The interesting Upper Permian Montan-flora from the Dolomites

Michael Wachtler
P. P. Rainerstrasse 11, 39038 Innichen, Italy; E-mail: michael@wachtler.com
Collaboration: Nicolas Wachtler; E-mail: nicolas@wachtler.com

The Upper Permian (probably ?Capitanian-Wuchiapingian) sediments between Gleno and Montan (South-Tyrol, Northern Italy) attracted just in the early 1800 the attention of geologists like Roderick and Charlotte Murchison, as well the author of the "Principles of Geology" Charles Lyell and also another influential British geologist Adam Sedgwick, due to its richness in fossilised plants. In 2021, Michael Wachtler made his first research in this area discovering an interesting new Ginkgophyta, *Ginkgoites gasseri* n. sp., the new fir ancestor *Majonica lyellae* n. sp. and additionally he encountered the Araucaria-ancestor *Ortiseia visscheri*. All they were discovered in exceptionally well preserved specimens.

October 2021
Key words: Upper Permian floras, Dolomites, Coniferophyta, Ginkgoales, Cycadophyta, gymnosperm-evolution

Late Permian (end Capitanian-Wuchiapingian, about 265 mio years), Montan-flora Northern Italy

Left is visible the fir-ancestor **Majonica lyellae** with a decayed female cone and a winged seed scale, additionally to a shed pollen cone. **Middle** grow a **Ginkgoites gasseri** tree. Also a bunch of seed-berries is visible. **Right** can be encountered the Araucaria ancestor **Ortiseia visscheri** with a pollen- and a seed cone in the foreground **Below** in the middle sprout an isolated cycad ***Macrotaeniopteris wachtleri***

Roderick and Charlotte Murchison, Charles Lyell, George Hall and an unidentified person travelling in Southern France (1828). Illustration made by Henry and Carol Faul. In the following weeks they arrived also in the Dolomites.

The Enn-Castle over Montan. To reach the famous geological site near Predazzo the researchers had to use this path-way. The most interesting plant-lenses were located behind the castle and must had arouse the interest of the scientists, especially Murchison, which recorded in his geological map the "fine grits with plants"

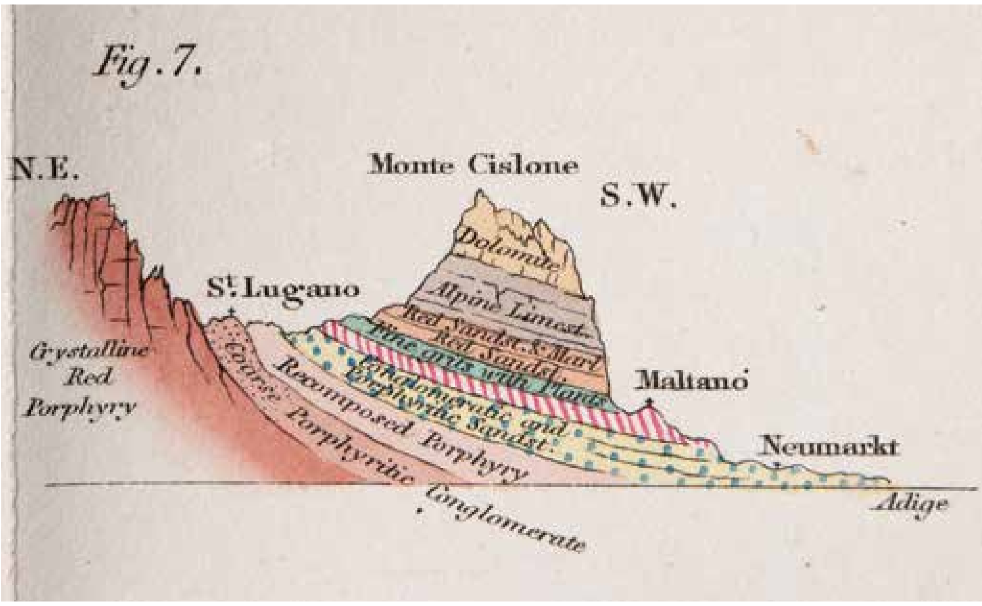
The mountain-range near Gleno till Montan over the village of Neumarkt (South-Tyrol, Northern Italy) attracted just from the beginning of the 18th century the scientists. Following the path over the San Lugano-Pass they reached additionally the famous geological sites around Predazzo and Cavalese. Especially in immediate vicinity of the Enn-Castle over Montan a rich and well preserved Upper Permian flora crop out.

Historical overview

The first written mention of the fossilised plant layers between Neumarkt and the San Lugano Pass was made by Reverend **Adam Sedgwick** (1785 -1873) and **Roderick Impey Murchison** (1792–1871) in the "*Philosophical Magazine*" on August 1830 with the title "*A sketch of the structure of the Eastern Alps*".

The basis were several lectures (6 and 20 November 1829, 4 December 1829 and 5 March 1830) in the London Geological Society. The publication contained a hand-coloured copper engraving with geological profiles of the area probably made by **Charlotte Murchison**, née Hugonin (1788–1869), a fervour palaeontologist and wife of Roderick Impey Murchison. The Murchison's had already acquired a good knowledge about the Dolomites through their previous journeys in 1828, accompanied by **Charles**

Left: **Charlotte Murchison** accompanied her husband **Roderick Impey Murchison** (middle: portrait painted in October 1829 during his visit in the Nave d'Oro of Predazzo) and helped him in his geological researches. Charlotte Murchinson was a strong influence for her husband and introduced him in the world of geology Right: Reverend **Adam Sedgwick** travelled in 1829 together with the Murchison's in the Alps (1866, albumen print Dolomythos-Museum)



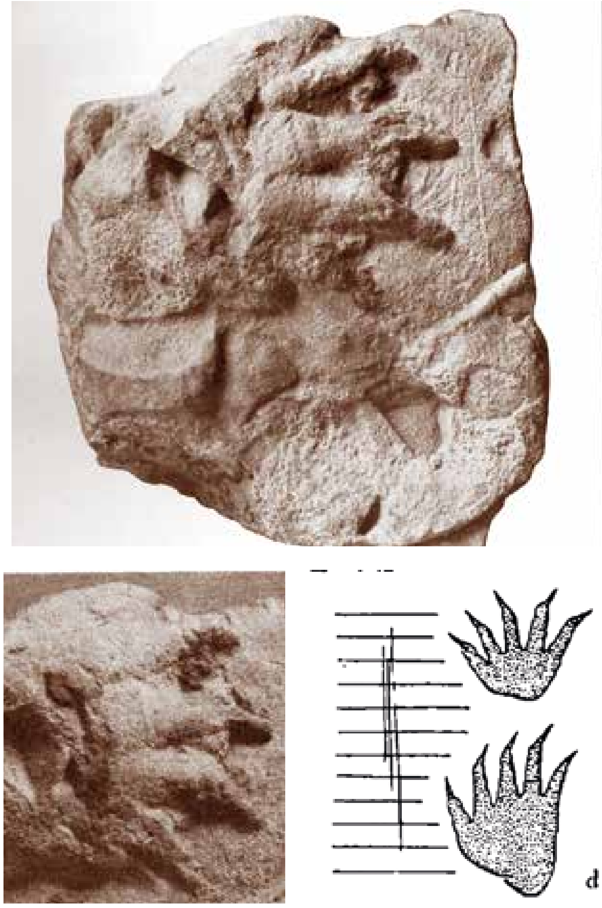
A first mention of the fossilised plant horizons between Gleno and Mantana (Montan). Roderick Murchison and Adam Sedgwick (1835): "*A sketch of the structure of the Eastern Alps*" (Dolomythos-Museum, Innichen)

Lyell (1797-1875), in 1829 together with **Adam Sedgwick**, and in 1830 as couple.
Although the English scientist Roderick Impey Murchison in 1841 by his travels in the Russian Ural-Region entered in history as the name giver for the "*Permian system*", an until this moment overlooked – fifty million-year-long gap, interestingly in 1830 he was not able to recognize, that this geological period was also largely present in Europe and the Dolomites. The well done copper engraving from 1830 evidence good the geological layers below the Monte Cislon, beginning from the "*Red Porphyry*", prosecuted by various stages of decomposed porphyry till arriving to the "*Fine grits with Plants*", so classified by Murchison. Sedgwick and Murchison observed right that "*these beds contain impressions and detached portions of plants*" without going more in detail, to which plant families this vegetation belonged. A further and expanded work was than published in 1835 (Sedgwick & Murchison).
It is possible that both - **Leopold von Buch** (in several voyages from 1802 on) and **Alexander von Humboldt** (in a short stay on 30 September 1822) - were pointed out by the local population to these thin coal lenses, but these clues did not find way into their publications.

Murchison was eager to make his public image appear in the best light. Portrait in the Journal "Vanity Fair" on Nov. 26, 1870 as "Men of the day". Below: Autograph (All Dolomythos-Museum, Innichen).

The German geologist Carl Wilhelm Gümbel (Albumen-print, 1879, Deutsches Bergbau-Museum). In a short paper edited in 1873 he described the "*Flora from Neumarkt" i*n South-Tyrol.

A more exhausting work completed in 1873, the German palaeontologist **Carl Wilhelm Gümbel** (1823–1898). Gümbel observed right that there were two levels with plants: in the "*weissen Sandstein"* (the white sandstone) could be found only "*raw stems and trunks covered with charcoaled bark, which cannot be further determined*" (*rohe, mit kohliger Rinde bekleidete Pflanzenstengel und - Stämme, die nicht weiter zu bestimmen sind)*. In the contact lenses (Zwischenlagen) in an "*unfortunately very crumbly slate individual scales, needles, short branches and cones can be found of magnificent preservation, so that they can be detached and examined microscopically, especially after a treatment with chlorate potassium and nitric acid, almost like dried plants*" *(In dem leider sehr bröcklichen Lettenschiefer sind einzelne Schuppen, Nadeln, kurze Zweige und Zapfen von prächtiger Erhaltung, so dass man sie ablösen und besonders nach der Behandlung mit chlorsauren Kali und Salpetersäure fast wie getrocknete Pflanzen mikroskopisch untersuchen kann)*.



Herpetichnium acrodactylum, the oldest known ichno-species from the Alps. It was found by F. Glassner and first mentioned by Ernst Kittl in 1891. Othenio Abel described and figured the track in 1929 and classified it as belonging to pelycosaurs, an order composed of primitive mammal-like reptiles or turtle-ancestors. The locality Neumarkt (between Gleno and Montan, Monte Cislon) belongs to the Grödner-Sandstone. In vicinity Roderick Murchison (1830) and Wilhelm Gümbel (1877) recovered also their Upper Permian plants.

Initially Gümbel doubted if these plants belong to the Triassic, finally he accepted, after consulting the palaeobotanist Wilhelm Philipp Schimper (1808-1880) that they belong to the Permian period.

In reference to a similar vegetation from the Hungarian Fünfkirchen and plant findings from the German Zechstein of Upper Permian age, he classified the conifers as *Voltzia hungarica, Ullmannia bronnii* and *Ulmannia geinitzii,* the ginkgo as *Baiera digitata*, and the cycad as *Pterophyllum jaegeri* with additionally some undefined ferns and horsetails. It was not an exact definition, but just a milestone in research.

Years later - in 1929 - the Austrian ichnologist Othenio Abel classified some tracks found in the vicinity by by Dr. Friedrich

The Upper Permian Flora of Montan (Neumarkt)

1. The hamlets Montan (left) and Gleno (right). The red line over the Enn Castle indicate the plant horizons; 2. An outcrop over the former Fleimstal-railway with indication of a fine-grained-lense; 3. Detail of plants recovered from the "weisse Sandstein" (the white sandstone) indicated by Gümbel in which only "*raw stems and trunks covered*" can be found; 4. Only rarely reasonably classifiable conifer-branchlets can be found there (*Ortiseia visscheri).*

Glassner and first mentioned by Ernst Kittl in 1891 as *Herpetichnium acrodactylum* and supposed that they belong the to pelycosaurs an order composed of primitive mammal-like reptiles or turtle-ancestors.

In the following decades over the two World Wars did happen nothing of exciting. **Piero Leonardi** (1908–1998) described in 1948 a fern recovered by the geologist **Nino Dal Piaz** from the Upper Permian sandstone of Neumarkt, the old fossil site of Gümbel as *Pecopteris (Cyatheites) miltoni.* The fern today can better be inserted as *Lepidopteris martinsii,* a seed fern with shield-like fructificactions. It was a first step in a new era. Beginning from 1964 the interest returned of anew. In 1964 the Swedish palaeobotanist **Rudolf Florin** (1894-1965) classified a new discovered Upper Permian conifer from the Seceda mountains near Ortisei in the Gröden-Valley as *Ortiseia leonardii.*

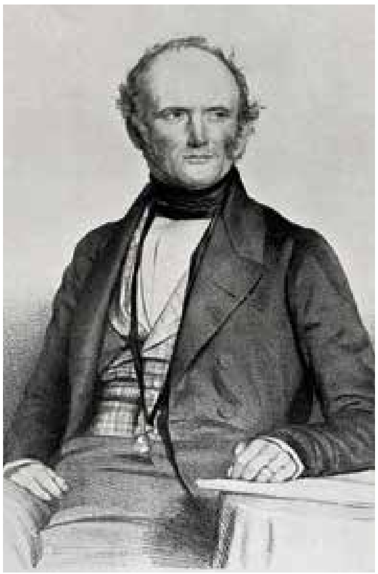
And in 1984 the young Dutch researcher **Johanna Clement-Westerhof** started intensive studies, based mainly on the fructifications and the cuticles of the plants. She published first results in 1984, establishing as part of the genus *Ortiseia* two other new Upper Permian species: *Ortiseia visscheri* (found in the Bletterbach-Butterloch) and *Ortiseia jonkeri recovered* from the Vicentinian Alps (Valli del Pasubio) (Clement-Westerhof, 1984). Nevertheless Clement-Westerhof was not able to classify the *Ortiseia* species in one of the existing families, especially the Araucariaceae, and inserted them—influenced by Florin—in the doubtful family of the Walchiaceae, comprising mainly all Permian conifers, stating that "*unambiguous descendants remain unknown"* (Clement-Westerhof, 1984). In 1987, Johanna Clement-Westerhof described the first winged seed conifer worldwide, naming it *Majonica alpina* (after her family). But she was not able to recognize, that they belong to the oldest ancestors of the Abietaceae. Also this conifer was found in the Bletterbach, a deep gorge between the hamlets of Aldein and Radein and located only about ten kilometres from the plant-outcrops near Montan.

Beginning from 2021 **Michael Wachtler** started his researches on the traces of Murchison and Gümbel. The German bibliophilic Helmut Schwank provided him with the rare original works of Murchison and Sedgwick and based on these informations Wachtler combed through the partly dense forests above Montan. Especially above the decommissioned Fiemme-Railway near the Enn-Castle Michael Wachtler found plant-fossil rich horizons, probably the same that just attracted the attention of Murchison and Gümbel.

Strangely after the heyday in the 19th century nobody were again interested in the study of these outcrops. The short report of Carl Wilhelm Gümbel can be fully supported: Thick layers with charcoaled stems and plant debris change with intermediate finest-grained thin lenses with perfectly preserved leaves, seeds and cones. The flora can be regarded as typical Permian with a dominance of the Abies-ancestor *Majonica*, the Araucariaceae *Ortiseia* and the ginkgo *Gingkoites*. Rare are other plant families like cycads or ferns. The abundance of male cones is striking, so it can be assumed that it is belongs to a spring-time community. Especially the carpets of well preserved male *Majonica*-cones are impressive.

Geology and time-dating

The base with the "*Crystalline Red Porphyry"*, followed by a "*coarse Porphyritic Conglomerate*", "*Recomposed Porphyry*", "*Conglomeratic and Porphyritic Sandstone*" was just observed by Roderick Murchison. The plant lenses were than covered by small - also Upper Permian - sediments of sandstone, followed by the Bellerophon- and the Werfen-Formation (Picotti et. al, 2012). Between them, we encounter - well exposed - the Tesero-Horizon as Permian-Triassic border. In the Upper Permian Gröden-Formation coarse-grained conglomerates change with fine sludge cemented layers, that are today covered by a dense vegetation. So unfortunately the outcrops are visible only rarely. The fine lenses are the result of ancient small non-marine lakes and ponds in which isolated tracks of animals and shed twigs, leaves, seeds, scales or cones could be fossilise and remain in excellent preservation. They can be compared with other nearby localities like the Bletterbach-gorge, the Seceda, or the areas around the Valli del Pasubio and Recoaro.



The married couple **Mary Lyell née Horner** (1808-1873) and **Charles Lyell** (1797-1875). They were scientific partners. Their honeymoon brought them to the Alps. The multilingual Mary (she spokes fluently French, German, Spanish and Swedish), accompanied Charles on field trips and assisted him by sketching geological drawings or cataloguing their collections. Charles masterwork "*Principles of Geology*" presented the idea that the earth was shaped by the same natural processes still in operation today. Right: The young Charles Lyell after a lithograph from 1843 made by Thomas H. Maguire (1821-95) (Archive Dolomythos-Museum).

The area was in the Late Permian south of the equator and drifted further and further north. Towards the end of the Permian, the first foothills of the Tethys Sea approached with the fossilisation of marine cephalopods (known in the Bletterbach-gorge as Cephalopoden-Bank), clear evidence of a sea flooding that lasted for many millions of years.
An exact time-dating is not so easy: Radiometric dating (U/Pb) indicates a Kungurian age of 274.1±1.4 Ma for the top of the oldest underlying volcanic Ora Formation (Morelli et al., 2007). About 260 Ma ago began in the Dolomites a phase of changing marine ingression with subsequently drying out of large areas. Because in these layers no macrofloras can be found, a deposition of the plants in the Lopingian, and more restrained in the Wuchiapingian can be accepted. Probably the Montan-flora is the oldest one, being deposited just in the Capitanian. The differences in the various gymnosperms with many subspecies from *Ortiseia, Majonica, Ginkgoites* are probably based on some slightly time-different evolutions.
Who believe that in the Late Permian a tropical vegetation in the immediate vicinity of the ocean and the equator was predominant, would have to be disappointed. Gymnosperms like conifers and gingkos dominate, whereas the cycads, ferns, horsetails are seldom.
The marine influences increased especially towards the Late Permian in the Gröden-Formation. It is proven by the abundance of the small-sized brackish water fish *Acentrophorus robustus* (Brandt, 2021). In the end of the Permian the climate in the Dolomites become arid. Beginning from the Changhsingian age more and more frequent gypsum layers displaced the rich fossil plant deposits. And this lasted till the Early Triassic. Probably this phenomenon can only be explained by a striking climate collapse.

References

Abel. O., 1929. Eine Reptilienfährte aus dem Oberen Perm (Grödener Sandstein) der Gegend von Bozen in Südtirol. – Palaeobiologica, 2: 1–14

Brandt, S., 2021. Beschreibung paläozoischer Semionotiden (Holostei) und Anmerkungen zur Gattung *Acentrophorus* aus dem Oberperm der Dolomiten und des europäischen Zechsteins, Dolomythos, Innichen

Clement-Westerhof, J., 1984. Aspects of Permian Palaeobotany and Palynology. IV. The conifer *Ortiseia* from the Val Gardena Formation of the Dolomites and the Vicentinian Alps (Italy) with special reference to a revised concept of the Walchiaceae (Goeppert) Schimper. - Rev. Palaeobot. Palynol., n. 41, pp. 51-166

Clement-Westerhof, J., 1987. Aspects of Permian Palaeobotany and Palynology; VII, The Majonicaceae, a new family of Late Permian conifers. - Rev. Palaeobot. Palynol. 52 (4), pp. 375-402

Gümbel, W. 1877. Vorläufige Mitteilung über das Vorkommen der Flora von Fünfkirchen im sog. Grödener Sandstein Südtyrols (Ullmanniensandstein). — Verh. k. k. Geol. Reichsanst., Nr. 1, Wien

Kittl E., 1891C. Saurierfährte von Bozen. Mittheilungen österreichischder Touristen-Klub, Wien III, 7

Leonardi, P. 1948. Contributi alla conoscenza della flora delle arenarie di Val Gardena (Permiano Medio-Inf.) dell'Alto Adige: La nuova Flora di Redagno e una felce di Egna. — Mem. 1st. geol. Univ. Padova, 16: 3—15; Padova

Morelli C., Bargossi G.M., Mair V., Marocchi M., Moretti A., 2007. The Lower Permian volcanics along the Etsch Valley from Meran to Auer (Bozen). Mitteilungen der Österreichischen Mineralogischen Gesellschaft 153, 195-218

Murchison, R. I., Sedgwick, A., 1835. A sketch of the structure of the Eastern Alps; with sections through the newer formations on the northern flanks of the chain, and through the tertiary deposits of Styria etc. Geological Society of London, p. 301-420

Murchison, R. I., Leonhard, G., 1850. Ueber den Gebirgsbau in den Alpen, Apenninen und Karpathen, namentlich um einen Uebergang aus sekundären Gebilden in tertiäre darzuthun, und über die Entwicklung eocener Ablagerungen im südlichen Europa. Stuttgart, J.- B. Müller, 2 Blätter, pages 162

Picotti, V., Cocco S., Mair V., Avanzini M., Bargossi, G.M., Borsato A., Cucato M., Selli, L., Abbà T., Casolari E., Morelli C., Ferretti P., Marini M., Rinaldo M., Santacattarina M., Spanò M., Tomassoni R., Vallone R., Varrone D., Zambotti G., 2012. Carta Geologica d'Italia alla scala 1:50.000, Foglio 043 "Mezzolombardo". Servizio Geologico d'Italia - ISPRA

Sedgwick, A., Murchison, R. I.,1831. A sketch of the structure of the Eastern Alps; with sections through the newer formations on the northern flanks of the chain, and through the tertiary deposits of Styria etc. ‚&c. &c." read in the London Geological Society on 6 and 20 November 1829, 4 December 1829 and 5 March 1830. The Philosophical Magazine or Annals of Philosophy, New Series, Vol. VIII, August 1830, S. 81 - 114

Wachtler M. 2015. Revision of Permian Conifer *Ortiseia*; in Wachtler M., Perner T., 2015. Fossil Permian plants from Europe and their evolution. Rotliegend and Zechstein-Floras from Germany and the Dolomites. Published by Dolomythos Museum, Innichen, South Tyrol, Italy; Oregon Institute of Geological Research, Portland, OR, (USA), ISBN 978-88-908815-4-1; pp. 99-102

Wachtler M. 2015. Revision of Upper Permian (Lopingian) conifer *Majonica alpina* from the Dolomites (Northern Italy); in Wachtler M., Perner T., 2015. Wachtler, M., 2019. Die Entstehung der Dolomiten, Verlag DoloMythos - Innichen. ISBN 978-88-944100-0-6

Wachtler M. 2021. Upper Permian floras of the Dolomites; p. 165-240; in: Wachtler M., Wachtler N. (eds.): Permian Fossil Floras and Faunas from the Dolomites, ISBN 978-88-944100-6-8

Wachtler M. 2021. The Upper Permian climate changes in the Dolomites; p. 141-164; in: Wachtler M., Wachtler N. (eds.): Permian Fossil Floras and Faunas from the Dolomites, ISBN 978-88-944100-6-8

The main plants of the Montan-Flora

Ginkgophyta

The first doubtful ginkgo-leaves appeared in the Middle Devonian, but information about barely recognizable Ginkgoales we have only form the Carboniferous-Permian border. Beginning from the Early Permian we have than knowledge of fully evolved ginkgos with attached seeds and pollen-organs. *Ginkgoites pohli* from Kungurian-age Tregiovo can be regarded—due to its inchoate and irregular branching system—as the most primitive ginkgo so far recorded. But it has all of the features of real ginkgos: these characteristics include a collar-like ring from which the leaves emanate and one or two ovules aggregated together. The ovules/seeds were held by a modified leaf segment and are in that slightly different from those of modern ginkgos that are connected at the end by a distinctive stalk. After that we can than follow their evolution over the Late Permian till the Triassic-Jurassic and today's times.
Extant ginkgo leaves are fan-shaped with veins radiating out into the leaf blade. In the Permian, their leaves were irregularly lobed and needle-like. Beginning from the Permian two separated Ginkgoalean lineages were established: a *Baiera*-line characterized by their needle like foliage, sprouting on one level and a *Ginkgoites*-line evidenced by their more or less fan-shaped leaves with a repeatedly forking vein structure—typical of modern Ginkgoales.
Strangely in the Late Permian of the Dolomites we encounter on one side with *Ginkgoites murchisonae* just more evolved Ginkgophyta referring to their fan-shaped foliage and on the other side a new primitive ginkgo-species, characterized by their extremely rudimental leaves. This new ginkgo-species will be described.

Devonian supposed gingko-ancestors
Ginkgo-like arrangement of leaves from the Middle Devonian (385 Mio. years) of Lindlar (LIND 195, Coll. Fuchs, Dolomythos-Museum

Class: Ginkgopsida

Order: Ginkgoales

Family: Ginkgoaceae

Genus: Ginkgo

Ginkgoites gasseri n. sp. (WACHTLER, 2021)

Locus typicus

Montan, a municipality in South Tyrol (Northern Italy, about 15 km (9.3 miles) south of Bolzano.

Geological age

Upper Permian (Wuchiapingian)

Repository

All Wachtler Collection, Museum Dolomythos, Innichen

Etymology

Named after Arnold Gasser a man of science and entrepreneurship who supported the research in the Alps.

Holotype

MON 130, **Paratypes:** MON 282 (seeds), **Repository:** Coll. Wachtler, Dolomythos-Museum, Innichen. In addition, more than hundred specimen were catalogued.

Diagnosis

Foliage irregularly divided into several forking needle-like segments. Subtle veins crossing the leaves. Ovules/Seeds oval till rounded, sitting on an elongated stalk. Pollen organs cone-like.

Description

Leaves: Branchlets divided into several forking needle-like foliage. The leaves fork irregularly on different levels (designed holotype MON 130, also MON 03, MON 188, MON 252, MON 253). Single needles reach considerable lengths of 10-12 cm (MON 253). Foliage varying from small-sized, needle-like till forming broader laminas (about 1-1.5 cm) with clearly visible forking veins (MON 269, MON 139). A geometrical concept in the dividing needles is not recognizable.

Female fructifications: Ovules/seeds elongated and from 0.5 till 0.8 cm long, about 0.5 cm wide (MON 46, MON 42, MON 272, MON 71, MON 227, MON 67, MON 65, MON 152, MON 55, MON 224). Sometimes they could be found connected in bunches with needle-like stalks (MON 282, MON 181), but usually they are collected isolated or in mass-occurrences (MON 46, MON 42). As in living ginkgo-trees shed ovules till mature seeds and stalks can be found in the same sediments.

Pollen organs: From 2-3.5 cm long, 0.7-1.0 cm wide, characterised by many small-sized bracts (MON 253) MON 12, MON 11, MON 248, MON 130, MON 263). Sometimes supported by a 1 cm long fragile peduncle.

Discussion

Ginkgoales which can hardly be distinguished from today's in terms of their fertile organs became widespread already from the early Permian on. If Kasimovian-Gzhelian *Baiera perneri* (Wachtler, 2013, Perner & Wachtler, 2015), may be still doubtful due to the lack of preserved fructifications, this changed just in Early Permian (Kungurian *Ginkgoites pohli* from the Alps. From it all fertile organs are preserved in good quality. The closer we get to the end of the Perm, the more numerous the finds are and, due to slightly time differences in the various areas and locations more species were described (Wachtler, 2021).

This is especially valid for the Dolomites, where we encounter in some places, especially in the Gröden-Formation on the Seceda with *Ginkgoites murchisonae* (Wachtler,

A historical *Ginkgo-biloba* tree planted in 1750 in Padova, the oldest botanical garden of the world

2021) just well developed Ginkgophyta with partially laminate leaves evidencing a tendency to today's maidenhair trees.

In this context the new discovered *Ginkgoites gasseri* has more resemblances with Early Permian *Ginkgoites pohli* as with more evolved *Ginkgoites murchisonae.* It seems as *Ginkgoites gasseri* evidence even more primitive traits than *Ginkgoites pohli* and approach to some Devonian archaic plants with their irregularly dividing leaves.

Effectively the foliage or the branchlets of *Ginkgoites gasseri* can not or only with difficulty be determined which part correspond to a single leave or form a tuft of leaves belonging together.

Strangely another known Ginkgophyta, coeval *Baiera digitata* from the European Zechstein form leaves sprouting from one single petiole and fork than several times at the same level. This feature is unknown in *Ginkgoites gasseri.*

From the near Montan lying Bletterbach-gorge, recovery-locality of other late Permian ginkgos, were described seeds attached directly on the leaves, recognized rarely also today in *Ginkgo biloba* and called with the Japanese term O-ha-tsuki (Fischer et al., 2010). Unfortunately the ginkgoales from the Bletterbach-gorge are not well preserved and therefore can not be established if single seeds were deposited accidentally during the fossilisation over the leaves (as happened also sometimes in those of the Montan-fossil-site) or effectively we have to do it with the O-ha-tsuki-phenomenon. Additionally it seems that those from the Grödner Sandstein-Formation of the Bletterbach have resemblances with *Ginkgoites murchisonae,* bearing more laminate foliage.

Common to all Permian ginkgo species are their similar fructifications especially their seeds/ovules. As in todays, they were connected with the branchlet by a relatively long stalk, that can be interpret also as a modified leaf.

Unresolved till now is the question in which way the gymnosperms including ginkgos, conifers and cycads can be connected together in a common evolution-way or in which manner they developed and separated each from the other. In the same layers from the Montan-fossil-site can be recovered as well the Araucarian conifer *Ortiseia*, the Abietaceae *Majonica,* but also isolated remains of cycads. This symbiosis can be followed back till the Early Permian. It is plausible that the many micro-leaves covering the single seed of the *Ortiseia*-cones, and a plethora of small-sized leaves forming a fleshy sarcotesta in the gingkoales can be reunited during a common evolution. The single divided cycad scale has also some resemblance with the ginkgos, but probably their evolution-line divided just beginning from the Devonian as recorded in some ginkgo-similar foliage from the Middle Devonian fossil site Lindlar in Germany.

It is obvious, that the enigma of the evolution of the ginkgoales can only be resolved in fossil sites with many well preserved single or connected parts of the plants, like Montan or the Seceda, where hundreds and hundreds of specimen can be found in the fine Upper Permian sediments. It is not always easy to distinguish conifer scales from ginkgo-seeds due to its uniformity in the deposition.

The development of the Ginkgoales can be prosecuted in minor case over the Triassic, but beginning from the Triassic-Jurassic border they were again widespread in many parts of the world. Therefore they can be brought in connection as a good climate indicator, growing today in temperate regions of the world, and avoiding too cold areas, like the Northern parts of the world or too high temperatures with water poverty like Mediterranean regions or the arid zones of the United States. Such a climate can also be assumed for the Late Permian ginkgos in the equatorial-near Montan-area.

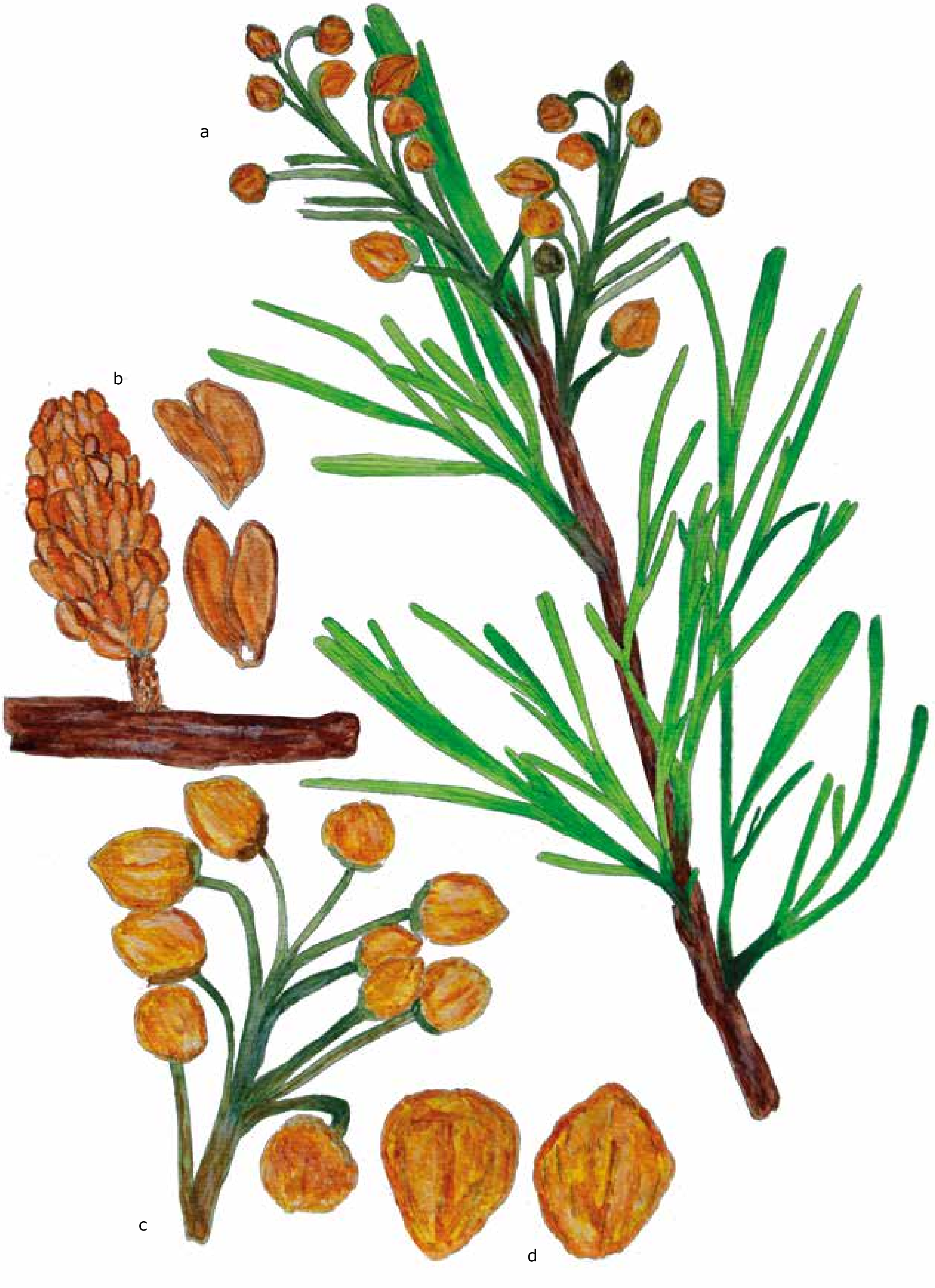
A nomenclatural question in which manner the two Paleozoic-Mesozoic ginkgo genera-terms *Baiera (Sphenobaiera)* and *Ginkgoites* can be reasonably used is for the Permian not easy. Repeatedly dichotomizing or bilobed leaves based on Rhaetian-Hettangian specimen of Bayreuth were first described as *Baiera dichotoma* (Braun, 1843). Further this genus-name was brought in connection with archaic ginkgos and adopted for various deeply dissected leaves, like late Permian *Baiera digitata* from the European Zechstein (Heer, 1876). The American researcher Albert Charles Seward introduced the name *Ginkgoites* (Seward, 1919) for more or less fan-shaped leaves conducting to the only species existing *Ginkgo biloba*. Because both names are just established well and used largely probably the less confusing solution could effectively be leave the name *Baiera* for deeply dissected fossil ginkgo leaves originating on one level from a long or short petiole, whereas for the other the term *Ginkgoites* is more appropriate.

What we know and what not about the genesis of ginkgos

Ancestor of all gymnosperms in the Devonian: Since the ginkgos were already fully developed just in the early Permian, a separation of the gymnsoperms must have already taken place just in the Devonian.

Formation of the fleshy seed by micro-leaflets: The clearly recognizable coating of the ovule by a number of tiny sterile leaves, especially in the ancient Araucarias in the Permian, allows the conclusion that the fleshy sarcotesta in the ginkgos was formed in a similar way. The evolutionary advantage were a protection of the inner sclerotesta and even more an attractive range of food for semen-dispersing animals.

Merging of the individual needles into a fan-shaped leaf: The frequent presence

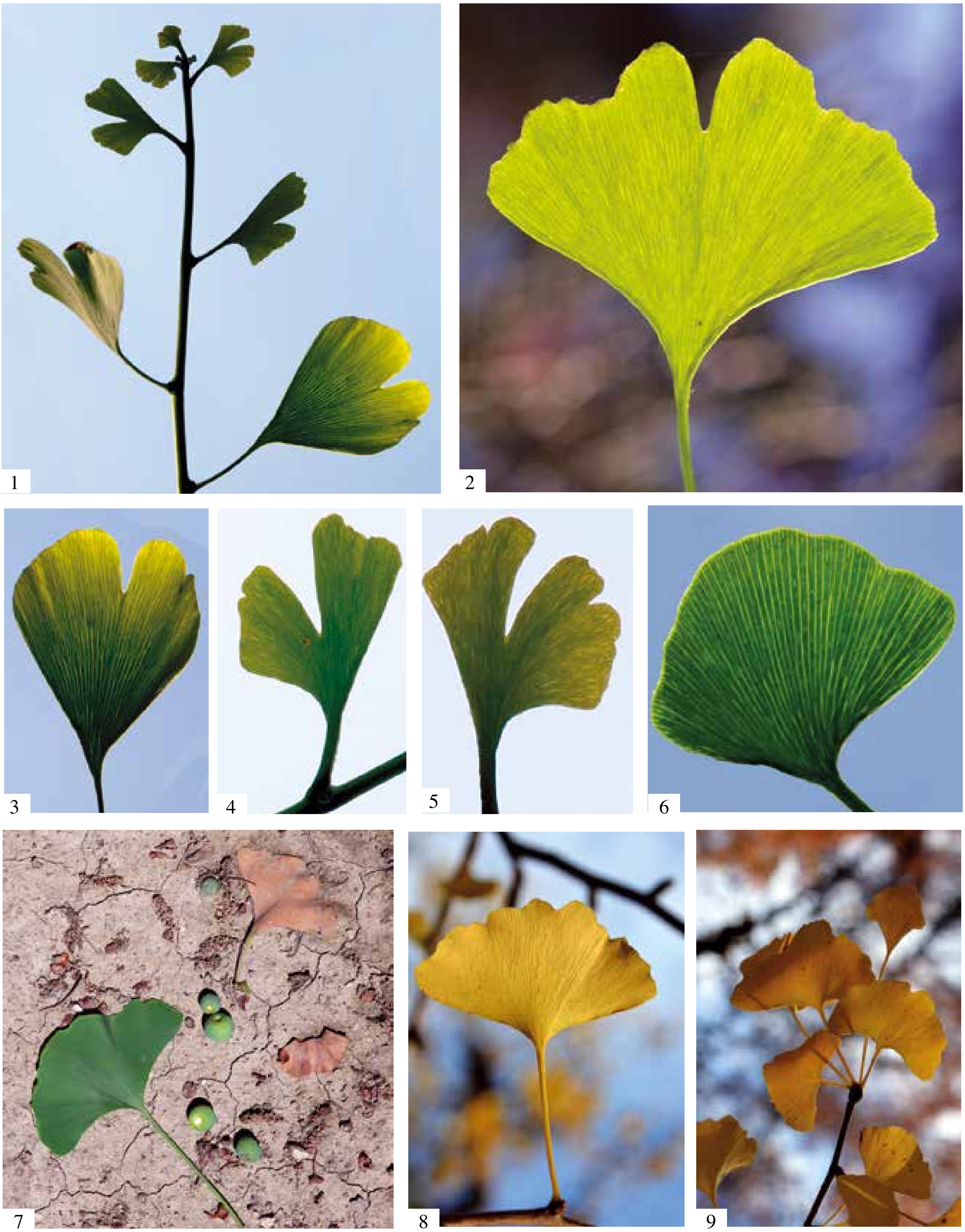


***Ginkgoites gasseri*. Reconstructions. (Late Permian, Wuchiapingian)**

a. Shoot with several berries (MON 130, MON 130, MON 03, MON 188, MON 252, MON 10, MON 282, MON 181); b. Male cone with detail of the microsporophylls (MON 253); c. Tuft of seeds (MON 282, MON 181); d. Single berries with open and closed sarcotesta (MON 272, MON 71, MON 227, MON 67, MON 65, MON 152, MON 55, MON 224)

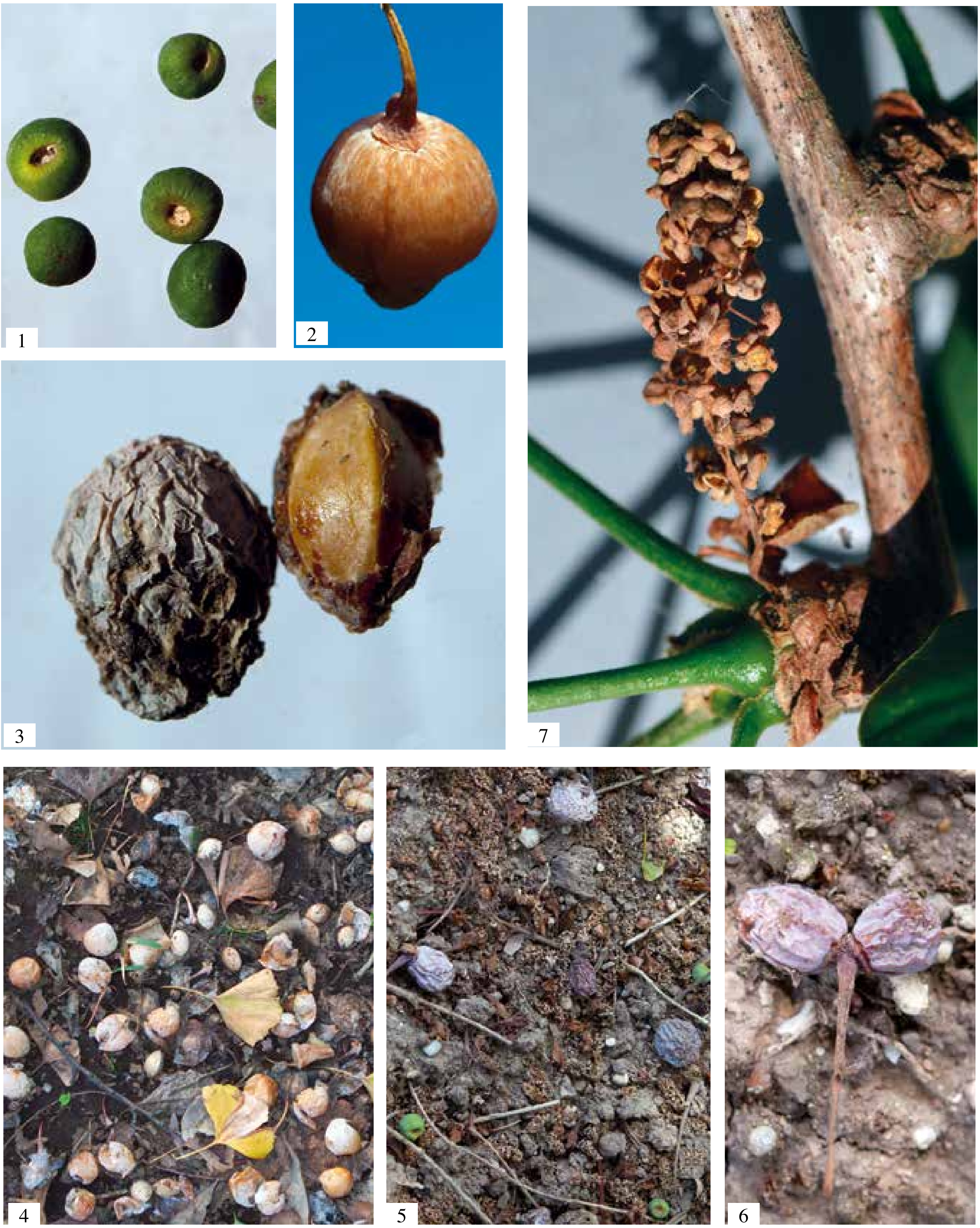
Ginkgo biloba. Leaves and seeds

1. Autumnal tree with shed leaves; 2. Spur shot with one single leaf attached; 3. Tree with seeds in spring; 4. Tree in autumn with seeds



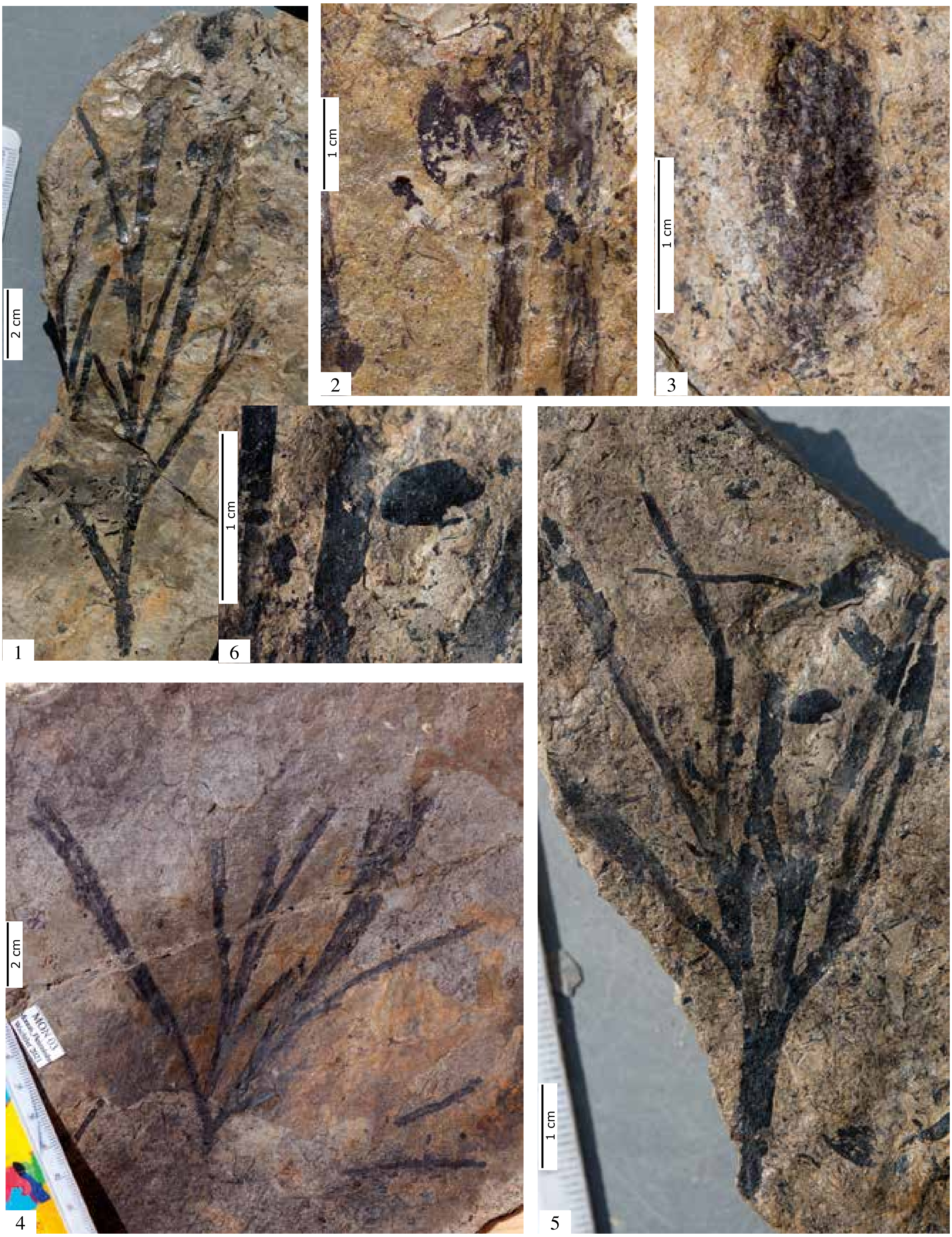
***Ginkgo biloba*. Leaves**

1-9. Various leaf-forms and branchlets of extant ginkgos



Ginkgo biloba. **Fruits and Pollen cones**

1. Shed immature ovules in the spring; 2. Mature seed; 3. Shed seeds with a dried wrinkled aril and an open fruit; 4. Shed seeds and leaves in autumn; 5. Shed springtime green ovules and wrinkled fruits from the last year; 6. Isolated connected fruit; 7. Mature pollen cone

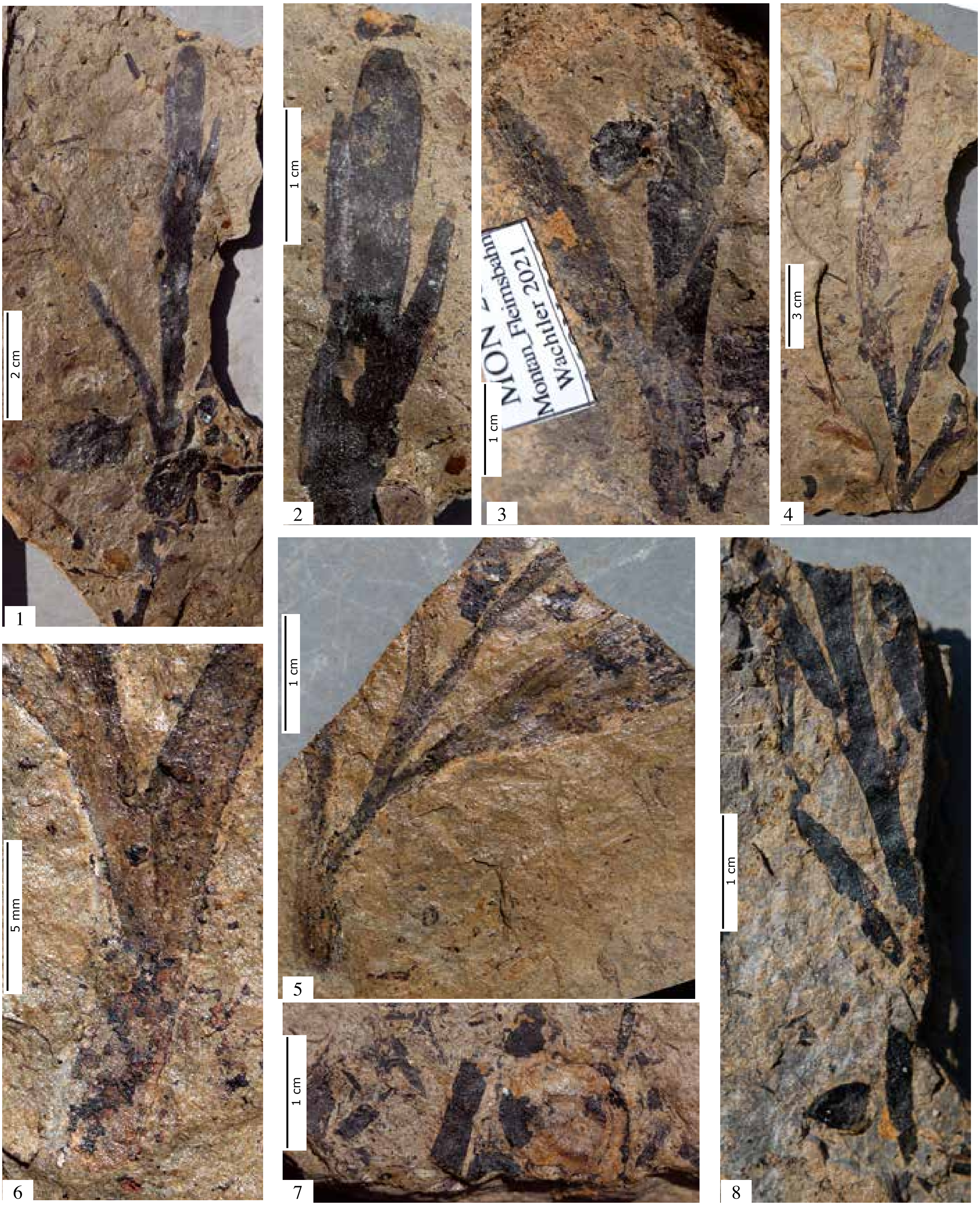


Ginkgoites gasseri. Leaves (Late Permian, Wuchiapingian)

1. Twig with leaves and seeds (designed holotype, MON 130); 2. Seed connected with a stalk (MON 130); 3. Isolated suggested male cone (MON 130); 4. Branchlet with leaves (MON 03); 5-6. Branchlet with connected seeds/ovules (MON 188); all Montan, Coll. Michael Wachtler, Dolomythos Museum

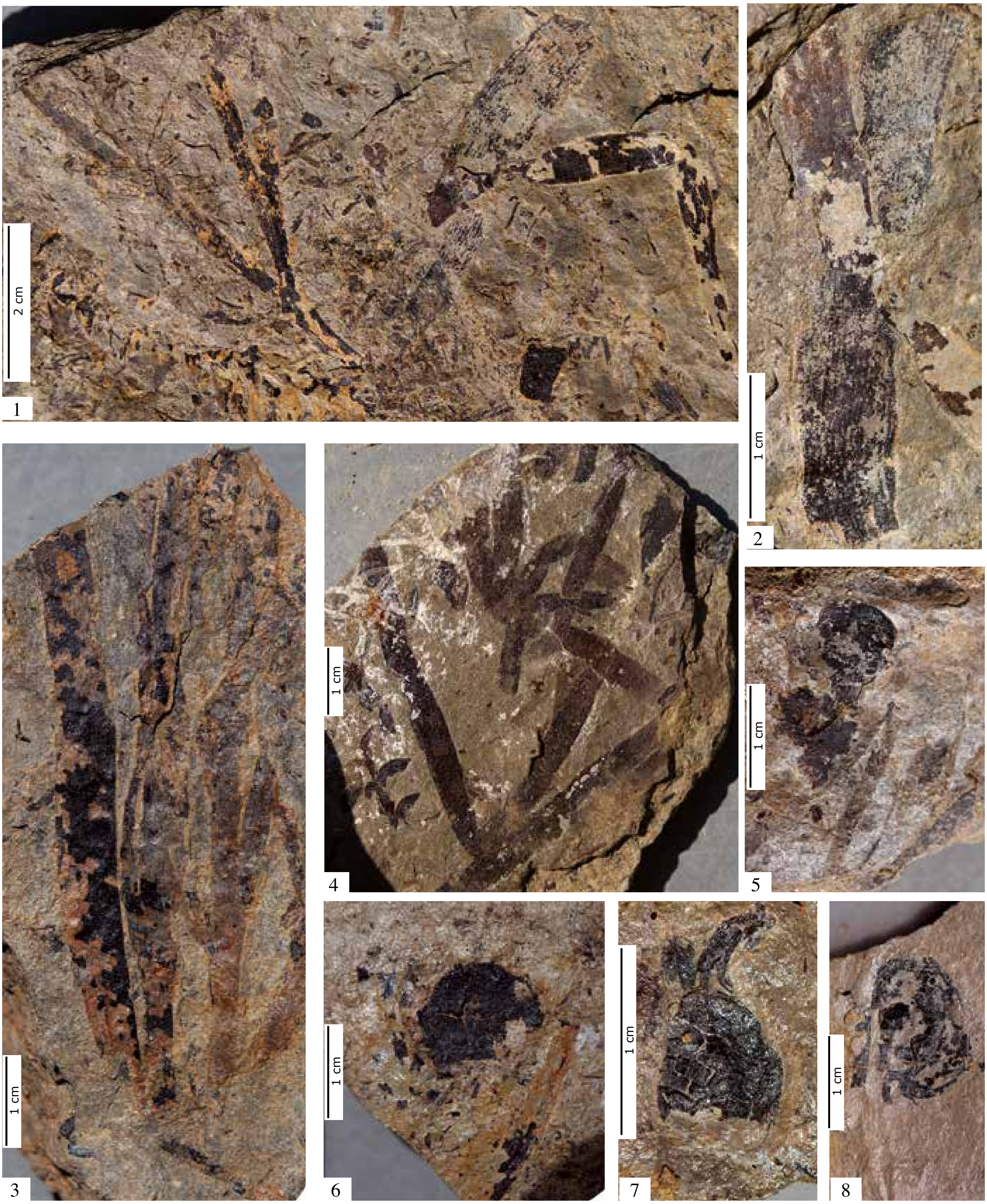
Ginkgoites gasseri. Leaves (Late Permian, Wuchiapingian)

1. Branchlet with leaves and seeds (MON 252); 2. Base of a branchlet (MON 10); 3. Branchlet with isolated seeds (MON 133); 4-5. Branchlet with an isolated male cone (MON 253); 6. Branchlet with connected seeds/ovules (MON 08); all Montan, Coll. Michael Wachtler, Dolomythos Museum



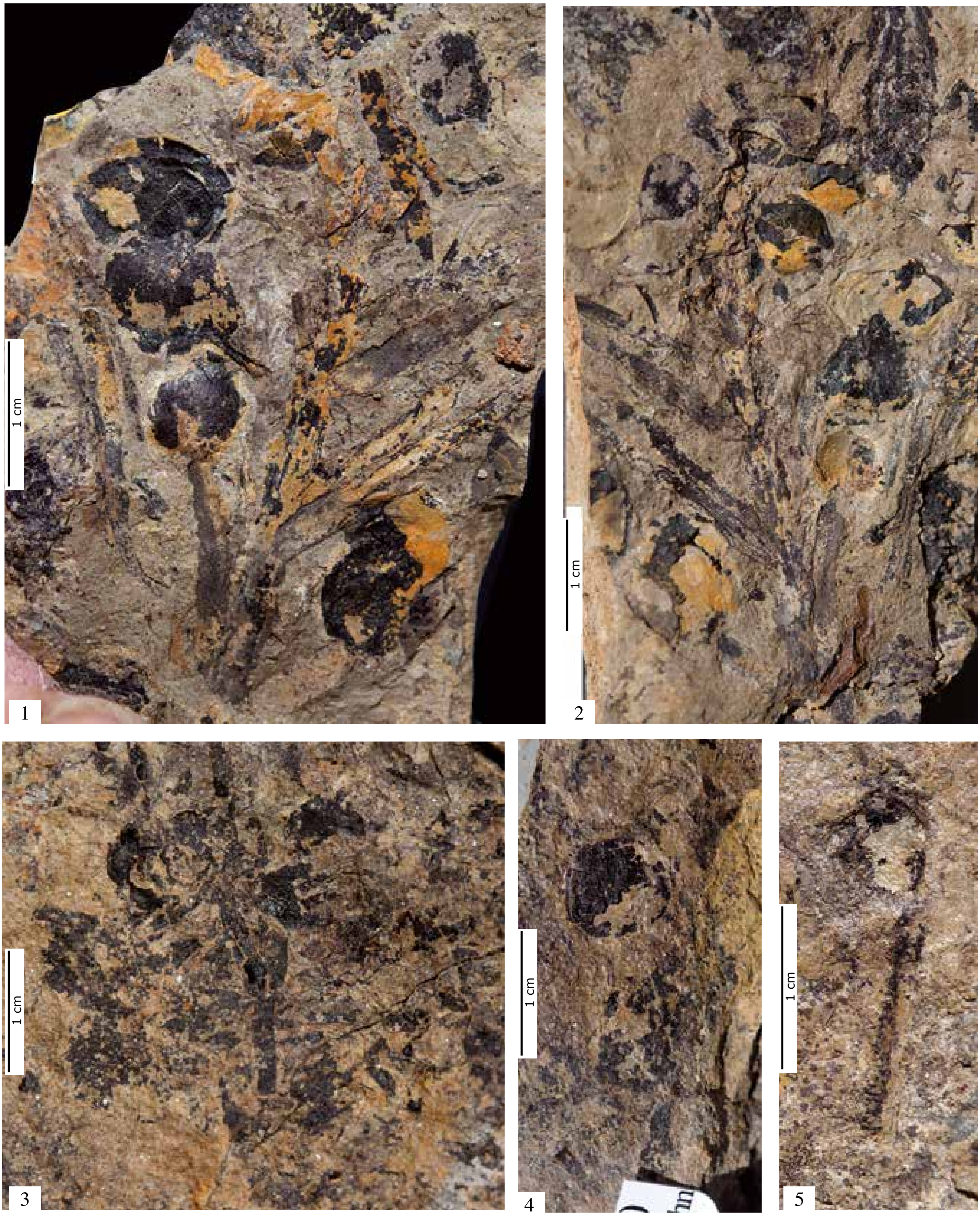
Ginkgoites gasseri. Leaves (Late Permian, Wuchiapingian)

1-2. Branchlet with a wider middle leaf (MON 269); 3. Wider leaves with seed (MON 285); 4. Branchlet (MON 139); 5-6. Branchlet evidencing the basal part forking to smaller and wider leaves (MON 138); 7. Seed connected with a stalk (MON 36); 8. Branchlet with a seed; all Montan, Coll. Michael Wachtler, Dolomythos Museum



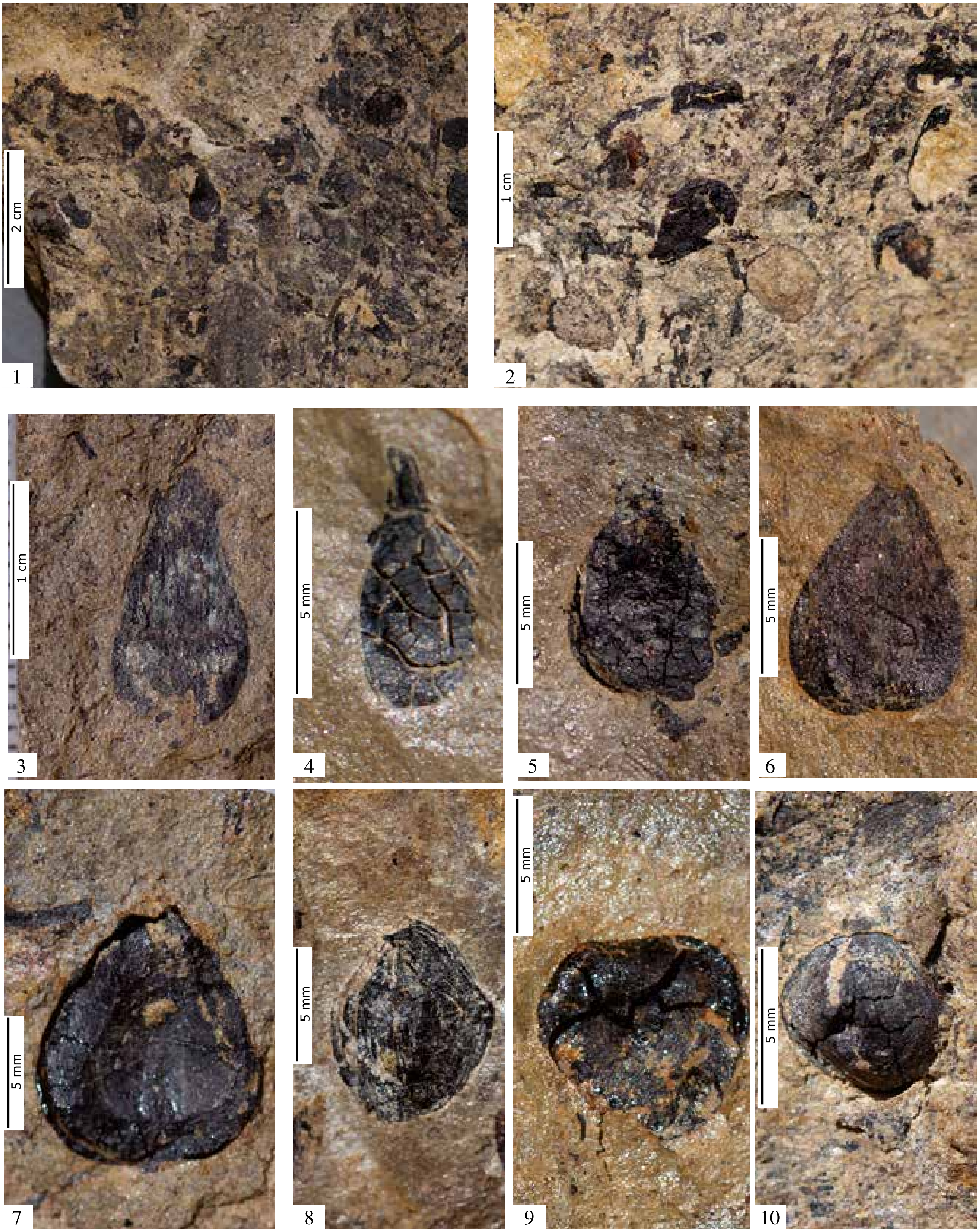
Ginkgoites gasseri. Leaves and seeds (Late Permian, Wuchiapingian)

1-2. Branchlet with smaller and wider leaves (MON 259); 3. Leaf (MON 258); 4. Decomposed branchlet (MON 254); 5. Seeds hanging on a stalk (MON 234); 6-8. Several seeds connected with stalks MON 38, MON 53, MON 35); all Montan, Coll. Michael Wachtler, Dolomythos Museum



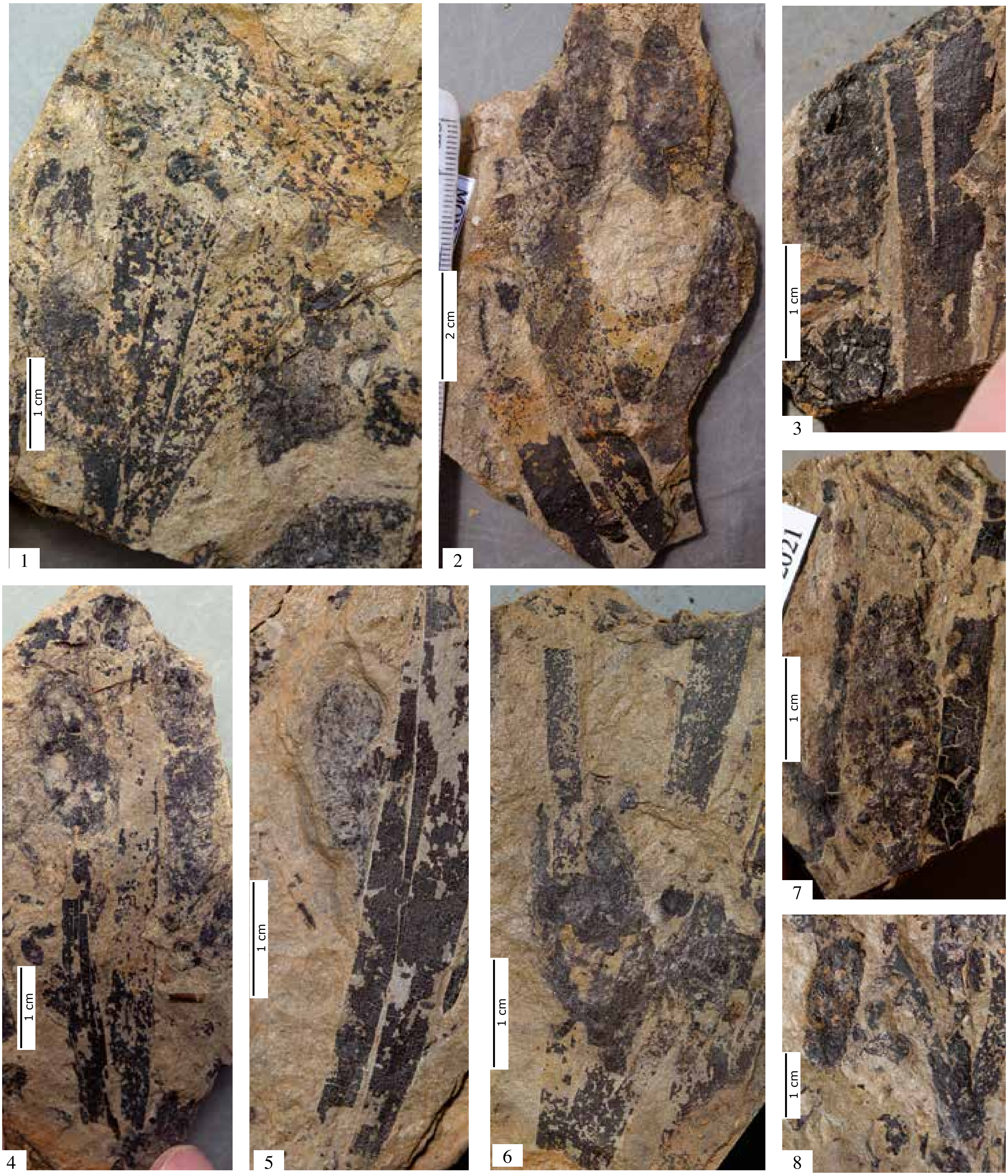
Ginkgoites gasseri. Seeds an ovules (Late Permian, Wuchiapingian)

1. Beautiful preserved branchlet with several attached seeds (MON 282); 2. Twig with several attached seeds (MON 181); 3 Seeds attached on a branchlet (MON 48); 4-5. Single ovules/seeds on a stalk (MON 240, MON 235); all Montan, Coll. Michael Wachtler, Dolomythos Museum



***Ginkgoites gasseri*. Seeds an ovules (Late Permian, Wuchiapingian)**

1-2. Shed isolated seeds (MON 46, MON 42); 3-10. Single ovules/seeds (MON 272, MON 71, MON 227, MON 67, MON 65, MON 152, MON 55, MON 224); all Montan, Coll. Michael Wachtler, Dolomythos Museum



***Ginkgoites gasseri*. Male cones (Late Permian, Wuchiapingian)**

1-8. Male cones (MON 142, MON 143, MON 22, MON 149, MON 146, MON 150, MON 23, MON 132); all Montan, Coll. Michael Wachtler, Dolomythos Museum

***Ginkgoites gasseri*. Male cones (Late Permian, Wuchiapingian)**
1-3. Pollen cones (MON 263, MON 11, MON 248); all Montan, Coll. Michael Wachtler, Dolomythos Museum

of fused individual leaflets, having parallel veins in *Ginkgoites gasseri* and a rapid further development till *Ginkgoites murchisonae* all occuring in the late Permian allow the conclusion that the fan-shaped leaflet of today's ginkgos originated from a continued merging of the needles with formation of dividing veins.

Coniferophyta

Abietaceae-ancestors

Additionally to the Ginkgo-ancestors (*Ginkoites*) and Araucaria-progenitors (*Ortiseia*), we encounter over the whole Permian a conifer which is characterized by its winged seeds. Although many of today's conifers generate alate seeds, some other features like plagiotropic branchlets, small-sized pollen cones and female cones with more or less the seed scale projecting bracts make them easily distinguishable as Abietaceae-ancestors.
The first fir-progenitors can just be encountered worldwide (USA, New Mexico, Kinney Brick, Carrizo Arroyo), Niederhausen, Oberhof (Germany), Lodéve (France) from the late Carboniferous (Kasimovian) on with the two bracted *Gomphostrobus bifidus* and the one-bracted *Wachtlerina bracteata*. They generate in this time symmetrically arranged combs, whereas in the Early Permian the recoveries of fully developed Abietaceae-ancestors change than above all to the Alps, where we encounter first with Artinskian *Majonica suessi* (Wachtler, 2015) the first plagiotropic fir-ancestor. They prosecuted their evolution way with Kungurian *Majonica ambrosii* till splitting in the Late Permian of the Alps in several species, that can mainly be distinguished by some differences in the blue-print of the bracts, the leaves or the winged seeds.
Also in the by Roderick Murchison and Adam Sedgwick just in 1830 first mentioned Montan fossil-site over Neumarkt occur an interesting fir-ancestor, that is distinguished by several differences between mainly coeval *Majonica alpina* or *Majonica clementwesterhofae.* Strangely this new Late Permian species has regarding its leaves and branchlets more resemblances with Early Permian firs Abietaceae (*Majonica suessi* or *Majonica*

ambrosii). Additionally in difference to all others, carpets of pollen cones with hundred and hundreds of pieces can be found in the fine sediments.

Majonica lyellae n. sp. (WACHTLER, 2021)

Holotype

MON 214, paratype MON 275 (pollen cone), paratype MON 158 (seed scale) Dolomythos Museum, Innichen, Coll. Wachtler

Locus typicus

Montan, South-Tyrol, Upper Permian (Wuchiapingian)

Additional material

More than 100 specimen were catalogued

Repository

All Wachtler Collection, Museum Dolomythos, Innichen

Etymology

Remembering Mary Lyell, neè Horner (1808 – 1873), who assisted the British geologist Charles Lyell in his scientific work. Although she never appears on his publications it is believed that she made major contributions to her husband's work. Mary Lyell accompanied him on the field trips and assisted him intensely. Before marrying, Charles Lyell accompanied Roderick and Charlotte Murchison in their voyage through the Dolomites.

Diagnosis

Conifer with slender plagiotropic twigs, leaves descending and slightly curved, seed scales with two winged seeds and equipped with an abaxial never the scale projecting bract. Pollen cones are small-sized elongated.

Description

Branchlets and leaves: Twigs pendulous and irregularly diverging in a plagiotropic manner (MON 220, MON 241, MON 206, MON 202)). Usually the leaves are 0.7–1 cm long, but also heterophyllous foliage reaching till about 5 cm (MON 74, MON 219, MON 199, MON 198) can be encountered. The leaves are equally wide for the whole length and end rounded till slightly tapered. One ore two fibrovascular canals expand through almost the entire leaf (MON 04). The needles are decurrent and do not overlap each other; they sprout laterally to curve easily upwards, only sometimes they are slightly falcate, from the whole base of the branchlet.

Male cones: Elongated, from 2.0 to 3.0 cm long (and 1.5 to 2.0 cm wide (MON 135, MON 265, MON 275,(paratype), MON 271, MON 100). They sit in many on the apical end of a needle/stalk (MON 275, paratype). No bracts are visible. They end rounded with reflexed involucral scales (MON 89, MON 280, MON 293, MON 85) and are shed at maturity forming so extended cone carpets in the sediments.

Female cones: Female cones slender, loosing their seed scales at maturity, so that only a thinly spindle remain (MON 211). Seed scales about 1 cm long 0.7 cm wide (MON 158 (paratype), divided in the middle to form a horny curved extension. Seed-side (adaxial) holding two winged seeds that occupy two-thirds of the scale (MON 155, MON 27, MON 284). Abaxial side with a bracted appendix that do not project the end of the scale. Bract divided in one main bract-leaf and several accompanying microleaves (MON 224, MON 32 MON 277, MON 215). The seeds are winged, about 0.5 till 0.7 cm long, incorporating basally the elongated ovule (MON 214, designed holotype, MON 39, MON 24, MON 238, MON 18).

Discussion

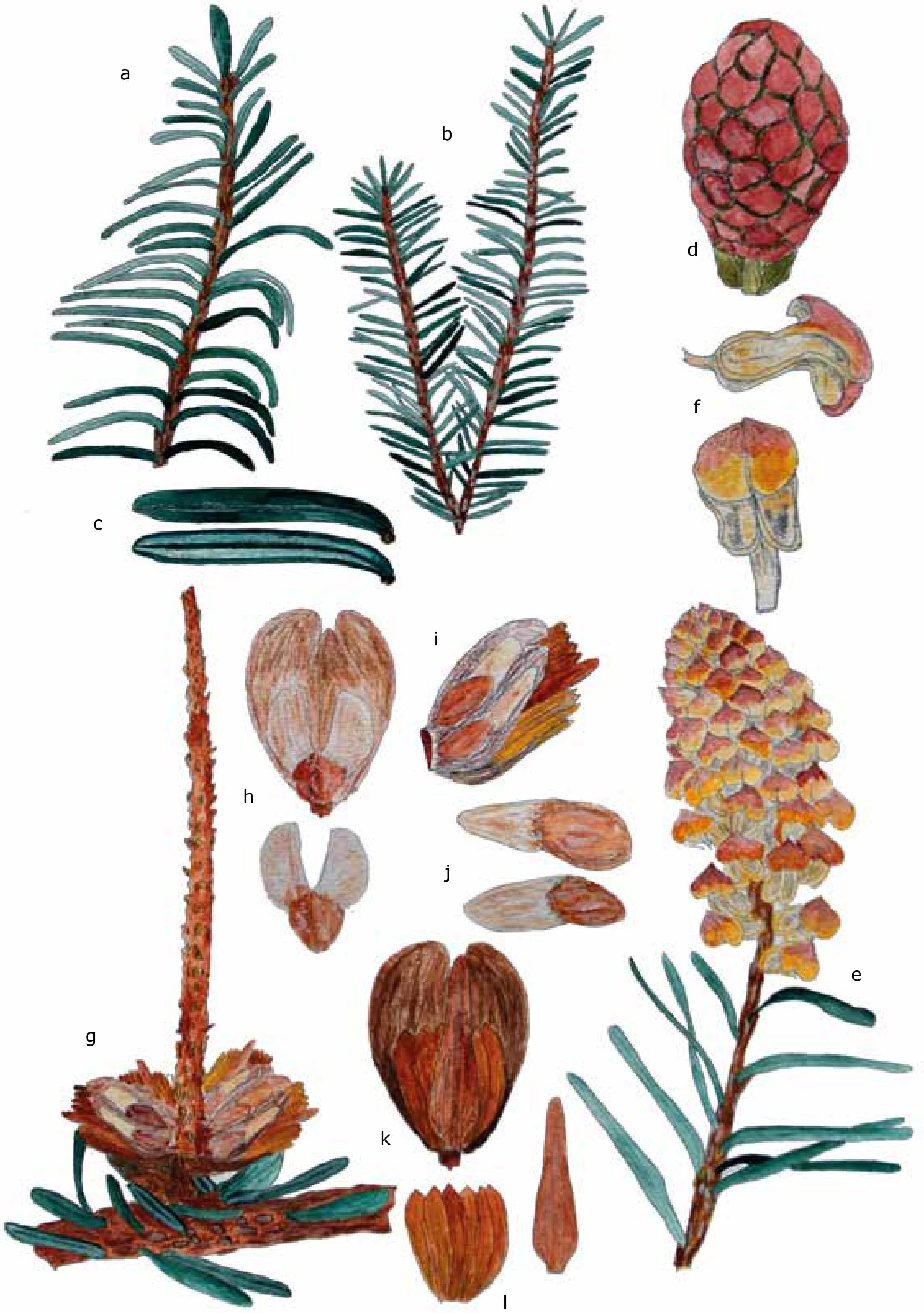
The fir-ancestor *Majonica lyellae* has more characteristics in common with Kungurian *Majonica ambrosii* or Artinskian *Majonica suessi* than with coeval *Majonica alpina* and *Majonica clementwesterhofae* (Wachtler, 2015, Wachtler, 2021). The needles are in the equal way pendulous as the Early Permian one and also the bracts did not project the scale as it occur in *Majonica alpina.* Because also *Ginkgoites gasseri* evidence many archaic features and can be distinct in this from Upper Permian *Ginkgoites murchisonae* a plausible explanation could be that they might belong to older Upper Permian sediments than the other ones. Maybe they belong to the Middle Permian Guadalupian (Capitanian). Especially the Upper Permian Gröden-Formation was deposited prob-

ably in a time span of from 10 till 15 million years.
Otherwise *Majonica lyellae* evidence just all modern features of today's firs like plagiotropic branchlets, bracted seed scales, winged seeds, decaying cones at maturity and similar pollen cones. Therefore naked spindles can be recovered whereas entire female cones could be only rarely found.
A strange feature and never recorded from other Early till Late Permian localities are the carpets of pollen cones in the fine sediments. Probably an explanation can be a growth of *Majonica lyellae* in the immediate vicinity of lakes or slowly streaming rivers, whereas the male cones of all other *Majonica*-species were transported over longer distances. Interesting is also the change of the pollen cones from shortly bracted (*Majonica suessi, Majonica ambrosii)* in the Early Permian till reflexed involucral scales of *Majonica lyellae*, the same as today's. It can be assumed that the fir trees had already completed their full evolution just in the Permian.
Interestingly the fossil sites of Montan and the Bletterbach-gorge are located only of a few kilometres in distance but both Upper Permian fir-species can be distinct easily. *Majonica alpina,* first described in 1987 by the Dutch researcher Johanna Clement-Westerhof from the Bletterbach-gorge (South-Tyrol) is distinct by its extremely long and the scale largely projecting bract, (as it occurs also in the Valli del Pasubio) whereas the bract of *Majonica lyellae* is inconspicuous subtle.
After this heyday all over the Permian we have than a declining of the firs till the Eocene, about 50 million years ago, were they reappeared with their alate seeds, plagiotropic branchlets mostly in the same blueprint as 250 million years earlier.

Araucaria-ancestors

An interesting group inside the conifer-families is represented by the Araucarias. Now they are restricted to the Southern hemisphere, but for a long period—from the Earliest Permian till the Triassic-Jurassic—they were widespread on the Northern part of the globe. One feature that distinguishes them from other conifers are their one-seeded megasporophyll in contrast to many other conifers like the Pinaceae, Piceaceae, Abietaceae, which bear two, mostly alate seeds on their scales or the three- or more seeded *Cryptomeria*-conifers and Sequoias. The Araucarias are also distinct by their huge pollen cones with apically and dorsiventrally hanging pollen sacs or their bulbous female cones.

Majonica lyellae: Sometimes the leaves could reach also considerable lengths (till 5 cm) (MON 199, MON 198).



Majonica lyellae. Reconstructions (Late Permian, Wuchiapingian)

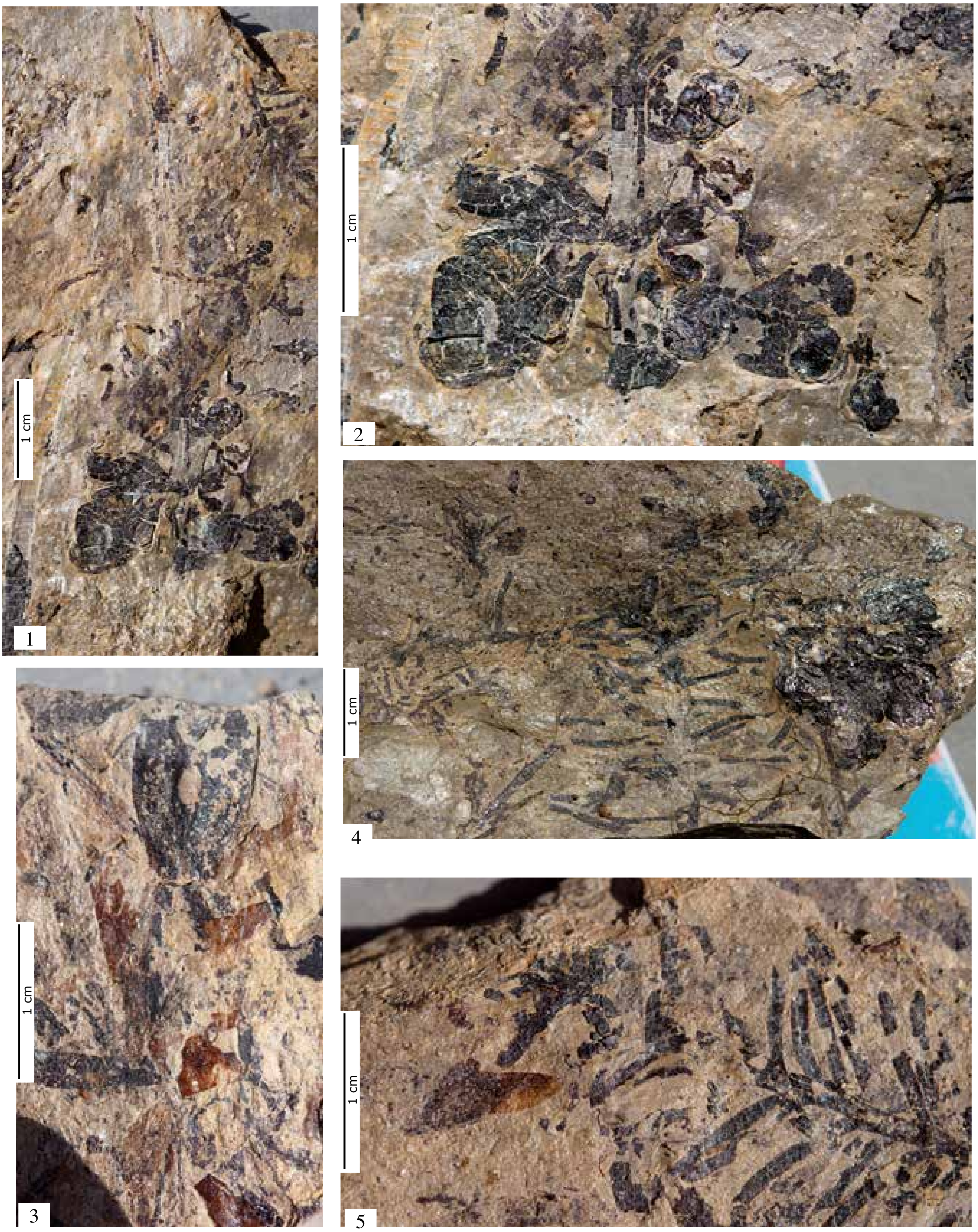
a. Twig with characteristic pendulous needles (MON 74); b. Plagiotropic branchlet (MON 241, MON 206, MON 202); c. Single leaf (abaxial and adaxial side; d. Juvenile male cone (MON 279); e. Male cone on a twig (MON 288); f. Single microsporophylls (MON 89, MON 280, MON 293, MON 85); g. Female cone with shed seed scales (MON 211); h. Seed scale adaxial side (MON 158, MON 155, MON 27, MON 284); i. Seed scale lateral side; j. Single winged seeds (MON 214, designed holotype, MON 24, MON 238, MON 18); k. Seed scale abaxial side (MON 224, MON 32 MON 277, MON 215); l. Blue-print of the bract-complex

***Majonica lyellae*. Branchlets (Late Permian, Wuchiapingian)**

1. Plagiotropic branchlet (MON 220); 2. Several branchlets (MON 151); 3. Twig with characteristic pendulous needles (MON 74); 4. Branchlet (MON 69); all Montan, Coll. Michael Wachtler, Dolomythos Museum

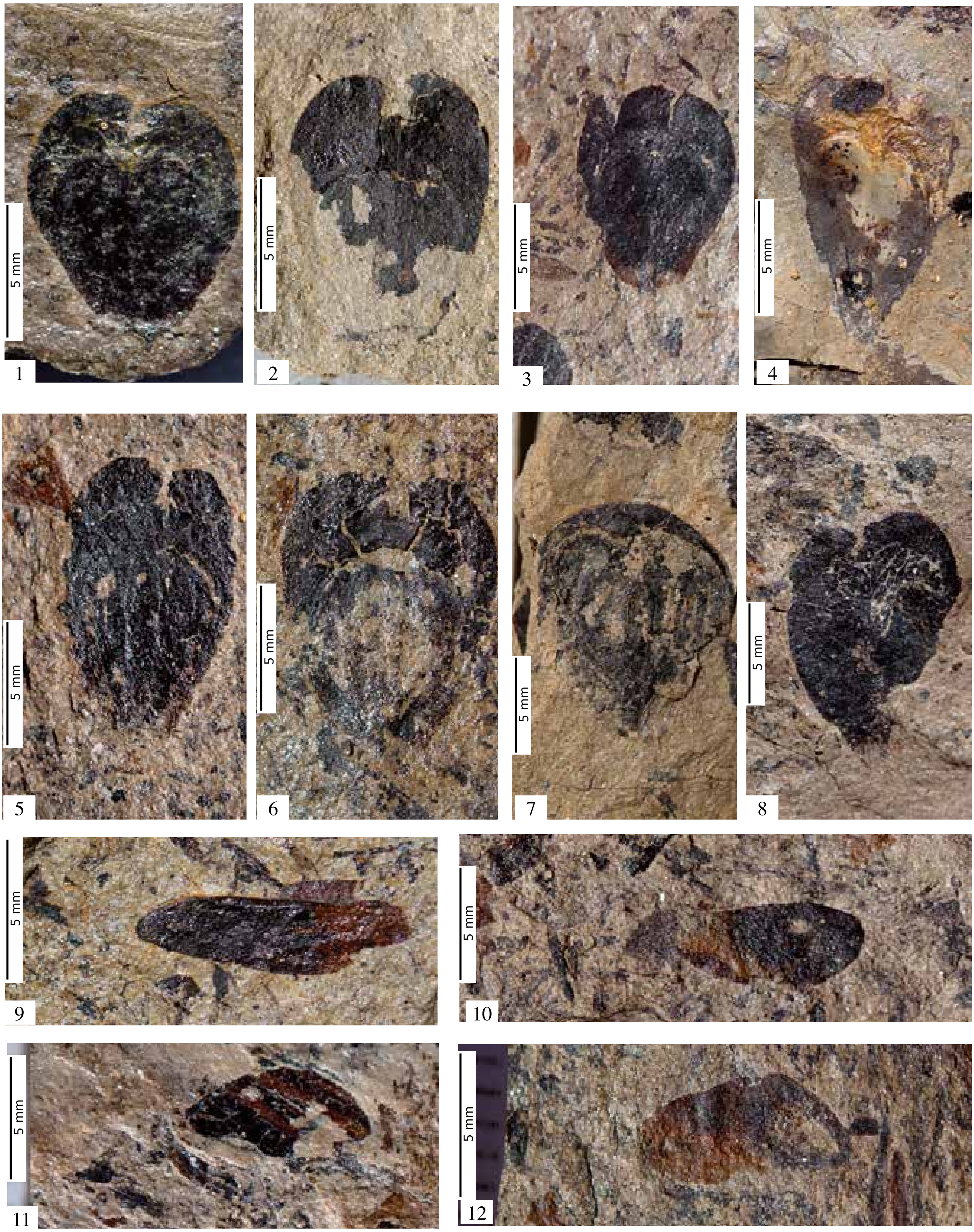
Majonica lyellae. Branchlets (Late Permian, Wuchiapingian)

1-3. Plagiotropic branchlets (MON 241, MON 206, MON 202); 4-5. Several branchlets (MON 219, MON 75); all Montan, Coll. Michael Wachtler, Dolomythos Museum



***Majonica lyellae*. Cones and seeds (Late Permian, Wuchiapingian)**

1-2. Female cone with naked stipe and basal seed scales (MON 211); 3. Isolated winged seeds and seed scale (MON 229); 4. Branchlets and basal part of a cone (MON 79); 5. Branchlet and winged seed (MON 214, designed holotype); all Montan, Coll. Michael Wachtler, Dolomythos Museum

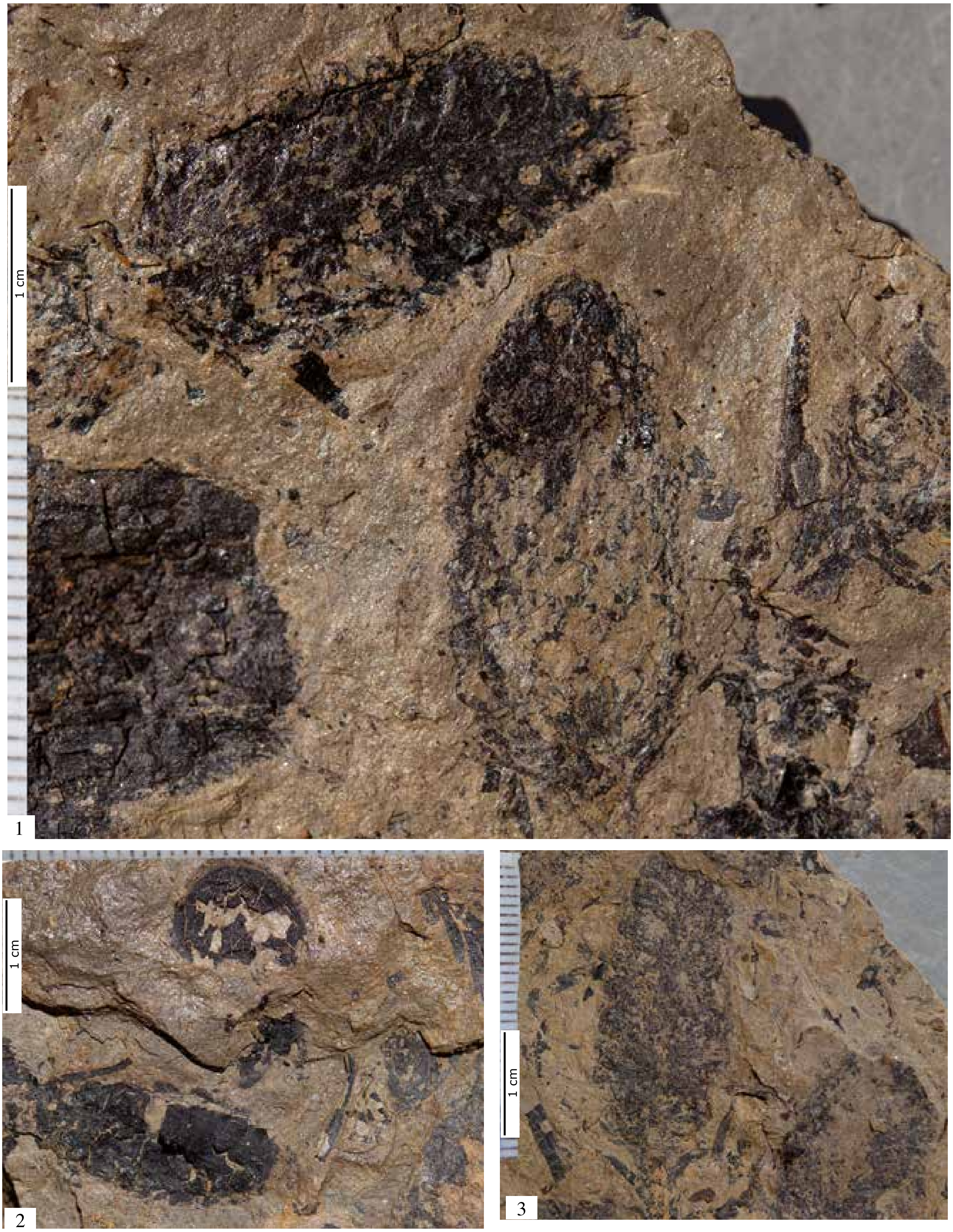


***Majonica lyellae*. Seed scales and winged seeds (Late Permian, Wuchiapingian)**

1. Seed scale with shadow of the winged seeds (MON 158, paratype); 2-4. Seed scales, seed side (MON 155, MON 27, MON 284); 5-8. Seed scales reverse abaxial side with impressions of the bracts (MON 224, MON 32 MON 277, MON 215); Winged seeds (MON 39, MON 24, MON 238, MON 18); all Montan, Coll. Michael Wachtler, Dolomythos Museum

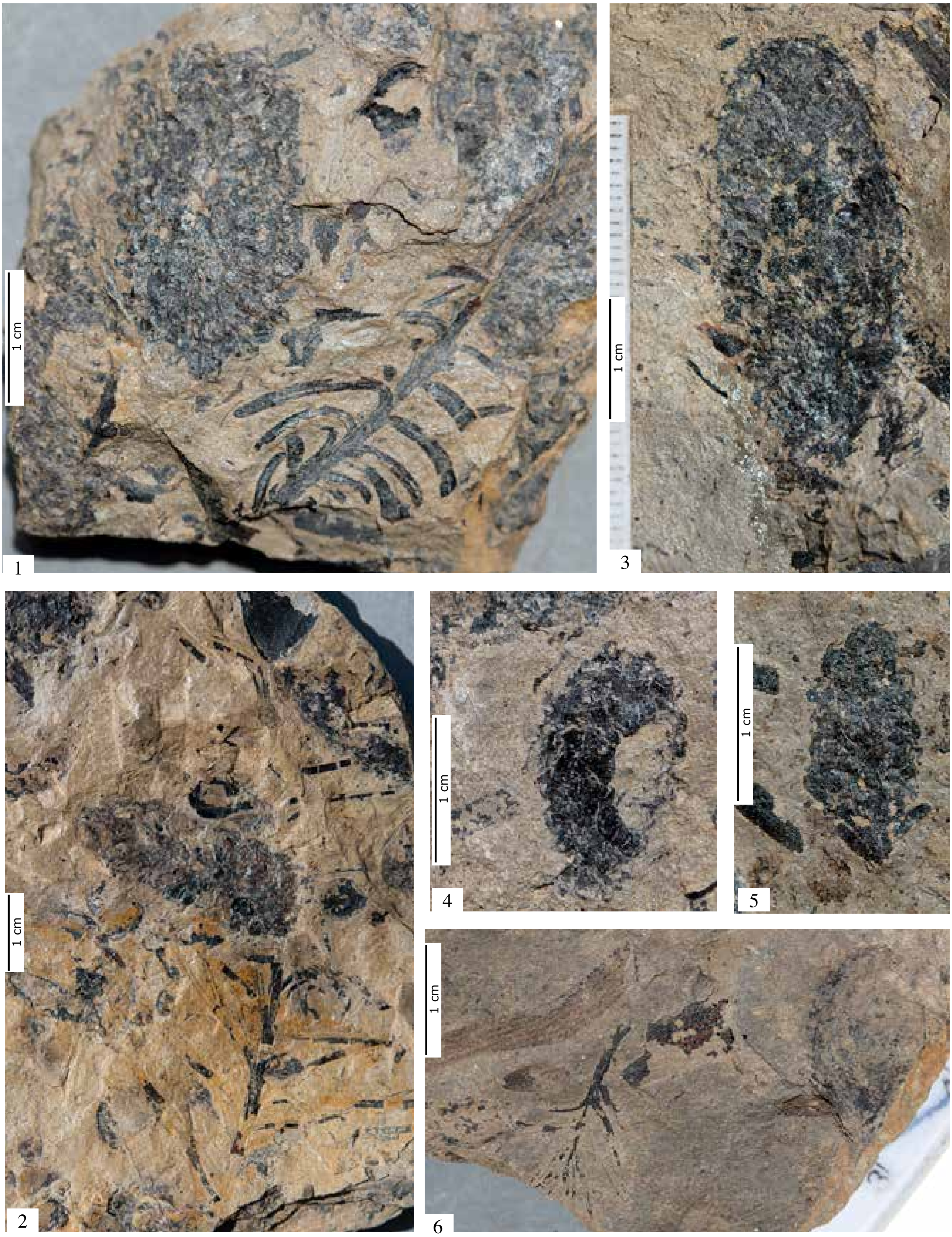
***Majonica lyellae*. Male cones (Late Permian, Wuchiapingian)**

1.-3. Several pollen cones on a slab (MON 135, MON 265); 4. Branchlet with several connected pollen cones (MON 275, paratype) all Montan, Coll. Michael Wachtler, Dolomythos Museum



***Majonica lyellae*. Male cones (Late Permian, Wuchiapingian)**

1. Slab with two well preserved pollen cones (MON 271); 2-3. Slab with pollen cones and connected twigs (MON 100, MON 104); all Montan, Coll. Michael Wachtler, Dolomythos Museum



***Majonica lyellae*. Male cones (Late Permian, Wuchiapingian)**

1. Pollen cone with branchlet (MON 98); 2. Twig with connected pollen cone (MON 288); 3-5. Juvenile, not mature male cones (MON 286, MON 279, MON 283) 6. Twig with male cone (MON 64); all Montan, Coll. Michael Wachtler, Dolomythos Museum

Majonica lyellae. Male cones (Late Permian, Wuchiapingian)

1-2. Pollen cones with connected branchlets (MON 88, MON 93); 3-6. Male cones with detail of the pollen bracts (MON 89, MON 280, MON 293, MON 85); all Montan, Coll. Michael Wachtler, Dolomythos Museum

Majonica lyellae. Male cones (Late Permian, Wuchiapingian)

1-2. Well preserved pollen cones (MON 301, MON 270) 3. Twig, seeds scales and pollen cone (MON 297); all Montan, Coll. Michael Wachtler, Dolomythos Museum

***Abies*. Branchlets and leaves**

1-2. *Abies magnifica:* Plagiotropic twig; 3. *Abies sibirica:* Branchlet

Abies. Leaves and scales

Abies alba: 1. Single needle upper side; 2. Single needle lower side; 3. Juvenile shoot; 4. *Abies sibirica:* Seed scale with shadows of the winged seeds, 5. *Abies numidica:* Seed scale evidencing the bract

***Abies*. Female cones, scales and pollen cones**

Abies alba: 1. Naked stipes of the female cones with shed scales; 2. Winged seed; 3-4. *Abies vejari:* Juvenile pollen cones; 5. Mature pollen cone

Since Upper Permian *Ortiseia (leonardii)* was established by Rudolf Florin 1964, diverse species covering the whole Permian were found and described (Clement-Westerhof, 1984; Wachtler, 2012, 2015, 2021). Therefore, this conifer can be regarded as one of the best-known Permian conifers.
Just in the Early Permian they developed their characterising features, such as their elongated and long bracted pollen organs and rounded an decaying female cones, as well as their symmetrical arranged foliage branchlets.
An interesting feature is the evolving of their one-seeded scales. In the beginning and during the whole Permian, various minute sterile leaves covered densely the seed scale, probably to protect the seed from predators. After maturity the scale and within them the seed was shed entirely. Clearly as Araucaria-conifers, recognizable conifers we encounter beginning from the Carboniferous-Permian border with *Ortiseia uhli* from the Kasimovian/Gzhelian Saar-Nahe-Basin in Germany, although also from the Carinthian Alps representatives are known from this time. After that the recoveries moved to the Southern Alps, especially the Dolomites. Artinskian *Ortiseia dasdanai* was followed by Kungurian *Ortiseia daberi.* In the late Permian we then have in the Dolomites a great diversity with slightly different features, probably also due to geological time differences, like *Ortiseia leonardii, Ortiseia jonkeri, Ortiseia zanettii* or *Ortiseia visscheri.*
After the Permian-Triassic border the Araucariaceae mostly changed their blueprint. The only clearly identifiable representative, evidencing a little the old feature of the sterile leaflets surrounding the seed-scale we encounter with *Ortiseia collii* in Early Middle Triassic (Anisian) sediments on the Balearic islands (Malllorca, Estellencs) in Spain (Juárez & Wachtler, 2015).
Moreover, in the Dolomites, the Araucaria-ancestors can be followed from the Anisian till the Carnian period (*Araucarites churchillae, Araucarites gilbertae, Araucarites spinosa*) but in a modified form. The many small leaves on the seed scales are no longer perceptible, but probably just entirely fused with the scale and only a small-sized sterile bract is observable, whereas the twigs were formed sometimes (Carnian *Araucarites spinosa*) as spreading pseudo-whorls with second till third order branches of unequal length with rigid leathery pungent needles like extant *Araucaria araucana*. On the Triassic-Jurassic border, the last *Araucarites* species disappeared from the Northern hemisphere to enlarge their areas on the Southern globe.
Whereas Upper Permian *Ortiseia leonardii, Ortiseia jonkeri,* and *Ortiseia zanettii* are now due to recent findings largely known in all parts (Wachtler, 2015, Wachtler 2021) major doubts there were still greater ambiguities with *Ortiseia visscheri* known only fragmentary from the Bletterbach-Butterloch (Clement-Westerhof, 1984). Now from the nearby lying Montan plant fossil site Michael Wachtler recovered enough material, especially branchlets, female cones, seed scales and pollen cone that also this Araucaria-species can be regarded as well known.

Ortiseia visscheri (CLEMENT WESTERHOF, 1984)

1984 *Ortiseia visscheri* CLEMENT-WESTERHOF Pl. XII-XIV pp. 136-145

Etymology

Honouring the Dutch palaeobotanist Henk Visscher

Description

Branchlets and leaves: Shoots pinately branched forming symmetrical combs. Leaves having a length till 2.0 cm ending in an acute till obtuse apex (MON 191, MON 192).
Male cones: Reaching a length of 4.5 cm–6 cm and about 2–3 cm in width (MON 94). They are elongated and slender. The microsporophylls end in a short-pointed bract (MON 97). From the end of the microsporophyll hang dorsiventrally the pollen sacs in direction to the main axis (MON 107).
Female cones: Round-bodied, about 6 cm cm in length and 3 cm in width (MON 20). Cone axis holding spirally arranged seed scales. They are composed of various minute and elongated sterile leaves surrounding the seed scale. The scale holds only one rounded to slightly elongated ovule/seed in the approximate middle. Seed scales 1.0 cm long, dropped after maturity as a single unit (MON 33, MON 246, MON 181). No visible

projecting bract. Seeds about 0.5-0.7 cm long, and 0.4–0.5 cm wide.

Taxonomic notes

In 1984 the Dutch paleobotanist Johanna Clement-Westerhof interpret the conifer *Ortiseia leonardii* new and described two new species: *Ortiseia jonkeri* from the Valli del Pasubio and *Ortiseia visscheri* from the Bletterbach-gorge near Aldein-Radein. Since she did not found male or female cones, and also only poorly preserved branchlets, their main interest focuses on the seed scales and the cuticular analyses of the isolated found leaves. As interesting feature she noted *Ortiseia visscheri: "Leaves slightly overlapping, arising at an angle of max. 45°, straight triangular (only at presumed main axis) or ovate, apex acute to obtuse"*.
In 2021 Michael Wachtler recovered from the nearby Montan-fossil site, located about 10 kilometres in distance from the Bletterbach-gorge, branchlets and twigs that could correspond to the features mentioned by Clement-Westerhof. Additionally he found also the till now ignote male and female cones. It is not completely proven if these remains belong to *Ortiseia visscheri* or they have to be classified as a new species, but till now can be assumed that they have resemblances with it.
For several reasons they do not correspond to *Ortiseia leonardii* the most common species in the Dolomites, having long bracted male cones and evolving tapered and pointed needles. Also *Ortiseia zanettii* is due to its massive male cones different, whereas it seems that *Ortiseia jonkeri* from the Valli del Pasubio has pollen cones with extremely subtle bracts.
Ortiseia visscheri stands in the Montan-locality in frequency largely behind the fir-ancestor *Majonica lyellae* or *Ginkgoites gasseri,* but it is enough common to determinate all the essential parts of the plant, like female cones, seed scales, pollen cones or branchlets with their from obtuse till tapered changing needles. Because *Ortiseia visscheri* cones are robust enough to be transported and twirled over longer distances especially the female cones could also be found in the coarse sandstone, although less well preserved, were *Majonica* and *Ginkgoites*-remains where just largely destroyed.

Cycadophyta

In the Upper Permian Montan-Fossil-site the cycads are present, but play only a marginal rule. Opposite to the coeval Ariche-locality in the Valli del Pasubio, were the cycads, especially well preserved cones, but also leaves and fronds are frequent and can be subdivided in the Cycas-progenitors *Macrotaeniopteris wachtleri* and *Taeniopteris* sp., the archaic cycad-like plant *Pernerina pasubi* and the Zamiaceae *Nilssonia brandtii* (Perner, 2015; Wachtler, 2015; Wachtler, 2021), this is not possible due to their fragmentary occurrence in the Montan-locality (MON 02, MON 196). Probably the same genera as in the Valli Pasubio can be found, but more information can not be given.

Pteridospermatophyta

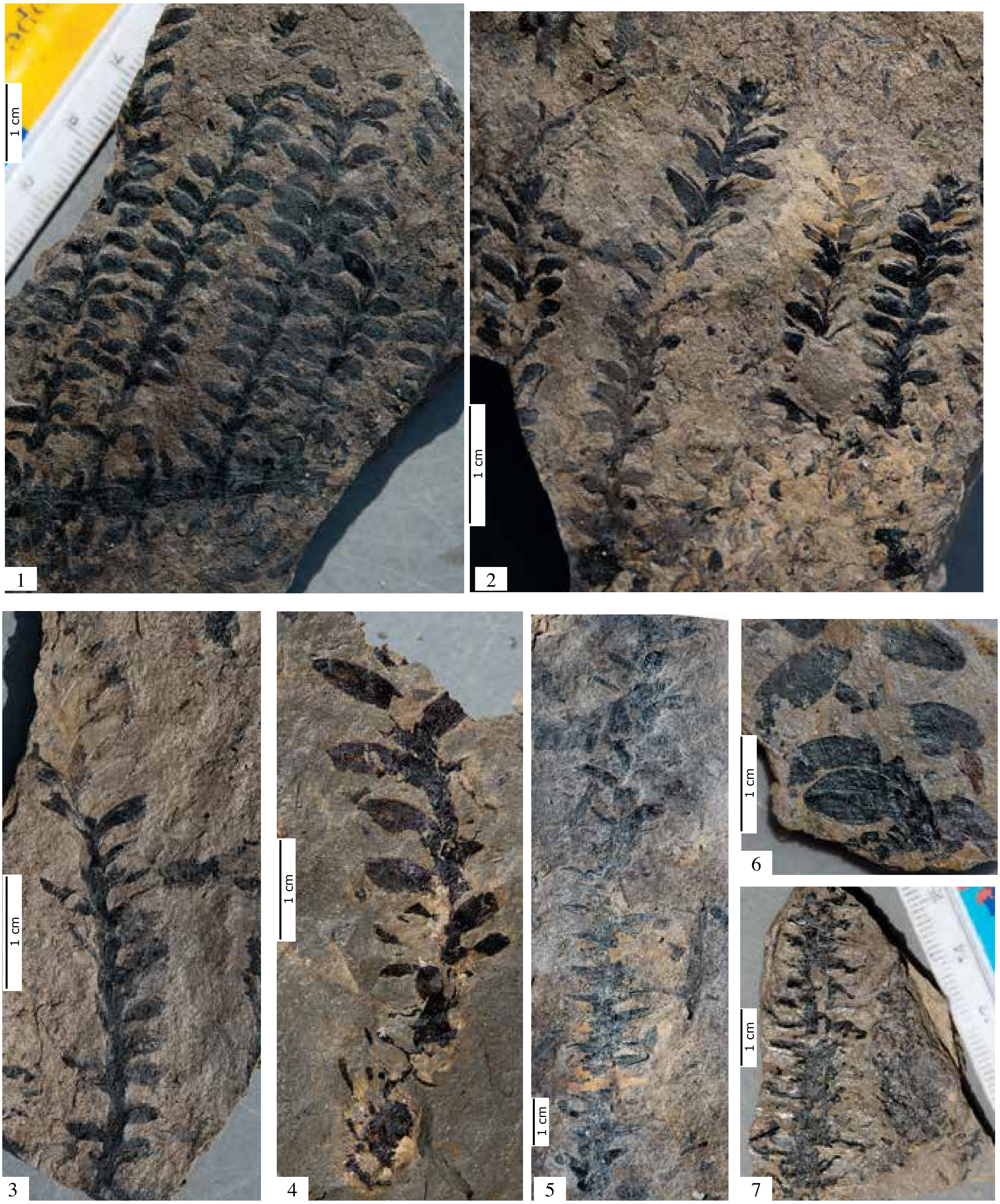
In the Upper Permian localities of the Dolomites, several fragmented sterile leaves as well as *Peltaspermum* shields of the enigmatic seed ferns have been found. Due to the poor conservation only a generic classification could be done. Piero Leonardi described in 1948 a fern recovered by the geologist Nino Dal Piaz from the Upper Permian sandstone of Neumarkt-Montan as *Pecopteris (Cyatheites) miltoni.* Probably it belongs to the seed ferns especially *Lepidopteris martinsii,* because isolated Peltaspermum shield (MON 212, MON 217) can be found.

Acknowledgments

This publication was supported by Arnold Gasser, Eppan (South Tyrol), man of science, due to his natural history and astronomical research (satellite construction Max Valier, technical college in Bozen). The ginkgo ancestor *Ginkgoites gasseri* honors Arnold Gasser for his contributes to science.

Was glänzt, ist für den Augenblick geboren;
Das Echte bleibt der Nachwelt unverloren.

What shines is born for the moment;
What is genuine remains unchanged for posterity.
Johann Wolfgang von Goethe: Faust, prelude

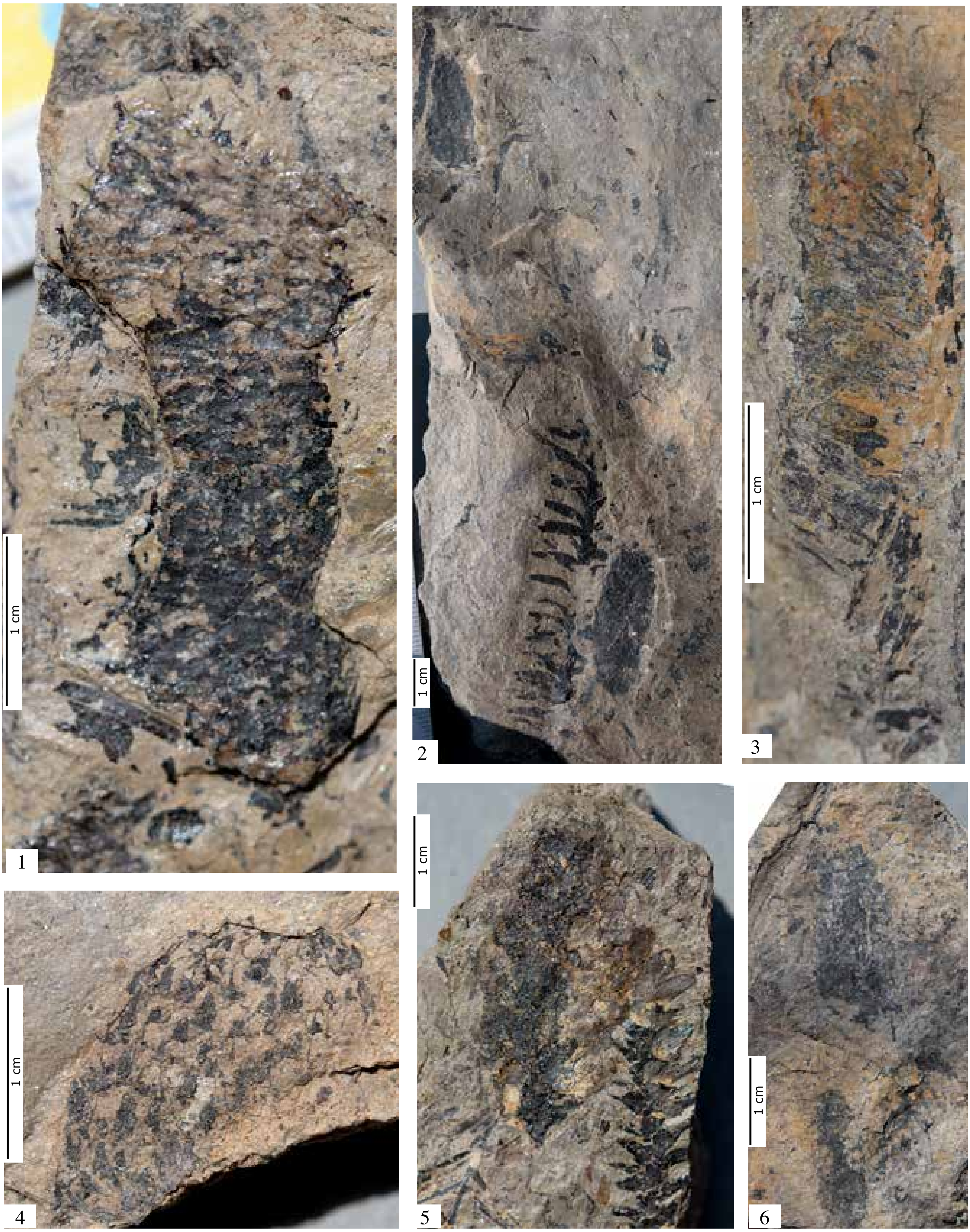


Ortiseia visscheri. Branchlets and leaves (Late Permian, Wuchiapingian)

1-2. Branchlets with leaves evidencing the changing from obtuse to acute apex (MON 191, MON 192); 3-7. Single twigs and leaves with obtuse till tapered apex (MON 193, MON 264, MON 187, MON 34, MON 78); all Montan, Coll. Michael Wachtler, Dolomythos Museum

***Ortiseia visscheri*. Female cones and seed scales (Late Permian, Wuchiapingian)**

1-2. Female cone showing the seed-scales coated by micro-leaves (MON 20); 3-5. Female cone form the coarse grained sandstones (MON 9 MON 01, MON 245); 6-8. Several shed seed scales (MON 33, MON 246, MON 181); all Montan, Coll. Michael Wachtler, Dolomythos Museum



***Ortiseia visscheri*. Male cones (Late Permian, Wuchiapingian)**

1. Entire male cone (MON 94); 2. Branchlet and two male cones (MON 244); 3. Pollen cone showing the microsporophylls (MON 107); 4. Apical part of a pollen cone evidencing the short bracts (MON 97); 5-6. Pollen cones with branchlets (MON 257, MON 04); all Montan, Coll. Michael Wachtler, Dolomythos Museum

***Araucaria heterophylla*. Female cones, scales and pollen cones**

1. Tree evidencing the symmetrical branchlets; 2. Tree with bulbous female cones; 3. Shed seed scales abaxial and adaxial side; 4. Entire pollen cone; 5. Broken male cone with the microsporophylls

Ortiseia visscheri. Reconstructions (Late Permian,Wuchiapingian)

a. Branchlets with leaves evidencing the changing from obtuse to acute apex (MON 191, MON 192); b. Leaves with tapered apex (MON 193, MON 264, MON 187); c. Leaf with obtuse apex (MON 34); d. Female cone (MON 20); e. Seed scale lateral and abaxial side (MON 33); f. Seed scale adaxial side; g. Pollen cone (MON 94); h. Pollen cone (broken) MON 107, MON 97); i. Single microsporophylls (MON 107)

References

Abel. O. 1929. Eine Reptilienfährte aus dem Oberen Perm (Grödener Sandstein) der Gegend von Bozen in Südtirol – Palaeobiologica, 2: 1–14

Bauer, K., E. Kustatscher, R. Butzmann, T.C. Fischer, J.H.A. van Konijnenburg-van Cittert, and M. Krings. 2014. Ginkgophytes from the upper Permian of the Bletterbach gorge (Northern Italy). Rivista Italiana di Paleontologia e Stratigrafia 120(3): 271–279

Brandt, S. 2021. Beschreibung paläozoischer Semionotiden (Holostei) und Anmerkungen zur Gattung *Acentrophorus* aus dem Oberperm der Dolomiten und des europäischen Zechsteins, Dolomythos, Innichen

Braun, C. F. W., 1843. Beiträge zur Urgeschichte der Pflanzen. 1. Heft. Als Programm zum Jahresbericht der Königl. Kreis – Landwirthschafts – und Gewerbeschule zu Bayreuth, F. C. Birner, Bayreuth

Clement-Westerhof, J., 1984. Aspects of Permian Palaeobotany and Palynology. IV. The conifer *Ortiseia* from the Val Gardena Formation of the Dolomites and the Vicentinian Alps (Italy) with special reference to a revised concept of the Walchiaceae (Goeppert) Schimper. - Rev. Palaeobot. Palynol., n. 41, pp. 51-166

Clement-Westerhof, J., 1987. Aspects of Permian Palaeobotany and Palynology; VII, The Majonicaceae, a new family of Late Permian conifers. - Rev. Palaeobot. Palynol. 52 (4), pp. 375-402

Fischer TC., Meller B., Kustatscher E., Butzmann R., 2010. Permian ginkgophyte fossils from the Dolomites resemble extant O-ha-tsuki aberrant leaf-like fructifications of Ginkgo biloba L, BMC evolutionary biology 10 (1), 1-17 http://www.biomedcentral.com/1471-2148/10/337

Florin, R., 1964. Über *Ortiseia leonardii* n. gen et sp., eine Konifere aus den Grödener Schichten im Alto Adige (Südtirol). - Mem. Geopaleont. Univ. Ferrara, 1(1), pp. 3-11, n. 41, pp. 51-166

Juárez , J., Wachtler M., 2015. Early-Middle Triassic (Anisian) Fossil Floras from Mallorca (Spain), Dolomythos, Innichen, p. 1- 49.

Gümbel, W. 1877. Vorläufige Mitteilung über das Vorkommen der Flora von Fünfkirchen im sog. Grödener Sandstein Südtyrols (Ullmanniensandstein). — Verh. k. k. Geol. Reichsanst., Nr. 1, Wien

Heer, O., 1876. Über permische Pflanzen von Fünfkirchen in Ungarn. Mitteilungen aus dem Jahrbuch der königlich ungarischen geologischen Anstalt 5, 3–18

Kittl E., 1891C. Saurierfährte von Bozen. Mittheilungen österreichischder Touristen-Klub, Wien III, 7

Leonardi, P. 1948. Contributi alla conoscenza della flora delle arenarie di Val Gardena (Permiano Medio-Inf.) dell'Alto Adige: La nuova Flora di Redagno e una felce di Egna. — Mem. 1st. geol. Univ. Padova, 16: 3—15; Padova

Morelli C., Bargossi G.M., Mair V., Marocchi M., Moretti A., 2007. The Lower Permian volcanics along the Etsch Valley from Meran to Auer (Bozen). Mitteilungen der Österreichischen Mineralogischen Gesellschaft 153, 195-218

Murchison, R. I., Sedgwick, A., 1835. A sketch of the structure of the Eastern Alps; with sections through the newer formations on the northern flanks of the chain, and through the tertiary deposits of Styria etc. Geological Society of London, p. 301-420

Murchison, R. I., Leonhard, G., 1850. Ueber den Gebirgsbau in den Alpen, Apenninen und Karpathen, namentlich um einen Uebergang aus sekundären Gebilden in tertiäre darzuthun, und über die Entwicklung eocener Ablagerungen im südlichen Europa. Stuttgart, J.- B. Müller, 2 Blätter, pages 162

Perner T. Wachtler M., 2015. Permian - Birth of a New World, ISBN 978-88- 908815-3-4, Ed. Dolomythos-Museum, Innichen, Italy

Perner T., 2015. The cycad *Bjuvia wachtleri* n. sp. from the Late Permia (Lopingian) Gröden-Formation (Dolomites - Northern Italy); in Wachtler M., Perner T., 2015. Fossil Permian plants from Europe and their evolution. Rotliegend and Zechstein-Floras from Germany and the Dolomites. Published by Dolomythos Museum, Innichen, South Tyrol, Italy; Oregon Institute of Geological Research, Portland, OR, (USA), ISBN 978-88-908815-4-1; pp. 138-143

Picotti, V., Cocco S.; Mair V.; Avanzini M.; Bargossi, G.M.; Borsato A.; Cucato M., Selli, L., Abbà T.; Casolari E.; Morelli C.; Ferretti P.; Marini M.; Rinaldo M.; Santacattarina M.; Spanò M.; Tomassoni R.; Vallone R.; Varrone D., Zambotti G., 2012. Carta Geologica d'Italia alla scala 1:50.000, Foglio 043 "Mezzolombardo". Servizio Geologico d'Italia - ISPRA

Sedgwick, A., Murchison, R. I.,1831. A sketch of the structure of the Eastern Alps; with sections through the newer formations on the northern flanks of the chain, and through the tertiary deposits of Styria etc. ,&c. &c." read in the London Geological Society on 6 and 20 November 1829, 4 December 1829 and 5 March 1830. The Philosophical Magazine or Annals of Philosophy, New Series, Vol. VIII, August 1830, S. 81 - 114

Seward, A.C., 1919. Fossil plants, IV Ginkgoales, Coniferales, Gnetales. 543 pp. Cambridge University Press, Cambridge

Wachtler, M., 2012a. The latest Artinskian/Kungurian (Early Permian) Flora from Tregiovo-Le Fraine in the Val di Non (Trentino, Northern Italy) - Preliminary researches. Dolomythos, 3-56 Innichen. ISBN 978-88-904127

Wachtler, M., 2013. The latest Artinskian/Kungurian (Early Permian) Flora from Tregiovo-Le Fraine in the Val di Non (Trentino, Northern Italy) - Additional and revised edition, pp. 22 -35, Editors: Dolomythos Museum, Innichen, South Tyrol, Italy, Oregon Institute of Geological Research, Portland, OR, (USA), ISBN 978-88-908815-1-0, Innichen, Italy

Wachtler M. 2015. Revision of Permian Conifer *Ortiseia*; in Wachtler M., Perner T., 2015. Fossil Permian plants from Europe and their evolution. Rotliegend and Zechstein-Floras from Germany and the Dolomites. Published by Dolomythos Museum, Innichen, South Tyrol, Italy; Oregon Institute of Geological Research, Portland, OR, (USA), ISBN 978-88-908815-4-1; pp. 99-102

Wachtler M. 2015. Revision of Upper Permian (Lopingian) conifer *Majonica alpina* from the Dolomites (Northern Italy); in Wachtler M., Perner T., 2015. Wachtler, M., 2019. Die Entstehung der Dolomiten, Verlag DoloMythos - Innichen. ISBN 978-88-944100-0-6

Wachtler M., 2015. *Pernerina pasub*i nov. gen. n. sp. an enigmatic plant of unknown botanical affinity from the Late Permian Wuchiapingian (Lopingian) of the Dolomites (Northern Italy); in Wachtler M., Perner T.,

Cycadophyta and Pteridospermatophyta (Late Permian, Wuchiapingian)

1-2. Undefined cycad-leaf (MON 02); 3. Probably part of a female cusp of *Taeniopteris* (MON 196); 4. Male cycad cone (MON 44); Enrolled fern or cycad frond (MON 41); 6-7. *Peltaspermum* sp. Fertile parts of a seed fern, all Montan, Coll. Michael Wachtler, Dolomythos Museum

2015. Fossil Permian plants from Europe and their evolution. Rotliegend and Zechstein-Floras from Germany and the Dolomites. Published by Dolomythos Museum, Innichen, South Tyrol, Italy; Oregon Institute of Geological Research, Portland, OR, (USA), ISBN 978-88-908815-4-1; pp. 144-149

Wachtler M., 2015. The cycad *Nilssonia brandtii* n. sp. from the Late Permian (Lopingian) Gröden-Formation (Dolomites - Northern Italy); in Wachtler M., Perner T., 2015. Fossil Permian plants from Europe and their evolution. Rotliegend and Zechstein-Floras from Germany and the Dolomites. Published by Dolomythos Museum, Innichen, South Tyrol, Italy; Oregon Institute of Geological Research, Portland, OR, (USA), ISBN 978-88

Wachtler, M., 2015. Upper Permian (Lopingian) seed ferns from the Dolomites, Northern Italy; in Wachtler Kustatscher, E., Bauer, K., Butzmann, R., Fischer, T.C., Meller, B., Van Konijnenburg-Van Cittert, J.H.A., Kerp, H. 2014. Sphenophytes, pteridosperms and possible cycads from the Wuchiapingian (Lopingian, Permian) of Bletterbach (Dolomites, Northern Italy). Review of Palaeobotany and Palynology 208, 65-82

Wachtler M. 2021. Upper Permian floras of the Dolomites; p. 165-240; in: Wachtler M., Wachtler N. (eds.): Permian Fossil Floras and Faunas from the Dolomites, ISBN 978-88-944100-6-8

Wachtler M. 2021. The Upper Permian climate changes in the Dolomites; p. 141-164; in: Wachtler M., Wachtler N. (eds.): Permian Fossil Floras and Faunas from the Dolomites, ISBN 978-88-944100-6-8