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Studies in the Post-Glacial History of British Vegetation. XI. Late-Glacial Deposits in Cornwall: Appendix: Report on Diatom Flora from Hawks Tor, Cornwall

R. Ross

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reason why trace of them should not be found. The results already obtained show how prolific these deposits can be, and doubtless many others of comparable age and character await fuller investigation.

Mr C. A. Ralegh Radford, F.S.A., was most helpful in the early stages of our investigations, in advising as to the most suitable sites. Mr C. Croft Andrews also gave valuable information and assisted with the field-work at Dozemare Pool.

We are indebted to the Council of Newnham College, Cambridge, for the award to two of us (E. M. M. and A. P. C.) of studentships through which it was possible to pursue this research in Cambridge. Our very grateful thanks are given to Mrs Hazel Whitmore and Miss Robin Andrew, who, as scientific assistants, were responsible for a good deal of the pollen counting, Miss Andrew especially for the identification and recording of pollen of late-Glacial herbaceous plants. We gratefully acknowledge also assistance and courtesy from the manager of the Hawks Tor China-Clay Works, the foreman of the china-clay pit at Parsons Park, and Dr Hooper of Falmouth Public Library.

Finally, we wish to express thanks to Mr Ross for the thorough analysis of the diatomite which forms the appendix to this paper.

APPENDIX

Report on diatom flora from Hawks Tor, Cornwall

By R. Ross

Botany Department, British Museum (Natural History)

A sample of the diatomite collected from the base of the lower muds and peats at the kaolin china-clay pit at Hawks Tor, Bodmin, was submitted to me by Dr Godwin. In it sixty-three species of diatoms were found, of which a number were represented by more than one variety, there being seventy-four different forms in all. A list of these is given below in which the relative abundance, the present geographical distribution and the ecological preferences of each diatom are indicated.

The names in this list are applied in the sense adopted by Hustedt (1930) in the latest comprehensive account of the diatoms of the fresh waters of western and central Europe. Some of the nomenclature adopted in that work is, however, not in accordance with the *International Rules*, and where this is the case the legitimate name has been used, or a new and legitimate combination made. Mills (1933–5) or Ross (1947) provide the synonymy necessary to relate these legitimate names to those used by Hustedt.

No objective value for the relative frequency of the various diatoms could be obtained as any procedure based on counting was made impossible by the number of broken valves present. A subjective estimate was therefore made for each species using the terms conventionally employed in plant-ecological field-work.

Most diatoms have a very wide geographical distribution, but it proved possible to group the forms found into four classes according to whether or not they are at present generally distributed in western and central Europe and whether they are as common there as farther north or south. The geographical divisions adopted are as follows:

Arctic-alpine: known at present only from northern Europe or from high altitudes in the mountains of central Europe.

Temperate, arctic: known from western and central Europe, but appreciably commoner at high altitudes or farther north.

Temperate: distributed throughout western and central Europe and as common or more common at low altitudes there than either to the north or south or at high altitudes.

Temperate, southern: known from western and central Europe but appreciably commoner farther south.

In placing the species in the various geographical divisions I have relied principally on the information given by Hustedt (1927–37, 1930).

Where information is available, the position of each diatom in the halobion system proposed by Kolbe (1927, p. 112) is given; this defines the range of chloride content of the water in which it is normally found. The principal source of this information has been Foged (1948), but for forms not mentioned by him I have consulted Petersen (1943) and the many other papers mentioned in the latter's bibliography. The pH group, as defined by Hustedt (1938–9, p. 285), to which each diatom belongs and the type of lake or pond in which it is normally found are also indicated in the list, the information on these points coming from Jørgensen (1948) supplemented by Budde (1942).

The abbreviations used in the list are as follows:

abundance

va	very abundant
a	abundant
f	frequent
o	occasional
r	rare

geographical distribution

A–A	arctic-alpine
T, A	temperate, arctic
T	temperate
T, S	temperate, southern

halobion class

M	mesohalobous
Hphil	oligohalobous, halophilous
Ind	oligohalobous, indifferent
Hphob	oligohalobous, halophobous

pH group

Alkphil	alkaliphilous
Indiff	indifferent
Acphil	acidophilous
Acbiont	acidobiontic

Lake type

E	eutrophic
O	oligotrophic
O–E	is used for species occurring in lakes of both types, but not in extreme examples of either type.

The following is a summary of the geographical and ecological status of the seventy-four diatoms listed in table 8, the numbers in brackets being the totals of the twenty-three forms whose abundance is frequent or more:

geographical distribution

arctic-alpine	3 (—)
temperate, alpine	8 (1)
temperate	61 (22)
temperate, southern	2 (—)

pH group

alkaliphilous	29 (13)
indifferent	17 (4)
acidophilous	12 (4)
acidobiontic	1 (—)
?	15 (2)

halobion class

mesohalobous	1 (—)
oligohalobous, halophilous	1 (—)
oligohalobous, indifferent	49 (18)
oligohalobous, halophobous	13 (2)
?	10 (3)

lake type

eutrophic	30 (11)
eutrophic-oligotrophic	16 (5)
oligotrophic	14 (4)
?	14 (3)

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TABLE 8

species	abundance	geographical distribution	halobion class	pH group	lake type
Achnanthes lanceolata (Bréb. ex Kütz.) Grun. apud Cleve & Grun.	o	T	Ind.	Alkphil.	E
Amphora ovalis (Kütz.) Kütz.	o	T	Ind.	Alkphil.	E
Caloneis silicula (Ehrenb.) Cleve	o	T	Ind.	Alkphil.	E
Ceratoneis arcus (Ehrenb.) Kütz.	o	T	Hphob.	?	?
Cocconeis placentula Ehrenb. var. *euglypta* (Ehrenb.) Cleve		T	Ind.	Alkphil.	E
Cymbella cistula (Hempr. & Ehrenb.) Kirchn.		T	Ind.	Alkphil.	E
C. cornutum (Ehrenb.) Ross.	o	T	Ind.	Alkphil.	E
C. cuspidata Kütz.	o	T	Ind.	?	O–E
C. cymbiformis (Kütz.) Bréb.	f	T	Ind.	Alkphil.	E
C. gastroides (Kütz.) Kütz.	f	T	Ind.	Alkphil.	E
C. maculata (Kutz.) Kutz.	f	T	Ind.	Alkphil.	?
C. naviculiformis Auersw. apud Rabenh.	o	T	Ind.	Indiff.	O–E
C. Rabenhorstii Ross	r	A–A	Hphob.	Indiff.	O–E
C. ventricosa Ag.	r	T	Ind.	Indiff.	E
Diatoma hiemale (Lyngb.) Heib. var. *quadratum* (Kütz.) Ross	o	T, A	Ind.	?	?
Diploneis interrupta (Kütz.) Cleve	r	T	M.	?	?
Epithemia adnata (Kütz.) Bréb. var. *genuina* (Grunow) Ross	f	T	Ind.	Alkphil.	E
E. adnata (Kütz.) Bréb. var. *porcellus* (Kütz.) Ross	a	T	Ind.	Alkphil.	E
E. turgida (Ehrenb.) Kütz.	a	T	Ind.	Alkphil.	O–E
Eunotia curvata (Kütz.) Lag.	o	T	Hphob.	Acphil.	O–E
E. pectinalis (O. F. Mull.) Rabenh. var. *minor* (Kütz.) Rabenh.	f	T	Hphob.	Acphil.	O
E. praerupta Ehrenb.	r	T, A	Hphob.	Acphil.	O
Fragilaria bicapitata Mayer	o	T, A	Hphob.	Alkphil.	E
F. brevistriata Grun. apud Van Huerck	a	T	Ind.	Alkphil.	E
F. capucina Desm. var. *genuina* Grun.	r	T	Ind.	Alkphil.	E
F. capucina Desm. var. *mesolepta* Rabenh.	o	T	Ind.	Alkphil.	E
F. construens (Ehrenb.) Grun. var. *binodis* (Ehrenb.) Grun.	o	T	Ind.	Alkphil.	E
F. construens (Ehrenb.) Grun. var. *genuina* Grun.	o	T	Ind.	Alkphil.	E
F. leptostauron (Ehrenb.) Hust.	f	T	Hphob.	?	?
F. pinnata Ehrenb.	a	T	Ind.	Alkphil.	E
F. vaucheriae (Kütz.) Boye Pet.	o	T	Ind.	Alkphil.	E
Frustulia vulgaris (Thwaites) De Toni	r	T	Ind.	Alkphil.	E
Gomphonema acuminatum Ehrenb.	o–	T	Ind.	Alkphil.	O–E
G. dichotomum Kütz.	r	T	Ind.	Alkphil.	E
G. gracile Ehrenb.	r	T, S	Ind.	Indiff.	O–E
G. longiceps Ehrenb. var. *montanum* (Schum.) Hust.	o	T, A	Ind.	?	E
G. parvulum Kütz.	r	T	Ind.	Indiff.	O–E
G. truncatum Ehrenb.	o–f	T	Ind.	Alkphil.	E
Hantzschia amphioxys (Ehrenb.) Grun. apud Cleve & Grun.	o	T	Ind.	Indiff.	O–E
Meridion circulare (Grev.) Ag.	f	T	Ind.	Alkphil.	E
Navicula bacilliformis Grun. apud Cleve & Grun.	o	T	Hphob.	Indiff.	E
N. cincta (Ehrenb.) Ralfs apud Pritch.	r	T	Hphil.	Alkphil.	E
N. pseudoscutiformis Hust. in Pasch.	f	T, A	?	Indiff.	O
N. pupula Kütz.	f	T	Ind.	Indiff.	E
N. radiosa Kütz.	f	T	Ind.	Indiff.	O–E
Neidium longiceps (Greg.) Ross	r	A–A	?	Acphil.	O
Nitzschia stagnorum Rabenh.	r	T	Ind.	?	?
Pinnularia biceps Greg.	o	T	Ind.	Acphil.	O
P. borealis Ehrenb.	r	T	Ind.	Indiff.	O
P. cuneata (Østr.) Cleve-Euler	o	T, A	?	?	?
P. divergens W. Smith	r	T, A	?	Indiff.	?
P. gibba Ehrenb. var. *linearis* Hust.	f	T	?	Acphil.	O
P. hemiptera (Kütz.) Rabenh.	f	T	Ind.	?	?
P. major (Kütz.) W. Smith var. *andesitica* (Pant.) Ross	r	T	?	?	?
P. major (Kütz.) W. Smith var. *genuina* Mayer	a	T	Ind.	Acphil.	O–E
P. nobilis (Ehrenb.) Ehrenb.	a	T	?	Acphil.	O
P. subcapitata Greg. var. *genuina* Mayer	o	T	Ind.	Acphil.	O
P. subcapitaat Greg. var. *Hilseana* (Jan.) O. Mull.	o	T	Hphob.	Acbiont.	O
P. subcapitata Greg. var. *stauroneiformis* (Van Huerck) Mayer	r	T	Hphob.	?	?
P. viridis (Nitzsch) W. Smith var. *Clevei* Meist.	o	T	Ind.	Indiff.	O–E
P. viridis (Nitzsch) W. Smith var. *fallax* Cleve	o–f	T	?	?	?
Rhopalodia gibba (Ehrenb.) O. Mull.	a	T	Ind.	Alkphil.	E
R. parallela (Grun.) O. Mull.	o	T, A	Ind.	?	E
Stauroneis anceps Ehrenb. var. *amphicephala* (Kütz.) Cleve	o	T	Ind.	Indiff.	O–E
S. anceps Ehrenb. var. *gracilis* (Ehrenb.) Brun	o	T	?	Acphil.	O
S. anceps Ehrenb. var. *siberica* Grun. apud Cleve & Grun.		A–A	?	?	?
S. phoenicenteron (Nitzsch) Kütz. var. *amphilepta* (Ehrenb.) Cleve	o	T	Ind.	?	?
S. phoenicenteron (Nitzsch) Kütz. var. *genuina* Cleve	f	T	Ind.	Indiff.	O–E
S. Smithii Grun.	r	T	Ind.	Indiff.	O
Surirella robusta (Ehrenb.) Ehrenb.	r	T	Hphob.	Indiff.	O–E
Synedra capitata Ehrenb.	o	T, S	Ind.	Alkphil.	E
S. ulna (Nitzsch) Ehrenb.	va	T	Ind.	Alkphil.	O–E
Tabellaria fenestrata (Lyngb.) Kütz.	o	T	Hphob.	Acphil.	O
T. flocculosa (Roth.) Kütz.	o	T	Hphob.	Acphil.	O

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In interpreting these results it must be remembered that there is a tendency amongst diatoms, as in so many other groups, for forms with an arctic-alpine distribution in central Europe to be found at comparatively low altitudes in the west of Britain. Another point to be noted is that a number of the halophobous, acidophilous and oligotrophic diatoms found infrequently in this deposit are much more characteristic of streams than of ponds or lakes, and probably did not grow in the pool on the floor of which this deposit was formed, but were washed into it in the waters of the streams feeding it. Bearing these facts in mind we may deduce with some certitude that the temperature at the time when this deposit was being laid down did not differ appreciably from that of England at the present day, and that the pool in which it was formed was a moderately eutrophic one with a chloride content of 15 to 25 mg. Cl′ per litre and a pH slightly over 7. The waters of the streams draining into the pool were probably of lower chloride content and pH than those of the pool itself.

For a few of the diatoms found in the material from Hawks Tor the names in current use are illegitimate, and no legitimate name is available. The necessary new combinations are made below:

Cymbella cornutum (Ehrenb.) Ross n.comb.

Cocconema cornutum Ehrenb. in *Abh. preuss. Akad. Wiss.* 1841, p. 412 (1843).

Cymbella lanceolata (Ehrenb.) Kirchn. in Cohn, *Krypt.-Flora Schlesiens*, **2**, 1, 188 (1878) *non C. lanceolata* (Ag.) Ag. (1830).

[*C. lanceolata* (Ehrenb.) Kirchn., the name by which this species is usually known, is a later homonym and must therefore be rejected.]

Diatoma hyemale (Lyngb.) Heib. var. *quadratum* (Kütz.) Ross n.comb.

Diatoma mesodon Kütz. var. *quadratum* Kütz. *Die kies. Bacill.* p. 47 (1844).

Diatoma hiemale (Lyngb.) Heib. var. *mesodon* (Ehrenb.) Kirchn. in Cohn, *Krypt.-Flora Schlesien*, **2**, 1, 204 (1878).

[*quadratum* is earlier than *mesodon* as a varietal epithet and must therefore be used, even although *mesodon* was published first as a specific epithet.]

Epithemia adnata (Kütz.) Bréb. var. *genuina* (Grun.) Ross n.comb.

Epithemia zebra (Ehrenb.) Kütz. var. *genuina* Grun. in *Verh. zool.-bot. Ges. Wien*, **12**, 328 (1862).

[Lagerstedt (1884) showed that *Frustulia adnata* Kütz. (1833) is the same diatom as *Navicula zebra* Ehrenb. (1834), and Kützing's epithet must therefore be used for this species on grounds of priority. This necessitates the new combination above and that below.]

Epithemia adnata (Kütz.) Bréb. var. *porcellus* (Kütz.) Ross n.comb.

Epithemia porcellus Kütz. *Die kies. Bacill.* p. 34 (1844).

Epithemia zebra (Ehrenb.) Kütz. var. *porcellus* (Kütz.) Grun. in *Verh. zool.-bot. Ges. Wien*, **12**, 328 (1862).

Pinnularia major (Kütz.) W. Smith var. *andesitica* (Pant.) Ross n.comb.

Navicula major (Kütz.) Kütz. var. *andesitica* Pant. *Beitr. Kenntn. foss. Bacill. Ungarns*, **3**, plate 7, figure 113 (1892).

Pinnularia major (Kütz.) W. Smith var. *linearis* Cleve in *K. svenska VetenskAkad. Handl.*, n.f. **27** (3), 89 (1895).

[Priority requires that Pantocsek's epithet for this variety should be preferred to Cleve's.]

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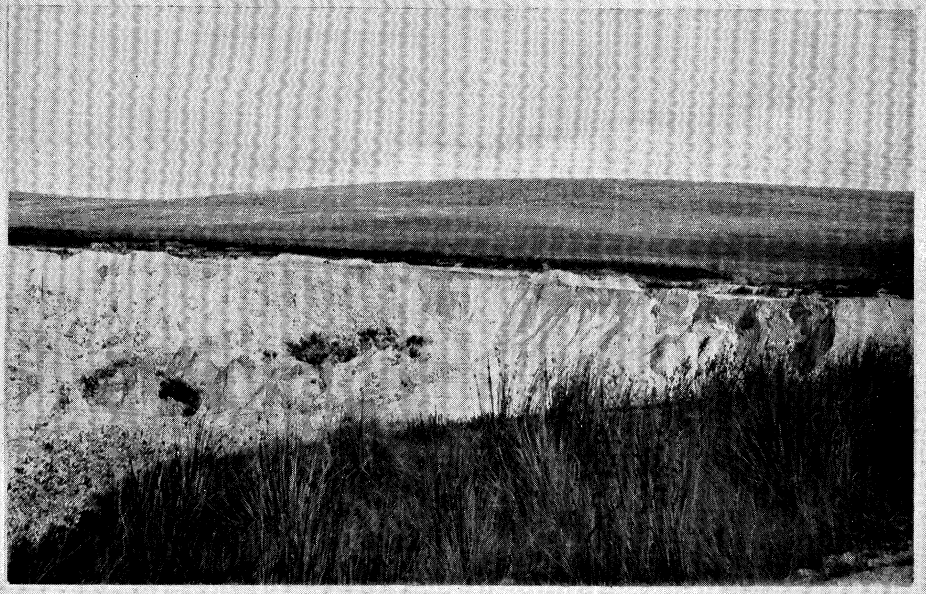

Figure 26

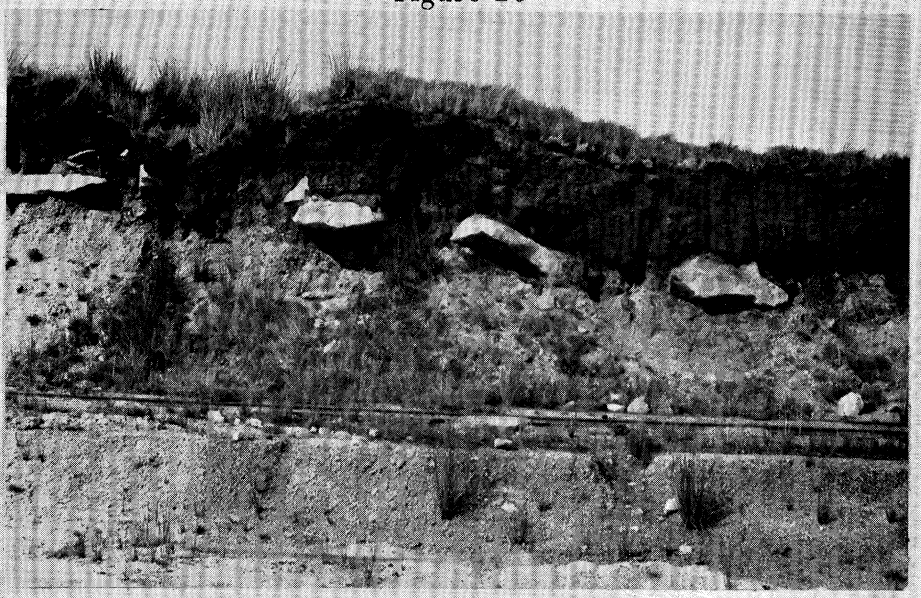

Figure 27

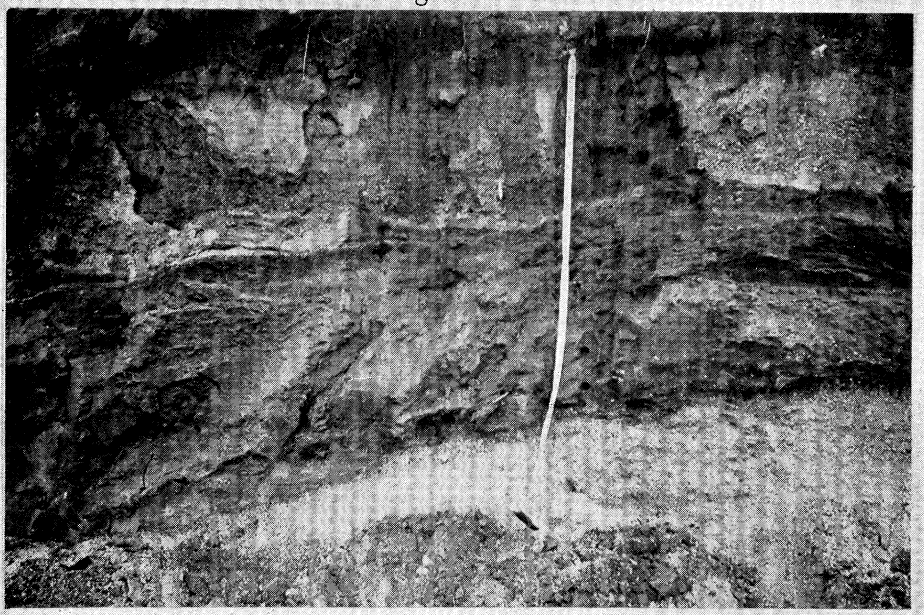

Figure 29

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PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

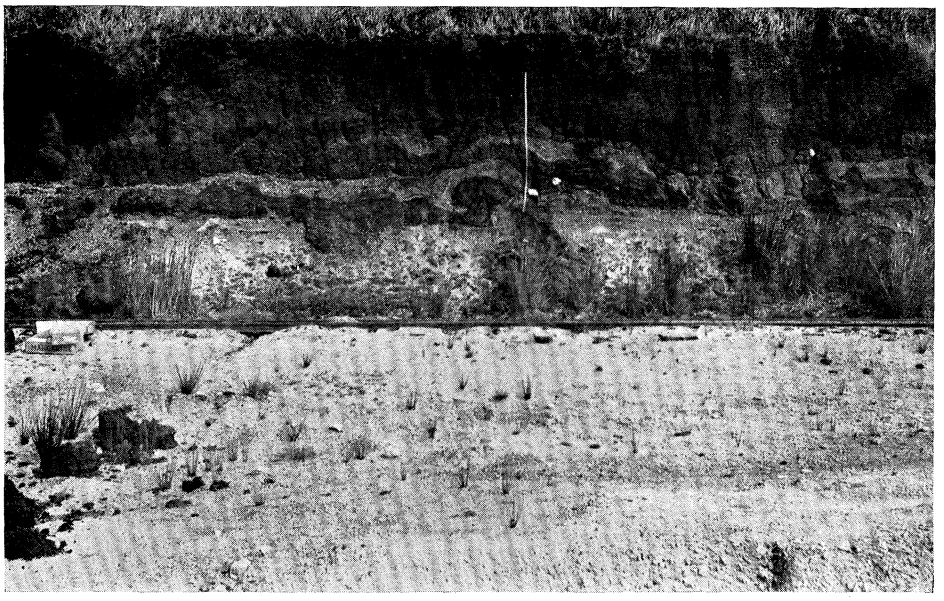

FIGURE 28*a*

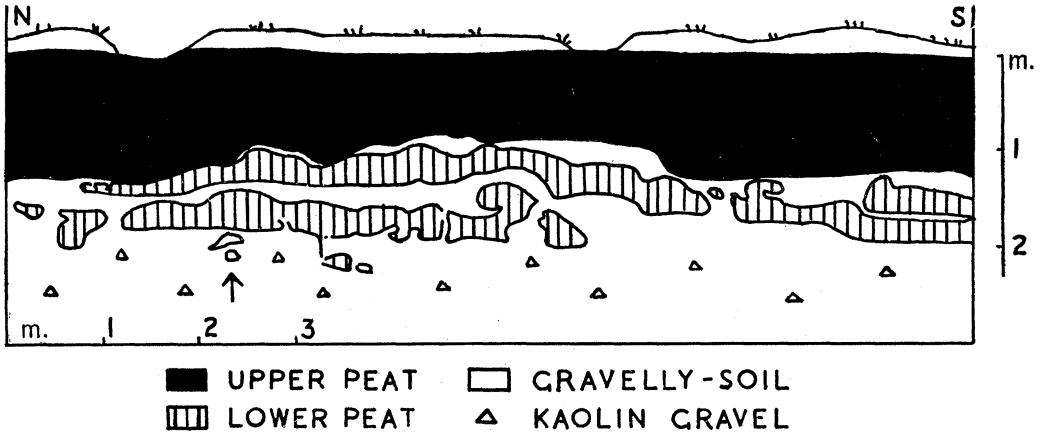

FIGURE 28*b*

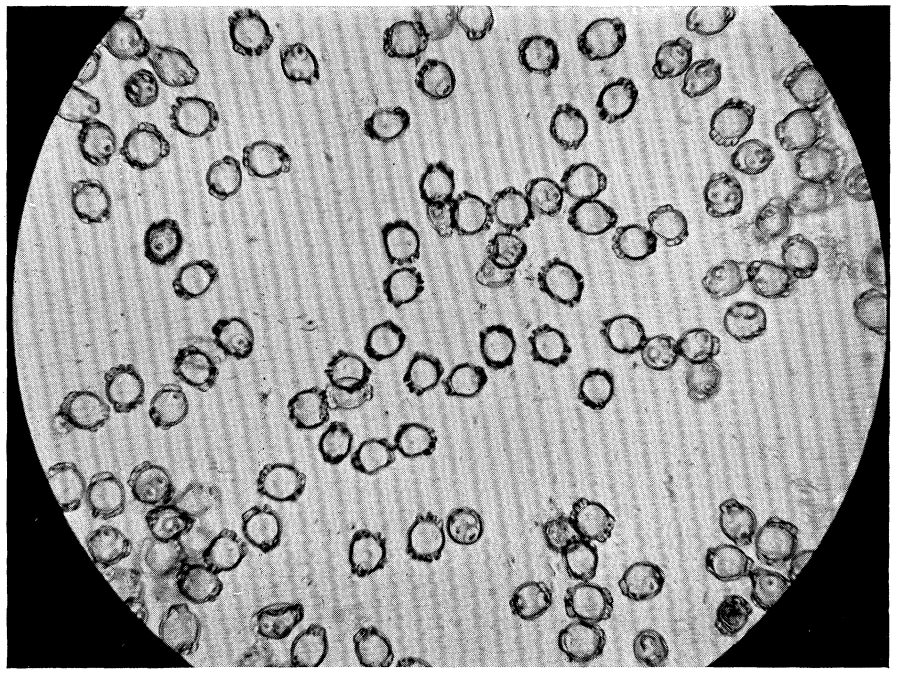

FIGURE 30

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Description of Plates

Plate 24

Figure 26. General view of Hawks Tor china-clay pit, 1943, looking north-east towards Brockabarrow Down, across the Warleggan valley. The peat profile is visible as a dark line above the deep excavations of the pit. The deeper channel deposits lie to the right (site 42).

Figure 27. Hawks Tor china-clay pit, 1943. Site 43A, on the north-west face, showing large angular granite boulders moved down the hill-slope upon the gravel surface before deposition of the upper peat. No lower peat is developed here.

Figure 29. Hawks Tor china-clay pit, 1942. Site 42A at line of tape. The tape is affixed in the base of the upper peat and crosses the gravelly-soil and the lower peat to the kaolin gravel. It is the site of the pollen sampling.

Plate 25

Figure 28*a*, *b*. Hawks Tor china-clay pit, 1943. Site 43B. On the extreme left and right the lower peat is separated by a narrow band of gravelly-soil from the thick upper peat. In the centre the lower peat is contorted and penetrated by the gravelly-soil presumably by cryoturbatic movements. On the extreme left angular boulders are present at the surface of the kaolinized gravel. The vertical tape is 1·5 m. long: the white stones near it have been put in as markers.

Figure 30. Photomicrograph of pollen grains of *Myriophyllum alterniflorum* taken from squashed anthers of male flowers (lower muds at site 42B).

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Figure 26

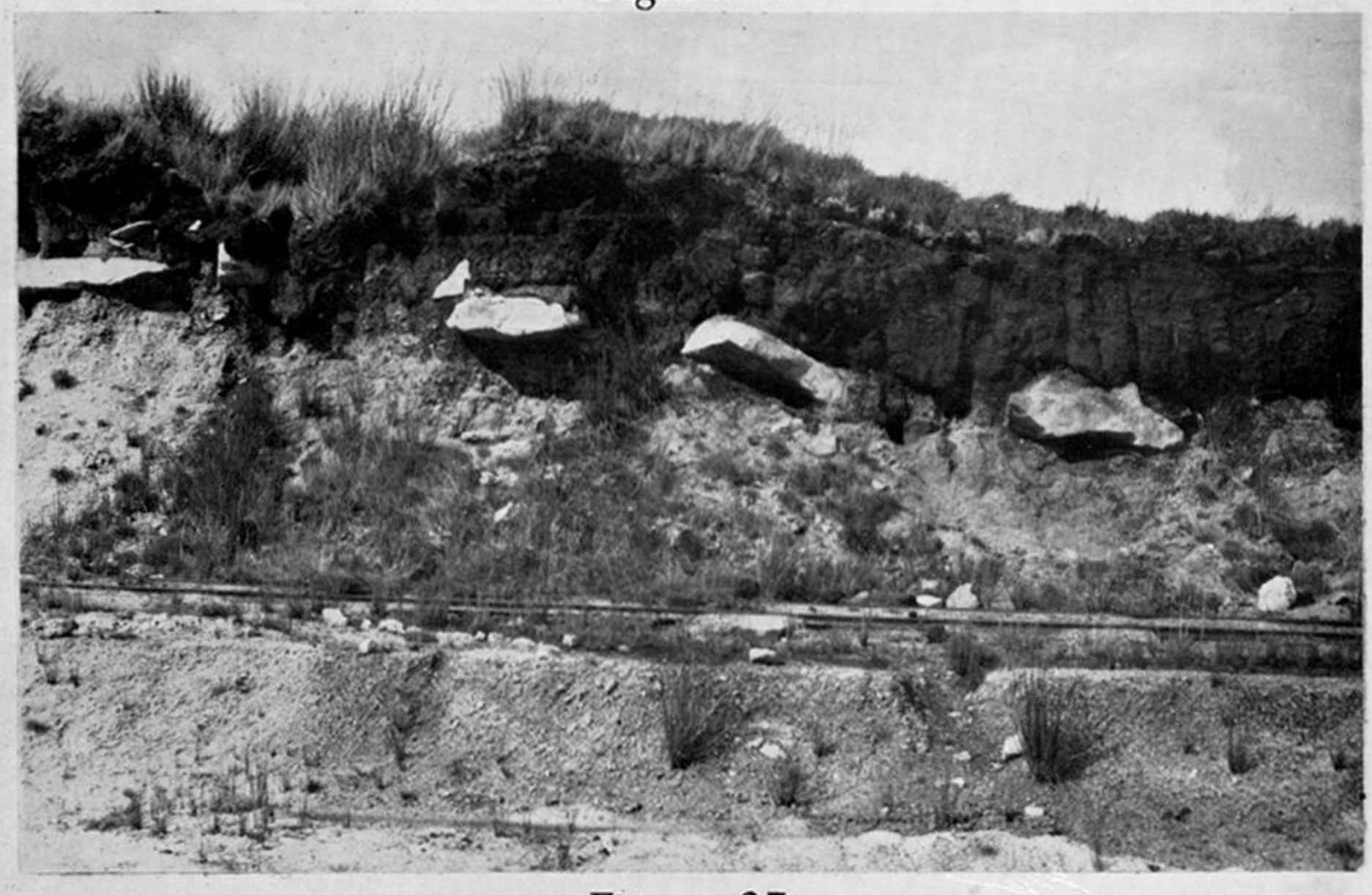

Figure 27

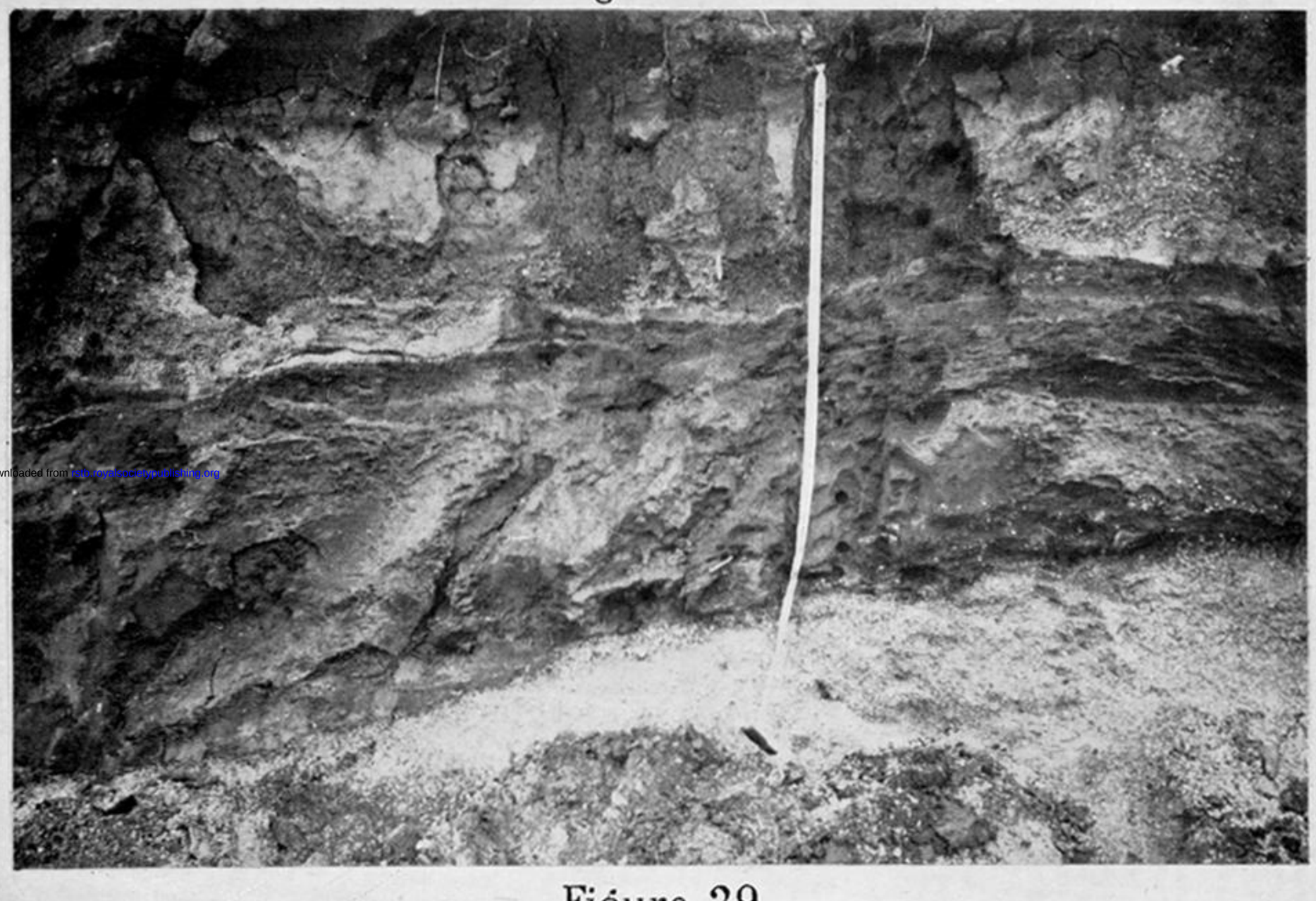

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FIGURE 28*a*

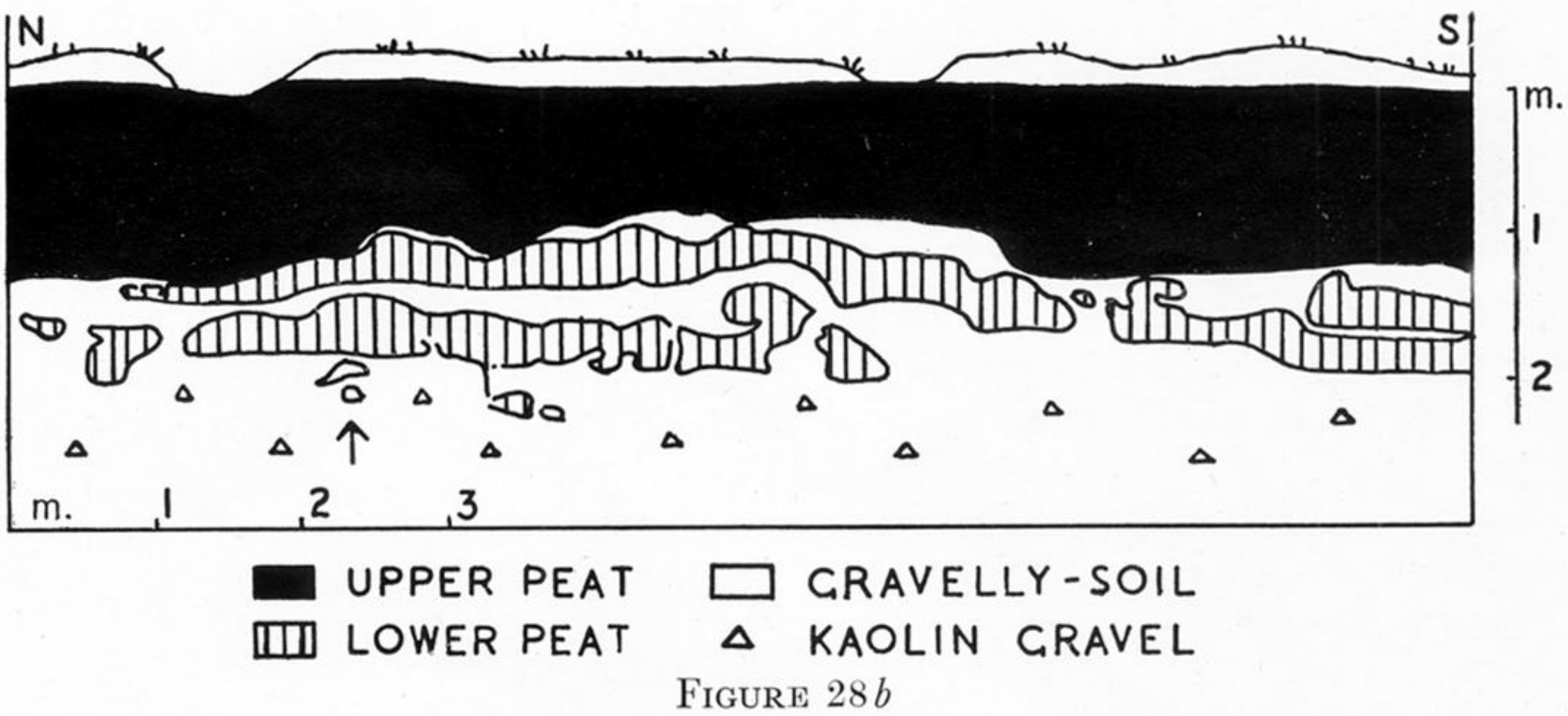

FIGURE 28*b*

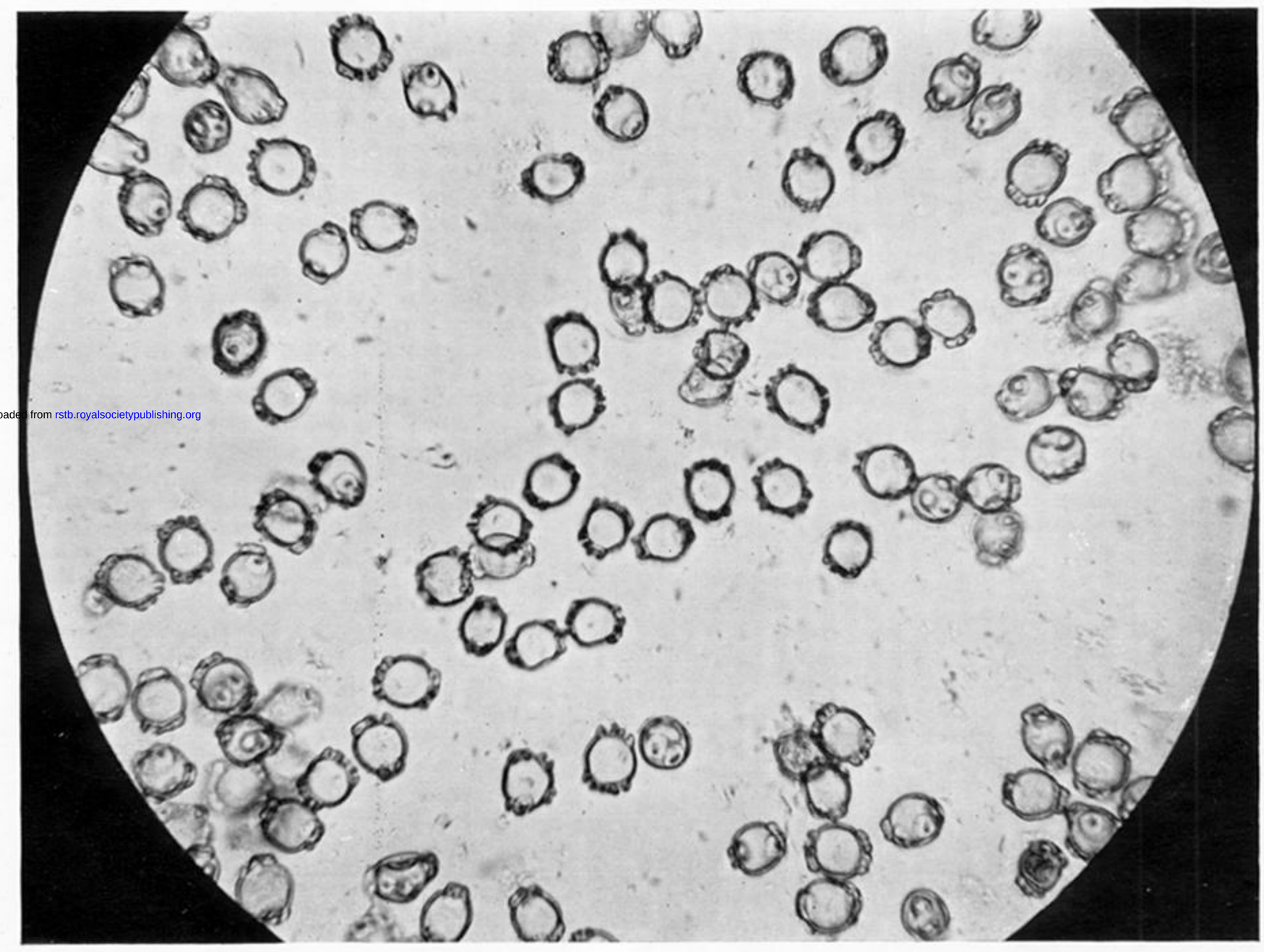

FIGURE 30

PLATE 25

FIGURE 28*a*, *b*. Hawks Tor china-clay pit, 1943. Site 43B. On the extreme left and right the lower peat is separated by a narrow band of gravelly-soil from the thick upper peat. In the centre the lower peat is contorted and penetrated by the gravelly-soil presumably by cryoturbatic movements. On the extreme left angular boulders are present at the surface of the kaolinized gravel. The vertical tape is 1·5 m. long: the white stones near it have been put in as markers.

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