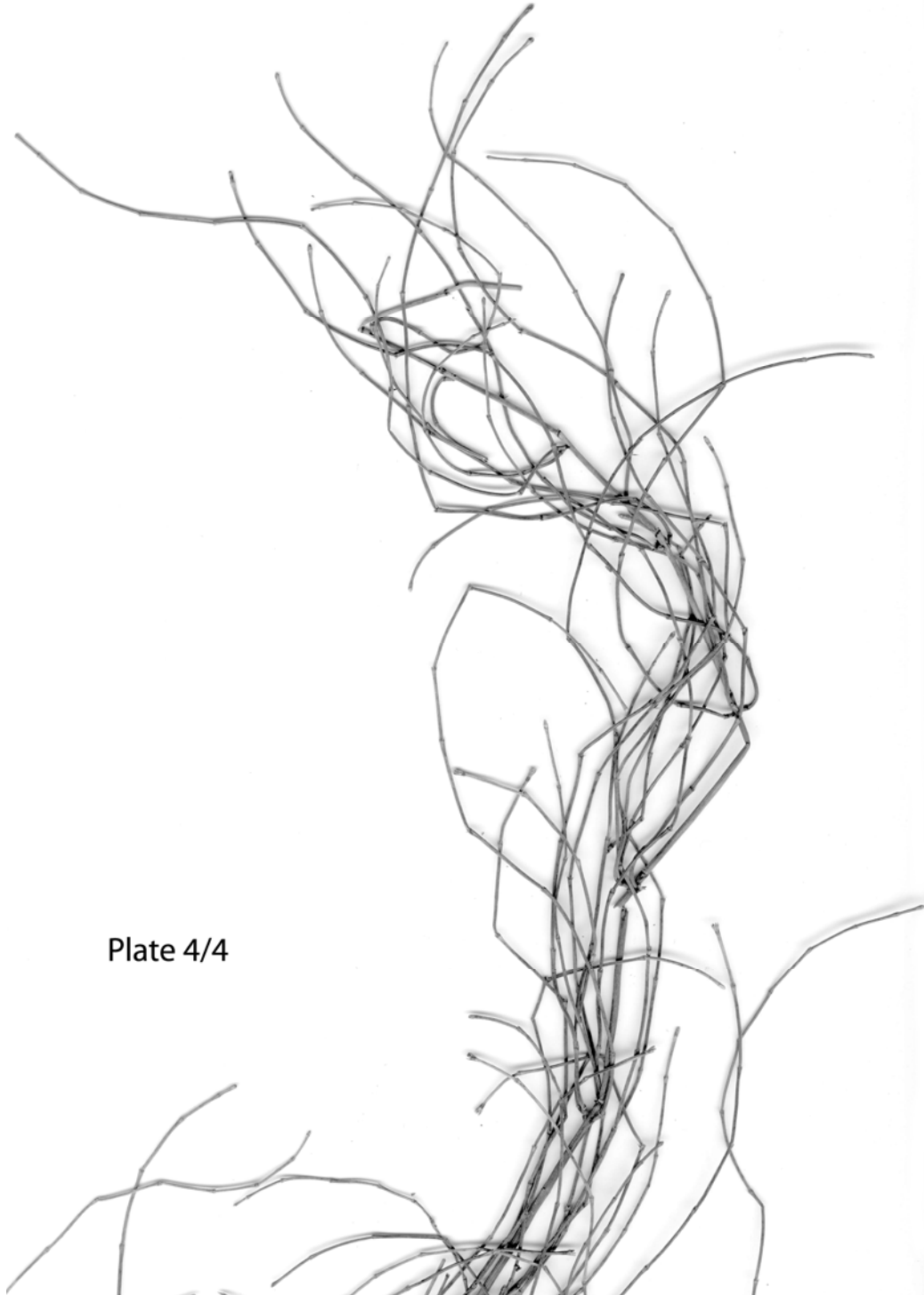


Plate 4/4

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Autor(en)/Author(s): Skvortsov Vladimir Engelsoich

Artikel/Article: [An unexpected record of an African horsetail, *Equisetum ramosissimum* Desf. var. *flagelliferum* Milde \(Equisetaceae\), fromCaucasus 69-83](#)