PLATES

PLATE I

Selected Early Jurassic bivalves of Poland

Phot. 1. An Unionacea bivalve, MUZ PIG 80.VI.1, coll. M. Pieńkowski; Sołtyków exposure; lowermost Hettangian; depositional sequence Ia; Zagaje Fm. *Photo. M. Krzyżanowski*.

Phot. 2. An Unionacea bivalve, MUZ PIG 80.VI.2, coll. W. Karaszewski; Sołtyków exposure; lowermost Hettangian, depositional sequence Ia; Zagaje Fm. *Photo. S. Kolanowski*.

Phot. 3. *Pseudocardinia* sp. (Martinson, 1961; Unionacea); Gromadzice oucrop; Lower Hettangian, depositional sequence I, uppermost part of the "b" parasequence; Zagaje Fm. *Photo. G. Pieńkowski*.

Phot. 4. *Homomya* cf. *venulithus* Troedsson; Zawada PA 3 borehole, depth 19.00 m; Middle Hettangian, depositional sequence If; Skłoby Fm. *Photo. J. Modrzejewska*.

Phot. 5. *Modiolus hillanus* Sowerby; Gromadzice oucrop; Lower Hettangian, depositional sequence Ib; Zagaje Fm. *Photo. S. Kolanowski*.

Phot. 6. *Cardinia phillea* d'Orbigny, det. J. Kopik (1997); Parkoszowice 58 BN borehole, depth 167.3 m, depositional seqeunce IVc, Lower Pliensbachian; Blanowice Fm. *Photo. J. Modrzejewska*.

Phot. 7. *Cardinia sp*., MUZ PIG 80.VI.24; Zapniów exposure; Upper Hettangian, depositional sequence Ik; Przysucha Ore-bearing Fm (see Pl. XII, phot. 5 for locality of the find). *Photo. M. Krzyżanowski*.

Phot. 8. *Cardinia follini* Lundgren, MUZ PIG 80.VI.16, Starachowice exposure; Middle Hettangian, depositional sequence I (probably "d" parasequence); Skłoby Fm. Note hinge area typical for *Cardinia*, similar to that illustrated by Troedsson (1951 — Pl.VI, 1; Pl. VII, 7, 10) — arrowed. *Photo. M. Krzyżanowski*.

Phot. 9. *Liostrea hissingeri* Lungren, MUZ PIG 79.VI.7; Ubyszów exposure (Holy Cross Mts region); Lower Hettangian, depositional sequence I (probably "c" parasequence); Skłoby Fm. *Photo. J. Modrzejewska*.

Phot. 10. *Taeniodon nathorsti* Lundgren; Ninków borehole, depth 103.8 m (Holy Cross Mts region); Middle Hettangian, depositional sequence Ic; Skłoby Formation. *Photo.S. Kolanowski*.

Phot. 11. "*Inoceramus*" *nobilis* Goldfuss, MUZ PIG 80.VI.33; Kamień Pomorski IG 1borehole depth 257.4 m; Lower Pliensbachian, depositional sequence IV; Łobez Fm. *Photo. M. Krzyżanowski*.

Phot. 12. *Tancredia erdmanni* Lundgren, MUZ PIG 522.II.4, coll. et det. J. Kopik (1964); Mechowo IG 1 borehole, depth 797.8 m; Upper Sinemurian, depositional sequence IIIc, Ostrowiec Fm. *Photo. M. Krzyżanowski*.

Scale in all the figures = 1 cm. Phots. 3–6, 9, 10 — lost specimen.
MUZ PIG — Geological Museum of the Polish Geological Institute

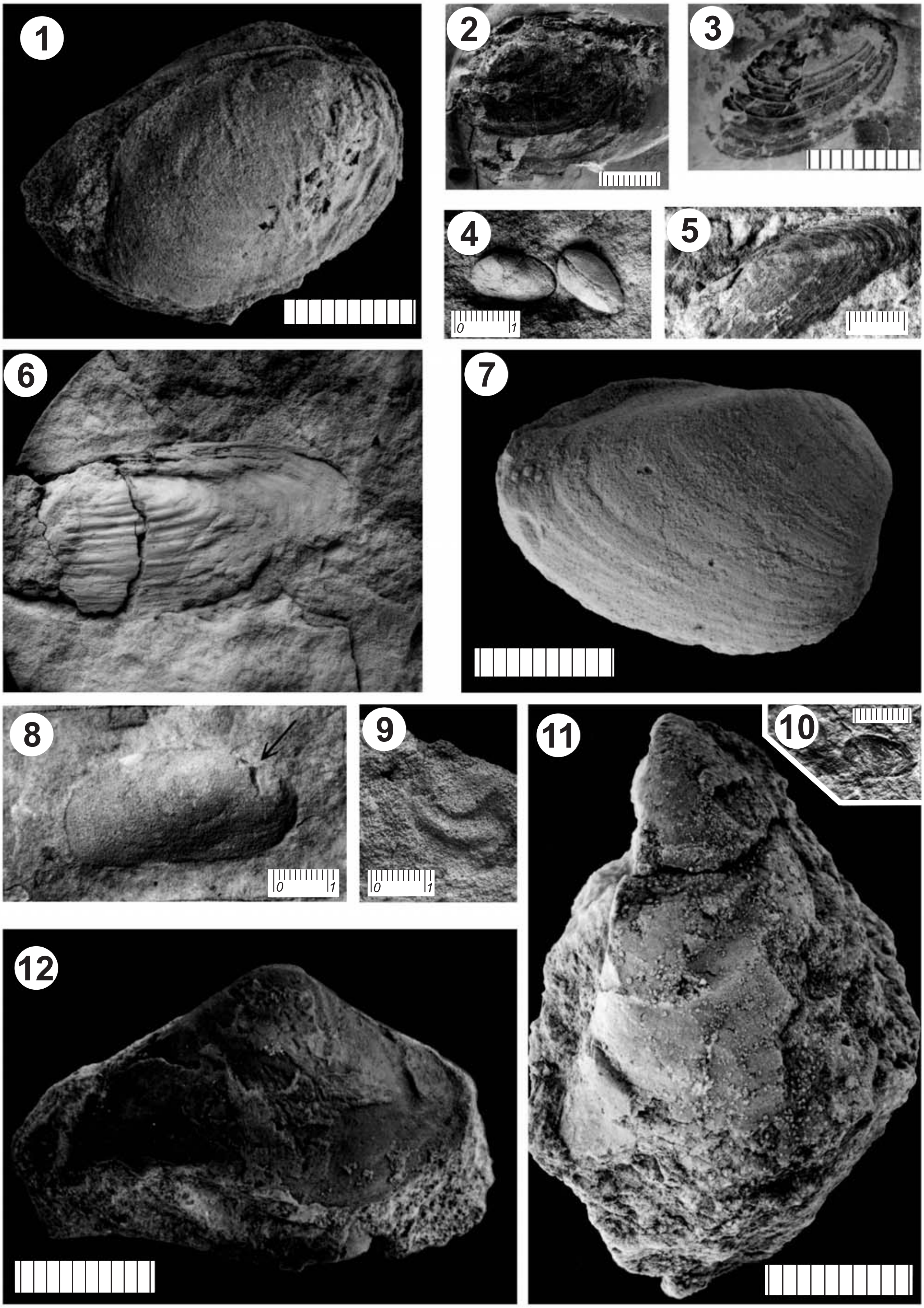

1
2
3
4
5
6
7
8
9
10
11
12

PLATE II

Plant roots and other plant remains

Phot. 1. Coalified, well preserved plant root. Mudstone/claystone, delta plain/interdistributary/lagoon-marsh depositional subsystem, waterlogged type of palaeosol, probably Gleysol. MUZ PIG 80.VI.108; Gorzów Wielkopolski IG 1 borehole, depth 1102.5 m; Middle Hettangian, depositional sequence Id; Skłoby Fm. *Photo. M. Krzyżanowski*.

Phot. 2. Sediment-filled plant root with coaly lining. Mudstone, barrier-lagoon/marsh depositional system. MUZ PIG 80.VI.72, Kamień Pomorski IG 1 borehole, depth 638.9 m; Lower/Middle Hettangian, depositional sequence Id; Skłoby Fm. *Photo. M. Krzyżanowski*.

Phot. 3. Sediment-filled plant roots with coaly linings. Sandstone, delta depositional system (delta plain-distributary channel subsystem), probably Podzol type of palaeosol. MUZ PIG 80.VI.80, Kamień Pomorski IG 1 borehole, depth 479.1 m; uppermost Hettangian/lowermost Sinemurian, depositional sequence IIa; Ostrowiec Fm. *Photo. M. Krzyżanowski*.

Phot. 4. Coalified plant roots in sideritic mudstone (pedogenic concretion). Lagoon depositional system. Association of siderite and plant roots suggests a coastal swamp palaeosol — Histosol. MUZ PIG 80.VI.41; Gliniany Las exposure; Late Hettangian, depositional sequence Ij; Przysucha Ore-bearing Fm. *Photo. M. Krzyżanowski*.

Phot. 5. *Equisetum* (horsetail) rhisome in life position, MUZ PIG 80.VI.79; Kamień Pomorski IG 1 borehole, depth 488.4 m. Sandstone, delta depositional system (delta plain/distributary channel subsystem) — Podzol; Upper Hettangian, depositional sequence Ik; Ostrowiec Fm. *Photo. M. Krzyżanowski*.

Phot. 6. A plant burried in whole in an eolian dune, Sandstone, barrier-lagoon depositional system (backshore/backbarrier depositional subsystem). MUZ PIG 76.III.1, Śmiłów exposure; Lower Pliensbachian, depositional sequence VI; Drzewica Fm. (see Pl. XIII, Phots. 3, 4, 6, 7). Diameter of the objective cover = 5 cm. *Photo. G. Pieńkowski*.

Phot. 7. Long, sand-filled plant roots with coaly coatings. Sandstone, alluvial plain — meandering river depositional system (alluvial channel subsystem). The length of plant roots in this section is up to 40 cm, which indicates well-drained and well-oxygenated sediments associated with lowered water-table level. Podzol type of palaeosol (field photo). Pilichowice P-1 borehole, depth 50.8–51.0 m; Lower Hettangian, depositional sequence Ib; Skłoby Fm. *Photo. G. Pieńkowski*.

Phot. 8. Coalified plant roots in sandstone. Barrier depositional system (top of barrier), Podzol type of palaeosol. MUZ PIG 80.VI.107, Gorzów Wielkopolski IG 1 borehole, depth 1105.4 m; Lower Hettangian, depositional sequence Ic. *Photo. M. Krzyżanowski.*

Phots. 9a, b. Two sides of the same sample showing coalified, pyritized plant root (9a, deeper level) and sand-filled plant root (9b, shallower level). Different state of preservation indicates a rapid change of the redox condition at a shallow depth in sediment. Sulphate ions were introduced by marine water during regional transgression associated with the parasequence boundary; barrier-lagoon/marsh depositional system, just beneath the flooding surface (compare with Pl. IV, Phot. 3). MUZ PIG 80.VI.72, Kamień Pomorski IG 1 borehole, depth 638.9 m; Middle Hettangian, depositional sequence Id; Skłoby Fm. *Photo. M. Krzyżanowski*.

Phot. 10. Rounded cross-section of a sand-filled plant root. Mudstone, delta depositional system. MUZ PIG 80.VI.69, Kamień Pomorski IG 1 borehole, depth 640.78 m; Middle Hettangian, depositional sequence Ic; Skłoby Fm. *Photo. M. Krzyżanowski*.

Phot. 11. Totally decayed plant roots ("root ghosts"), subsequently substituted by ferruginuous mudstone. Greenish lagoonal mudstone. MUZ PIG 80.VI.115, Gorzów Wielkopolski IG 1 borehole, depth 782.6 m; Middle Toarcian, depositional sequence VIIIc; Ciechocinek Fm. *Photo. M. Krzyżanowski.*

Phots. 1, 4, 10, 11 — scale = 1 cm, Phots. 2, 3, 5, 7, 8, 9a, b — scale = 2 cm.

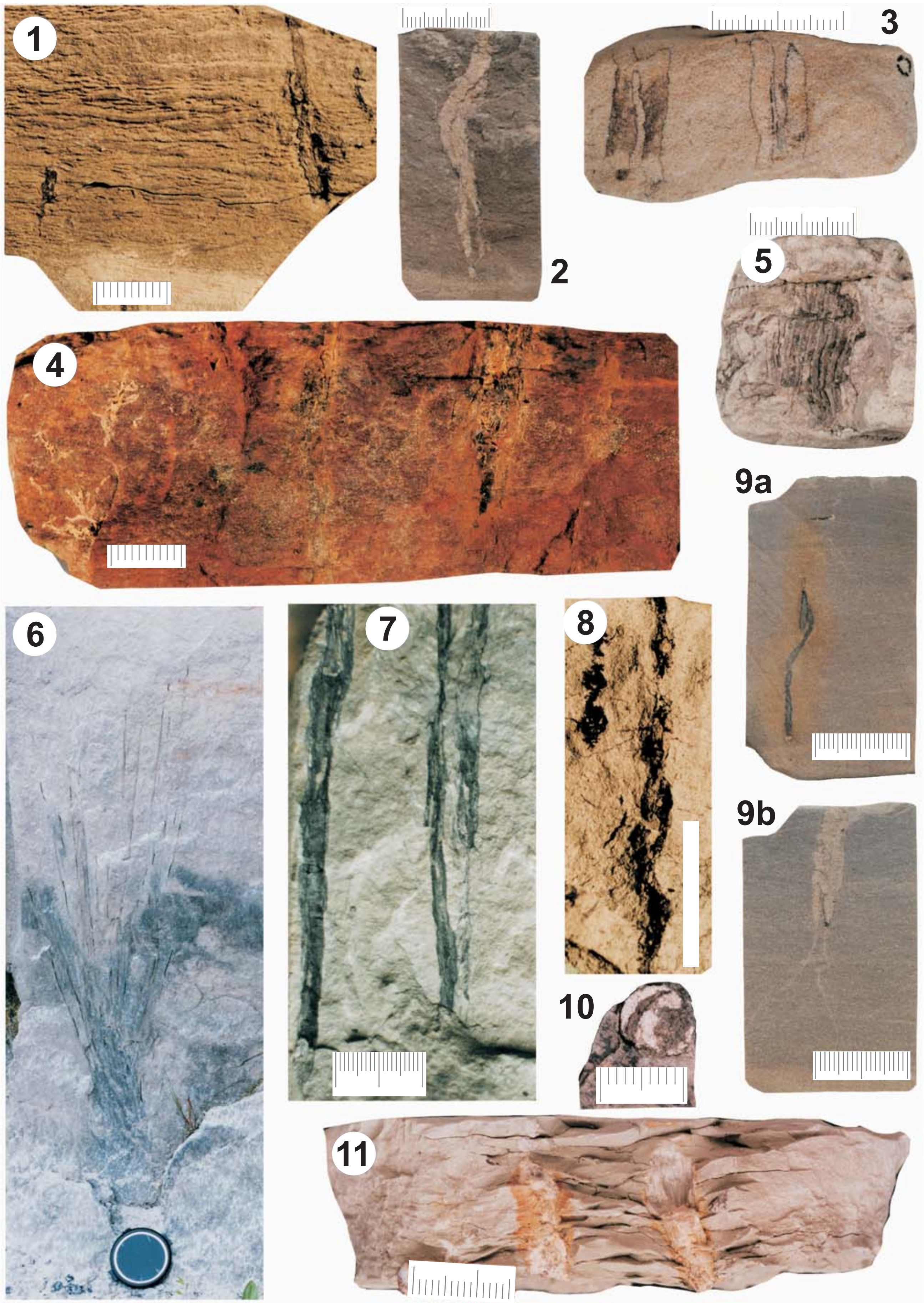

1
2
3
4
5
9a
6
7
8
9b
10
11

PLATE III

Sedimentary structures in mudstones and heteroliths

Phot. 1. Laminated, varve-like mudstone with light-grey laminae (sample "a") and dark-grey laminae (sample "b"). Light-grey laminae contains less translucent phytoclasts and more black, opaque phytoclasts than the dark-grey laminae. The light-grey laminae is characterised by the bisaccate pollens/other miospores ratio 10/90% and dark-grey laminae shows 23/77% bisaccate pollens/other miospores ratio. Sparse dinoflagellatae cysts found in both samples point to a connection with marine basin. The mudstone represents deposits of lagoonal/interdistributary bay — lower delta plain depositional system (lagoon-marsh subsystem). Varve-like lamination reflects probably seasonal changes — light lamina contain abundant oxidized organic matter, scarce translucent plant detritus and more silt, which indicates oxidizing conditions and a better drainage in nearby delta plain/swamp. The dark lamina with abundant translucent plant tissue likely correspond to a wet season with poor drainage and reducing conditions. This example shows a "micro-scale" fluctuations in palynofacies determined by seasonal changes, although a general palynofacies characteristics are similar in both samples. MUZ PIG 80.VI.67, Kamień Pomorski IG 1 borehole, depth 637.6 m; Lower Hettangian, depositional sequence Ic; Skłoby Fm. *Photo. M. Krzyżanowski*.

Phot. 2. Lenticular lamination, each sandstone laminae is normally graded and represents a micro-turbidite. Both mudstone lamina and sandstone lamina are rich in plant detritus. Delta depositional system, delta-front sub-system. Gródek OP-2 borehole, depth 95.65 m; Upper Sinemurian, depositional sequence IIIb; Ostrowiec Fm. *Photo. G. Pieńkowski*.

Phot. 3. Lenticular lamination with a single ripple forming incipient lenticular bedding. Embayment–offshore depositional system. Wręczyca 3/81 borehole, depth 103.6 m; Lower Toarcian, depositional sequence VIIIc; Ciechocinek Fm. *Photo. G. Pieńkowski*.

Phot. 4. Wavy bedding with micro-hummocky cross lamination (note visible anti-forms). Note opposing foresets, draping lamina and cross-strata offshots indicative of wave action. Nearshore depositional system (shoreface–offshore transition subsystem). Gaj-Modrzew borehole, depth 17.5 m (Holy Cross Mts region); Upper Sinemurian, depositional sequence IIIc; Ostrowiec Fm. *Photo. S. Kolanowski.*

Phot. 5. Lenticular bedding, nearshore depositional system (offshore subsystem). Gaj-Modrzew borehole, depth 20.15 m (Holy Cross Mts region); Upper Sinemurian, depositional sequence IIIc; Ostrowiec Fm. *Photo. S. Kolanowski*.

Phot. 6. Flaser bedding, nearshore depositional system (shoreface subsystem). Note opposing foresets, draping lamina and cross-strata offshots indicative of wave action. MUZ PIG 80.VI.65; Kamień Pomorski IG 1 borehole, depth 651.8 m; Middle Hettangian, depositional sequence Ic. Skłoby Fm. *Photo. M. Krzyżanowski*.

Phot. 7. Trough cross bedding with flaser bedding, nearshore depositional system (shoreface subsystem). Gaj-Modrzew borehole, depth 16.9 m (Holy Cross Mts region); Upper Sinemurian, depositional sequence IIIc. Ostrowiec Fm. *Photo. S. Kolanowski*.

Scale: Phots. 2, 3 — × 0,7; Phots. 5, 7 — × 0,5; Phot. 4 — natural size. Phots. 2–5, 7 — lost specimen

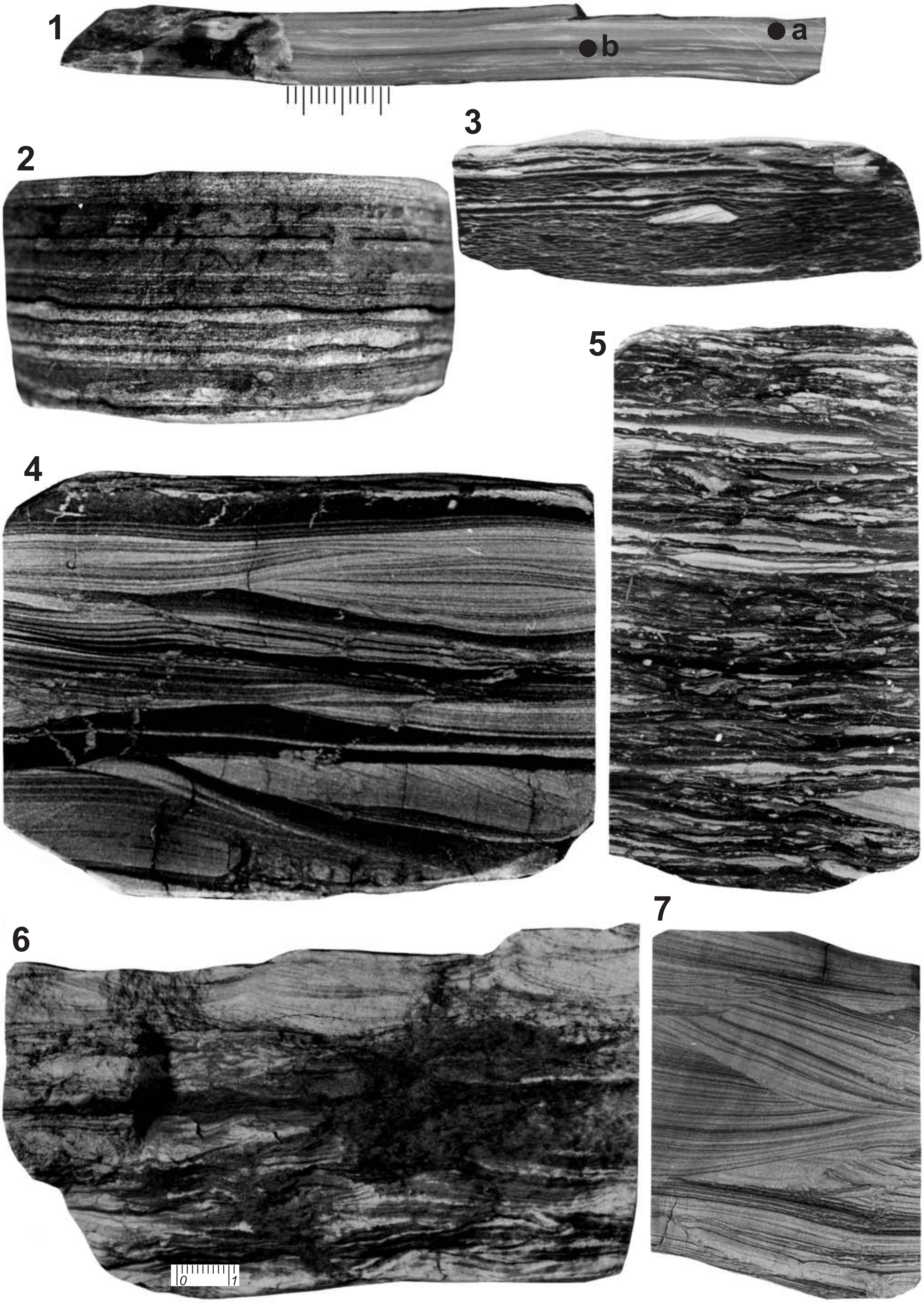

1
a
b
3
2
5
4
6
0
1
7

PLATE IV

Sedimentary structures in heteroliths

Phot. 1. Lenticular bedding disturbed by bioturbations (fodinichnia), MUZ PIG 1692.II.13; Ruszkowice borehole, depth 27.5 m (Holy Cross Mts region); Middle Hettangian,depositional sequence Ie; Skłoby Fm. Scale = 2 cm.

Phot. 2. Lenticular lamination and lenticular bedding (lower part) passing into wavy bedding, which reflects gradual shallowing of the sedimentary environment. Note “diffused” character of the heteroliths, rich floral detritus (black lamina) and fodinichnia burrows. Delta depositional system (delta front–delta plain depositional subsystem). MUZ PIG 80.VI.74, Kamień Pomorski IG 1 borehole, depth 604.4 m; Middle Hettangian, depositional sequence Ie; Skłoby Fm. Scale = 2 cm.

Phot. 3. Boundary between parasequences Ic and Id. Note grey-reddish lacustrine/delta plain ferrugineous mudstone with plant roots (the lower plant root is pyritized, while the upper one is filled with sand). The lacustrine mudstone is overlain by grey heterolith with lenticular bedding. Pyritization of the lower plant root incicates to the sulphate reduction at the shallow depth in the sediment. Sulphate ions were introduced by marine water during a regional transgression and resulting flooding surface at the parasequence boundary (compare with Pl. II, Phots. 9a, b). The contact between the mudstone with plant roots and the heterolith corresponds to the flooding surface and parasequence boundary. MUZ PGI 80.VI.70, Kamień Pomorski IG 1 borehole, depth 639.8 m; Lower/Middle Hettangian, depositional sequence I; Skłoby Fm. Scale = 2 cm.

Phot. 4. Greenish-grey bioturbated heterolith with lenticular bedding — lithofacies typical for the Ciechocinek Fm; MUZ PIG 1692.II.9, Piła IG 1 borehole, depth 374.0 m (Pomerania region); Lower Toarcian, depositional sequence VIII; Ciechocinek Fm. Scale = 2 cm.

Phot. 5. Micro-hummocky cross stratification (lamination). Note slightly undulated lamina and flat antiforms. Intermediate-distal storm deposits. MUZ PIG 80.VI.73; Kamień Pomorski IG 1 borehole, depth 637.9 m; Lower Hettangian, depositional sequence Ic; Skłoby Fm. Scale = 2 cm.

Phot. 6. Spill-over wave ripples formed during a waning storm. Note decoupling sides of the ripples over the underlying mud lamina (compare with the text Fig. 7). MUZ PIG 80.VI.61; Bartoszyce IG 1 borehole, depth 721.4 m; Lower Toarcian, depositional sequence VIII; Ciechocinek Fm. Scale = 2 cm.

Phot. 7. Graded bedding in very fine-grained sandstone and siltstone passing upward into mudstone. Note a gradualy upward-growing density of bioturbation (*Planolites* sp., fodinichnia). The bed is interpreted as a distal microturbidite formed during a storm event, followed by colonisation of burrowing organisms (compare with the text Fig. 7). MUZ PIG 80.VI.102, Kamień Pomorski IG 1 borehole, depth 236.2 m; Lower Pliensbachian, depositional sequence IV (upper part); Łobez Fm. Scale = 1 cm.

Photo. 1 — G. Pieńkowski; Photos. 2–7 — M. Krzyżanowski.

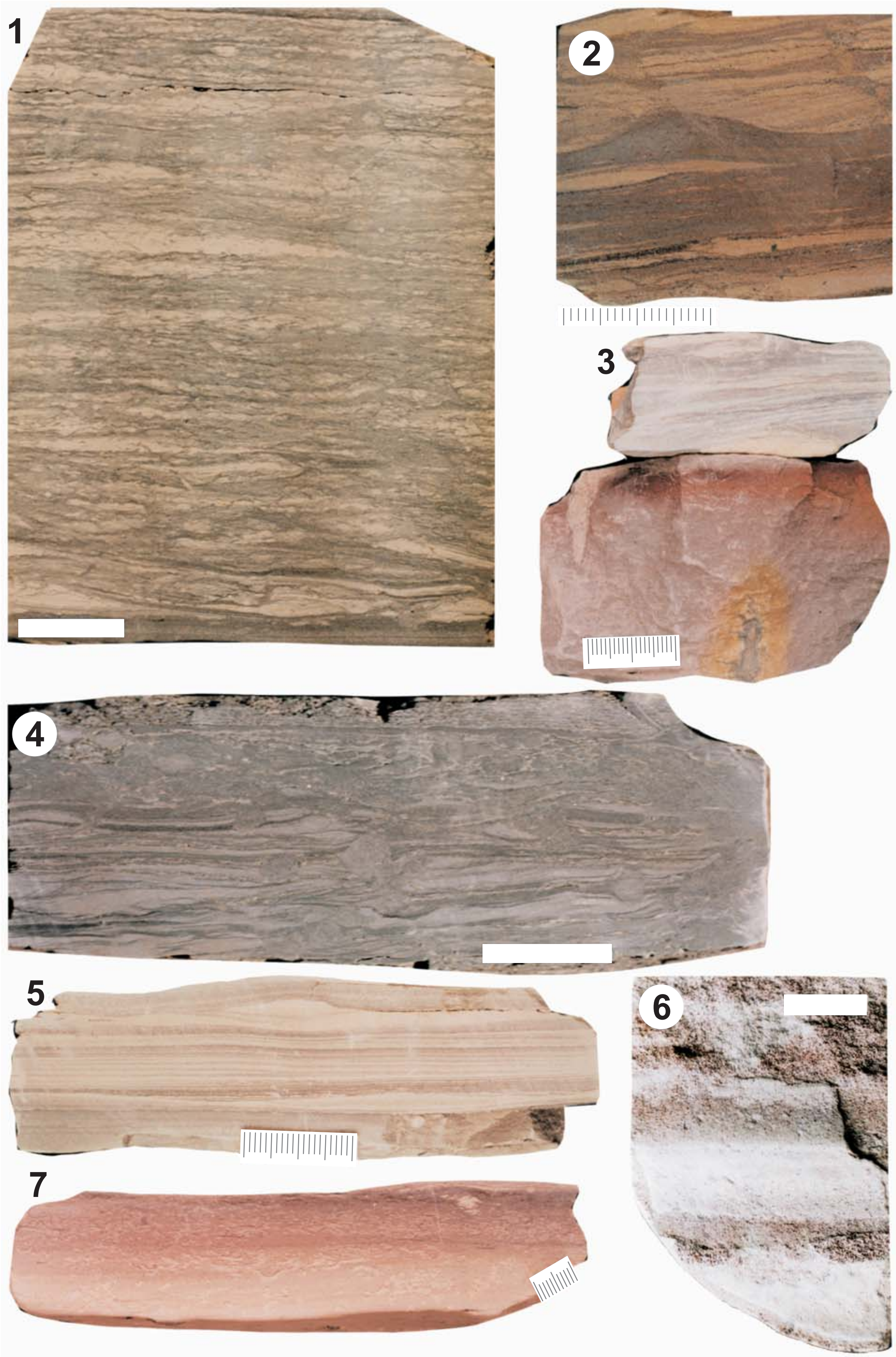

1
2
3
4
5
6
7

PLATE V

Sedimentary structures — heteroliths and sandstones

Phot. 1. Hummocky cross stratification with a well-visible antiform. MUZ PIG 80.VI.55, Szydłowiec N-1 borehole, depth 23.1 m; Lower Pliensbachian, depositional sequence Vb; Gielniów Fm. Scale = 2 cm.

Phot. 2. Micro-hummocky cross stratification. MUZ PIG 80.VI.114, Gorzów Wielkopolski IG 1 borehole, depth 795.8 m; Lower/Middle Toarcian, depositional sequence VIIIc; Ciechocinek Fm. Scale = 1.5 cm.

Phot. 3. Heterolith with lenticular lamination and lenticular bedding with two superimposed scour-and-fill structures produced by currents associated probably with storm events (distal tempestite). MUZ PIG 80.VI.54, Szydłowiec N-1 borehole, depth 29.3 m; Lower Pliensbachian, depositional sequence Vb (near the maximum flooding surface); Gielniów Fm. Scale = 2 cm.

Phot. 4. Heterolith with wavy- and lenticular bedding. Note the sandstone bed (in the uppermost part) with erosional sole and hummocky cross stratification. Opposing foresets, draping lamina and cross-strata offshots are indicative of wave action. The sandstone bed was deposited by a storm event. MUZ PIG 80.VI.84, Kamień Pomorski IG 1 borehole, depth 461.4 m; Lower Sinemurian, depositional sequence IIc (close to the m.f.s.); Ostrowiec Fm. Scale = 2 cm.

Phot. 5. Bioturbation obliterating primary sedimentary structures (horizontal bedding and cross bedding) in sandstone. Nearshore depositional system, shoreface subsystem, amalgamated storm deposits. MUZ PIG 1692.II.12, Ruszkowice borehole, depth 31.9 m (Holy Cross Mts region); Lower/Middle Hettangian, depositional sequence Id; Skłoby Fm. Scale = 2 cm.

Phot. 6. Siderite concretions in mudstone. Lagoon-embayment depositional system. MUZ PIG 80.VI.93, Kamień Pomorski IG 1 borehole, depth 350.8 m; Upper Sinemurian, depositional sequence IIIe; Ostrowiec Fm. Scale = 2 cm.

Phot. 7. Symmetrical wave ripples in cross section. Note chevron-like lamina in the upper part. Opposing foresets, draping lamina and cross-strata offshots are indicative of wave action. Shoreface depositional subsystem. MUZ PIG 80.VI.62, Bartoszyce IG 1 borehole, depth 721.4 m; Lower/Middle Toarcian, depositional sequence VIIIc. Ciechocinek Fm. Scale = 2 cm.

Phot. 8. Heterolith with wavy bedding. Offshore–shoreface depositional subsystem. MUZ PIG 79.VI.8, Zawada PA-3 borehole, depth 24.0 m; Middle Hettangian, depositional sequence If; Skłoby Fm. Scale = 2 cm.

Photos. 1–7 — M. Krzyżanowski, Phot. 8 — G. Pieńkowski.

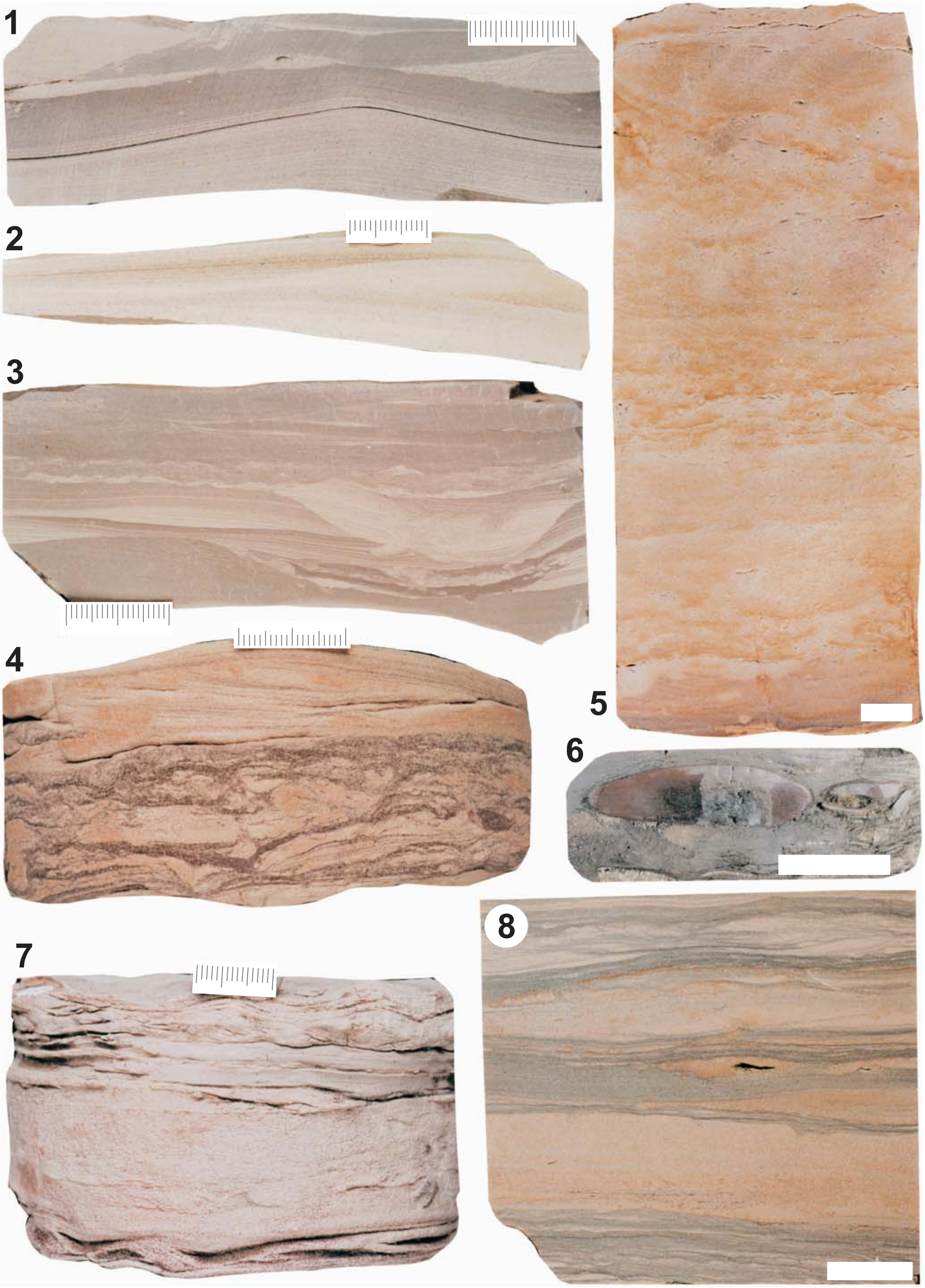

1
2
3
4
5
6
7
8

PLATE VI

Palynofacies — all examples from the Gliniany Las I borehole
(depositional sequence I, Skłoby Fm., see Fig. 5 CD)

Phot. 1. Very rich palynomacerals: large fragments of dark-brown to black, opaque phytoclasts (oxidized structured organic matter of terrestrial origin — „black wood") and translucent phytoclasts, relatively less numerous miospores. Palynofacies **1**, alluvial (alluvial plain) depositional system. Depth 33.1 m.

Phot. 2. Numerous palynomorphs, relatively less numerous other palynomacerals — small fragments of black, opaque phytoclasts or AOMT (amorphous organic matter of terrestrial origin) and large, translucent structured phytoclasts (cuticle). Only sporadically STOM fragments are large (as one of the fragments of cuticle presented on the photograph). Palynofacies 3, lagoonal depositional system. Depth 55.2 m.

Phot. 3. Dispersed, rounded and oxidised fragments of opaque phytoclasts or AOMT (amorphous organic matter of terrestrial origin), mechanically destroyed palynomorphs, rare dinoflagellates. Palynofacies 4, shallow nearshore (shoreface) depositional system. Depth 64.4 m.

Phot. 4. Translucent, white AOMA (amorphous organic matter of aquatic origin - arowed), very few small fragments of opaque phytoclasts or AOMT (amorphous organic matter of terrestrial origin), few corroded palynomorphs, presence of dinoflagellates. Palynofacies 5, open brackish-marine (offshore) depositional system. Depth 77.4 m.

Scale = 1:100 . *Photo. M. Waksmundzka.* For palynofacies number see text Fig. 9.

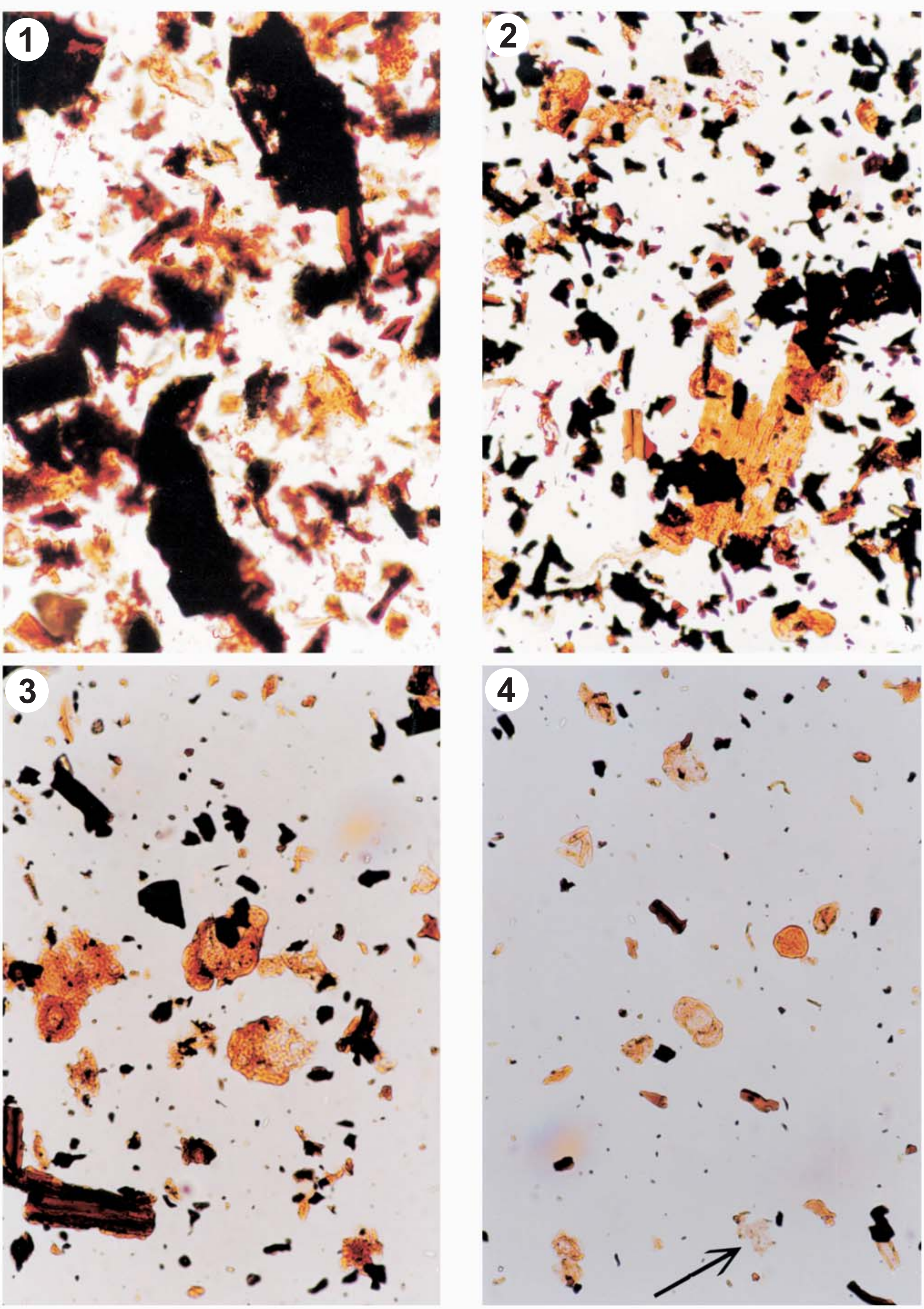

1
2
3
4

PLATE VII

Continental trace fossil assemblage

Phot. 1. cf. *Megalosauripus* sp. Lessertisseur, *sensu* Lockley *et al*. (1996), gigantic (total length = 65 cm) footprint of an allosauroid or ceratozauroid theropod. Alluvial (meandering river) depositional system, crevasse splay subsystem. Ichnofacies — facies-specific form, typical of alluvial plain deposits. MUZ PIG 1661.II.1, Sołtyków exposure; lowermost Hettangian, lowermost part of the depositional sequence Ia; Zagaje Fm. *Photo. G. Gierliński.*

Phot. 2. cf. *Megalosauripus* sp. Lessertisseur, *sensu* Lockley *et al*., 1996). Slightly smaller form left by an allosauroid theropod; alluvial (meandering river) depositional system. Ichnofacies — facies-specific form, typical of alluvial plain deposits. MUZ PIG 1560.II.37, Idzikowice exposure (Holy Cross Mts region); Upper Toarcian, depositional sequence IX or X. *Photo. G. Gierliński.*

Phot. 3. *Scoyenia* sp. (insect-made, probably beetle burrows), one of characteristic forms of the continental ichnofacies. Note unbranching pattern, horizontal, oblique or vertical directions and ropey outer texture of the burows; alluvial depositional system (meandering river), crevasse splay subsystem. MUZ PIG 80.VI.34, Sołtyków exposure; Lower Hettangian, lowermost part of the depositional sequence I (“a” parasequence); Zagaje Fm. *Photo. G. Pieńkowski*.

Phot. 4. a — bivalve dwelling-escape burrows in alluvial plain deposits representing a variety of ichnoforms: *Lockeia czarnockii* (Karaszewski), *Conichnus* sp. *Conostichus* sp. and other forms; alluvial depositional system (meandering river), crevasse splay subsystem. b — the same specimen, lateral view showing depth of the bivalve dwelling-escape burrows. MUZ PIG 80.VI.35, Sołtyków exposure; lowermost Hettangian, lowermost part of the depositional sequence Ia; Zagaje Fm. *Photos. G. Pieńkowski*.

Phot. 5. *Parabrontopodus* sp., var. *minor*; P — pes, M — manus set, left by a juvenile sauropod. Alluvial depositional system (meandering river), crevasse splay subsystem — facies-independent. MUZ PIG 1560.II.67, Sołtyków exposure; lowermost Hettangian, lowermost part of the depositional sequence Ia; Zagaje Fm. Scale bar = 0.5 m. *Photo. G. Gierliński*.

Phot. 6. *Parabrontopodus* sp., P — pes, M — manus set, left by an adult sauropod. Alluvial depositional system (meandering river), crevasse splay subsystem. Ichnofacies — facies-specific form, typical of alluvial plain deposits (after G. Gierliński & G. Pieńkowski, 1999). Sołtyków exposure; lowermost Hettangian, lowermost part of the depositional sequence Ia; Zagaje Fm. Field photo. Scale bar = 0.5 m. *Photo. G. Gierliński.*

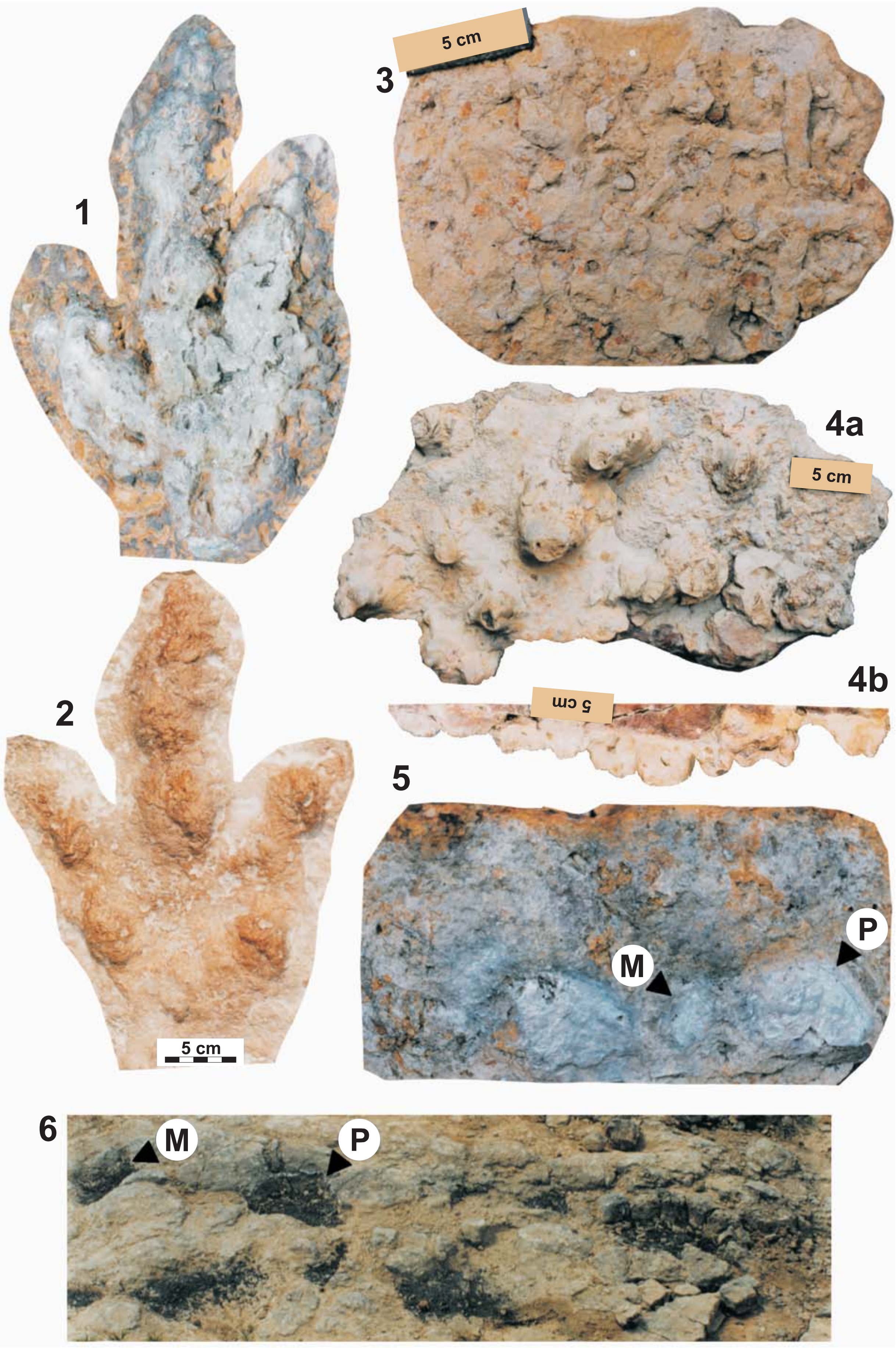

1
2
5 cm
3
5 cm
4a
5 cm
4b
5 cm
5
M
P
6
M
P

PLATE VIII

Deltaic, barrier-lagoon and shallow nearshore (foreshore) trace fossil assemblage

Phot. 1. *Anomoepus pienkovskii* Gierliński — natural cast of pes (down, with metatarsal impression) and manus (above). The tracks were left by a thyreoforan (ornitishian) dinosaur. The track was left on top of a delta-fringing barrier transformed by wave processes. Barrier-lagoon (part of a deltaic depositional system). Coll. G. Pieńkowski (private collection) Gliniany Las exposure; uppermost Hettangian, depositional sequence I (uppermost part); Przysucha Ore-bearing Fm. *Photo. G. Gierliński*.

Phot. 2. *Moyenisauropus natator* Ellenberger — pes (down) and manus (above) left by an ornitishian dinosaur (it fits closely the foot of *Scelidosaurus harrisonii* Owen). This form is more robust than the *Anomoepus pienkovskii* Gierliński. Deltaic depositional system, delta plain-crevasse subsystem (compare with the text Fig. 11). MUZ PIG 1651.II.4, lower Gromadzice exposure; Lower Hettangian, depositional sequence Ib; uppermost part of the Zagaje Fm. *Photo. G. Gierliński*.

Phot. 3. *Anomoepus curvatus* Hitchcock, left by an ornitishian dinosaur; coll. G. Gierliński, Gliniany Las exposure, uppermost Hettangian, depositional sequence I (uppermost part); Przysucha Ore-bearing Fm. *Photo. G. Gierliński*.

Phot. 4. *Carmelopodus* sp., a track of a small theropod dinosaur; MUZ PIG 1560.II.9A, coll. G. Gierliński, Gliniany Las exposure, lowermost Hettangian, lowermost part of the depositional sequence Ia; Zagaje Fm. *Photo. G. Gierliński.*

Phot. 5. *Anchizauripus* sp., left by a medium-sized theropod; barrier-lagoon–nearshore (foreshore) depositional system. MUZ PIG 1560.II.36, Jakubów exposure near Przysucha; Upper Hettangian, depositional sequence I (upper part); Przysucha Ore-bearing Fm. *Photo. G. Gierliński.*

Phot. 6. *Monocraterion* Torell, note conical shape of dwelling burrows; nearshore (foreshore-shoreface) depositional system. Bielowice exposure; Lower Plensbachian, depositional sequence V, Gielniów Fm. Field photo. Scale bar = 5 cm. *Photo. G. Pieńkowski*.

Phot. 7. *Calycraterion* Karaszewski, calyx-shaped dwelling burrows. Barrier-lagoon–deltaic depositional system. This burrow is associated with dinosaur footprints, which proves that it was left in a very shallow water (foreshore depositional system). MUZ PIG 80.VI.42, Gliniany Las exposure; Upper Hettangian, depositional sequence I (uppermost part); Przysucha Ore-bearing Fm. Scale bar = 2 cm. *Photo. M. Krzyżanowski*.

Phot. 8. *Skolithos* Haldeman. Vertical, simple tube with constant diameter. Most common dwelling structure (domichnia) in the Lower Jurassic of Poland, diagnostic of a high-energy environment (associated with a very shallow water or periodic high-energy events, for example storms). Note ferruginous (primary sideritic) "hallo" around the burrow, which may indicate reducing conditions possibly caused by *post-mortem* decay processes following the death of a trace maker. MUZ PIG 80.VI.112, Gorzów Wielkopolski IG 1 borehole, depth 969.5–969.8 m; Lower Pliensbachian, depositional sequence IVb; Gielniów Fm. *Photo. M. Krzyżanowski.*

Phot. 9. *Arenicolites* Salter. Vertically oriented, U- or J-shaped dwelling burrows (domichnia) preserved in four superimposed levels or recurring deposition in a periodically high-energy, nearshore (shoreface) environment. MUZ PIG 1692.II.7, Wolica exposure (Holy Cross Mts region); Middle Hettangian, depositional sequence I; Skłoby Fm. Scale bar = 5 cm. *Photo. G. Pieńkowski*.

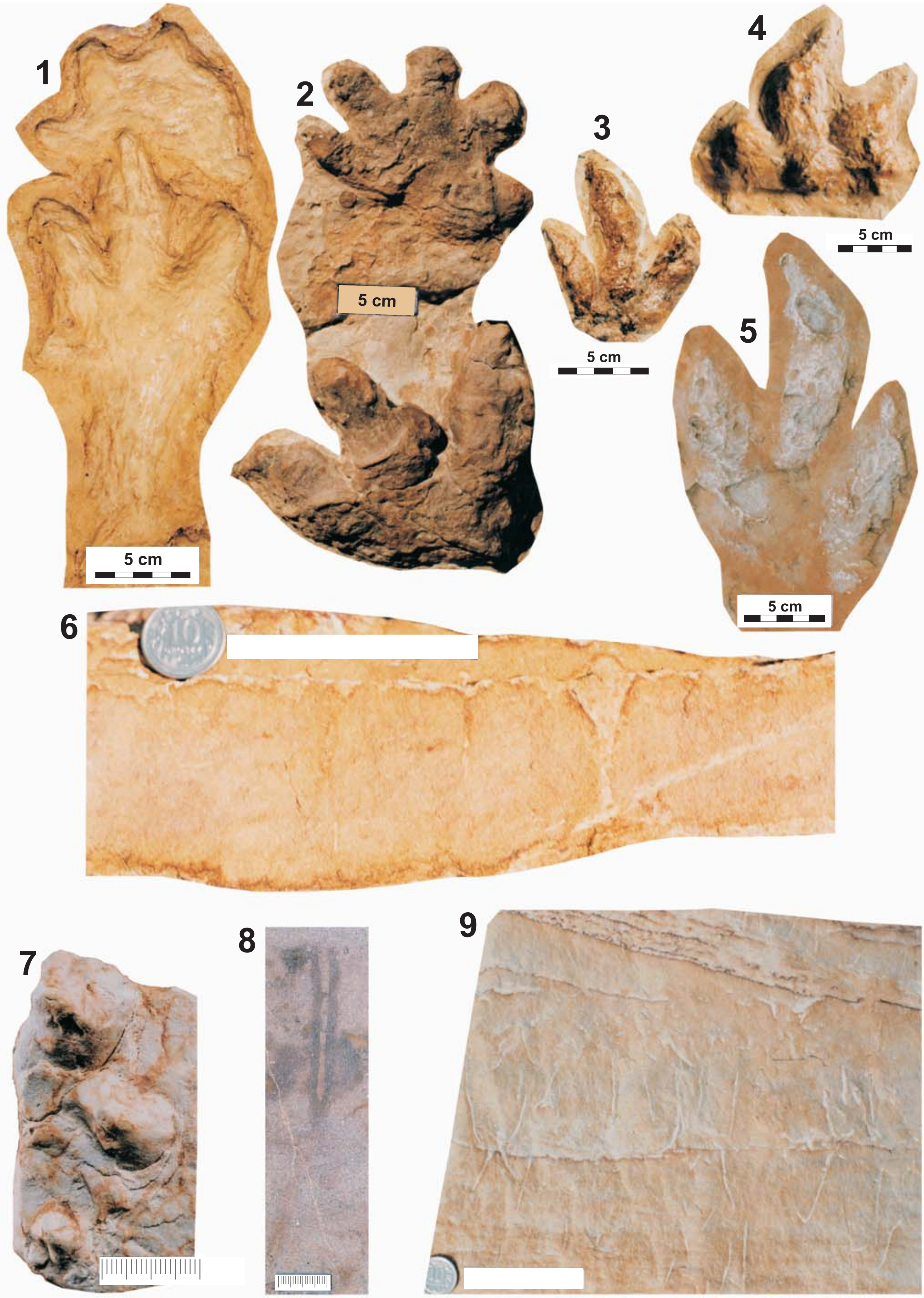

1
2
3
4
5
6
7
8
9
5 cm
5 cm
5 cm
5 cm
5 cm

PLATE IX

Deeper shoreface–shoreface/offshore transition assemblage

Phot. 1. *Diplocraterion paralellum* Torell, large form. Note a bisquite-shaped horizontal cross-section of the dwelling burrow. MUZ PIG 80.VI.88, Kamień Pomorski IG 1 borehole, depth 428.2 m; Upper Sinemurian, depositional sequence IIIb; Ostrowiec Fm. Scale bar = 2 cm. *Photo. G. Pieńkowski*.

Phot. 2, 3. *Diplocraterion paralellum* Torell, 2 — small form. Note a dumb-bell shaped horizontal cross-section of the dwelling burrow; scale bar = 1 cm, 3 — vertical cross-section showing the parallel arms and U-shaped spreite of the retrusive dwelling burrow, the trace maker moved up matching the rate of sedimentation; scale bar = 2 cm. MUZ PIG 80.VI.103, Kamień Pomorski IG 1 borehole, depth 233.0 m; Lower Pliensbachian, depositional sequence IV; Łobez Fm. *Photo. M. Krzyżanowski*.

Phot. 4. *Diplocraterion parallelum*Torell, median sections. Note two different types of *Diplocraterion* burrows in vertical section. On the left — the retrusive type of burrow (r), produced by an animal moving upwards in order to match the rate of sedimentation. On the right — the protrusive type of burrow (p), produced by an animal moving downwards in order to hide deeper against erosion. Joint occurrence of two types of burrows proves unstable sedimentary conditions, i.e. a rapid shift between erosion and sedimentation periods. The retrusive burrow "r" is earlier and corresponds with deposition, the protrusive burrow "p" is later and corresponds with erosion. Tide-influenced shore zone (tidal flat depositional system). MUZ PIG 80.VI.113, Gorzów Wielkopolski IG 1 borehole, depth 852.5 m; Upper Pliensbachian, depositional sequence VIId; Komorowo Fm. Scale bar = 2 cm. *Photo. G. Pieńkowski*.

Phot. 5. *Spongeliomorpha* sp. burrows in a sandstone with chamositic matrix. Intensively bioturbated part of the sediment with *Spongeliomorpha* represents a stable, moderate deposition. The overlying part (above the erosion surface marked with arrow) represents rapid deposition by storm event, terminated by recurrent colonisation by sand-dwelling animals, such as *Skolithos* (see Pl. VIII, 8). Tempestite layer of a proximal (shoreface)/transition zone (compare with the text Fig. 7). MUZ PIG 80.VI.112, Gorzów Wielkopolski IG 1 borehole, depth 969.5–969.8 m; Lower Pliensbachian, depositional sequence IVb. Scale = 2 cm. *Photo. G. Pieńkowski*.

Phot. 6. *Scolicia* sp., locomotion trail, probably left by a snail. Nearshore depositional system (foreshore). MUZ PIG 80.VI.44, Gliniany Las exposure; Upper Hettangian, depositional sequence I (uppermost part); Przysucha Ore-bearing Fm. *Photo. G. Pieńkowski*.

Phot. 7. *Lockeia amygdaloides* (Seilacher), resting tracks of bivalves. Nearshore depositional system. Bielowice exposure; Early Pliensbachian, depositional sequence V; Gielniów Fm. Field photo. Scale = 1 cm. *Photo. G. Pieńkowski*.

Phot. 8a, b *Rosselia* sp., a — conical dwelling burrow with concentric structure. Plain view, horizontal section. Nearshore depositional system (lower shoreface). *Photo. G. Pieńkowski*; b — vertical section. Note arrangement of the burrows in the uppermost part of a 3 cm thick layer with graded bedding. The layer was produced by storm and it represents a distal tempestite (see the text Fig. 7). Thus, the *Rosselia* burrows represent here a post-event ichnofacies. *Photo. M. Krzyżanowski*. MUZ PIG 80.VI.104, Kamień Pomorski IG 1 borehole, depth 155.0 m; Lower Pliensbachian, depositional sequence V; Łobez Fm. Scale = 2 cm.

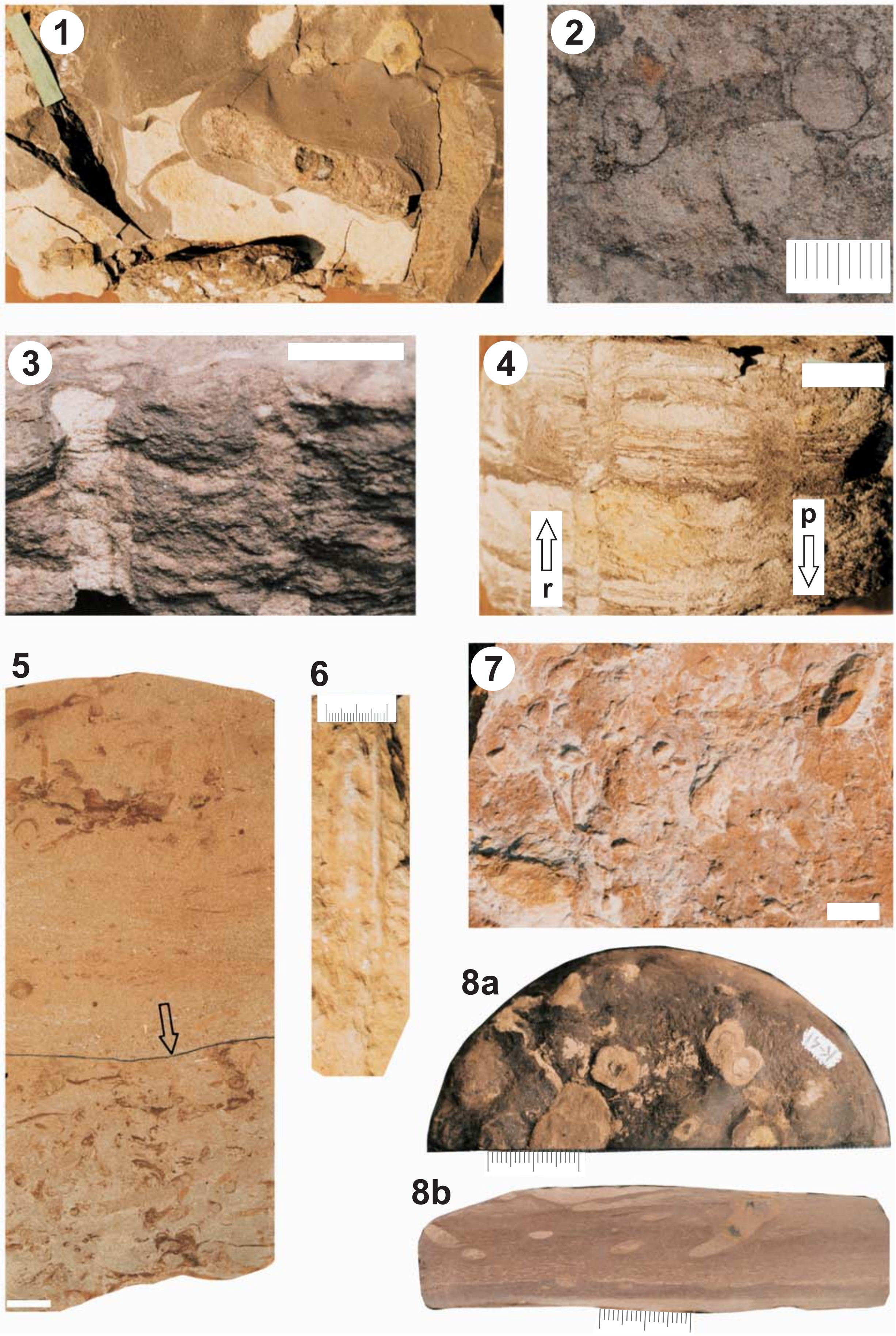

1
2
3
4
r
p
5
6
7
8a
8b

PLATE X

Shoreface and offshore burrows

Phot. 1. *Teichichnus* sp., a — horizontal cross section of the feeding burrow (arrowed), b — vertical section (arrowed), note retrusive character of the burrow; MUZ PIG 80.VI.86, Kamień Pomorski IG 1 borehole, depth 449.4 m; Lower Sinemurian, depositional sequence IIb; Ostrowiec Fm. *Photo. M. Krzyżanowski.*

Phot. 2. *Chondrites* sp., feeding burrow, vertical section, MUZ PIG 80.VI.49, Pilichowice P-1 borehole, depth 30.7 m; Middle Hettangian, depositional sequence If; Skłoby Fm. *Photo. M. Krzyżanowski.*

Phot. 3. *Chondrites* sp. (Ch) representing a deeper tier of burrows, superimposed on the *Palaeophycus tubularis* Hall, trail (P), representing a shallower tier; note the typical lining of *Palaeophycus* trail (arrowed); horizontal section. Open marine mudstones (offshore depositional system). MUZ PIG 1692.II.11, Mechowo IG 1 borehole, depth 654.0 m; Lower Pliensbachian, depositional sequence IV; Łobez Fm. Scale — coin diameter = 1.6 cm. *Photo. G. Pieńkowski.*

Phot. 4. *Tuberculichnus* sp., feeding burrow, positive hyporelief on a sole. Marine embayment depositional system. MUZ PIG 80.VI.93, Kamień Pomorski IG 1borehole, depth 350.8 m; Upper Sinemurian, depositional sequence III; Ostrowiec Fm. Scale = 2 cm. *Photo. M. Krzyżanowski.*

Phot. 5. *Chondrites* sp., marine embayment depositional system. MUZ PIG 80.VI.85, Kamień Pomorski IG 1 borehole, depth 449.8 m; Lower Sinemurian, depositional sequence IIc; Ostrowiec Fm. Scale = 2 cm. *Photo. M. Krzyżanowski.*

Phot. 6. *Palaeophycus* sp. The *Palaeophycus* trail represents a locomotion trail associated with predation (repichnia–praedichnia). The whole trail is filled with crushed fragments of small bivalve shells. It points that the trail was probably left by a predatory animal feeding on marine bentos. Offshore, open marine mudstones. MUZ PIG 80.VI.97, Kamień Pomorski IG 1borehole, depth 281.8 m; Lower Pliensbachian, depositional sequence IV; Łobez Fm. Scale = 2 cm. *Photo. M. Krzyżanowski.*

Phot. 7. *Palaeophycus tubularis* Hall, preserved as a “pyritized tube”. Note distinct lining of the burrow. Open marine mudstones (offshore depositional system). MUZ PIG 80.VI.96, Kamień Pomorski IG 1 borehole, depth 284.2 m; Lower Pliensbachian, depositional sequence IV; Łobez Fm. Scale = 2 cm. *Photo. M. Krzyżanowski.*

Phot. 8. *Planolites* sp. (Pl) and *Helminthopsis* sp. (H), both preserved as “pyritized tubes”. Shallow tier of burrowing systems. Open marine mudstones (offshore depositional system). MUZ PIG 80.VI.96, Kamień Pomorski IG 1 borehole, depth 284.2 m; Lower Pliensbachian, depositional sequence IV; Łobez Fm. Scale = 2 cm. *Photo. M. Krzyżanowski.*

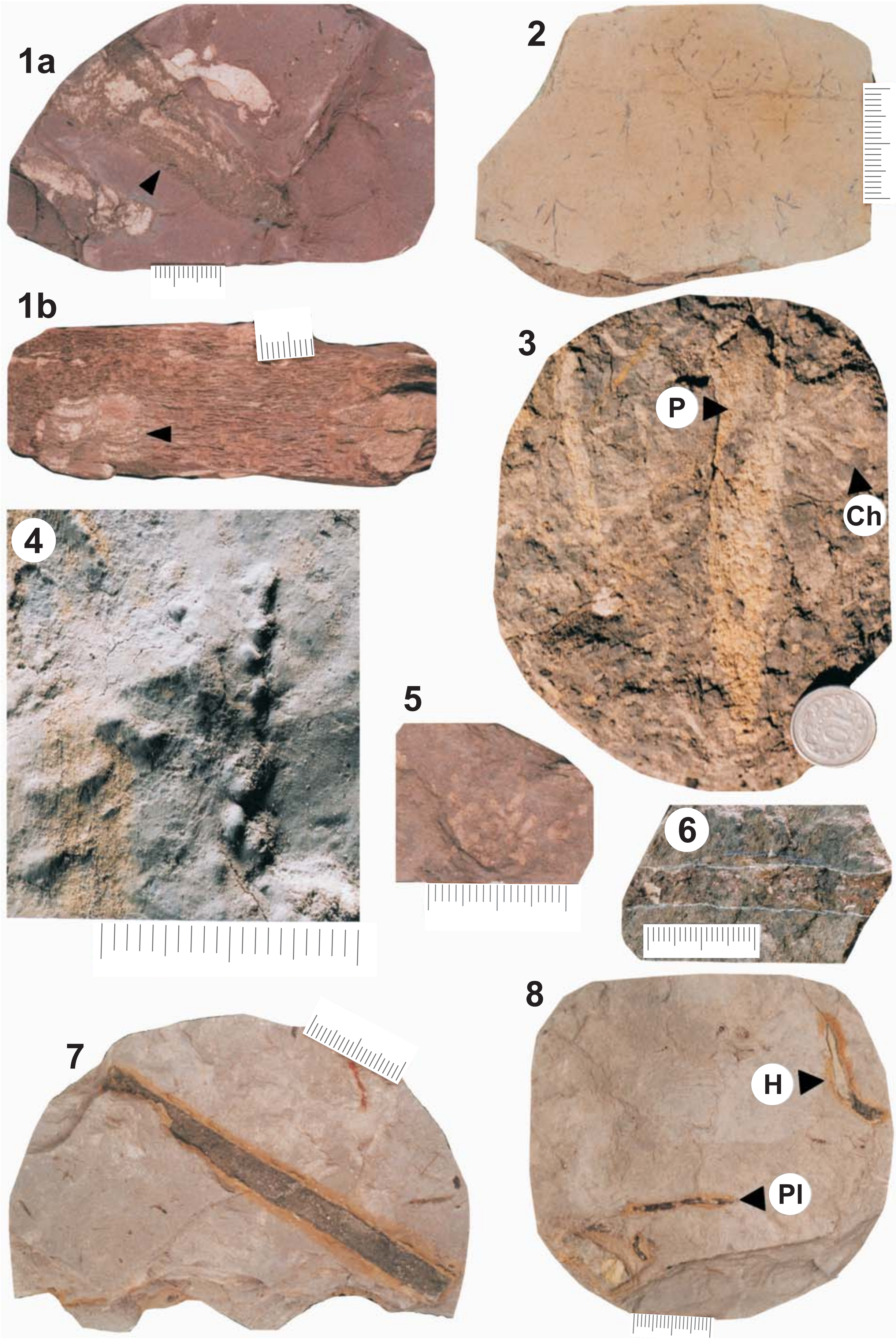

1a
1b
2
3
P
Ch
4
5
6
7
8
H
Pl

PLATE XI

Alluvial and deltaic depositional systems

Phot. 1. Alluvial (braided river) depositional system, channel subsytem. Note coarse grained lithofacies (conglomerates) and generally massive stratification. In places imbrication of pebbles, faint horizontal stratification and scour-and-fill structures occur. Lipa exposure near Przedbórz (Holy Cross Mts region); lowermost Hettangian, lowermost part of the depositional sequence Ia.

Phot. 2. Alluvial (braided river) depositional system, channel subsytem. Sandstone — conglomerate lithofacies with trough cross bedding sets. Direction of palaeocurrents marked with arrows. The sum of the vectors (heavy arrow) reflects the mean current direction and a local palaeoslope inclination to the north-east. Szkucin exposure near Przedbórz (Holy Cross Mts region); lowermost Hettangian, lowermost part of the depositional sequence Ia.

Phot. 3. Alluvial (braided river) depositional system, channel subsytem. Conglomerate — sandstone lithofacies with trough cross bedding sets. Direction of palaeocurrents marked with arrows. The sum of the vectors (heavy arrow) reflects the mean current direction and a local palaeoslope inclination to the north-east. Note the wedge-shaped sandstone lithosome in the middle part of the outcrop (transparent arrow), interpreted as the product of a side-chute bar migration on the flanks of a large longitudinal bar.during a low-discharge period. Note that the transport direction within this lithosome is approximately perpendicular to the mean transport direction in the river channels. Szkucin exposure near Przedbórz (Holy Cross Mts region); lowermost Hettangian, lowermost part of the depositional sequence Ia.

Phot. 4. Alluvial (meandering river) depositional system. Note general facies architecture typical for the crevassing/avulsion processes — well developed flood plain coaly mudstones (f.p.) and numerous encased lenticular sandstone lithosomes interpreted as crevasse splay deposits. Note dispersed directions of palaeocurrents, typical of a high sinuosity river. Sołtyków exposure; lowermost Hettangian, lowermost part of the depositional sequence Ia.

Phot. 5. Alluvial (meandering river) depositional system. Lenticular sandstone lithofacies representing meandering channel depositional subsystem, showing internal bounding surfaces (arrowed). These surfaces represent lateral accretion surfaces formed during lateral migration of the channel and point bars. Trough cross bedding measurements show that the transport was approximately from SSE to NNW (see diagram), i.e. it was perpendicular to the dips of the lateral accretion surfaces. Sołtyków exposure; Lower Hettangian, lowermost Zagaje Fm.

Phot. 6. Close-up view of the upper part of the Sołtyków outcrop showing floodplain depositional subsystems with crevasse splay facies; Lower hettangian, Zagaje Fm.

Phot. 7. Trough-cross bedding sets in the meandering river's channel depositional subsystem (point bar deposits). Fragment of the lenticular channelised lithosome presented in the text Fig. 11 — right frame. Gromadzice outcrop; Lower Hettangian.

Phot. 8. Delta plain depositional subsystem. The laterally-continuous layers represent crevasse splay deposits of a progradational, mini-delta type. The crevasse facies show coarsening-upward gradings and lack of prominent erosion at the bases of the crevasse layers. Lower arrow — setting of a mixed brackish/fresh-water (a „bay-line") bivalve assemblage. The assemblage contains *Modiolus hillanus* Sowerby (Pl. I, 5), *Cardinia follini* Lungren and *Unio* sp. Upper arrow — setting of the dinosaur footprints *Moyenisauropus natator* Ellenberger (Pl. VIII, 2). Joint occurrence of dinosaur footprints and brackish-marine bivalves points to a delta plain environment; Lower Hettangian, uppermost Zagaje Fm.

Photos. G. Pieńkowski.

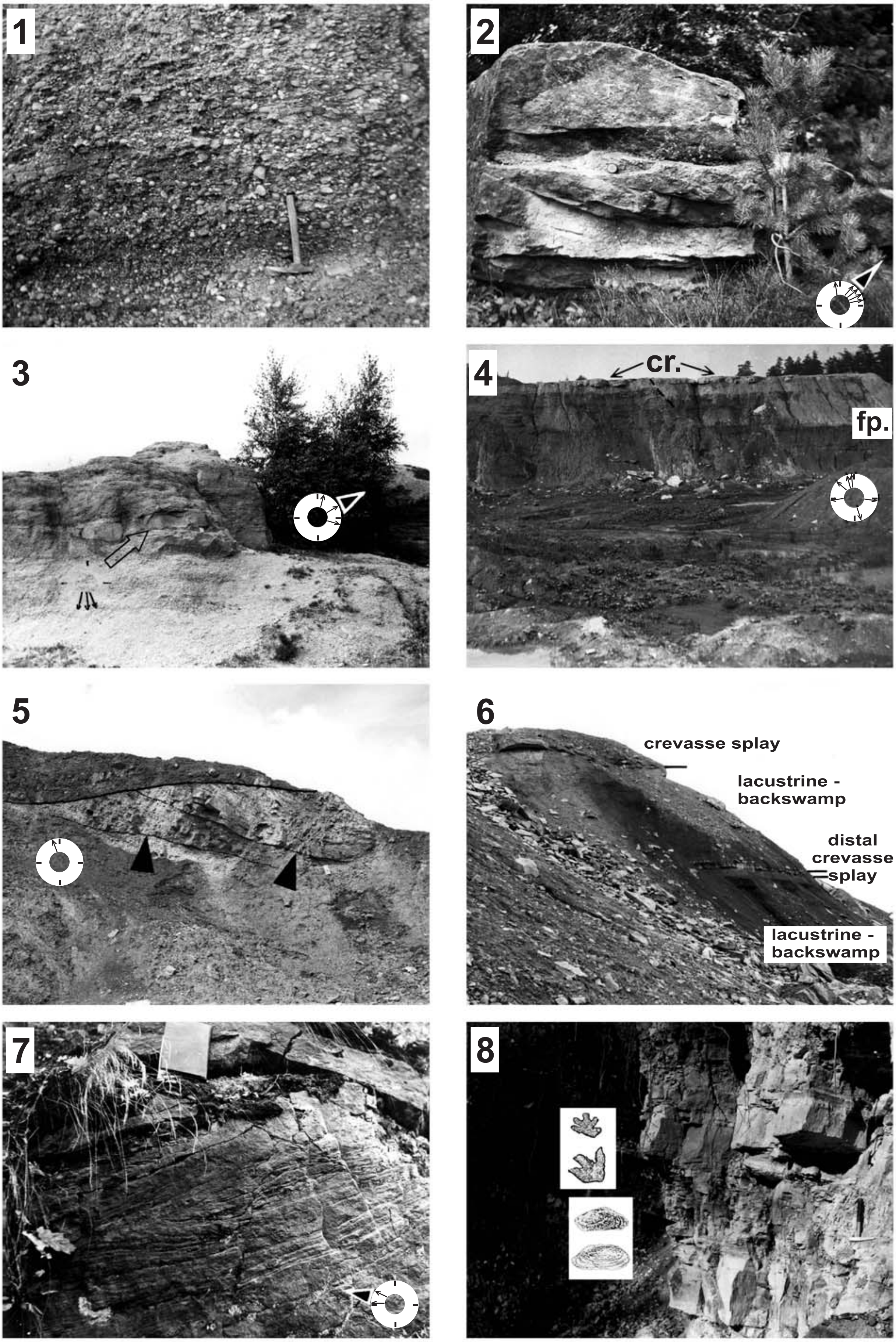

1
2
3
4
cr.
fp.
5
6
crevasse splay
lacustrine -
backswamp
distal
crevasse
splay
lacustrine -
backswamp
7
8

PLATE XII

Continental, deltaic, barrier-lagoon and nearshore depositional systems

Phot. 1. Close-up view of the lacustrine/backswamp flood-plain deposits from the Sołtyków exposure (lower part of the exposed interval presented on the PL. XI, 6). Note black colour of the mudstones caused by a high coal content. The reddish beds contain more silt and sand and are interpreted as distal crevasse splay deposits. Note abundant plant roots (dense vertical structures); Lower Hettangian, lowermost Zagaje Fm. Mobile phone for scale.

Phot. 2. Scour-and-fill structure (erosional channel). Fine-grained sandstone lithofacies with abundant plant fossils and trough cross bedding sets. Delta depositional system, distributary channel subsystem of a fluvial-dominated delta. Transport direction to the north-west. Podole exposure, lower part of the cycle "z" (Fig. 17); Lower/Middle Hettangian, depositional sequence Id–e; Skłoby Fm.

Phot. 3. Wavy heterolith lithofacies of the "diffused" type, gradually passing upwards into the flaser heteroliths and horizontally bedded/cross bedded sandstones. Delta front depositional subsystem. Podole exposure (Fig. 17), lower part of the cycle "z" (just below the distributary channels presented on the previous photograph); Lower/Middle Hettangian, depositional sequence Id–e; Skłoby Fm.

Phot. 4. Horizontally-bedded sandstone lithofacies with the broad, shallow scour-and-fill structure, representing a long-shore runnel structure. The trough is concordantly filled with sandstone lamina (arrowed). Nearshore depositional system, shoreface depositional subsystem, passing upwards into the foreshore depositional subsystem (planar, slightly inclined bedding at the top). Wolica exposure near Przedbórz Holy Cross Mts region); Middle Hettangian, depositional sequence I; Skłoby Fm.

Phot. 5. Deposits of the barrier-lagoon-embayment depositional system. Zapniów exposure near Przysucha; Upper Hettangian, depositional sequence Ij–k, Przysucha Ore-bearing Fm.; topped by the Early Sinemurian, parasequence IIa; Ostrowiec Fm.

Explanation: **f.s.–B** — foreshore–barrier lithofacies with *Anchizauripus* sp. footprints at the top (parasequence Ij); **o.s.-L** — embayment–lagoon mudstone lithofacies (parasequence Ij); **s.f.–B** — shoreface heterolith-sandstone lithofacies showing a gradual upward increase of the sandstone lithofacies (part of an incipient/submerged barrier-shoal facies with temporal emersions marked with dinosaur footprints — parasequence Ij); **o.s.-L–s.f.** — embayment-shoreface heterolith/sandstone lithofacies of parasequence Ik, lying on a flooding surface; **A.M. – ch.** — superimposed alluvial channels belonging to the next depositional sequence IIa. Contact between **o.s.-L–s.f.** and **A.M. – ch.** lithofacies assemblages marks the sequences I/II (Hettangian/Sinemurian) boundary. Hettangian deposits are kaolinized due to a non-deposition period and meteoritic water percolation at the sequence boundary and to the redeposition of kaolinite from the sediment source area. (For explanation of the profile see the text Fig. 4a). Arrowed — exact position of the bivalve *Cardinia* sp. (Pl. I, 7).

Phot. 6. Zapniów exposure, close-up view of the sequence I/II boundary, representing also the Przysucha Ore-bearing Fm./Ostrowiec Fm. boundary. Note the uneven, erosional contact between white-grey, fine grained arenites (shoreface deposits, uppermost part of highstand systems tract — depositional sequence Ik, Upper Hettangian; Przysucha Ore-bearing Fm.), and overlying medium–to coarse-grained, grey-brownish, cross bedded sandstones with mudstone intraclasts and drifted plant fossils representing alluvial channel depositional subsystem (basal deposits of the depositional sequence IIa, lowermost Sinemurian; lowermost part of the Ostrowiec Fm.). Widespread erosion of latest Hettangian age was associated with a world-wide eustatic fall. Alluvial deposits represent lowermost part of the transgressive systems tract commencing the depositional sequence II, associated with initial stage of gradual sea level rise at the beginning of Sinemurian. Diagram shows the palaeocurrent directions of the alluvial channels — the sum of vectors (heavy arrow) points to the palaeoslope tilt to the south-west. The end-Hettangian erosion caused substantial removal of previously deposited sediments (at least several metres of deposits belonging to the Ik parasequence).

Phot. 7. Laminated sandstone lithofacies with a scour-and-fill structure (arrowed). The channel structure is filled with coarser, massive sandstones. Nearshore depositional system, shoreface depositional subsystem. Note difference between this figure and the figure 5 of the same plate — the channel presented in this photograph represents a product of a much more violent process (interpreted as a storm-induced rip current, with orientation approximately perpendicular to the local palaeoshore direction). Bielowice exposure near Opoczno (Holy Cross Mts region); Lower Pliensbachian, depositional sequence V; Gielniów Fm.

Phot. 8. Hummocky cross-stratification. Nearshore depositional system, high-energy shoreface depositional subsystem. Skrzynno exposure near Przysucha (Holy Cross Mts region); Lower Pliensbachian, depositional sequence V; Gielniów Fm. Diameter of the coin = 1,6 cm.

Photos. G. Pieńkowski.

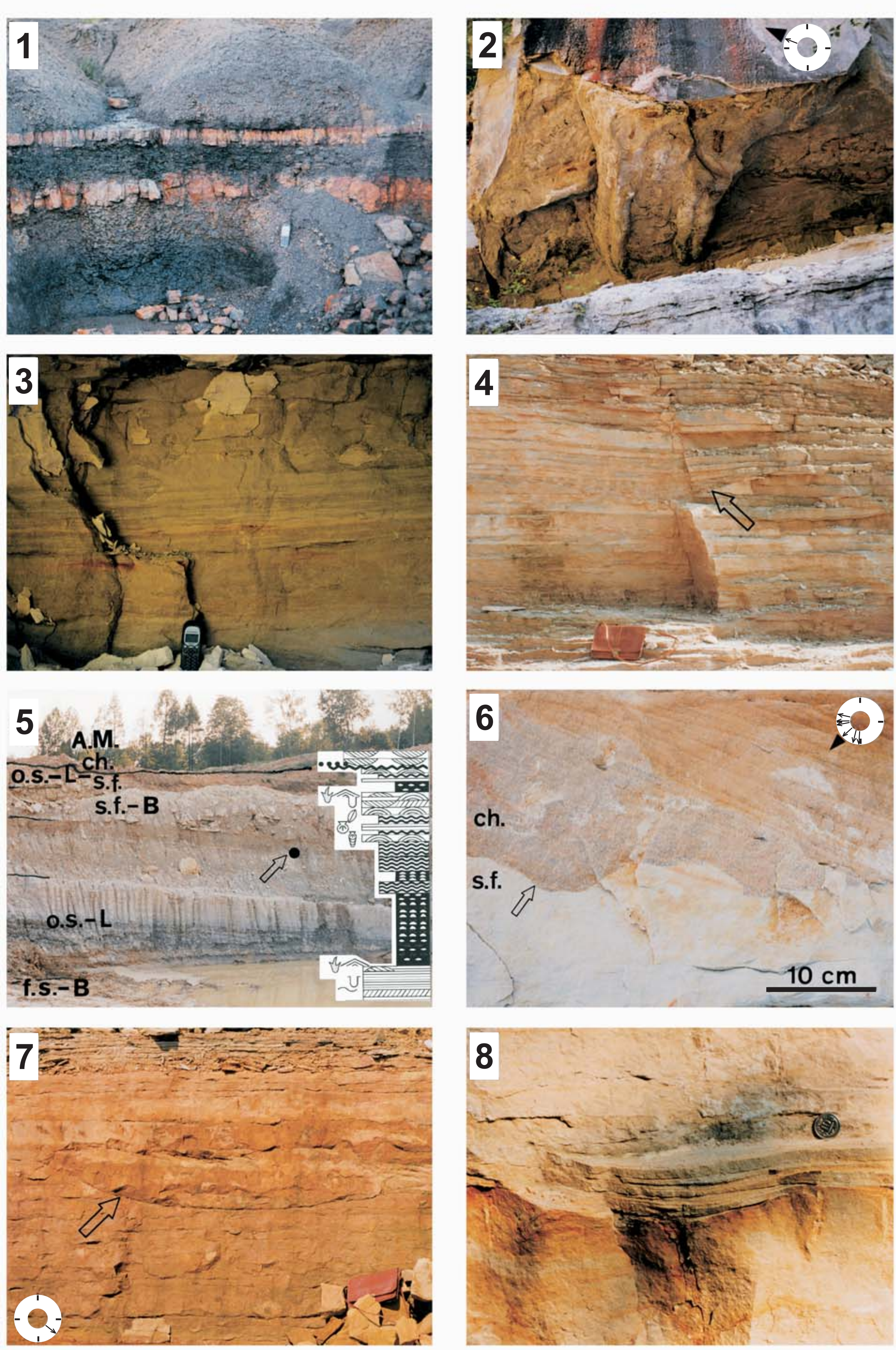

1
2
3
4
5
A.M.
ch.
o.s.–L–s.f.
s.f.–B
o.s.–L
f.s.–B
6
ch.
s.f.
10 cm
7
8

PLATE XIII

Barrier-lagoon, deltaic and nearshore depositional systems

Phot. 1. Nearshore depositional system, shoreface deposits. Fine-grained sandstones with hummocky cross-stratification (**H.C.S.**) and horizontally-bedded sandstones represent amalgamated storm deposits of the shoreface depositional subsystem. Rogów exposure near Końskie (Holy Cross Mts region). Lower Pliensbachian, depositional sequence IV, Gielniów Fm.

Phot. 2. Shore prograding cycle — shoreface deposits with hummocky cross stratification (**s.f.**) are covered by thin beach-welded facies (foreshore – **f.s.**) showing irregular “massive” bedding and numerous plant roots penetrating down from the undulated bounding surface (lower, up-pointing arrow). Superimposed are fine grained, very well sorted sandstones with giant tabular cross bedding set interpreted as beach (backshore depositional subsystem) eolian dune with complete plant remains buried in the wind-transported sand (upper, down-pointing arrow — compare with Karaszewski, 1962, his Plate VIII). Direction of wind is presented in the diagram. Szydłowiec exposure (former Antecki quarry); Pliensbachian, depositional sequence VI; Drzewica Fm.

Phot. 3. Nearshore, barrier-lagoon and delta depositional systems. General view of the exposure showing different lithofacies and depositional systems : **s.f.** — fine-grained, white and light-grey sandstones with hummocky cross stratification, tabular and trough cross bedding sets: shoreface depositional subsystem; **B–f.s.–e** — fine- to medium-grained, grey to brownish sandstones with flat tabular cross bedding and horizontal bedding with abundant drifted plant fossils and plant remains *in situ*: foreshoreb–arrier–eolian depositional subsystem; **L** — kaolinized grey mudstones with dispersed plant roots: lagoonal depositional subsystem (kaolinization occurred below the sequence boundary); **A.M. – ch.** — fine- to medium-grained, brown and yellow sandstones with trough cross bedding sets: alluvial channel depositional subsystem. The erosional base of the alluvial facies = sequence VI/VII boundary (for explanation of the profile see the text Fig. 4a). Note that in this case the width of the profile reflects the maximum grain size. Śmiłów Quarry near Szydłowiec; Upper Pliensbachian, depositional sequences VI and VII; Drzewica Fm.

Phot. 4. Close-up wiev of the Śmiłów exposure; **s.f.** — fine-grained, white and light-grey sandstones with hummocky cross stratification, tabular and trough cross bedding sets: shoreface depositional subsystem. Palaeocurrent directions are dispersed, trough cross bedding inclinations (probably offshore-directed rip currents — heavy arrow) point to the West. Measurements of wave ripple crests (continuous line on the diagram = sum of 15 vectors) approximately reflects a shoreline orientation; **B–f.s.–e** — fine- to medium-grained, grey to brownish sandstones with flat tabular cross bedding and horizontal bedding with abundant drifted plant fossils and plant remains *in situ*, foreshore — barrier depositional subsystem. Wave ripple crests orientation and orientation of fossil tree logs (sum of 30 vectors) is shown with continuous line, heavy arrow indicates inclination of the giant-scale, gently inclined tabular foreset continuing across the whole outcrop. These foresets are more steeply inclined that the regional bedding, because these surfaces represent seaward-dipping clinoforms. This inclination reflects the original inclination of a barrier slope (compare with the photo 7 of this plate); **L** — lagoonal mudstones with dispersed plant roots; **A.M.** (**ch.**) — fine- to medium-grained, brown and yellow sandstones with trough cross bedding sets of alluvial depositional system (amalgamated meandering channels — channel-fill deposits and point bar deposits). Note sharp, erosional base of the alluvial system, identified with the sequence VI/VII boundary. The sum of palaeocurrent vectors points to south-west.

Phot. 5. Close-up view of the fine-grained, white and light-grey sandstones with hummocky cross stratification in the Śmiłów exposure. These sandstones are the main object of exploitation because of their good building properties. Shoreface depositional subsystem; Upper Pliensbachian, depositional sequence VI; Drzewica Fm.

Phot. 6. Middle part of the **B–f.s.–e** lithofacies (see the phot. 4, this plate) showing slightly inclined beach foresets and plant roots (arrowed) in the barrier/foreshoreb–ackshore–eolian dune facies. A plant buried in whole (Pl. II, 6) comes from this part of the section. Drifted plant fossils and tree logs (marked with the flora symbol, with the compass on top) occur on the bedding surface. This gently inclined bedding surface represents a longer non-depositional period and in the same time reflects the original tilt of the beach (barrier top). Compare with the phots. 4 and 7 of this plate.

Phot. 7. Detail of the phot. 4 showing three depositional systems. Note inclined tabular cross bedding set (strike 30°, dip 10° to SE) in the barrier-foreshore lithofacies. These foresets are more steeply inclined that the regional bedding (reflected by the marked lithofacies/depositional systems contacts). This difference in inclination creates slight angle discordance between the barrier top and overlying lagoon deposits. The inclined foresets represent seaward-dipping clinoforms, i.e. the original inclination of a barrier slope (compare with the photo 7 of this plate). Note the sharp, erosional base of superimposed alluvial depositional system (channel subsystem, A.M.) commencing the depositional sequence VII.

Phot. 8. The offshore-embayment, greenish mudstones and intercalated fine-grained sandstones and siltstones (representing probably distal tempestites). Typical lithofacies of the Ciechocinek Fm. Kozłowiec exposure in the Częstochowa region; Lower Toarcian, *tenuicostatum* Zone, depositional sequence VIIIb.

Photos. 1–7 — G. Pieńkowski; Photo. 8 — P. Leonowicz.

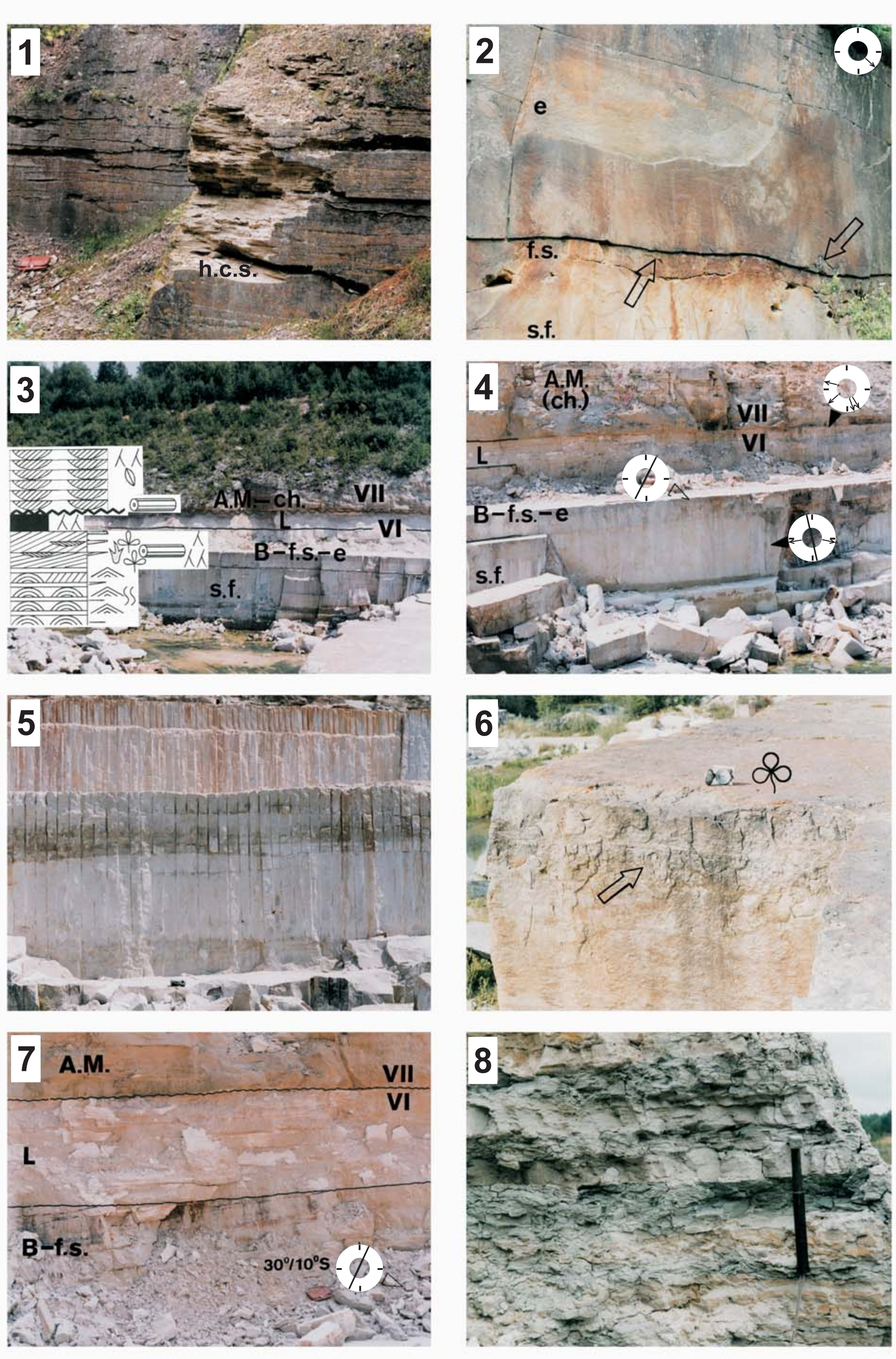

1
h.c.s.
2
e
f.s.
s.f.
3
A.M.–ch.
VII
L
VI
B–f.s.–e
s.f.
4
A.M.
(ch.)
VII
VI
L
B–f.s.–e
s.f.
5
6
7
A.M.
VII
VI
L
B–f.s.
30°/10°S
8

PLATE XIV

Nearshore depositional system

Phot. 1. Differently-oriented cross-bedding tabular sets in sandstone lithofacies. Diagrams show that one cross-bedding set is oriented perpendicularly to the neighbouring one. It is interpreted as an effect of changing longshore and onshore current directions in a nearshore (shoreface) depositional system. Szewna near Ostrowiec Świętokrzyski; Lower Sinemurian, depositional sequence II; Ostrowiec Fm.

Phot. 2. Part of a shore-prograding cycle showing fine-grained, white-grey shoreface sandstones (s.f.) passing upwards into darker, coarser foreshore sandstones (f.s.). Hummocky cross bedding sets and tabular cross-bedding sets dominate in the lower part of the exposure, while the upper one is dominated by low-amplitude, broad trough cross bedding sets (of a scour-and-fill type) and the slightly inclined or horizontal bedding. Starachowice exposure (Wojska Polskiego street); Middle Hettangian, depositional sequence I; Skłoby Fm.

Phot. 3. Hummocky cross stratification in fine-grained sandstones, deposited in a high-energy shoreface depositional subsystem. Starachowice exposure (Zakładowa street); Middle Hettangian, depositional sequence I; Skłoby Fm.

Phot. 4. Hummocky cross-stratification in fine-grained sandstones deposited in a high-energy shoreface depositional subsystem. Piekło exposure near Niekłań (Holy Cross Mts region); Lower Sinemurian, depositional sequence IIb; Ostrowiec Fm.

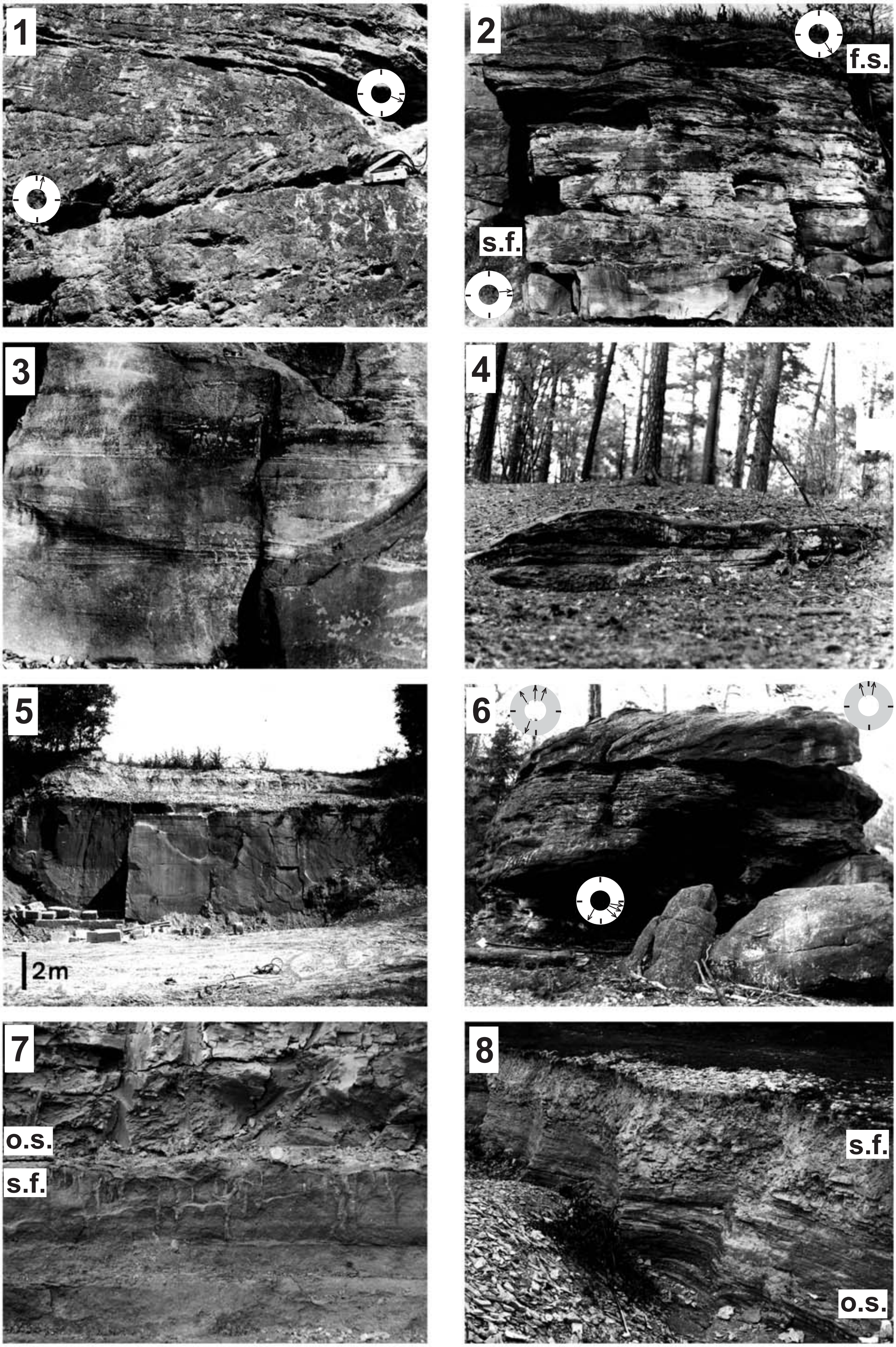
Phot. 5. Amalgamated, thick layers of horizontally bedded, fine-grained sandstones with subordinate hummocky cross stratification. Very high energy shoreface depositional subsystem. Quarry in Żarnów (Holy Cross Mts region); Lower Sinemurian, depositional sequence IIb; Ostrowiec Fm.

Phot. 6. Laminated, fine-grained sandstones with interbedding hummocky cross stratification and tabular cross bedding sets (note perpendicular longshore-offshore transport directions with domination of the longshore direction), capped by the medium-grained sandstones with giant-scale tabular sets showing opposite palaeocurrent directions (both onshore and offshore directions are represented). Lower part of the outcrop is interpreted as a shoreface depositional subsystem, while the upper part of the exposure represents foreshore depositional subsystem of a semi-emerged longshore bar with wash-over fans and offshore-directed swash — zone currents (compare with the text Fig. 30). Piekło exposure near Niekłań (Holy Cross Mts region); Lower Sinemurian, depositional sequence IIb, Ostrowiec Fm.

Phot. 7. Contact between deposits of the shoreface and offshore depositional subsystems. Shore-prograding cycle (s.f.) is visible in the lower part — note upwards-increasing density of the *Arenicolites* sp. and *Skolithos* sp. dwelling burrows. The shoreface sandstone lithofacies is covered by the offshore mudstones (o.s. — lenticular heteroliths). Grzybowa Góra exposure near Skarżysko Kamienna; Late Sinemurian, depositional sequence III; Ostrowiec Fm.

Phot. 8. The shore-prograding cycle showing offshore lenticular and wavy heterolithic lithofacies (o.s.) covered by flaser heteroliths and fine-grained, horizontally bedded sandstone lithofacies (s.f.), representing shoreface depositional subsystem. Klew (Diabla Góra) exposure near Przedbórz; Middle Hettangian, depositional sequence I; Skłoby Fm.

Photos. G. Pieńkowski.


1
2
f.s.
s.f.
3
4
5
2m
6
7
o.s.
s.f.
8
s.f.
o.s.