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Some Fungal Taxa from the Neyveli Lignite Formation

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Abstract

The present investigation is about the observation of some fungal fruiting bodies and spores from the Neyveli lignite formation. These includes the Asterothyrites konkanensis, Asterothyrites sp, Microthyriacites cooksoniae, Microthyriacites ramanujamii, Plochmopeltinites cooksonii, Trichothyrites denticulatus, and fungal spores like Ceratohirudispora miocenica, Curvularia sp, Involutisporonites trapezoids, Papulosporonites mohgaoensis, Papulosporonites sp and a few germlings. The availability of large number of fungal fruiting bodies and spores from this formation indicates the tropical and humid climate prevails during Miocene period. It is in turn indicates the presence of luxuriant vegetation prevails during this period in this region.

Keywords: Fossil fungi, Miocene, Neyveli lignite.

Introduction

The lignite deposits found in around Neyveli, a town in the Cuddalore district of Tamil Nadu ware named Neyveli lignite formation. This formation includes the lower part containing lignite as Neyveli Formation (Over 300m thick) and the Upper Cuddalore Formation (60–120m thick).

The Neyveli formation is a subsurface lithostratigraphic unit and consists of semi consolidated sandstones and clay beds with occasional limestone intercalations followed by carbonaceous clay and brownish black lignite (up to 23m thick). The lignite and underlying clay beds are rich in palynofossils and many research papers were published on the micro and megafossils available in the Neyveli lignite formation[1].

Report of Indian fossil fungi starts with the one initiated the studies onmicrothyriaceous fossil fungi from India[2]. Reported many well preserved fruit bodies of fungi from the Neyveli lignite[3]. Recently studied the fossil fungus of microthyriaceous from the tertiary of Laki sediments in Kutch and Tertiary coast in Kerala[4,5]. Later studied many well preserved fruit bodies from the Warkalli lignite of Kerala[6]. The present report is about the same well preserved fruit bodies and spores of fossil fungi of the Neyeli lignite formation.

Materials and Methods

The lignite samples were collected from the Mine-I, (Neyveli lignite formation), Tamilnadu, India. The lignite samples were partially crushed and macerated first with 60 % of nitric acid for one week. The macerated residue washed in distilled water. Then treated with concentrated HNO_3 for 12 hours to remove silica bodies and then repeatedly washed in distilled water and kept in 5% KOH for about 10 minutes. The final residue was centrifuged at 3000 rpm. A number of slides have been made from the residue with Glycerine–Jelly and the cover glass was sealed with paraffin wax. Slides were observed and photographed using an Olympus digital camera attached to Olympus microscope.

Observation

Asterothyrites[7,8]

Emended description[8]: Ascomata is ostiolate and ostiole is simple and not collar or thicken tissues, small and large may be irregular shape and outline regular. Ascomata are circular in shape, hyphae radially arranged and laterally interconnected to form of pseudo-parenchymatous cells. Cells are iso-diametric and squarish with elongated rectangular, ostiole are formed by lysogenetic dissolution of the central cells.
Classification: Ascomycetes, Microthyriales.

Asterothyrites konkanensis[8,9]: In the present specimen (Figure–1, A) the ascostroma is almost circular in shape, 64.0 µm in diameter, ostiole not clearly seen, hyphae forming apparatus, pseudo-parenchymatous cells. Cells in the central region are small and thick walled, whereas as the peripheral cell is rectangular. This specimen more closely related to *Paramicrothallites konkanensis* reported from Sindhudurg formation, Maharashtra[9]. So the present specimen assigned to this species. This is the first report of this species from Neyveli lignite formation.
Description[9]: Ascostromata shape is subcircular and dark brown, size range of 94–103 x 90–98 µm, ostiolate (7-9µm) and un-thickened, hyphae with radiating to forms of apparatus pseudo-parenchymatous cells, squarish of central cells, marginal cells are rectangular, uneven margin.

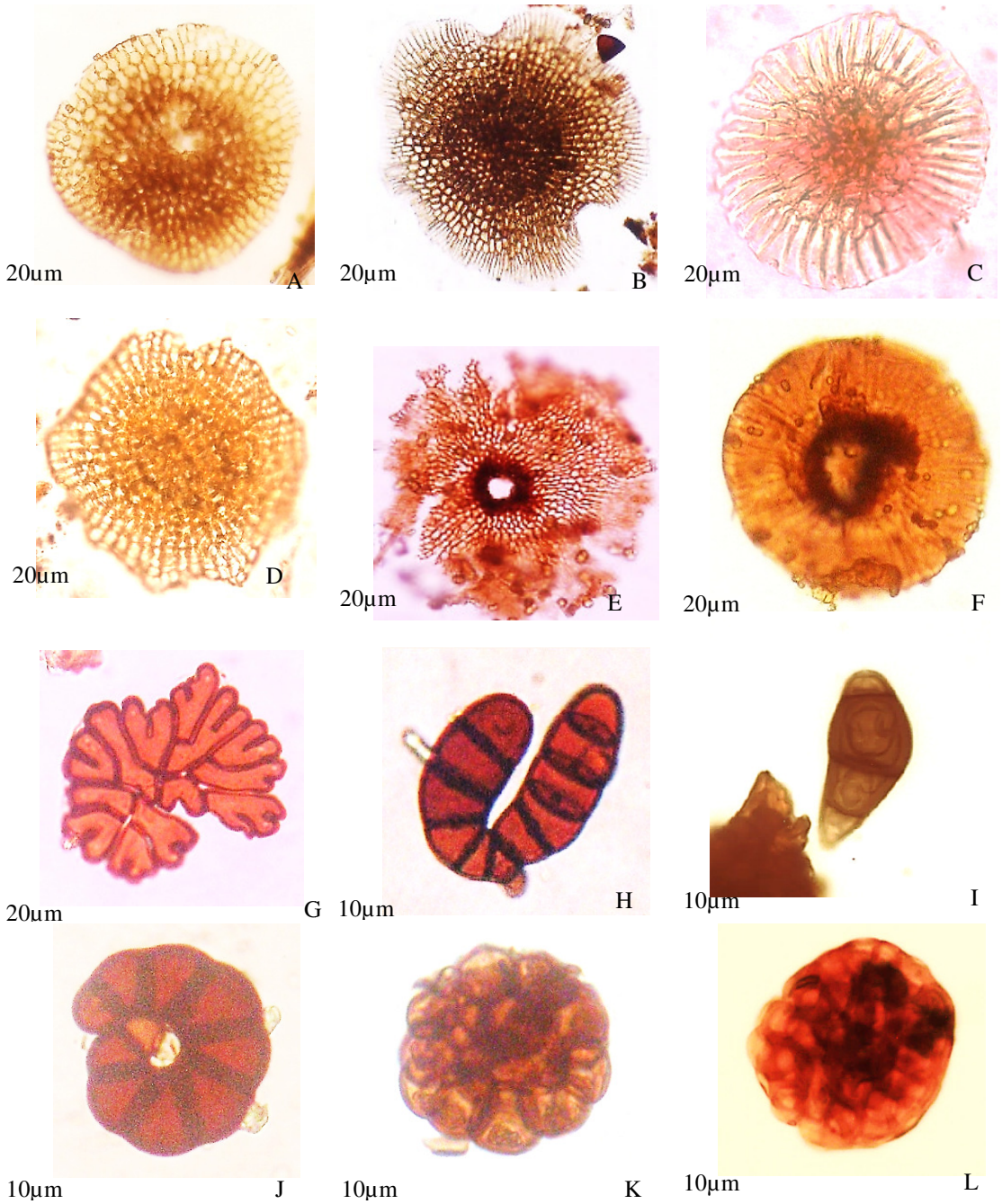

Figure-1

A. *Asterothyrites konkanensis* Saxena & Misra B. *Asterothyrites sp* C. *Microthyriacites cooksoniae* Rao D. *Microthyriacites ramanujamii* Saxena & Misra E. *Plochmopeltinites cooksonii* Ramanujam & Rao F. *Trichothyrites denticulatus* Reddy *et al* G. Germlings of *Microthyriaceous* fungi H. *Ceratohirudispora miocenica* I. *Curvularia sp* J. *Involutisporonites trapezoides* Kalgutkar K. *Papulosporonites mohgaeonsis* L. *Papulosporonites sp*.

***Asterothyrites sp*:** The present specimen (Figure–1, B) is more closely related to the *Asterothyrites* sp in having irregular ascomata, which is non–ostiolate dark–brown, in color. The central cells in the ascomata are thick walled, whereas the peripheral cells are thin walled, all cells are almost equal size and shape except the peripheral cells[10].

Microthyriacites[7]

Emended Description[8]: Ascomata is composed two parts. The central part is more or less equidimensional and hexagonal to squarish cells, little or no radial patterns, they tend to have thick walled and surrounded by hyphae is broad zone, composed to form of more elongated cells, with to form of interconnected a pseudo-parenchymatous cells, fabric with distinct radial patterns.
Classification: Ascomycetes, Microthyriales.

Microthyriacites cooksoniae[2]: In the present specimen (Figure–1, C) the thyriothecia is flat, circular, 78.0 µm in diameter, central region consists of small thick walled cells, whereas the peripheral cells are long and thin walled cells. The present specimen is more closely related to *M. cooksoniae* reported from Palana and Warkalli lignite formation[2]. So it is assigned to this species. This is the first report of this species from Neyveli lignite formation.
Description[2]: Thyriothecia flat, slightly dimidiate and orbicular or shield–shaped, 145–245 µm in diameter, central region of thick–walled compact cells, outer region of elongated, thin–walled cells.

Microthyriacites ramanujamii[9]: In the present specimen (Figure–1, D) the ascostroma is almost circular, non ostiolate, 68.0 µm, radiating hyphae forming a pseudoparenchymatous structure with small thick walled central cells, surrounded by thin walled, squarish peripheral cells, margin thin and wavy. The present specimen is more closely related to *M. ramanujamii* reported from Maharashtra[9]. So the present specimen is assigned to this species. This is the first report of this species from Neyveli lignite formation.
Description[9]: Ascostromata circular to subcircular, non–ostiolate, size range 110–126 x 90– 95 µm, hyphae radiating, forming pseudoparenchymatous, small thickened central cells and larger, rectangular to squarish outer cells, cells aporates, margin thin and wavy.

Plochmopeltinites Cookson 1947

Emended Description[7]: The fossil ascomata is dimidiate to form of ascomal sinuous plectenchyma membranes, ascomata characters are unknown.
Classification: Ascomycetes, Microthyriales.

Plochmopeltinites cooksonii[10]: The present specimen (Figure–1, E) is 65.0 µm in diameter and the ostiole is 15.0 µm in diameter. The ascomata is more or less rounded, consists of extremely sinuous, irregularly branched hyphae. The ostiole border is slightly elevated with thick walled cells. The present specimen is similar to that of the *P. cooksnii* described from Warkalli lignites of Kerala[10]. So the present specimen assigned to *P. cooksnii.* This is the first report of this species from Neyveli lignite formation.

Description[10]: Ascomata is superficial, discoid, rounded, 65–166 µm in diameter and ostiolate irregular in shape and more or less centric with slightly raised and border dense, thick-walled irregular cells and dark brown, 10.0–18.5 µm in diameter, covered by membranes of ascomata with plectenchymatous cells, consist of extremely with sinuous, hyphae irregularly branched, hyphae free, ascomata extending from marginal cells, hyphae cells (4-18 µm) long, consist of thick walled cells and excepted peripheral layers. The margins of fruiting bodies were not entire, peripheral cells are thin walled membranes.

Trichothyrites[11]

Emended description[12]: Thyriothecia due to compression, discor saucer in shape, form of upper and lower walls radiated rows, mostly square, cells 3–8×3–8µm. The cell wall of thyriothecium upper cell layer generally stronger and thicker than the lower layers. The thyriothecia rang of (70 µm to 200 µm in diam) and bearing to from don upper walls in erect and ostiolarwith collar, is made up of (2–6) tiers of small (2×2 µm), extremely thickened walls of quadrilateral cells, Upper mostly tier (ostiolar margin) of cells having short (setae) prolongations. In some cases of Thyriothecia have outline usually smooth and may appeared lobate.
Classification: Ascomycetes, Microthyriales.

Trichothyrites denticulatus[10–13]: The present specimen (Figure–1, F) is a ascomata with rounded margin, (65.0 µm in diam), margin smooth, ostiole is centric, (14.0 µm in diame) with border slightly raised, 6 denticular process projecting in to the ostiole cavity, cells between border ostiole and ascomata is periphery and regularly squarish to rectangular. The present specimen more closely related to *Notothyrites denticulatus* reported from Warkalli lignite[10]. Now this species placed under the genus *Trichothyrites*[8]. So the present specimen assigned to this species. This is the first report of this species from this formation.
Description[10–13]: Lacking of free myceliums, ascomata discoid and rounded, dimidate and smooth margin or rigid,(69–81µm in diam), ostiolate, Ostiole border 3–4 layered cells, elevated on slightly raised border. ostiole centric with 10–15 µm diameter, thick walled cells and dark brown, flattened to rounded, lumina narrow, marginal of ascomata5–16 × 3.8–6.5 µm, tangential walls thick, cells between the ostiole bordered, ascomata is periphery squarish or rectangular tangential walls 4–7 conical, teeth–liked ostiole cavity to form of inner layer of bordered, denticular processes, 3–5µm long, tip blunt or subacute, 4–5 µm broad, basally offenslightly reflexed.

Germlings of *Microthyriaceous* fungi*:* Many germlings of different developmental stage of microthyriaceous fungi have been observed in all the samples studied. The present specimen (Figure–1, G) is a germling of a Microthyriaceous fungi. A few centrally placed cells surrounded by more or less formed peripheral cells. All the cells are thick walled. Recently reported

more or less similar germlings from a Miocene carbonaceous clay near Quilon in Kerala[5].

Ceratohirudispora[14]

Emended Description[14]: Hyphomycetaceous types of fungi, growth germinated by form of apical conidium, the conidium may be enlarges and laterally form of opposite direction with two–three arms, the conidiopore small, conidia (5–10) cells, septa, 2 µm thick, broad base with narrow tips.
Classification: Fungi imperfecti, Phragmosporae.

Ceratohirudispora miocenica[10]: The present specimen (Figure–1, H) is two armed, arms mostly equal in size, V–shaped, 27.0 µm long, septateconidia. Septata 4–5 in each arm, in middle of conidia broader, narrow at the base and ape 5.7µm. So far two species of *Ceratohirudispora* viz. *C. miocenica* and *C. triradiata* reported from the Tertiary deposits of the world and they are only from India[14]. Among the two species the present specimens more closely related to *C. miocenica*. This specimen is more closely related to *Ceratohirudispora miocenica* reported from Mizoram, India. First report of this genus from this formation[14].
Description[14]: Imperfect fungi of Conidia, two arms and V–shaped conidia, laterally opposite to each other formed an acute angles, arms may be equal in size, 24–38×5–9 µm, conidia septates, septa 6–8, 2 µm thick, middle of conidia in broader, narrow at conidia base and apex, conidia walls 1 µm thick, surface laevigates.

***Curvularia sp*:** The present specimen (Figure–1, I) is a conidium of *Curvularia sp.* It is four celled, cells are slightly curved and thick walled. This type of conidium so far reported only from quaternary deposits. Very rarely it was also reported from Tertiary deposits[15]. This is the first report of this genus from Neyveli lignite formation.

Involutisporonites[16]

Emended description[16]: Fungal spore coiled, transversely septate, multicellate, individual cells of variable shapes, septal pores may or may not be present, terminal cell if present, may have a single pore, spore wall generally psilate to variously ornamented.
Classification: Fugi Imperfecti, Helicosporae

Involutisporonites trapezoides[17]: The present specimen (Figure–1, J) is a dark brown, helicoid, tightly coiled structure consists of ten cells arranged in aconical helix. Each cell is tetrazoidal in shape, outer cell walls very larger than inner cell wall, septum thick walled cells, 7.0 µm in diameter. The present specimen is more closely related to *I. trapezoids* reported from Canada[17]. So the present specimen is assigned to this species. This is the first report of this species from this formation.
Description[17]: This types spores multicellular, distinctive, dark brown, tightly coiled, helicoid, porate, spores smooth with open centre, ten to more cells formed by a conical helix, having irregularly and elongated, tetrazoidal shapes, outer cell wall longer than the inner cell walls and separated by thick cross walled. The cells generally not constricted septa, (10–12 µm in diam). Apical cells in the centre cells, porate, pore simple, pore rounded, septa 2 µm thick, with folded and central slit like opening, spore size ranges about 33–43×28–35 µm.

Papulosporonites[18]

Emended Description[18]: This fungal spores are elongated shape or globular, it consist of more or less polygonal cells with numerous, the cells fused into mulberry shape of aggregate types. The cells may be without order and concentrically arranged, no differentiation of outer walls, 1 to 3 of innermost cells and commonly larger.
Classification: Fungi Imperfecti, Dictyosporae.

Papulosporonites mohgaoensis[8-19]: The present specimen (Figure–1, K) is ball shaped consisting of 19 spores. Size of spore balls varies from 16µm. Individual spores may be globose shape, because compression of they looking polyhedral, spores are 6-7 µm in diameter. The present specimen is more closely related to *Sorosporium mohgaoensis* described from Madhya Pradesh and it is later transferred to *Papulosporonites* as *P. siwalikus*[19]. So the present specimen is assigned to this species. This is the first report of this species from Neyveli lignite formation.

Description[19]: This types of fungal spores deeply buried in the host tissues, spores pale yellow to reddish brown color, they are egg shaped, 5 to 25 spores, spores are united, spore ball not covered any sheath, and size of spore ball various from 17–21 x 35–46µm, individual spore like globose to ovoid shapes, because of compression they look polyhedral, The mycelium clearly not seen, spores (5.3 to 10.6 µm) in average of 8 µm in diam, and epispore is smooth, (0.3–0.7 µm).

***Papulosporonites sp*:** This specimen (Figure–1, L) more closely related to *Papulosporonites sp* reported from Milk River formation (Late Cretaceous) of Canada[20]. This species differ from *P.mohgaoensis* which having rounded cells and formed by outer layers and the distinct central tissues of the thick wall cells.

Discussion

In the present work some fruiting bodies and spores of fossil fungi belonging to Microthyriales were observed. The fruiting bodies observed from the sample includes *Asterothyrites konkanensis, Asterothyrites sp, Microthyriacites cooksoniae, Microthyriacites ramanujamii, Plochmopeltinites cooksonii, Trichothyrites denticulatus,* and fungal spores like *Ceratohirudispora miocenica, Curvularia sp, Involutisporonites trapezoids, Papulosporonites mohgaoensis* and *Papulosporonites sp* and few germlings were also observed**.**

Today, fossils of the microthyriaceae type are known from extensive regions all–round the globe mention may be made of the following studies. Argentina[21], North America[11-22], Auatralia[7–23], India[10], South Africa[24], Romania[25], Germany and the Netherlands[26], Finnish Lapland[27].

Conclusion

The observation of large numbers of *Microthyriaceous* fungi from Neyveli lignite formation indicated that during the Tertiary period of Miocene. The Neyveli ligmite deposited regions may be enjoying the tropical conditions or humid climates and concluded that the luxuriant vegetation in this area.

References

1. Saxena R.K. (1992). Neyveli lignites and associated sediments–their palynology, palaeoecology, correlation and age. *Palaeobotanist*, 40, 345-353.

2. Rao A.R. (1958). Fungal remains from some Tertiary deposits of India. *Palaeobotanist*, 7(1), 43-46.

3. Ramanujam C.G.K. (1963). Thyriothecia of Asterineae from the South Arcot lignite, Madras. *Current Science*, 32, 327-328.

4. Venkatachala B.S. and Kar R.K. (1969). Palynology of the Laki sediments in Kutch–2. Epiphyllous fungal remains from the bore–hole No. 14. *Palaeobotanist*, 17, 179-183.

5. Jain K.P. and Gupta R.C. (1970). Some fungal remains from the Tertiaries of Kerala coast. *Palaeobotanist,* 18, 177-182.

6. Ramanujam C.G.K. and Rao K.P. (1977). A palynological approach to the study of Warkalli deposits of Kerala in South India. *Geophytology*, 7(2), 160-164.

7. Cookson I.C. (1947). Fossil fungi from tertiary deposits in the Southern hemisphere, Part I. *Proc. Linn. Soc. NSW,* 72, 207-214.

8. Kalgutkar R.M. and Jansonius J. (2000). Synopsis of fungal spores, mycelia and fructifications. AASP Contribution Series, 39, 1-423.

9. Saxena R.K. and Misra N.K. (1990). Palynological investigation of the Ratnagiri Beds of Sindhu Durg District, Maharashtra. *Palaeobotanist*, 38, 263-276.

10. Ramanujam C.G.K. and Rao K.P. (1973). On some microthyriaceous fungi from a Tertiary lignite of South India. *Palaeobotanist*, 20(2), 203-209.

11. Rosendahl C.O. (1943). Some fossil fungi from Minnsota. *Bulletin of the Torrey Bot. Club*, 70, 126-138.

12. Smith P.H. (1980). Trichothyriaceous fungi from the Early Tertiary of southern England. *Palaeontology*, 23, 205-212.

13. Reddy P.R., Ramanujam C.G.K. and Srisailam K. (1982). Fungal fructifications from Neyveli lignite, Tamil Nadu – Their stratigraphic and palaeoclimatic significance. *Records of the Geological Survey of India*, 114(5), 112-122.

14. Kar R., Mandaokar B.D. and Kar R.K. (2010). Fungal taxa from the Miocene sediments of Mizoram, Northeast India. *Review of Palaeobotany and Palynology*, 158, 240-249.

15. Singh S.K. and Chauhan M.S. (2008). Fungal remains from the Neogene sediments of Mahuadanr Valley, Latehar District, Jharkhand, India and their climatic significance. *Journal Palaeontological Society of India*, 53(1), 73-81.

16. Clarke R.T. (1965). Fungal spores from Vermejo Formation coal beds (Upper Cretaceous) of Central Colorado. *Mountain Geologist*, 2, 85-93.

17. Kalgutkar R.M. (1993). Paleogene fungal palynomorphs from Bonnet Plume Formation, Yukon Territory. Geological Survey of Canada, Bulletin, 444, 51-105.

18. Schmiedeknecht M. and Schwab G. (1964). Bulbillen fossiler Pilze aus einer tertiären Weichbraunkohle. *Deutsche Akademie der Wissenschaften zu Berlin*, 6, 683-692.

19. Chitaley S.D. and Yawale N.R. (1978). Fungal remains from the Deccan Intertrappean Beds of Mohgaon Kalan, India. *Botanique*, 7(4), 189-194.

20. Ramakant M., Kalgutkar and Dennis R Braman. (2010). Santonian to? Earliest Campanian (Late Cretaceous) fungi from the Milk River Formation, Southern Alberta, Canada. *Palynology*, 32(1), 39-61.

21. Martinez A. (1968). Microthyriales (Fungi, Ascomycetes) fossils del Cretacico inferior de la provincia de Santa Cruz, Argentina. *Ameghiniana*, 5, 257-263.

22. Dilcher D.L. (1965). Epiphyllous fungi from Eocene deposits in westwrn Tennessee, U.S.A. *Palaeontographica*, 116, 1-54.

23. Selkirk D.R. (1975). Tertiary fossil fungi from Kiandra, New South Wales. Proc. Linn. Soc. Nw., 100, 70-94.

24. Thiergart F. Frantz V. and Ravkopf K. (1963). Palynologische Unter uchungen von Tertiary kohlen undeiner oberfliichen probe niine Knysna, Sud–Afrika. *Advg. PI Sci,* 4, 151-178.

25. Givulescu R. (1979). Paläobotanische Untersuchungen im Pflanzenfundort Chiuzbaia, (Kr. Maramureş, Rumanien. Inns. *Geol. Geof. Memorii Bucureşti,* 28, 1-81.

26. Van Geel B. (1978). A palaeoecological study of Holocene peat bog sections in Germany and The Netherlands, based on the analysis of pollen, spores and macro- and microscopic remains of fungi, algae, cormophytes and animals. *Rev. Palaeobot. Palynol*, 25(1), 1-120.

27. Tynni R. (1982). The reflection of geological evolution in Tertiary and interglacial diatoms and silicoflagellates in Finnish Lapland. *Geological Survey of Finland Bulletin,* 320, 1-40.