The Fascinating Upper Permian Montan Flora from the Dolomites

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The Upper Permian (probably Capitanian-Wuchiapingian) sediments between Gleno and Montan (South-Tyrol, Northern Italy), by virtue of their profusion of fossilised plants, attracted the attention of geologists like Roderick and Charlotte Murchison, as early as in 1800. They also drew the attention of Charles Lyell, the author of the "Principles of Geology", as well as the influential British geologist Adam Sedgwick. In 2021, Michael Wachtler conducted his pioneering research in this area, discovering an interesting new Ginkgophyta - *Ginkgoites gasseri* n. sp., the new fir ancestor *Majonica lyellae* n. sp., and the Araucaria-ancestor *Ortiseia visscheri.* All of these were discovered in the form of exceptionally well-preserved specimens.

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Late Permian (end Capitanian-Wuchiapingian, about 265 mio years), Montan Flora Northern Italy
Left: the fir-ancestor ***Majonica lyellae*** with a decayed female cone and a winged seed scale, in addition to a shed pollen cone. **Middle**: a ***Ginkgoites gasseri*** tree grows. Also, a bunch of seed-berries is visible. **Right:** the Araucaria ancestor ***Ortiseia visscheri,*** with a pollen- and a seed cone in the foreground. **Below:** an isolated cycad ***Macrotaeniopteris wachtleri*** sprouts in the middle.

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 in the Dolomites too.

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

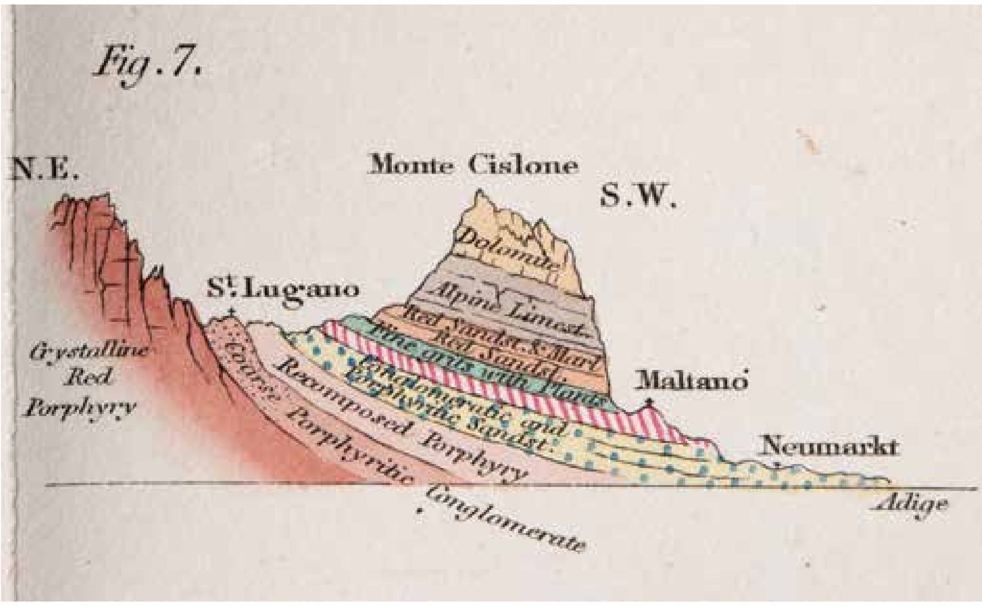
The mountain-range stretching from Gleno till Montan, over the village of Neumarkt (South-Tyrol, Northern Italy), attracted scientists from the beginning of the 18th century. Following the path over the San Lugano-Pass, they reached the famous geological sites around Predazzo and Cavalese. Notably, in the immediate vicinity of the Enn Castle over Montan, a rich and well-preserved Upper Permian flora stands 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, under the title "*A Sketch of the Structure of the Eastern Alps*".

This publication is based on several lectures (dated 6 and 20 November 1829, 4 December 1829 and 5 March 1830) delivered in the London Geological Society. It contains a hand-painted copper engraving with geological profiles of the area, probably made by **Charlotte Murchison**, née Hugonin (1788–1869), a fervent palaeontologist and wife of Roderick Impey Murchison. The Murchisons had already acquired solid knowledge about the Dolomites, through their journeys: in 1828, accompanied by **Charles Lyell**

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



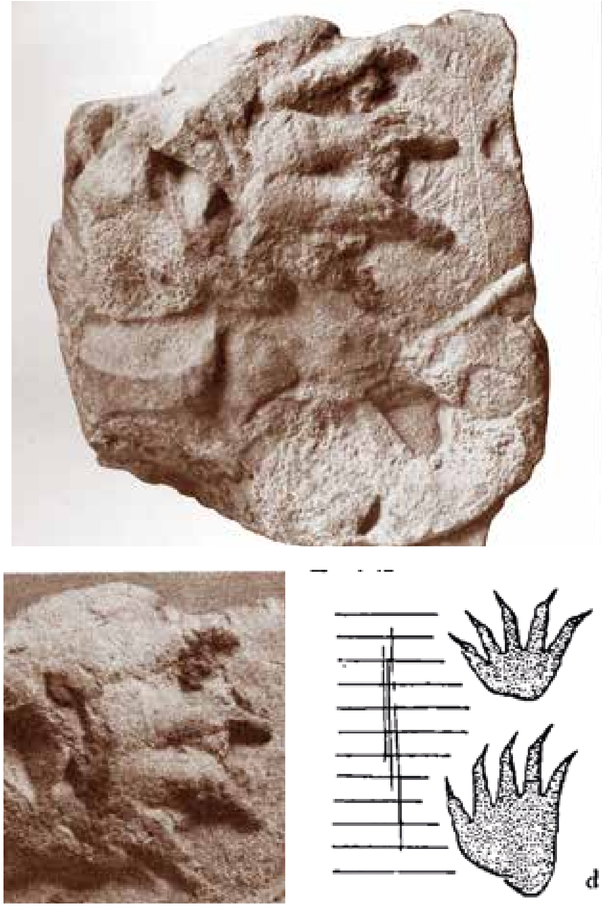
A first mention of the fossilised plant horizons between Gleno and Mantana (Montan). Roderick Murchison and Adam Sedgwick (1835): "A Sketch of the Structure of the Eastern Alps" (Dolomythos-Museum, Innichen).

(1797-1875); in 1829, together with Adam Sedgwick, and in 1830 as couple.
In 1841, the English scientist Roderick Impey Murchison, by virtue of his travels in the Russian Ural-Region, made his mark in history, as the namer of the "*Permian system*". However, there exists a fifty million-year-long gap, which has been overlooked until this time. Interestingly, in 1830, Murchinson was not able to identify that this geological period was also largely present in Europe and the Dolomites.
The well-done copper engraving from 1830 presents strong evidence of the geological layers below the Monte Cislon, beginning from the "*Red Porphyry*", prosecuted by various stages of decomposed porphyry, until the "*Fine grits with Plants*", as classified by Murchison. Sedgwick and Murchison rightly observed that, "*these beds contain impressions and detached portions of plants*", without going into the details of the plant families to which this vegetation belonged. A further expanded work was published in 1835 by Sedgwick and Murchison.
It is possible that both **Leopold von Buch** (in several voyages from 1802 onwards) and **Alexander von Humboldt** (in a short stay on 30 September 1822), were showed these thin coal lenses, by the local population. However, these clues did not find way into their publications. A more exhaustive

Murchison was eager to make his public image appear in the best light. Portrait in the Journal "Vanity Fair" on Nov. 26, 1870, titled 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" in South-Tyrol.

work was completed in 1873, by the German palaeontologist **Carl Wilhelm Gümbel** (1823–1898). Gümbel observed that plants existed at two levels: first, 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*).
Second, 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*). Initially,



Herpetichnium acrodactylum, the oldest known ichnospecies 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 of Neumarkt (between Gleno and Montan, Monte Cislon) belongs to the Grödner-Sandstone. In the vicinity, Roderick Murchison (1830) and Wilhelm Gümbel (1877) also recovered their Upper Permian plants.

Gümbel doubted if these plants belong to the Triassic. Finally, he accepted, after consulting the palaeobotanist **Wilhelm Philipp Schimper** (1808-1880), that they belonged to the Permian period. With reference to a similar vegetation from the Hungarian Fünfkirchen and plant findings from the German Zechstein of the 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*, in addition to some undefined ferns and horsetails. Though not an exact definition, it was a milestone in research.
Years later, in 1929, the Austrian ichnologist **Othenio Abel** classified some tracks found in the vicinity by Dr. **Friedrich Glass-**

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The Upper Permian Flora of Montan (Neumarkt)

1. The hamlets Montan (left) and Gleno (right). The red line over the Enn Castle indicates the plant horizons. 2. An outcrop over the former Fleimstal railway with indication of a fine-grained-lens. 3. Details 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 can reasonably classifiable conifer-branchlets be found there (*Ortiseia visscheri)*.

ner and first mentioned by **Ernst Kittl** in 1891 as *Herpetichnium acrodactylum*. He assumed that they belonged to the pelycosaurs, an order composed of primitive mammal-like reptiles or turtle-ancestors.
In the following decades, over the two World Wars, nothing exciting happened. **Piero Leonardi** (1908–1998) described a fern recovered in 1948 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 can be better identified today as *Lepidopteris martinsii*, a seed fern with shield-like fructifications. It was one of the first steps in the beginning of a new era. The interest in the region arose anew, 1964 onwards. In 1964, the Swedish palaeobotanist **Rudolf Florin** (1894-1965) classified a newly discovered Upper Permian conifer, from the Seceda mountains near Ortisei in the Gröden-Valley, as *Ortiseia leonardii.*
In 1984, the young Dutch researcher **Johanna Clement-Westerhof** initiated intensive studies, chiefly based on the fructifications and the cuticles of the plants. She published her first results in 1984, establishing two other new Upper Permian species as part of the genus *Ortiseia.* These species included: *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 of all Permian conifers, stating that "*unambiguous descendants remain unknown*" (Clement-Westerhof, 1984). In 1987, Johanna Clement-Westerhof described, for the first time, a winged seed conifer , naming it *Majonica alpina* (after her family). However, she was not able to recognize that they belonged to the family of the oldest ancestors of the Abietaceae. Also, this conifer was found in the Bletterbach, a deep gorge between the hamlets of Aldein and Radein, located only about ten kilometres from the plant-outcrops near Montan.

Beginning from 2021 onwards, **Michael Wachtler** started his research, tracing the footsteps of Murchison and Gümbel. The German bibliophile **Helmut Schwank** provided him with the rare original works of Murchison and Sedgwick. Based on these works, Wachtler combed through the partly dense forests above Montan. In particular, above the decommissioned Fiemme-Railway near the Enn Castle, Michael Wachtler found plant-fossil rich horizons, probably the same ones, which had attracted the attention of Murchison and Gümbel.

Strangely, after their heyday in the 19th century, the study of these outcrops did not interest anyone. Carl Wilhelm Gümbel's brief report on these outcrops, contains extremely authentic descriptions: "*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 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*" and "*Conglomeratic and Porphyritic Sandstone*" was 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 the well-exposed Tesero-Horizon, as the Permian-Triassic border. In the Upper Permian Gröden-Formation, coarse-grained conglomerates change with fine sludge-cemented layers, which are today covered by a dense vegetation. So, unfortunately, the outcrops are only rarely visible. 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 fossilised and remained in a state of excellent preservation. They can be compared with other adjacent locations such as, the

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 spoke 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).

Bletterbach-gorge, the Seceda, or the areas around the Valli del Pasubio and Recoaro.

This 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 emerged, with the fossilisation of marine cephalopods (known in the Bletterbach-gorge as Cephalopoden-Bank), which is a clear evidence of a sea-flooding lasting for several million years.

An exact time-dating is not easy: radiometric dating (U/Pb) indicates a Kungurian age of 274.1±1.4 Ma, for the top layer of the oldest underlying volcanic Ora Formation (Morelli et al., 2007). About 260 Ma ago, a phase of changing marine ingression began in the Dolomites, with subsequent drying out of large areas. As no macro-floras can be found in these layers, a deposition of mostly all plant-layers in the Lopingian, and more restrained deposits in the Wuchiapingian can be accepted. Because the Montan-flora seems to be the oldest one, probably it was just deposited in the Capitanian. The differences among the various gymnosperms, involving several subspecies from *Ortiseia, Majonica* and *Ginkgoites*, are probably based on some slightly different evolutions, with regard to time-period. Those who believe that, a tropical vegetation was predominant, in the immediate vicinity of the ocean and of the equator, during the Late Permian, would have to be disappointed. Gymnosperms like conifers and gingkos dominate, whereas the cycads, ferns, horsetails are rare.

The marine influences increased especially towards the Late Permian, during the Gröden-Formation. This is proved by the abundance of the small-sized brackish-water fish *Acentrophorus robustus* (Brandt, 2021). By the end of the Permian, the climate in the Dolomites had become arid. Beginning from the Changhsingian age, gypsum layers more and more frequently displaced the rich fossil plant deposits. This lasted till the Early Triassic. This phenomenon can probably be explained only by a striking climate collapse.

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The Major Plants of the Montan Flora

Ginkgophyta

The first suspected ginkgo-leaves appeared in the Middle Devonian, but we have information about barely recognizable Ginkgoales, only from the Carboniferous-Permian border. Beginning from the Early Permian, we have knowledge of fully evolved ginkgos, with attached seeds and pollen-organs. *Ginkgoites pohli* from the 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 emanated, with one or two ovules aggregated together. The ovules/ seeds were held together by a modified leaf segment, and are slightly different from those of modern ginkgos, which are connected at the end by a distinctive stalk. Subsequently, we can follow their evolution over the Late Permian, until the Triassic-Jurassic and present times.
Extant ginkgo leaves are fan-shaped, with veins radiating out into the leaf blade. During 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, during the Late Permian of the Dolomites, we encounter on one hand, *Ginkgoites murchisonae*, which are simply more evolved Ginkgophyta, as seen in their fan-shaped foliage. On the other hand, we come across a new primitive ginkgo-species, characterized by their extremely rudimental leaves. This new ginkgo-species is described below:

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 (in Northern Italy, about 15 km (9.3 miles) south of Bolzano).

Geological age

Middle-Late Permian: Guadalupian (Capitanian) - Lopingian (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. Additionally, more than hundred specimens 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 needle-like foliages. The leaves fork irregularly at 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 varies from small-sized, needle-like to 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, from 0.5 to 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 in bunches with needle-like stalks (MON 282, MON 181), but usually they are found isolated or in mass-occurrences (MON 46, MON 42). As in living ginkgo-trees, shed ovules as well mature seeds can be found in the same sediments.

Pollen organs: Around 2-3.5 cm long and 0.7-1.0 cm wide, characterised by several small-sized bracts (MON 253) MON 12, MON 11, MON 248, MON 130, MON 263). These are sometimes supported by a 1 cm long, fragile peduncle.

Discussion

Ginkgoales, which can hardly be distinguished from those found today, in terms of their fertile organs, had become widespread from the early Permian onwards. If Kasimovian-Gzhelian *Baiera perneri* (Wachtler, 2013, Perner & Wachtler, 2015) was still viewed doubtfully, due to the lack of preserved fructifications, this changed during the Early Permian (Kungurian *Ginkgoites pohli* from the Alps). All fertile organs are preserved in good quality here. The closer we get to the end of the Permian, the more numerous the finds are, and, due to slight time differences across various locations, more species have been described (Wachtler, 2021).

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

This is especially valid for the Dolomites, where we encounter in some places, especially in the Gröden-Formation on the Seceda *Ginkgoites murchisonae* (Wachtler, 2021). These are just well-developed Ginkgophyta, with partially laminated leaves resembling contemporary maidenhair trees.

In this context, the newly discovered *Ginkgoites gasseri* has more similarities with Early Permian *Ginkgoites pohli,* as with more evolved *Ginkgoites murchisonae.* It seems that *Ginkgoites gasseri* show even more primitive traits than *Ginkgoites pohli*, and approach some Devonian archaic plants, with their irregularly-dividing leaves.

Effectively, the foliage or the branchlets of *Ginkgoites gasseri* cannot or only with difficulty be determined, as parts corresponding to a single leaf, or forming a tuft of leaves belonging together. Strangely, another known Ginkgophyta, coeval *Baiera digitata,* from the European Zechstein, takes the form of leaves sprouting from one single petiole, and subsequently forking several times, at the same level. This feature is unknown in *Ginkgoites gasseri.*

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

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

The question as to how the gymnosperms (including ginkgos, conifers and cycads) can be connected together with regard to their evolution, or how they developed and separated, remains unresolved. In the same layers from the Montan-fossil-site, the Araucarian conifer *Ortiseia,* the Abietaceae *Majonica* and isolated remains of cycads can be located. This symbiosis can be traced back till the Early Permian. It is plausible that several 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 connected to a common evolution. The single, divided cycad scale also has some resemblance to the ginkgos. However, their evolution-line was probably divided, at the beginning of the Devonian, as recorded in certain ginkgo-similar foliage, from the Middle Devonian fossil site of Lindlar in Germany.

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

The development of the Ginkgoales can be seen in minor cases, over the Triassic, but beginning from the Triassic-Jurassic border, they are again found to be widespread in several parts of the world. Therefore, they can be seen as a good climate indicator, growing today in temperate regions of the world, and avoiding very cold areas, such as the Northern parts of the world, or too high temperatures with water scarcity, such as the 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 about how the two Paleozoic-Mesozoic ginkgo genera-terms *Baiera (Sphenobaiera)* and *Ginkgoites* can be reasonably used, with reference to the Permian, does not have easy answers. Repeatedly dichotomizing or bilobed leaves, based on the Rhaetian-Hettangian specimen of Bayreuth, were first described as *Baiera dichotoma* (Braun, 1843). Further, this genus-name was used in connection with archaic ginkgos, and adopted for various deeply dissected leaves, such as the 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, connected to the only existing species of *Ginkgo biloba*. Since both names are well-established and used widely, the less confusing solution could probably be, to assign the name *Baiera* for deeply dissected fossil ginkgo leaves originating at one level from a long or short petiole. Whereas, for the other categories, 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 in the early Permian, a separation of the gymnosperms must have taken place in the Devonian.

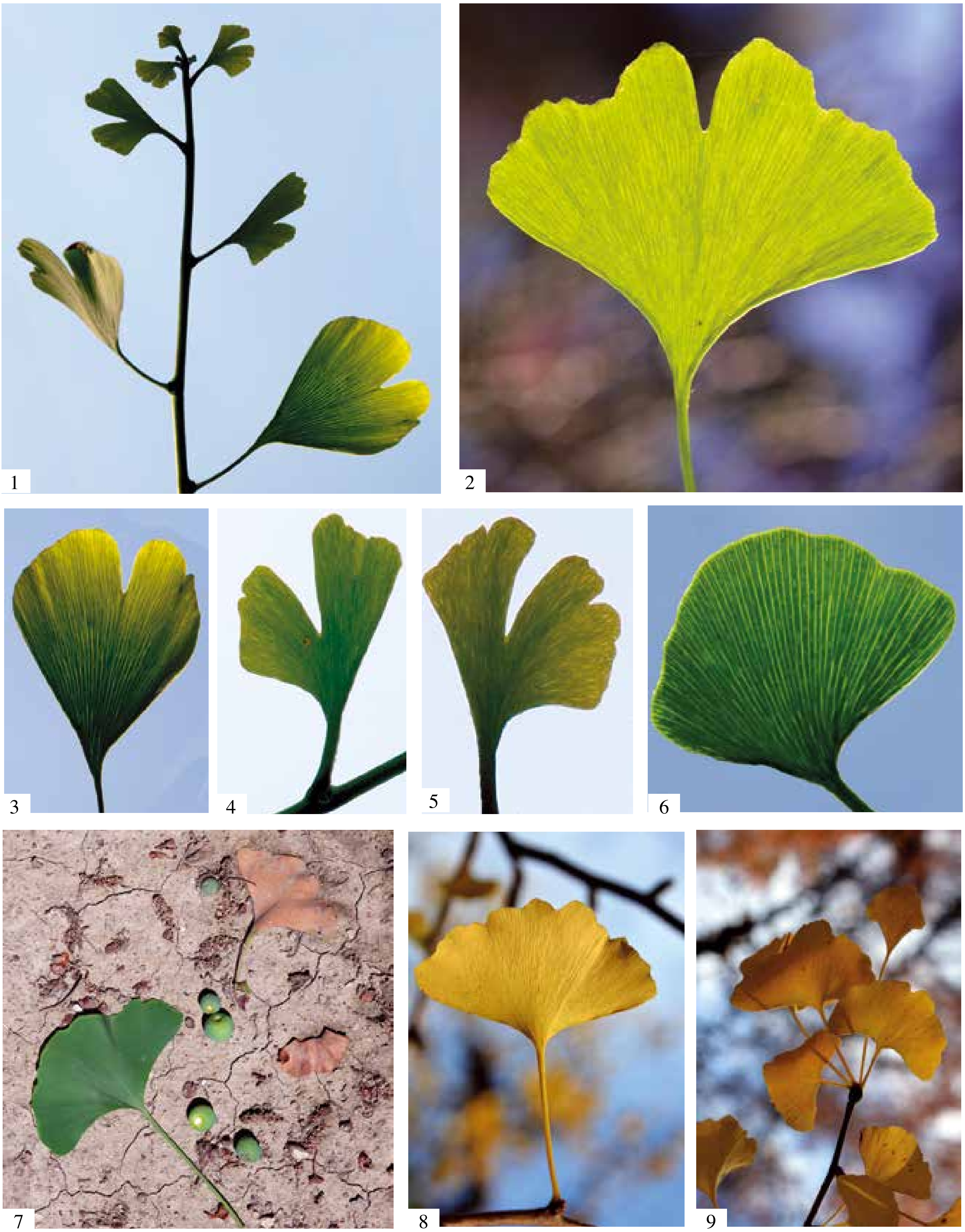
Formation of the fleshy seed by micro-leaflets: The clearly recognizable coating of the ovule by a number of tiny sterile leaves, especially in the ancient Araucarias in the

***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)

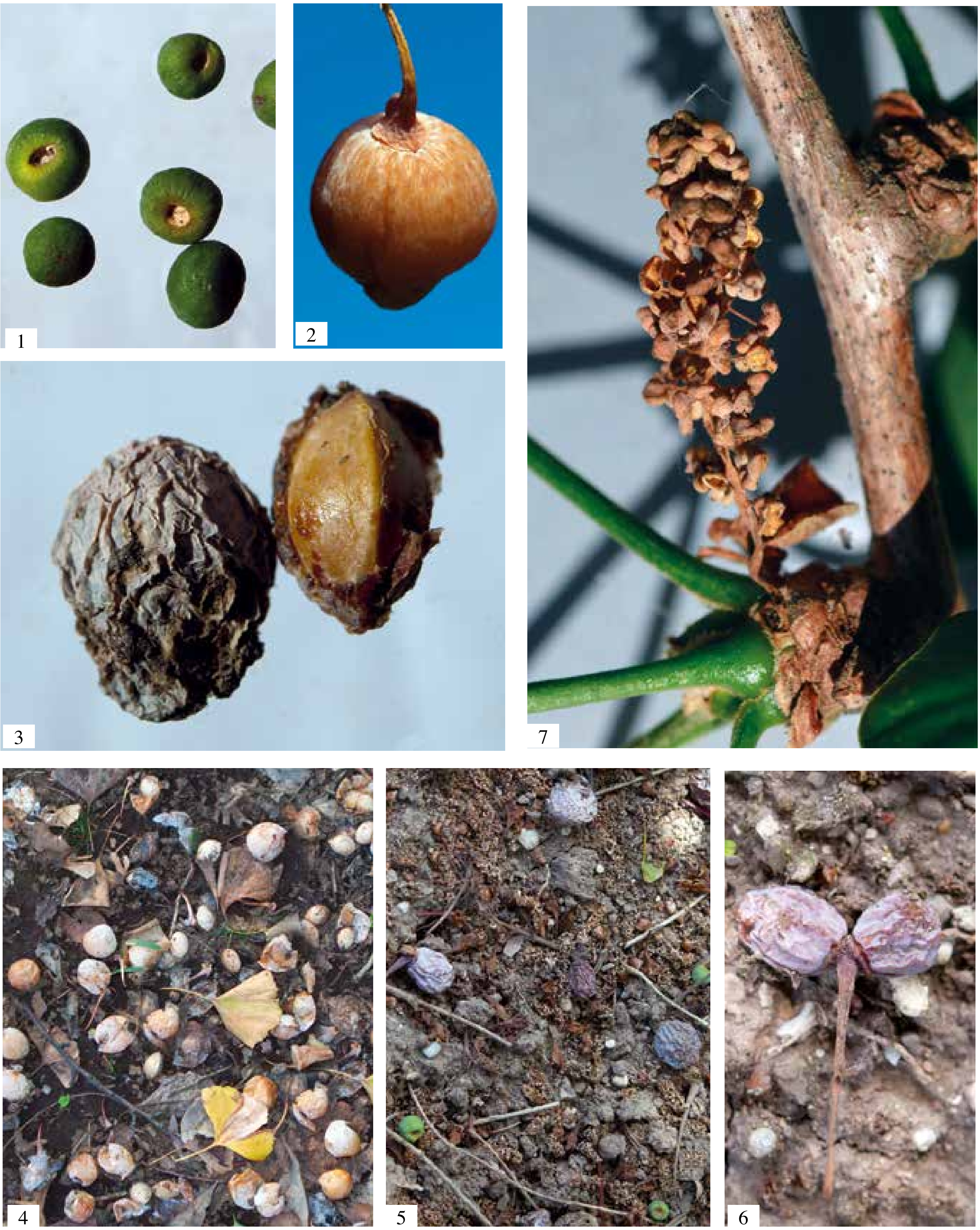
***Ginkgo biloba*. Leaves and seeds**

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.



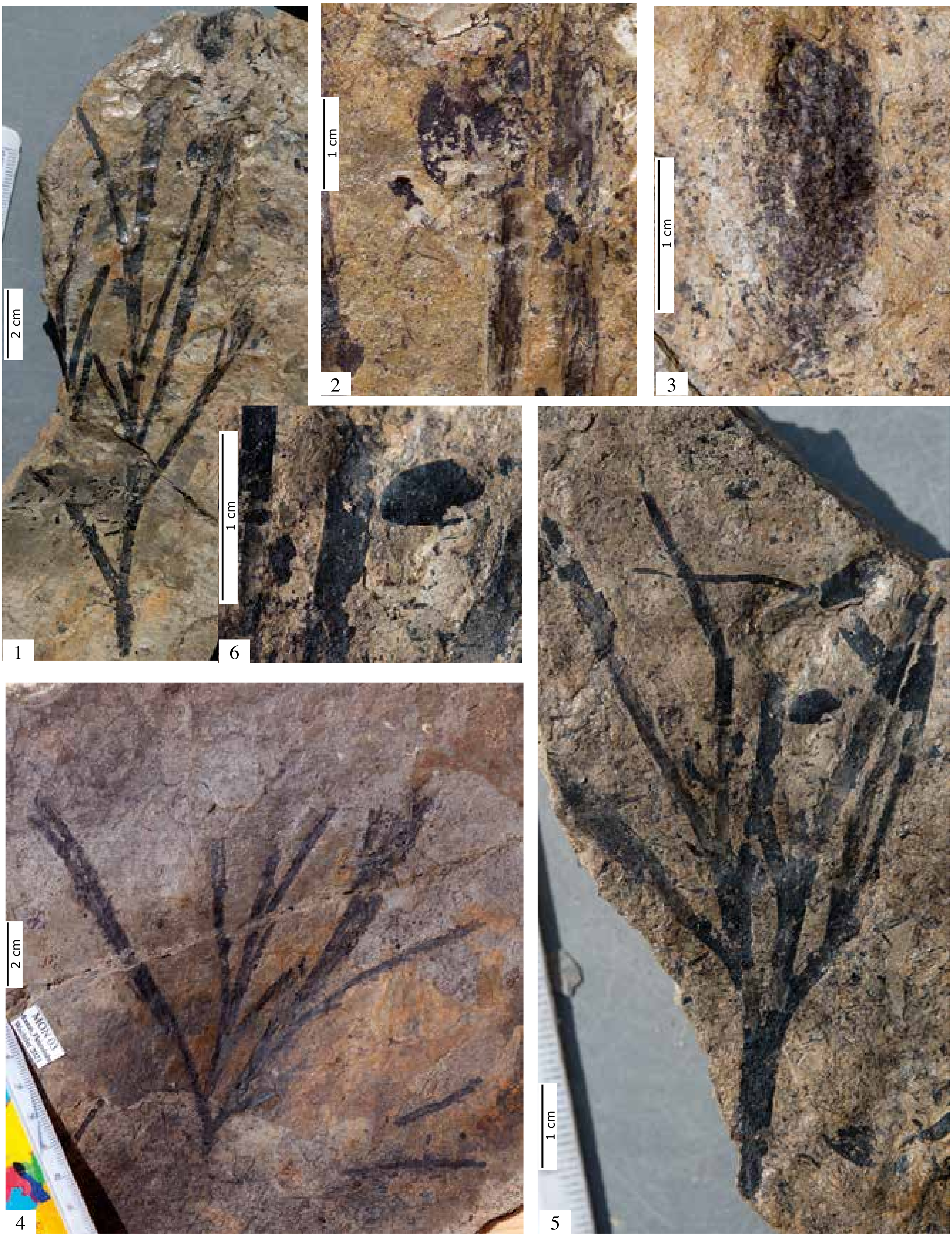
***Ginkgo biloba*. Leaves**

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 sarcotesta 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.

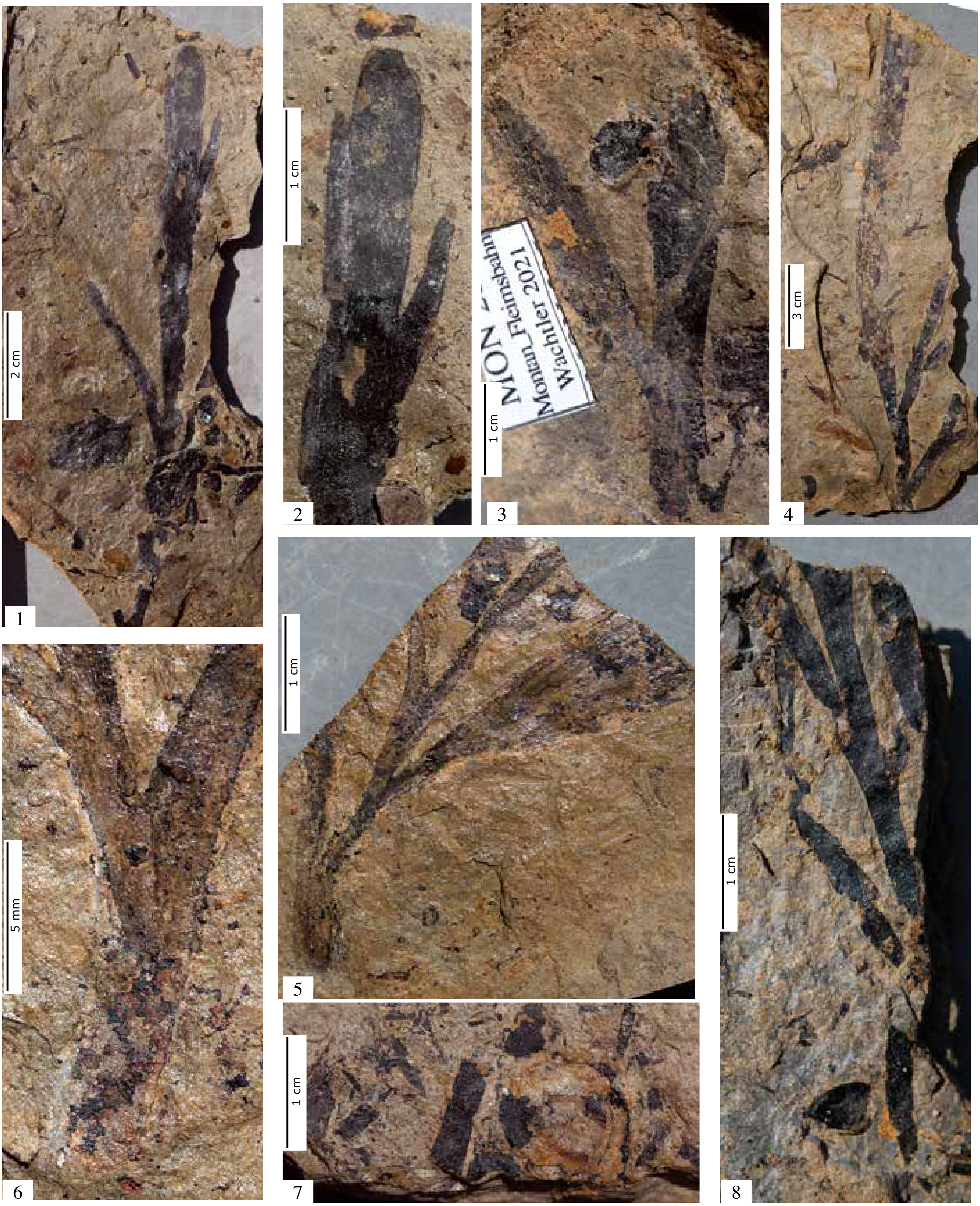


Ginkgoites gasseri. Leaves (Late Permian, Wuchiapingian)

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

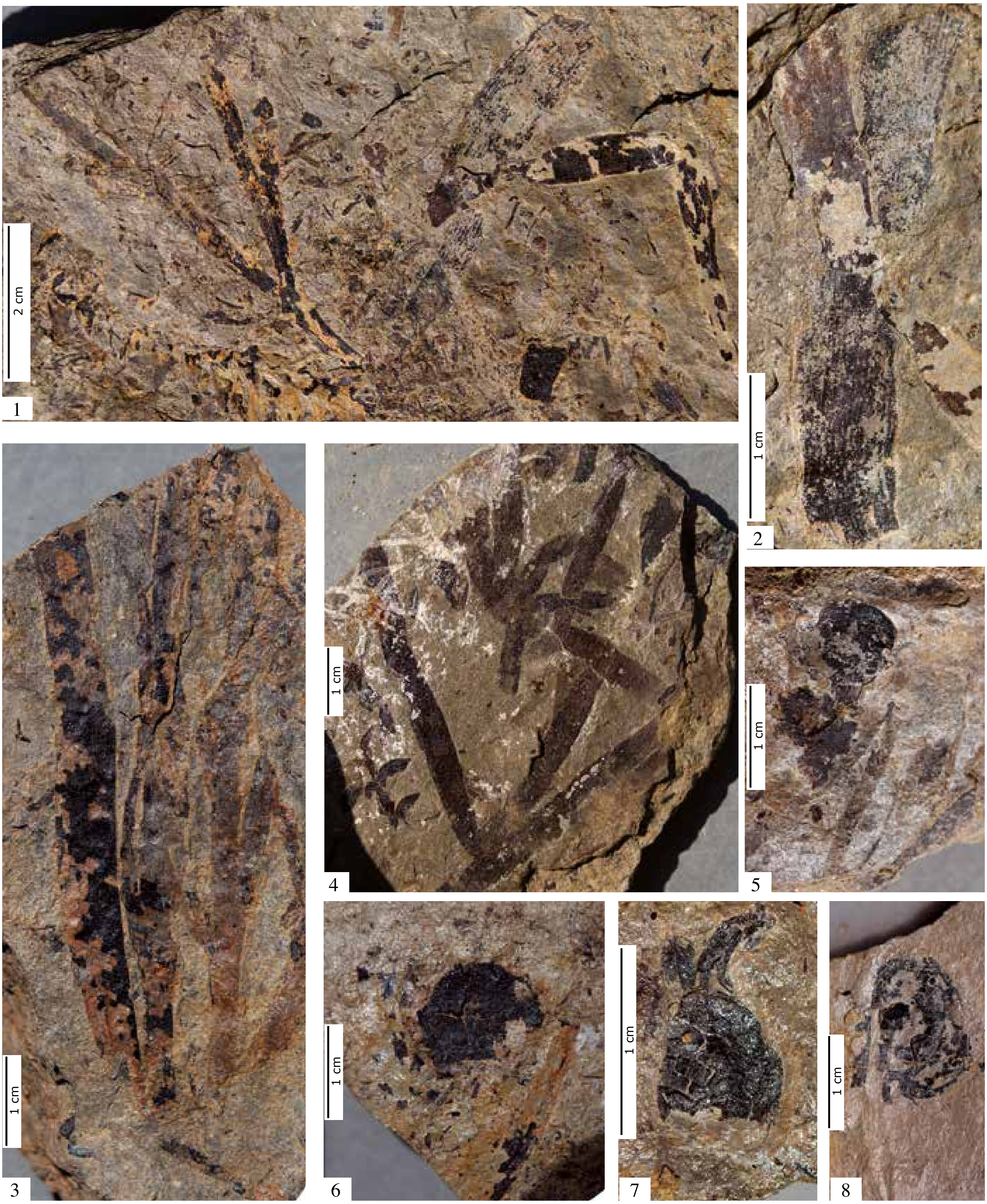
***Ginkgoites gasseri*. Leaves (Late Permian, Wuchiapingian)**

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



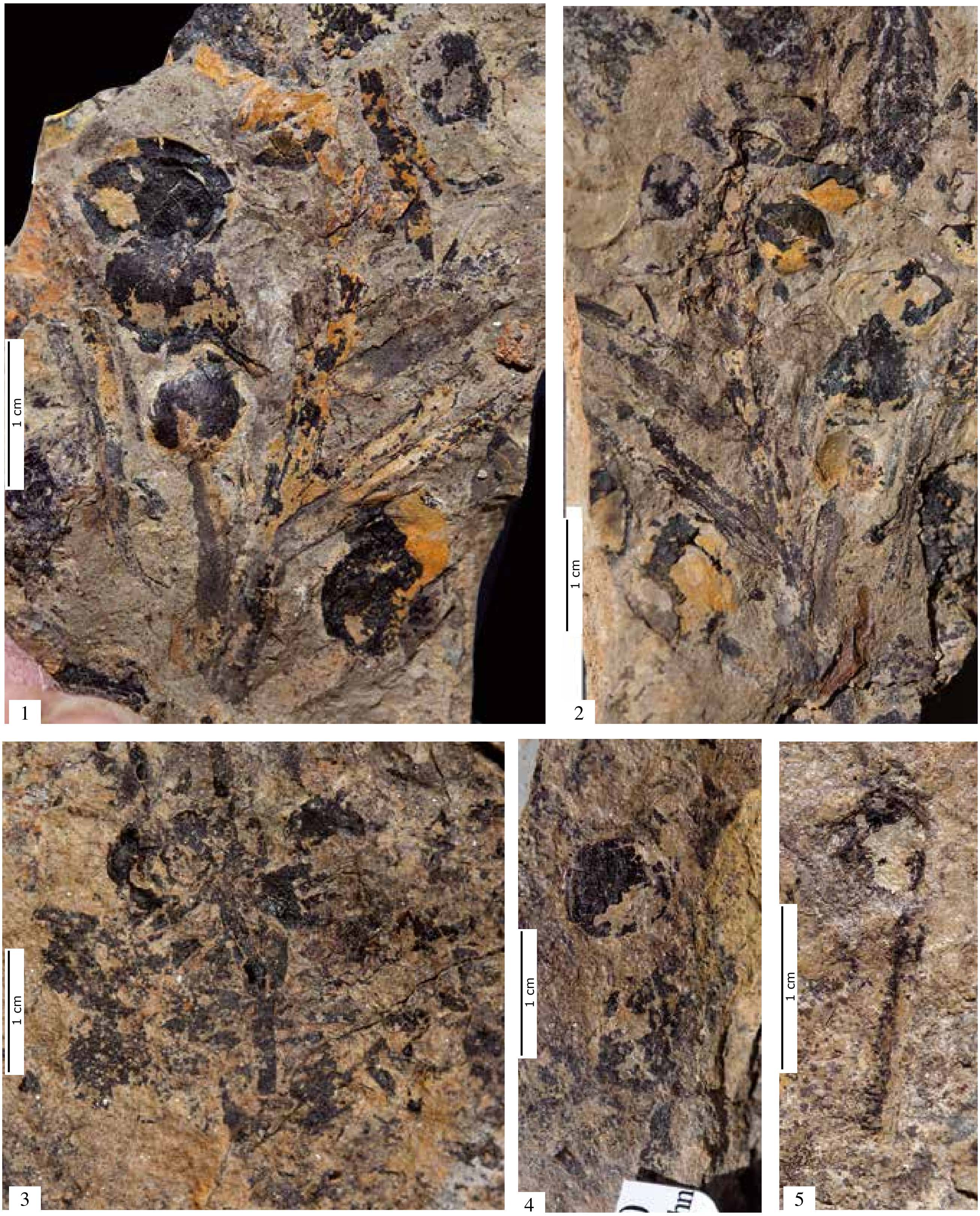
***Ginkgoites gasseri*. Leaves (Late Permian, Wuchiapingian)**

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



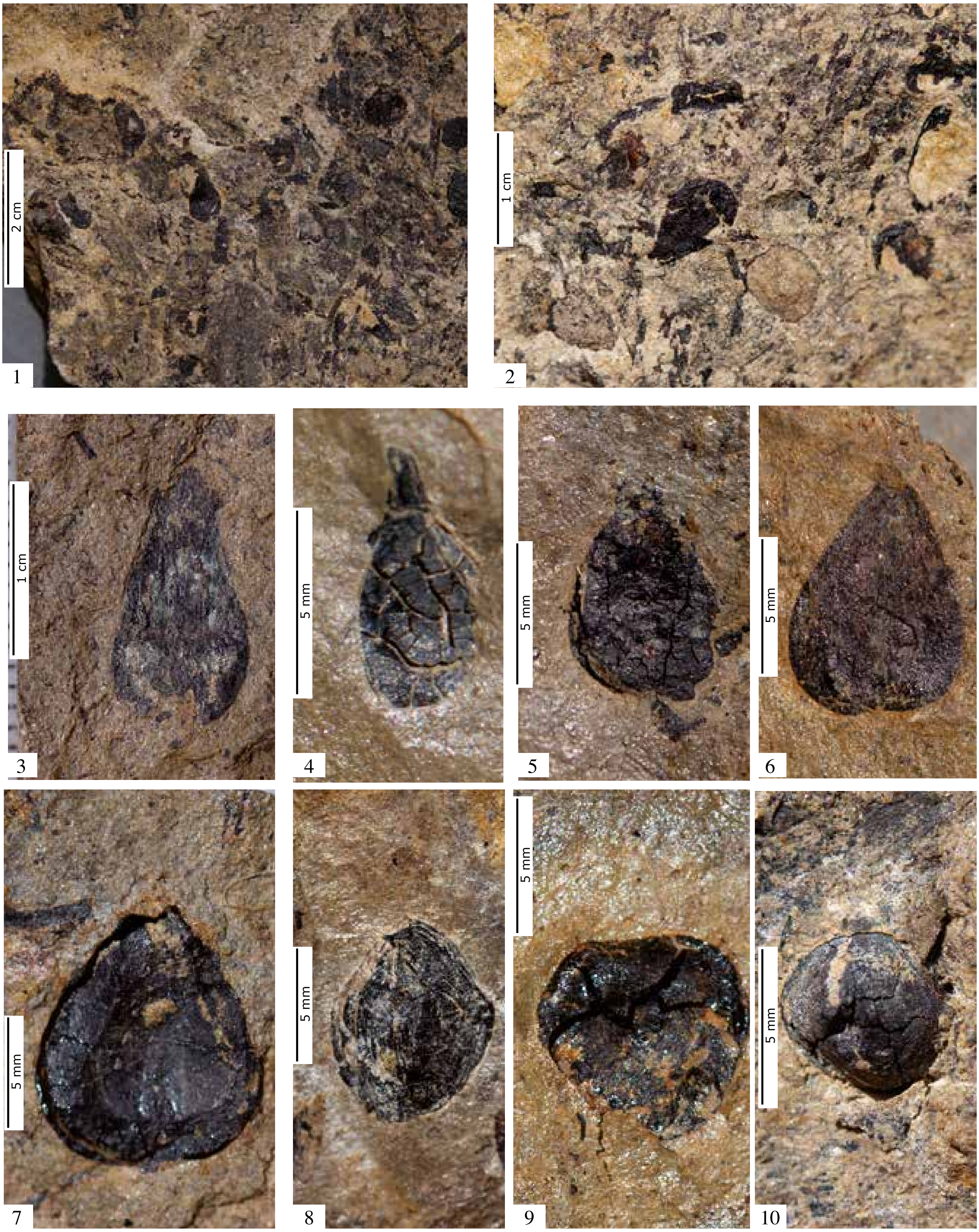
***Ginkgoites gasseri*. Leaves and seeds (Late Permian, Wuchiapingian)**

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



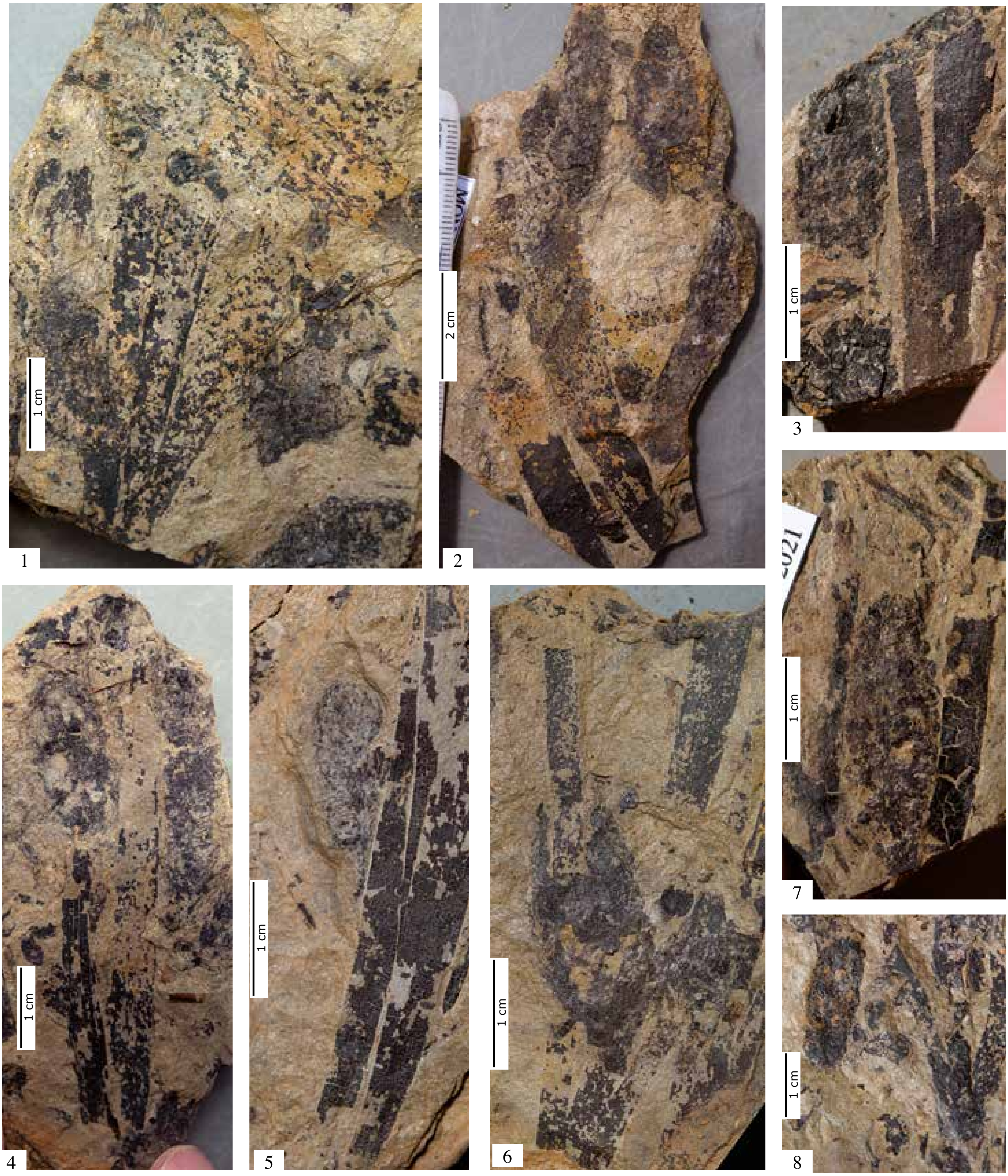
***Ginkgoites gasseri*. Seeds an ovules (Late Permian, Wuchiapingian)**

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

Permian, leads to the conclusion that the fleshy sarcotesta in the ginkgos was formed in a similar manner. The evolutionary advantages included a protection of the inner sclerotesta and moreover, an attractive range of foods for semen-dispersing animals.

Merging of individual needles into a fan-shaped leaf: There is a frequent presence of fused individual leaflets, having parallel veins in *Ginkgoites gasseri*, and showing rapid further development till *Ginkgoites murchisonae* phase, all occurring in the late Permian. This leads to the conclusion that the fan-shaped leaflet of present-day ginkgos originated from a continued merging of the needles, along with the formation of dividing veins.

Coniferophyta

Abietaceae-ancestors

In addition to the Ginkgo-ancestors (*Ginkoites*) and Araucaria-progenitors (*Ortiseia*), we encounter throughout the entire Permian, a conifer characterized by its winged seeds. Although several present-day conifers generate alate seeds, certain features such as, plagiotropic branchlets, small-sized pollen cones and female cones with more or less seed-scale projecting bracts, make them easily distinguishable as Abietaceae-ancestors.

The first fir-progenitors can be encountered worldwide (USA, New Mexico, Kinney Brick, Carrizo Arroyo), Niederhausen, Oberhof (Germany), Lodéve (France), just in the late Carboniferous (Kasimovian) with the two-bracted *Gomphostrobus bifidus* and the more evolved one-bracted *Wachtlerina bracteata*. They generate symmetrically-arranged combs during this time. Beginning from the Early Permian, the recoveries of fully-developed Abietaceae-ancestors connect them above all to the Alps, where we encounter with Artinskian *Majonica suessi* (Wachtler, 2015) a first plagiotropic fir-ancestor. Their evolution prosecutes with Kungurian *Majonica ambrosii*, until the Late Permian in the Alps where we encounter just, several species. They can mainly be distinguished through some differences in the blue-print of the bracts, the leaves or the winged seeds.

In the Montan fossil-site we encounter an interesting fir-ancestor that is distinguished by several differences, by mostly coeval *Majonica alpina* and *Majonica clementwesterhofae*. Strangely it has more resemblances with Early Permian Abietaceae (*Majonica suessi* and *Majonica ambrosii)*, with regard to its leaves and branchlets. Additionally, a major difference from all other species is that, carpets of pollen cones with hundreds 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

Geological age

Middle-Late Permian: Guadalupian (Capitanian) - Lopingian (Wuchiapingian)

Additional Material

More than 100 specimens were catalogued

Repository

All Wachtler Collection, Museum Dolomythos, Innichen

Etymology

It is significant to remember 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 field trips and assisted him intensely. Before his marriage, 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 heterophyllous foliage reaching till about 5 cm (MON 74, MON 219, MON 199, MON 198) can also be encountered. The leaves are uniformly wide over the entire length and end-rounded till slightly tapered. One or 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 do they be slightly falcate.

Male cones: 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 on the apical end of a needle/stalk (MON 275, paratype). They are elongated, end-rounded with reflexed involucral scales (MON 89, MON 280, MON 293, MON 85) and are shed at maturity, thereby forming extended cone carpets in the sediments.

Female cones: Female cones are slender, losing their seed scales at maturity, so that only a thin spindle remains (MON 211). Seed scales are about 1 cm long and 0.7 cm wide (MON 158, paratype), and divided in the middle to form a horny, curved extension. Seed-side (adaxial) holds two winged seeds, which occupy two-thirds of the scale (MON 155, MON 27, MON 284). Abaxial side has a bracted appendix, which does not project the end of the scale. Bract divided into one main bract-leaf and several accompanying micro-leaves (MON 224, MON 32 MON 277, MON 215). The seeds are winged, about 0.5 to 0.7 cm long, basally incorporating 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 the coeval *Majonica alpina* and *Majonica clementwesterhofae* (Wachtler, 2015, Wachtler, 2021). The needles are as equally pendulous as the Early Permian ones. Also, the bracts do not project the scale as in *Majonica alpina.* Since also *Ginkgoites gasseri* present several archaic features, which are distinct from Upper

Permian *Ginkgoites murchisonae*, a plausible explanation could be that they might belong to older Permian sediments. Perhaps, they belong to the Middle Permian Guadalupian (Capitanian). The Gröden-Formation seems to be deposited over a time span of 10 to 15 million years ranging from Middle till Late Permian.

Other than this, *Majonica lyellae* exhibits all modern features of present-day firs, such as plagiotropic branchlets, bracted seed scales, winged seeds, decaying cones at maturity and similar pollen cones. Therefore, while naked spindles can be recovered, entire female cones could be found only rarely.

A strange feature, never recorded in other Early to Late Permian localities, is the existence of carpets of pollen cones in the fine sediments. A possible explanation can be the growth of *Majonica lyellae* in the immediate vicinity of lakes or slow-flowing rivers. In contrast to this, the male cones of all other *Majonica*-species were transported over longer distances. It is also interesting to note the change of the pollen cones from shortly-bracted (*Majonica suessi, Majonica ambrosii*) in the Early Permian, to the reflexed involucral scales of *Majonica lyellae*, the same as in present times. It can be assumed that the fir trees had already completed their full evolution in the Permian.

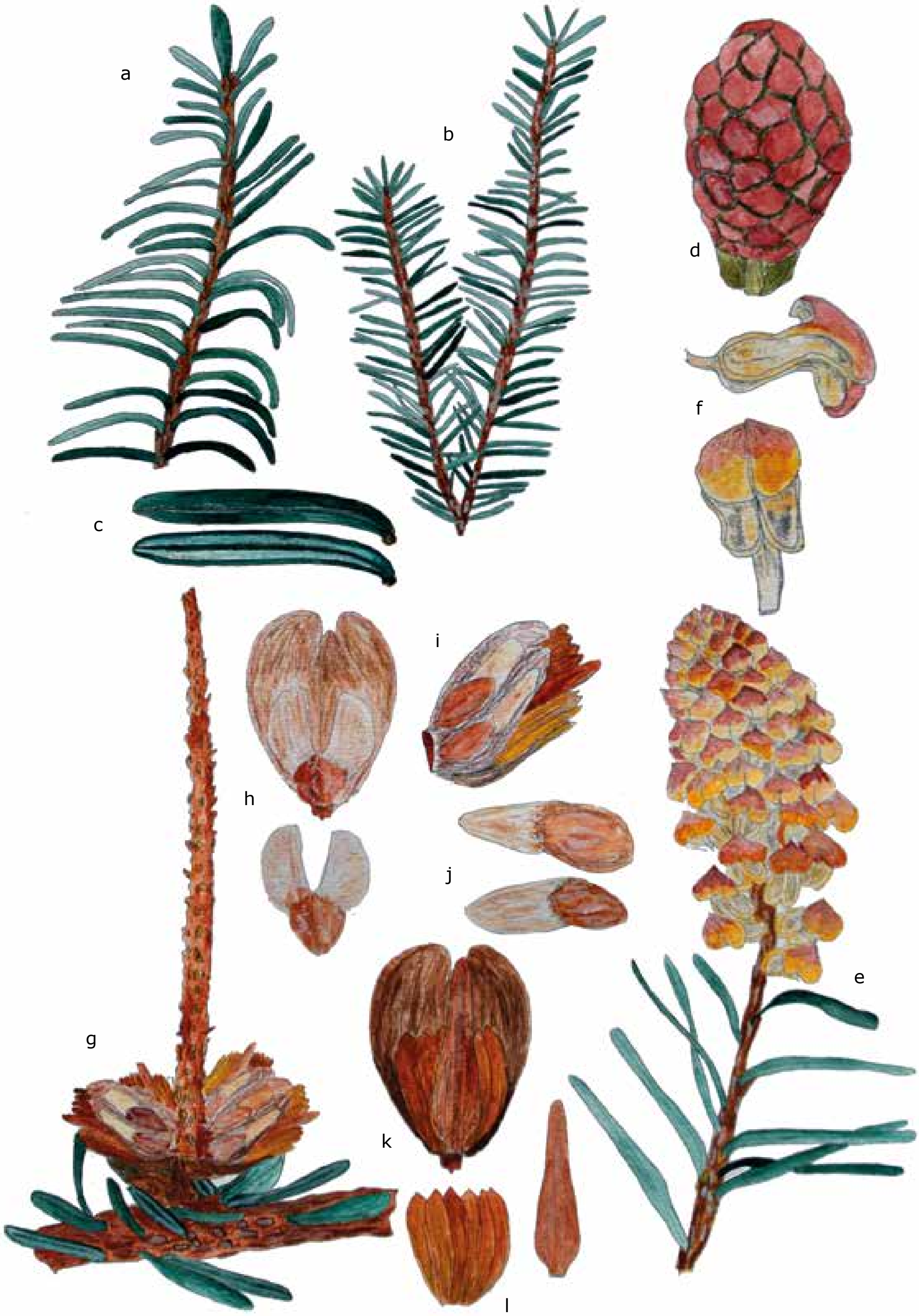
Interestingly, the fossil sites of Montan and the Bletterbach-gorge are located only a few kilometres apart. However both Middle/Upper Permian fir-species can be easily distinguished. *Majonica alpina*, first described in 1987, by the Dutch researcher Johanna Clement-Westerhof from the Bletterbach-gorge (South-Tyrol), is distinguished by an extremely long and largely the scale projecting bract, (as it occurs also in the Valli del Pasubio). Whereas the bract of *Majonica lyellae* is almost inconspicuous and subtle.

Following their heyday all over the Permian, we next have a decline of the firs, till the Eocene, about 50 million years ago. In the Eocene, they reappeared along with their alate seeds and plagiotropic branchlets, mostly following the same blue-print as seen 250 million years earlier.

Araucaria-ancestors

An interesting group within the conifer-families is represented by the Araucarias. They are now restricted to the Southern hemisphere, but for a long period—from the Earliest Permian till the Triassic-Jurassic—they were widespread in the Northern part of the globe. One feature that distinguishes them from other conifers is their one-seeded megasporophyll. This is in contrast

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



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

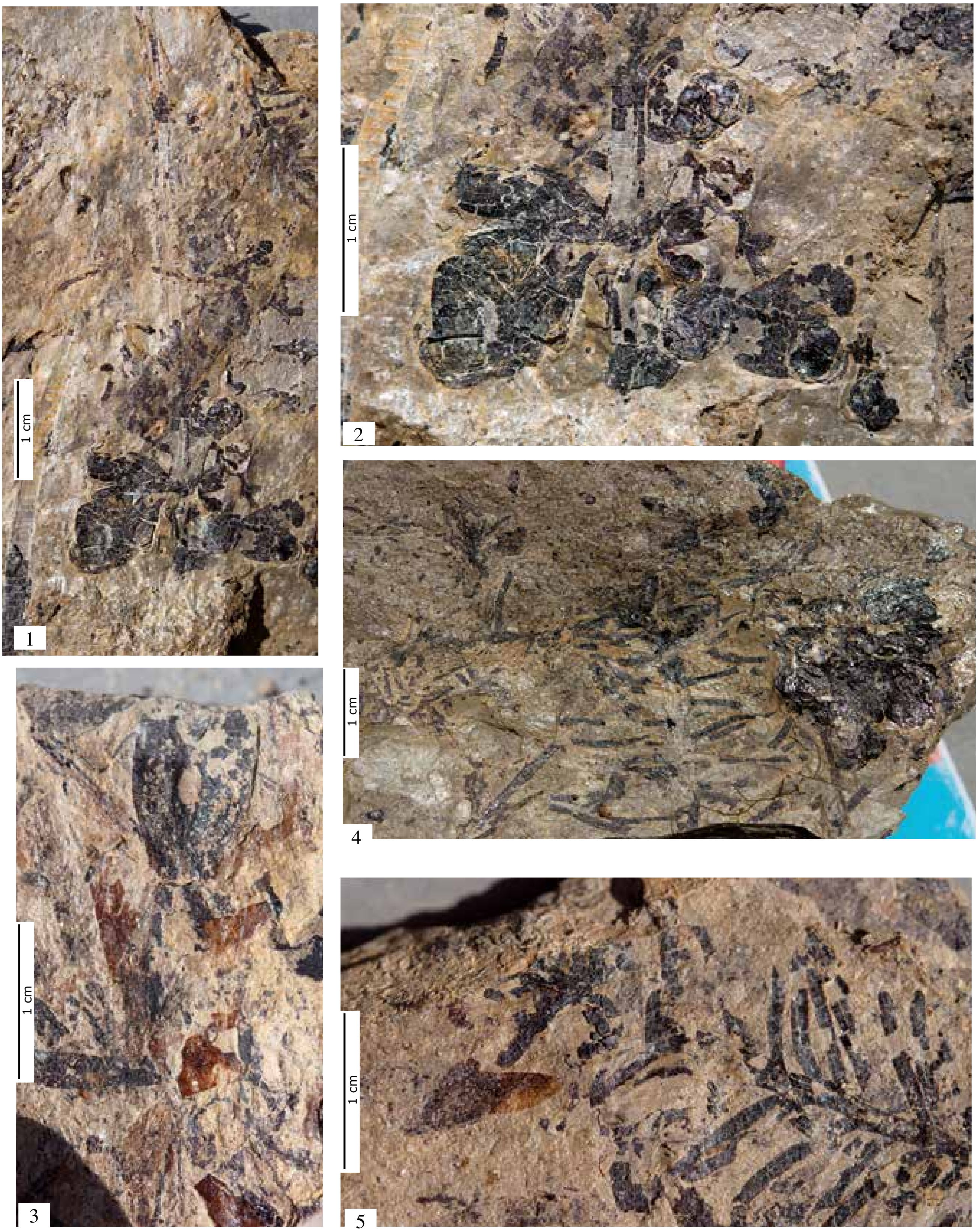
a. Twig with characteristic pendulous needles (MON 74). b. Plagiotropic branchlet (MON 241, MON 206, MON 202). c. Single leaf (abaxial and adaxial side; d. Juvenile male cone (MON 279). e. Male cone on a twig (MON 288). f. Single microsporophylls (MON 89, MON 280, MON 293, MON 85). g. Female cone with 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

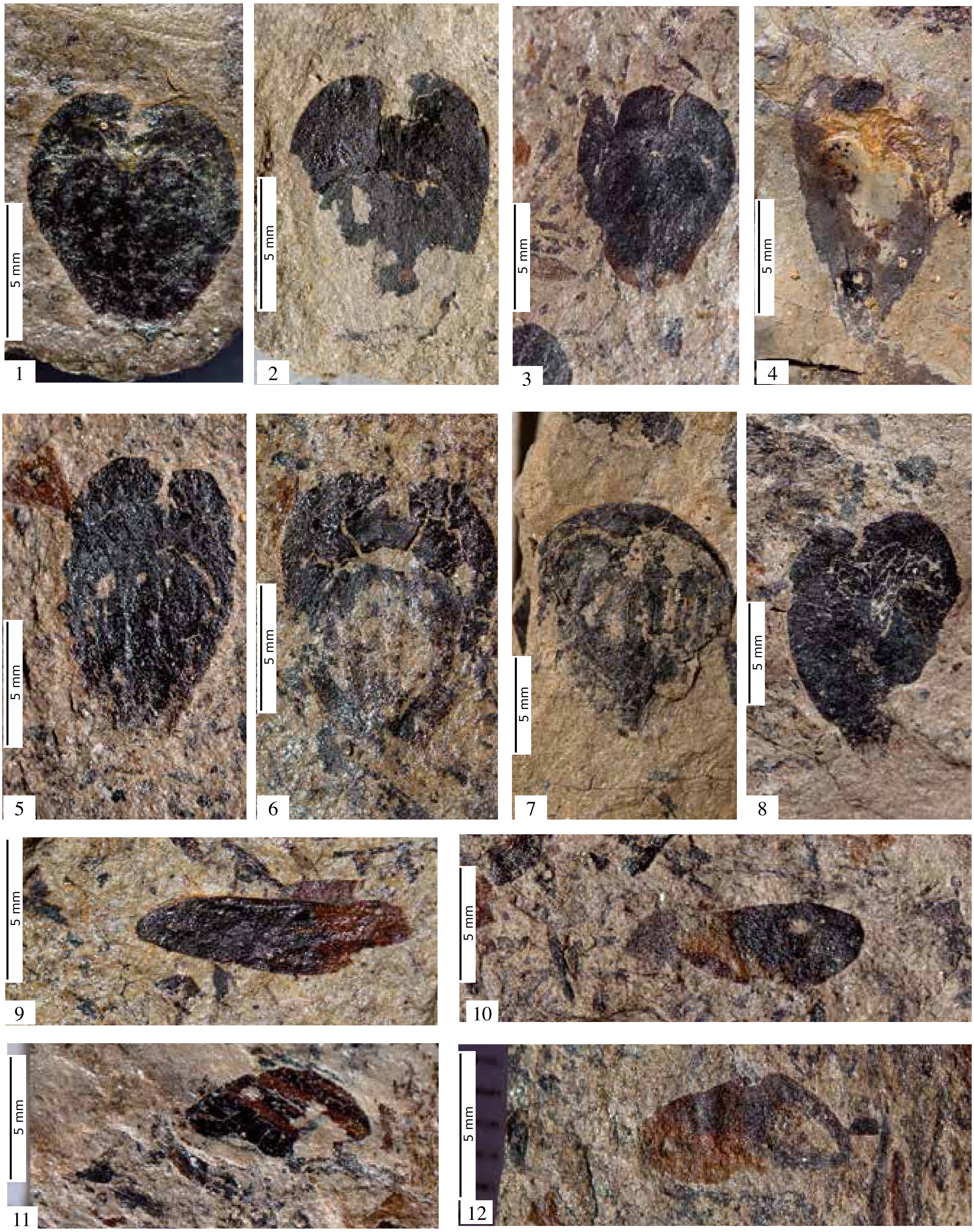
***Majonica lyellae*. Branchlets (Late Permian, Wuchiapingian)**

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

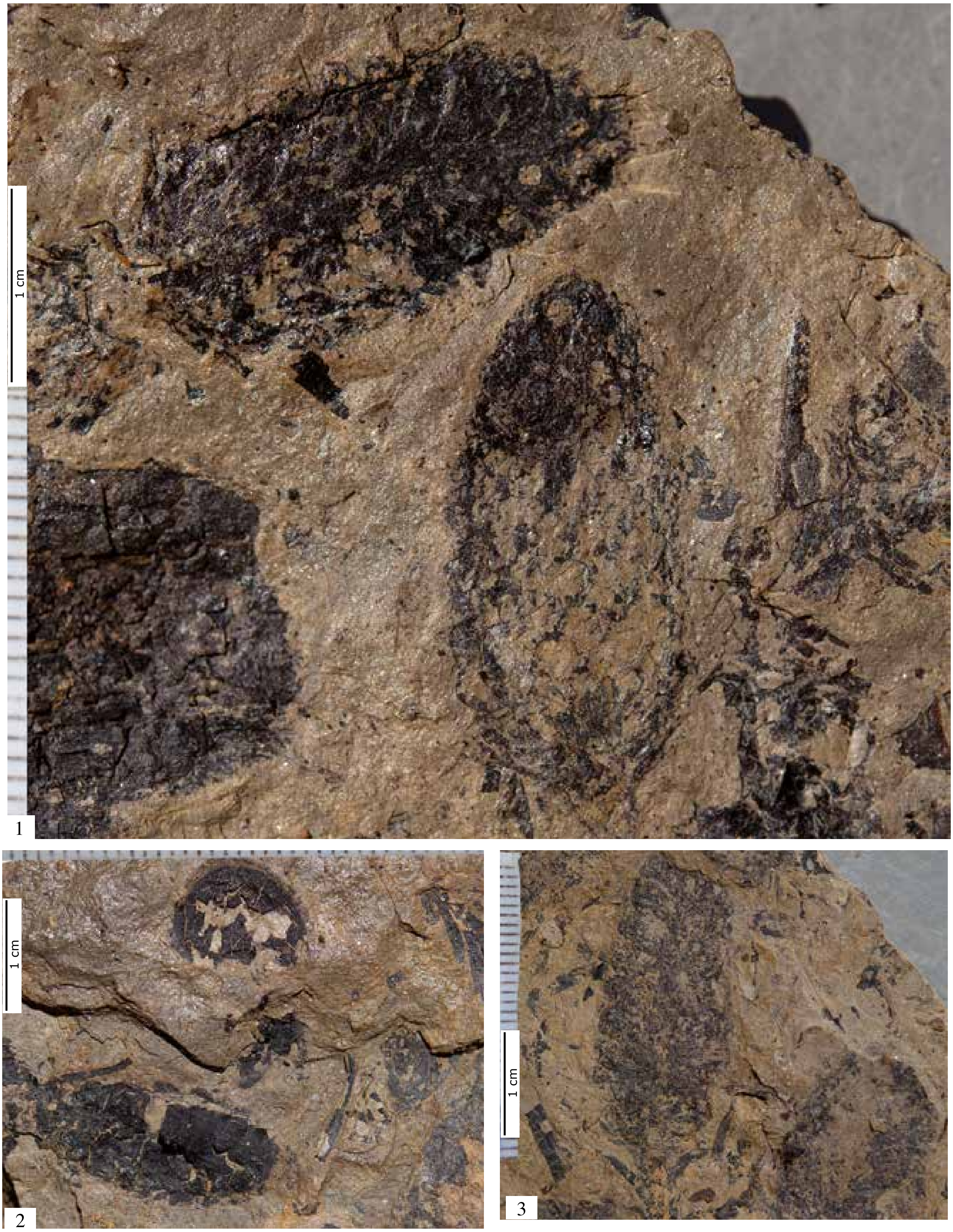


***Majonica lyellae*. Seed scales and winged seeds (Late Permian, Wuchiapingian)**

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

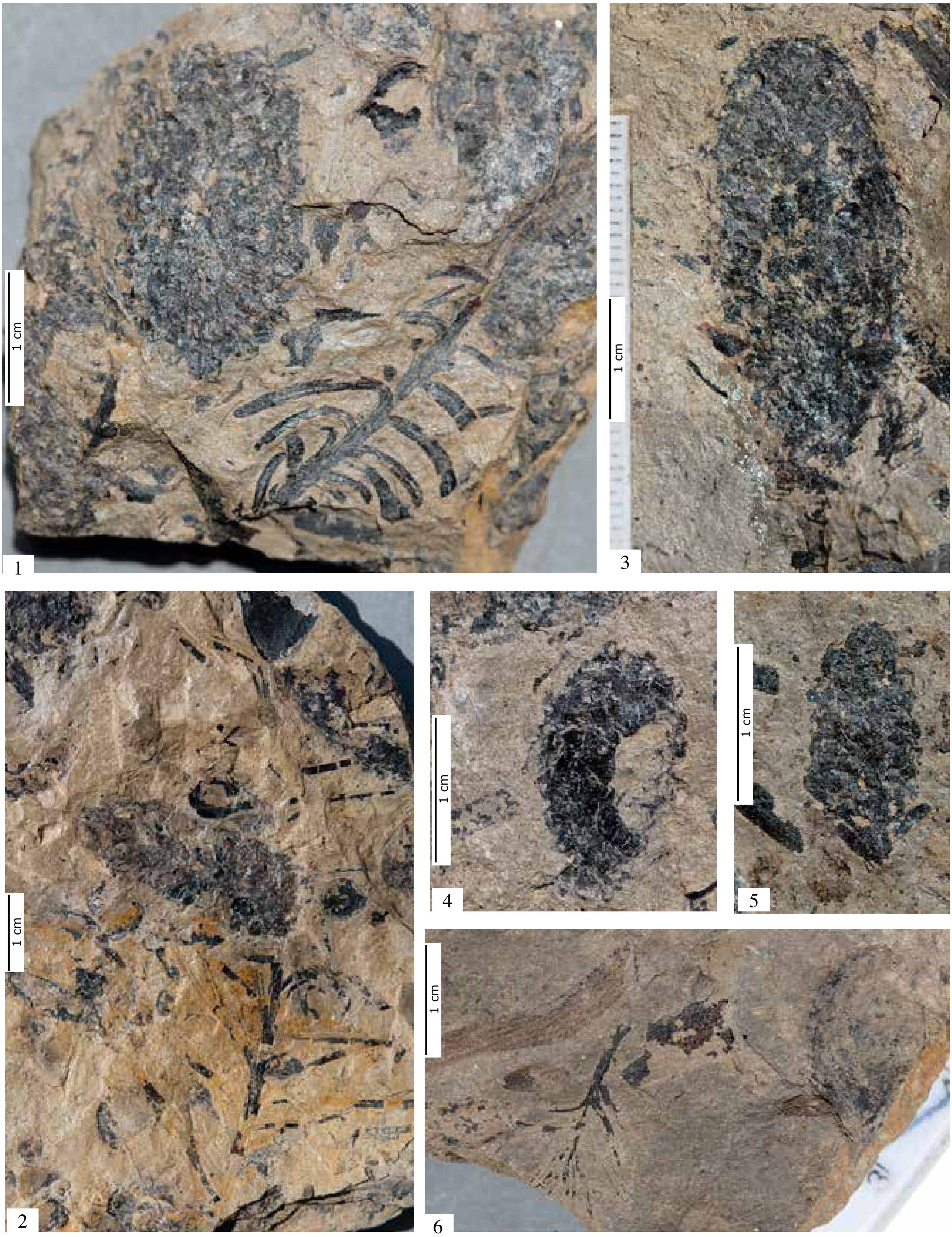
***Majonica lyellae*. Male cones (Late Permian, Wuchiapingian)**

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.

to several other conifers like the Pinaceae, Piceaceae and Abietaceae, which bear two (mostly alate) seeds on their scales, or to the three- or more seeded *Cryptomeria*-conifers and S*equoia*. The Araucarias are also distinguished by their huge pollen cones, with apically and dorsiventrally hanging pollen sacs, or by their bulbous female cones.

Ever since Upper Permian *Ortiseia (leonardii*) was identified by Rudolf Florin 1964, diverse species covering the entire Permian have been found and described (Clement-Westerhof, 1984; Wachtler, 2012, 2015, 2021). Therefore, this conifer can be regarded as one of the best-known Permian conifers.

In the Early Permian, it developed its characterising features, such as the elongated and long-bracted pollen organs, the rounded and decaying female cones, as well as the symmetrically-arranged foliage branchlets.

Another interesting feature is the evolution of its one-seeded scales. In the beginning of and during the entire Permian, various minute sterile leaves densely covered the seed scale, probably to protect the seed from predators. After maturity, the scale and the seed inside were shed entirely. Araucaria-conifers encountered in recognizable forms, date back till the Carboniferous-Permian border with *Ortiseia uhli* (Kasimovian/Gzhelian Saar-Nahe-Basin in Germany). Some other representatives were also found in Carboniferous/Early Permian layers from the Carinthian Alps (Rattendorfer Alm). Next, the recoveries moved to the Southern Alps, especially the Dolomites. Artinskian *Ortiseia dasdanai* was followed by Kungurian *Ortiseia daberi.* In the late Permian, we have in the Dolomites, a great diversity with slightly different features. This is also probably due to geological time differences. This includes varieties such as, *Ortiseia leonardii, Ortiseia jonkeri, Ortiseia zanettii* and *Ortiseia visscheri.*

Post the Permian-Triassic border, the Araucariaceae mostly changed their blueprint. The only clearly identifiable representative, evidencing a little of the old features of the sterile leaflets surrounding the seed-scale, is seen in *Ortiseia collii,* in the Early Middle Triassic (Anisian) sediments on the Balearic islands (Malllorca, Estellencs) of 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 several 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 are formed sometimes (Carnian *Araucarites spinosa*) as spreading pseudo-whorls, with second to third order branches of unequal length, consisting of rigid leathery pungent needles like the extant *Araucaria araucana.*

At the Triassic-Jurassic border, the last *Araucarites* species disappeared from the Northern hemisphere, in order to enlarge their spread over the Southern hemisphere. Upper Permian *Ortiseia leonardii, Ortiseia jonkeri,* and *Ortiseia zanettii* are now largely well-known in all regions of the Dolomites, due to recent findings (Wachtler, 2015, Wachtler 2021). However, major doubts still persist due to greater ambiguities, in the case of *Ortiseia visscheri,* known only in fragments from the Bletterbach-Butterloch (Clement-Westerhof, 1984). Nevertheless, Michael Wachtler has recovered enough material, especially branchlets, female cones, seed scales and pollen cone, from the adjoining Montan plant-fossil site, such that, this Araucaria-species can also 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 pinnately-branched, forming symmetrical combs. Leaves having a length of up to 2.0 cm, ending in an acute to obtuse apex (MON 191, MON 192)..

Male cones: Reaching a length of 4.5–6 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, the pollen sacs hang dorsiventrally in the direction of the main axis (MON 107).

Female cones: Round-bodied, about 6 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 interpreted the conifer *Ortiseia leonardii* anew 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 find male or female cones, and also found only poorly preserved branchlets, her main focus is on the seed scales and the cuticular analyses of the isolated found leaves. An interesting feature noted by her, with regard to *Ortiseia visscheri* is as follows: *"Leaves slightly overlapping, arising at an angle of max. 45o, 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 away from the Bletterbach-gorge, branchlets and twigs that could correspond to the features mentioned by Clement-Westerhof. Additionally, he also found the hitherto neglected male and female cones. It is not completely proved, if these remains belong to *Ortiseia visscheri* or need to be classified as a new species, but it can be assumed until now, that they have resemblances to it.

For several reasons, they do not correspond to *Ortiseia leonardii,* which is the most common species in the Dolomites, having long-bracted male cones and evolving tapered and pointed needles. Also, *Ortiseia zanettii* is different, due to its massive male cones, whereas *Ortiseia jonkeri* from the Valli del Pasubio has pollen cones, with extremely subtle bracts.

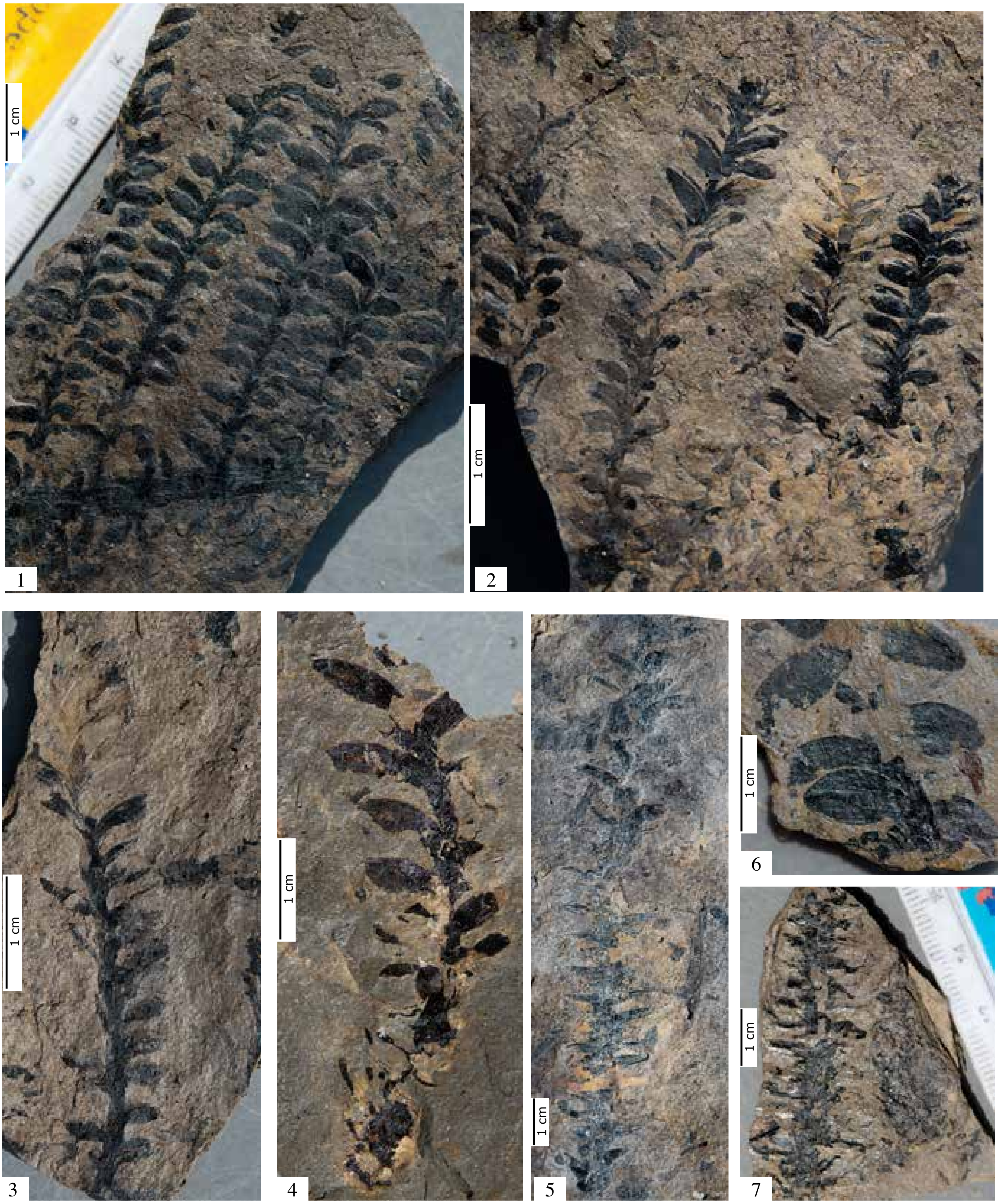
Ortiseia visscheri stands in the Montan locality, with frequency largely next to the fir-ancestor *Majonica lyellae* or *Ginkgoites gasseri.* However, it is common enough to determine all the essential parts of the plant, such as female cones, seed scales, pollen cones or branchlets, with obtuse to tapered changing needles. As *Ortiseia visscheri* cones are robust enough to be transported and twirled over longer distances, they could be found in the Montan-fossil site also in the coarse sandstone, although less well-preserved were other plant families with more fragile cones were largely destroyed.

Cycadophyta

Cycads were present in the Middle/Late Permian Montan fossil site, but they play only a marginal role, opposite to the Upper Permian Ariche-locality in the Valli del Pasubio, where cycads could be encountered in fair amounts, especially well-preserved cones but also leaves and fronds. They can be subdivided into the Cycas-progenitors *Macrotaeniopteris wachtleri* and *Taeniopteris* sp. an archaic cycad-like plant (*Pernerina pasubi)* and the Zamiaceae-ancestor *Nilssonia brandtii* (Perner, 2015; Wachtler, 2015; Wachtler, 2021). Due to their sparse occurrence in the Montan locality (MON 02, MON 196) an exact collocation can not be given, but probably we have the same genera as in the Valli Pasubio can be found, but more information cannot 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. 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*, bearing *Peltaspermum* fructifications (MON 212, MON 217). Due to the poor conservation, only a generic classification could be carried out.

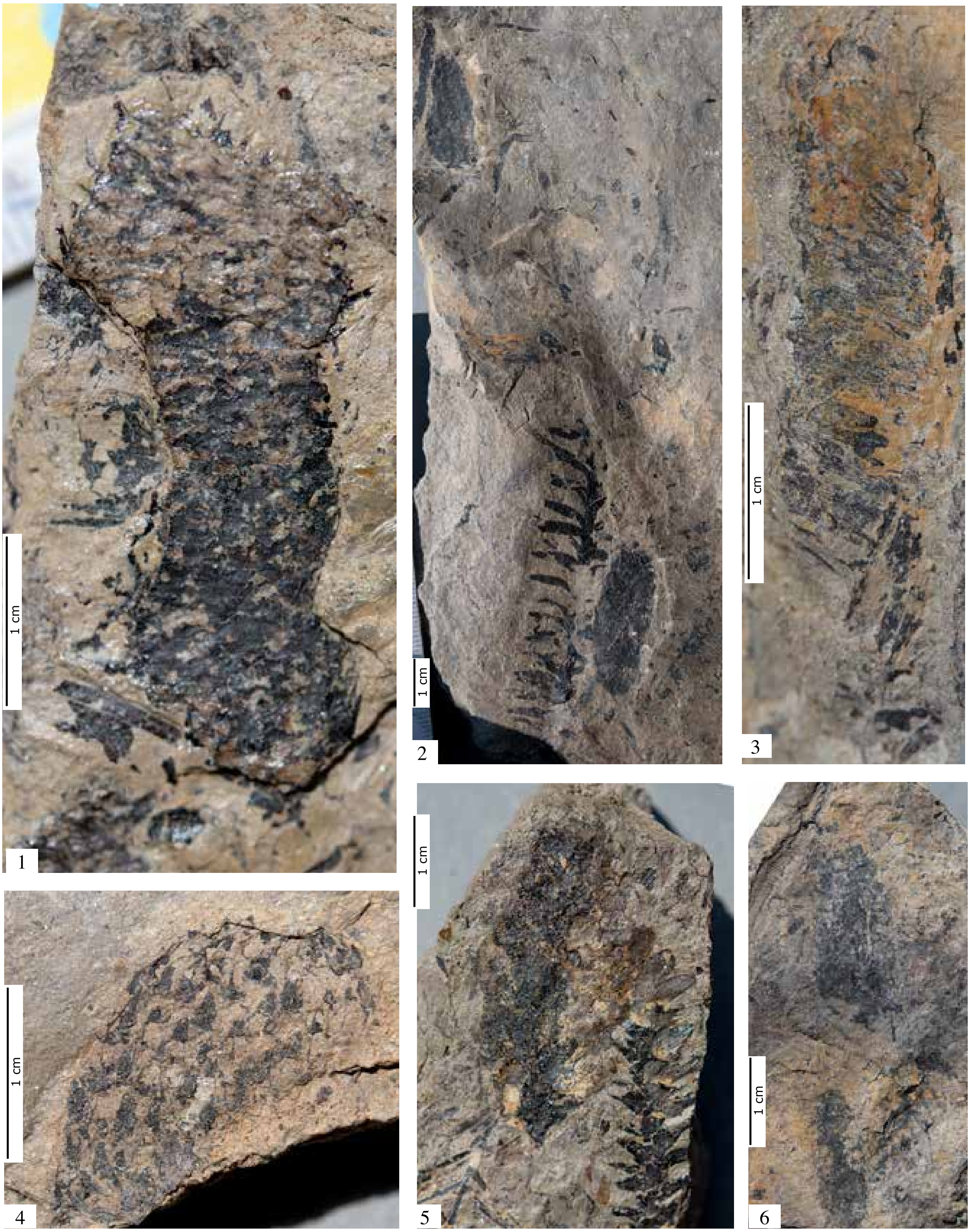


***Ortiseia visscheri*. Branchlets and leaves (Late Permian, Wuchiapingian)**

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 micro-sporophylls (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).

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

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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

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