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Contributions to the Geometry of Gastropods

by T. Jaskó

A 17th Century scientist, Christopher Wrenn, was the first to observe the logarithmic spiral shape of the gastropod and cephalopod shells. Several mathematicians followed him, making independently the same discovery (Leslie 1822, Moseley 1838, Naumann 1845). Only Thompson's synthesis cleared up the situation (Thompson 1963).

$$\Theta = k \log r \qquad (1)$$

The most important property of logarithmic spiral curve (1) is that it remains similar to itself during growth. The gastropod shell is a "coiled cone" from the geometrical point of view.

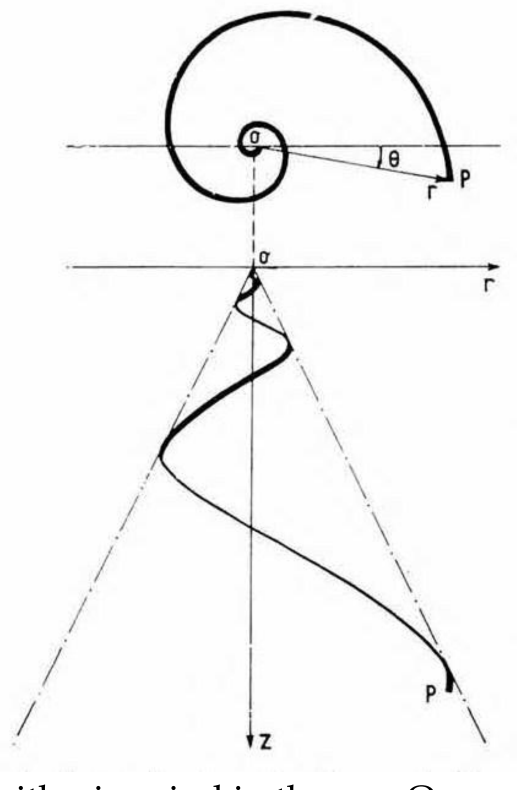

Fig. 1. The logarithmic spiral in the r, z, Θ coordinate system

Generatrices of the “cone” are the logarithmic spirals (e.g. suture), generating curves are the growth lines. So the equation of the shell is composed of two different equations, that of a logarithmic spiral and a growth line, by replacing the parameter in one with the other equation. Raup (1966) summarizes the properties of shell growth in four statements including the folowing equations (2).

$$r = r_0 W^{(\Theta/2\pi)}$$
$$z = z_0 W^{(\Theta/2\pi)} + r_0 T(W^{(\Theta/2\pi)} - 1) \qquad (2)$$

They allow to get the (2) equations for the shell in the cylindrical z, r, Θ co-ordinate system, where z is the coiling axis and the position of the centre of the initial generating curve is at z = 0.

$$\Theta\ (0, T, r_c) \qquad (3)$$

There are standard procedures for the measuring of the logarithmic spiral (Thompson 1963, Vasicek 1967). Theoretically, all free-moving animals characterized by inorganic outer shell and the lack of sloughing, obey this law.

Allometric measurements show systematic deviation in few cases only. It is a vexed question whether a more fitting curve is needed or not (Naumann 1845, Grabau 1872, Burnaby 1966).

Contrary to this, the laws governing the shape of the generating curve are not cleared yet.

Raup's four statements are reduced to two with a more favourable choice of the origo (placing it to the apex of the shell):

i. The shape of the generating curve remains constant during growth;
ii. The rate of whorl expansion is nearly constant. With this (2) will be simplified to (4).

$$r = r_0 W^{(\Theta / 2\pi)}$$
$$z = z_0 W^{(\Theta / 2\pi)} \qquad (4)$$

Several morphological features can be defined in mathematical terms.

Cox (1960) distinguishes four types of coiling direction; each corresponding to one orientation in the co-ordinate system (Table 1, Fig. 2).

Table 1. Types of coiling

	Position of internal organs	
	sinistralis	dextralis
Hyperstrophia	ultrasinistralis	ultradextralis
Isostrophia	planispiralis	
Orthostrophia	sinistralis	dextralis

The aperture is to be placed on the left or right side according to the orientation of the inner organs (if known); hyperstrophic forms should be placed with spire down. Symmetric forms (not found among gastropods) should be illustrated as if being right handed, this being the common "normal" case.

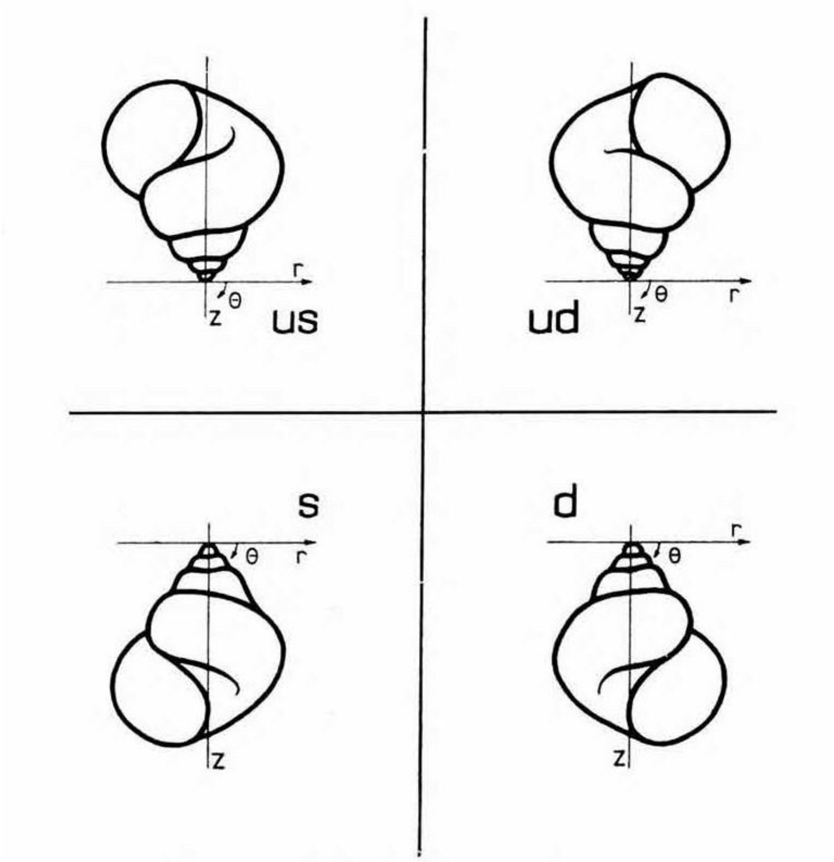

Fig. 2. Types of coiling (See Table 1) d = dextralis, s = sinistralis, ud = ultradextralis, us = ultrasinistralis

Table 2. táblázat

Variatons of shell form by conical angle values

	ϕ_b			
	<90°	90-180°	180°	>180°
$\phi_a > 0°$	uK	uU	uC	uA
$\phi_a = 0°$	cK	cU	cC	cA
$\phi_a < 0°$	aK	aU	aC	aA

Note: lower case letters refer to value of ϕ_a, upper case ones to ϕ_b oldalára utalnak: u = umbilicus, k = konvex, outer cone, c = columella, a = total overlap.

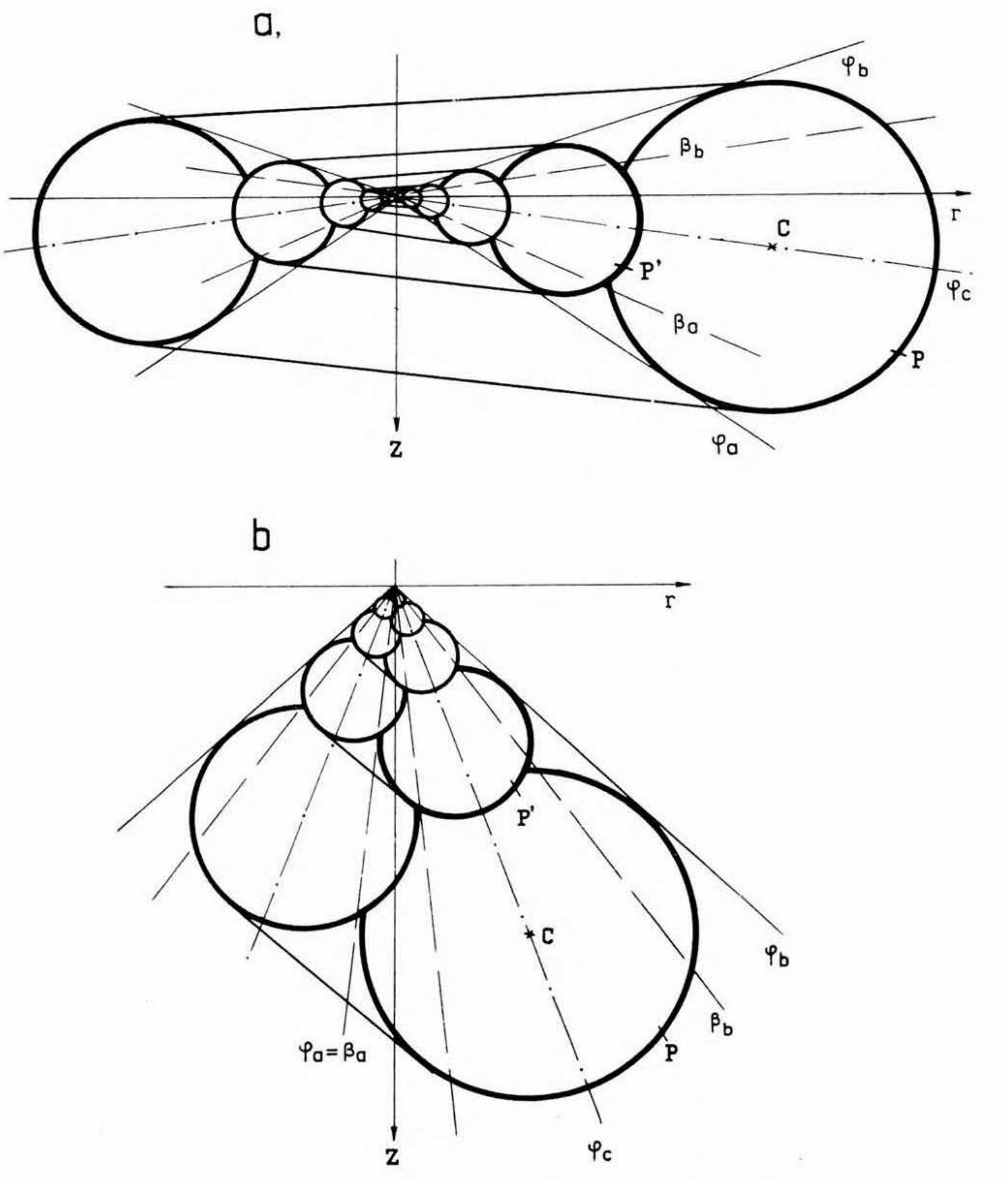

Fig. 3. Examples for different positions of the generating curve
Legend: φa, φb conical angles, *β*a, *β*b suture angles, P(r, z) is an arbitrarily placed point on the generating curve, P′ corresponds to P a whorl earlier, C is the centre of the generating curve. a) involute type ***uU***, b) ***aK*** type

We can determine the maximum and minimum values of (**p** = arc tg **r****z** in the **r**, **z** plane (ra, rb, ϕb, ϕa, respectively). These are real conical angles of the shell if $r_{min} > 0$; there is a columella at r_{min} — 0; and at

$$0° < \phi_a \text{ or } (180° - \phi_b) < 90° \qquad (5)$$

we find an umbilicus.

There is no suture unless equation (6) or (7) has at least one solution.

$$z\ (r) = z\ (r)\ W \qquad (6)$$

$$z\ (r) = z\ (-r)\ W^{1/2} \qquad (7)$$

Of the theoretically possible 4 solutions, only 2 sutures can be defined as a line on the shell surface where whorls meet, for three planar provinces can have only two common points.

Let the (two) suture angle(s) be ϕ (ϕb, ϕa) (if there are any). The sutures given by (6) are real and visible, those of (7) have negative r values, visible only at the end point and are not known to occur in the nature.

Theoretically, 18 combinations of solutions (6 of them symmetric) are possible.

We can interpret the mathematical bearing of some common terms: anomphalous (ϕa <= 0), phaneromphalous (ϕa >> 0), conispiral (ϕb<90°), planispiral (ϕb> 90°), evolute [lack of any solution of (6) and (7)], involute (two umbilicus, two sutures), convolute (columella in two directions).

We should use a periodical function of Θ or a discrete gnomonic series in describing a periodic ornament; the latter is specially advantageous for chambered shells.

Formulae (8) — (15) define the relations of shell equation parametres to common linear and angular measurements (for definitions, see Cox 1960), where α is the loxodrome angle, other symbols being the same as in Fig. 4.

$$H_{max} = \max (H_a, H_t) \quad (8)$$

$$\boldsymbol{H_a = z_{0max} - z_{0min}} \quad (9)$$

$$\boldsymbol{H_{sp} = z_{0min}} \quad (10)$$

$$\boldsymbol{H_k = z_{0max} - z_{0min}/W} \quad (11)$$

$$\boldsymbol{D_{max} = r_{0max}} \ (1 + 1/\sqrt{\boldsymbol{W}}) \quad (12)$$

$$\operatorname{tg} \boldsymbol{\lambda} = \operatorname{ctg} \boldsymbol{\alpha} \operatorname{ctg} \boldsymbol{\beta} = \ln W / 2 \boldsymbol{\pi} \ (\cos \boldsymbol{\beta} / \sin^2 \boldsymbol{\beta}) \quad (13)$$

$$\ln W = \sin \boldsymbol{\beta} \operatorname{ctg} \boldsymbol{\alpha} \quad (14)$$

In addition to conventional descriptions, whorl expansion rate (W) that is the rate of any linear measurement of two neighbouring whorls, should also be given.

$$W = a_n / a_{n+1} \quad (15)$$

Rate and angular measurements are more characteristic of a species than linear ones (Torre 1965). xxxx

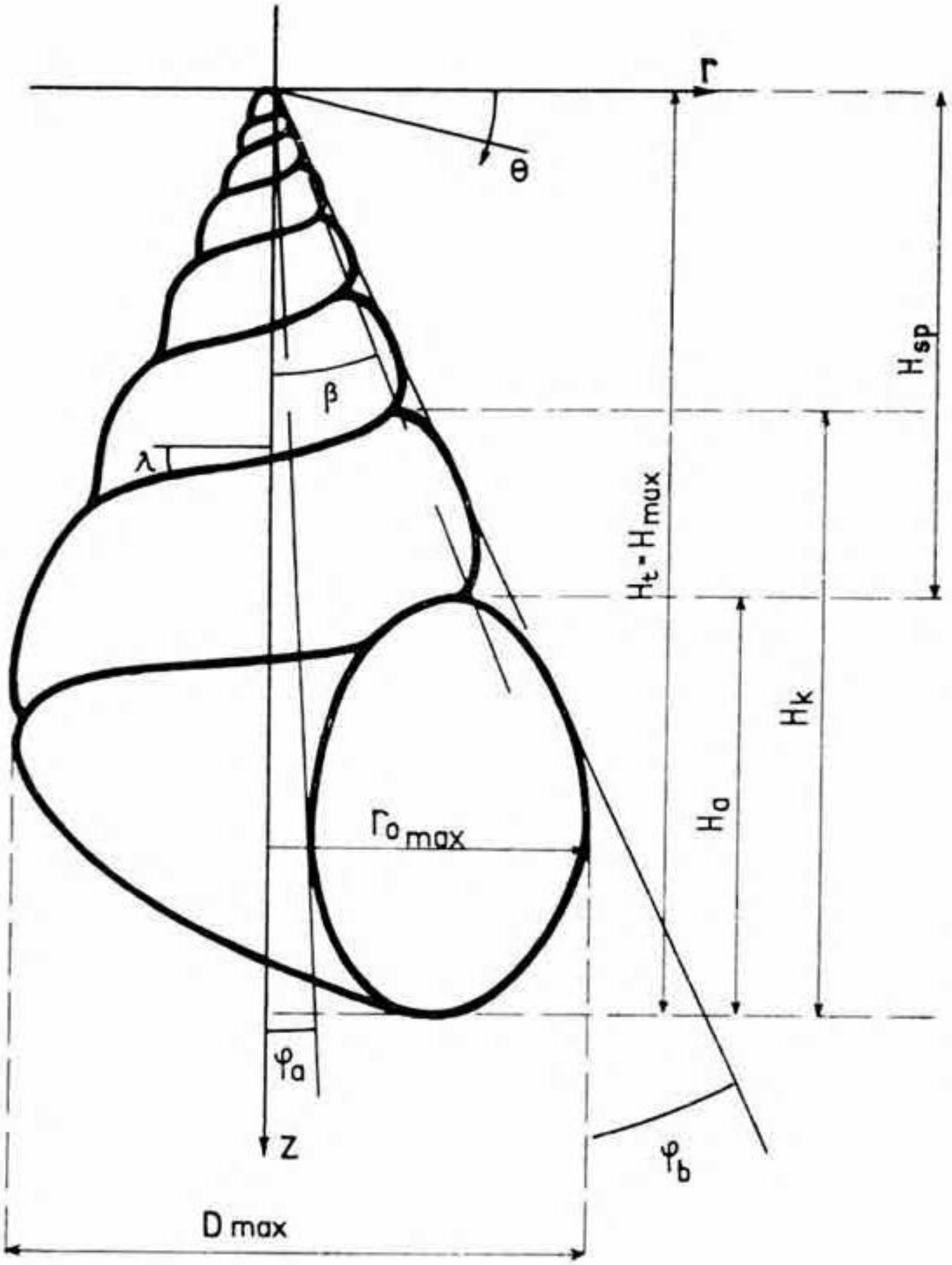

Fig. 4. Measurements on the gastropod shell
Angular measurements : ϕa umbilical angle, ϕb spire angle, ß suture angle, Λ sutural slope. *Linear measurements* : $\mathbf{H_{max}}$ height of shell, $\mathbf{H_t}$ = $\mathbf{Z_{0max}}$ maximal height measured from apex, $\mathbf{H_{sp}}$ height of spire, $\mathbf{H_k}$ height of last whorl, $\mathbf{H_a}$ height of aperture, $\mathbf{D_{max}}$ maximum diameter, $\mathbf{r_{0max}}$ maximum distance from coiling axis. *Coordinates*: r, z, Θ.

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(Magy. Áll. Földt. Int. Évi Jel., 1968 (1971), p.379-389)

Lignite exploration in Turkey - comparison with Hungarian experiences

S. Jaskó

The Bundesanstalt für Bodenforschung (Hannover, West Germany) has carried out extensive lignite exploration in Turkey in the late '60s. The principal objective was to locate deposits for large scale open pits. Exploration drilling amounted to 166,000 metres in 5 years. In Hungary, 15,000 metres were drilled yearly in 1963-1965, at the peak of lignite exploration activities.

Lignite deposits in Turkey range from Lower Miocene to Upper Pliocene in age, with fossil assemblages similar to that of Hungary.

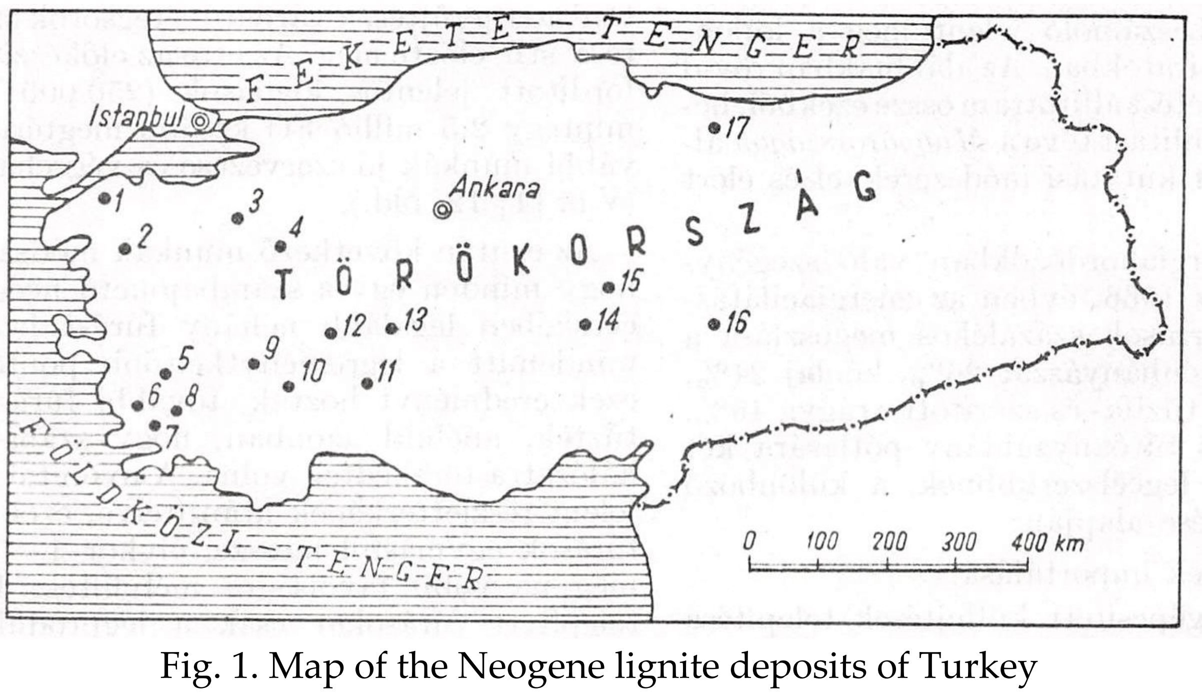

Fig. 1. Map of the Neogene lignite deposits of Turkey
Basins: 1 = Can, 2 = Soma, 3 = Tuncbilek, 4 = Seyt-Omer, 5 = Sahinali, 6 = Sekköy, 7 = Alakalise, 8 = Yatagan, 9 = Acigöl, 10 = Burdur, 11 = Bey§ehir, 12 = Yalva9, 13 = Ilgin, 14 = Yelihisar, 15 = Kayseri, 16 = Elbistan.

The main lignite deposits in age order (with numbers referring to the map):
Lower Miocene: Alakalise 7.
Middle Miocene: Can 1., Soma 2., Tuncbilek 3., Seyt-Ömer 4., Sahinali 5., Sekkőy 6., Yatagan 8.
Upper Miocene: Yalvae 12.
Lower Pliocene: Ilgin 13., Havza 17.
Upper Pliocene: Acigöl 9., Burdur 10., Beysehir 11., Yelihisar 14., Kayseri 15., Elbistan 16.

The Elbistan deposit is by far the largest of the 16 basins explored. Table 1 shows technical data for 3 blocks of this deposit: Afsin, Cöllolar, Kislaköy.

Table 1.

Propert	Unit	Afsin	Cöllolar	Kislaköy
Open cast area	km^2	12,6	18,7	12,3
Coal resource	million t	350	850	440
Thickness of overburden	m	60,7	101,9	66,9
Thickness of lignite	m	27,8	45,7	35,8
Average overburden/lignite	m/m	2,2	2,2	1,9
Planned depth of pit	m	49-100	92-179	36-133
Average calorific value	kcal/kg	1130	1185	1130
Average ash content (dry)	%	43,35	39,85	37,75
H_20	%	52,41	52,30	53,12

As in the case of Bükkábrány (northern Hungary), blocks are considered separately for opencast development. Elbistan was drilled in a 250 m square grid, Bükkábrány in a 350 m grid.

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(Bányászati és Kohászati Lapok Bányászat (Budapest), vol.106, no.12, p.848-851)

Lignite Formation in South-east Europe in the Pliocene

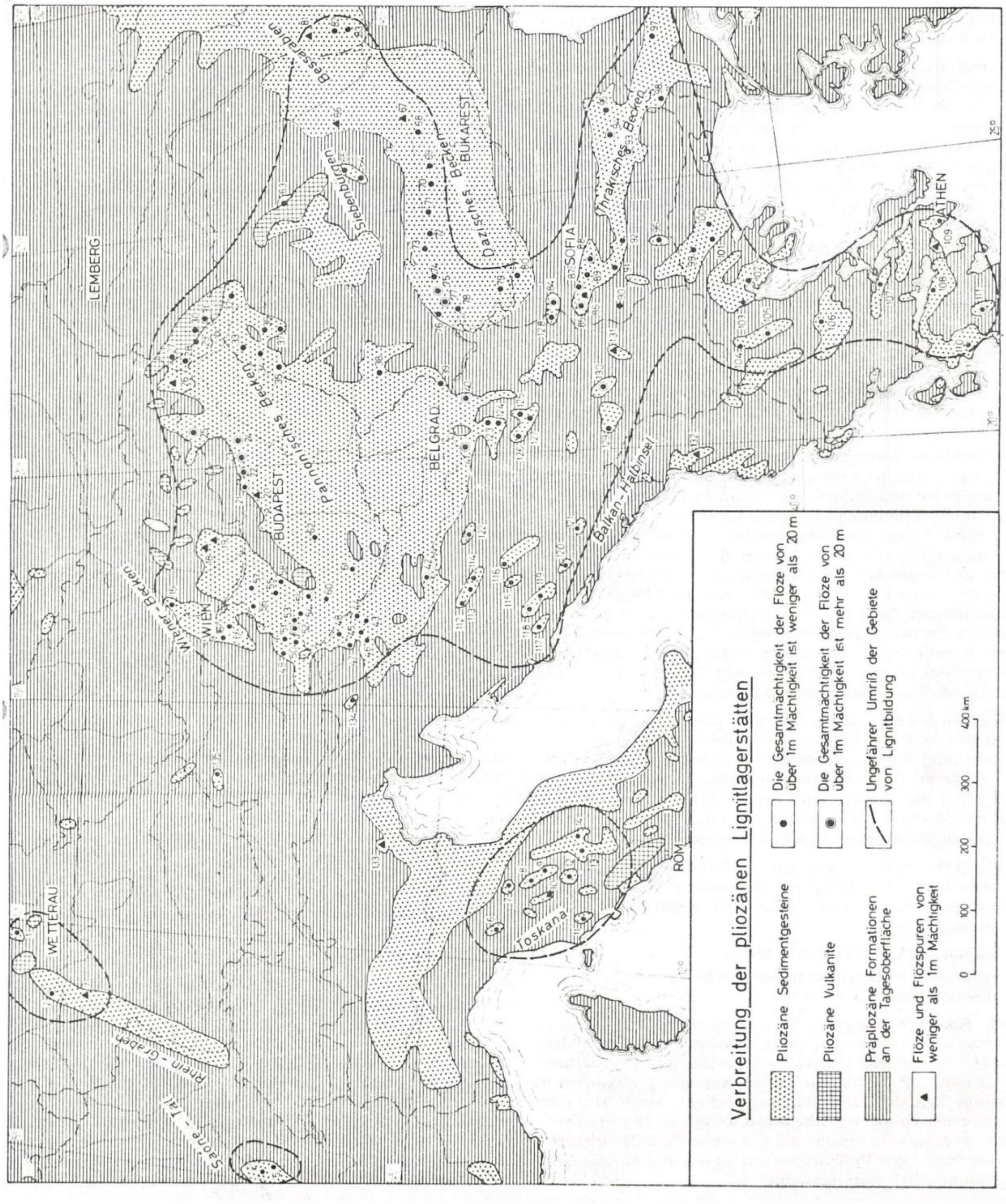
Dr. S. Jasko

The Pliocene lignite deposits of Europe can be assigned to two different types. (For their location, see attached map).

The first group includes the lignite deposits of the Vienna, Pannonian, Dacian and Thracian basins. These are paralic lignite formations within thick inland sea-deposited sedimentary sequences. The lignite formations extend laterally over great distances and consist of several, separate lignite seams of reduced thickness. All were formed in one and the same stratigraphic horizon — the Upper Pannonian (Dacian).

The second type includes the lignite deposits occurring in the valleys of the western and southern parts of the Alps, Tuscany and the Balkans. Laterally, these are of small extension and they consist, for the most part, of one thick lignite seam. They rest directly on the basement and are of limnic facies.

The deposits of this second type are of different age. The small isolated deposits represent various stratigraphic horizons from the lowermost Pliocene up to the Quaternary.



Map of the distribution of Pliocene lignite deposits:

Rhine-Graben and Wetterau: 1. Heichelsheim, 2. Hersfeld, 3. Stockstadt Saone-Tal (Bresse) 4. Vincelles, 5. Ratte

Tuscany: 6. Berga, 7. Mugello, 8. Santa Barbara (Valdarno), 9. Quarata, 10. Siena (Senese), 11. Ribolla (Bacinello), 12. Renelloni, 13. Piatrafita (Bastardo), 14. Frossione

Vienna Basin: 15. Dubnany, 16. Neufeld, 17. Zillingsdorf

Pannonian Basin: 18. Ghymes, 19. Lukanec, 20. Aszód, 21. Selyp, 22. Ecséd, 23. Visonta, 24. Bükkábrány, 25. Komjáti, 26. Mihalovce (Nagymihályi), 27. Novo-Selicko (Ujkemence), 28. Usgorod (Ungvár), 29. Berezina, 30. Ilnick, 31. Veliko-Rakovec (Nagyrákóc), 32. Baia-Mare (Nagybánya), 33. Bobota, 34. Derdsida, 35. Bodonos, 36. Ip-Zauani, 37. Valea-Neagra, 38. Sinersig (Szinérszeg), 39. Radjevo, 40. Kostolac, 41. Kolubara, 42. Nova-Gradiska, 43. Glogovac, 44. Kapronca, 45. Sokalovac, 46. Lapavina, 47. Ivanovec, 48. Bányavár, 49. Ilz, 50. Henndorf, 51. Deutschützen, 52. Torony (Nárai), 53. Ják, 54. Vasvár, 55. Sárvár, 56. Fertőd, 57. Csorna, 58. Döbrönte, 59. Vállus, 60. Zalamerenye, 61. Gige, 62. Nagyberény

Transylvania (Siebenbürgen, Erdély, Transilvania): 63. Borsec (Borszék), 64. Ilieni (Ilyefalva), 65. Baraolt (Bárót)

Dacian Basin: 66. Pralea-Caiusti, 67. Ojasca, 68. Ceptura, 69. Filipesti, 70. Sotinga, 71. Schitu, 72. Curtea, 73. Olt, 74. Carbunesti, 75. Rovinari, 76. Arama, 77. Tismann, 78. Motrul, 79. Bailesti, 80. Lom

Bessarabia: 81. Kagul, 82. Belgrád, 83. Etulisko

Thracian Basin: 84. Stanici, 85. Belobres, 86. Aldomirovsk, 87. Sofia, 88. Bistrica, 89. Tsdiukorovo, 90. Küstendil, 91. Samokov, 92. Gabrovnisk, 93. Dimitrovgrad (Marica-West), 94. Marica-Ost, 95. Elhovo, 96. Gocedeltdiev, 97. Tozlaki, 98. Ophiolon

Western & Southern Balkan Peninsula: 99. Sidhirokastron, 100. Alistrati, 101. Serral, 102. Thesaloniki, 103. Mosoptaraos, 104. Vevi, 105. Ptolemais, 106. Larissa, 107. Locrida, 108. Korinthos, 109. Megara, 110. Pyrgos, 111. Megalopolis, 112. Banja-Luka, 113. Kotor-Varos, 114. Maslovare, 115. Bugojno, 116. Zenica, 117. Sinj, 118. Livno (Prolog-Celebric), 119. Dubno, 120. Mostar, 121. Gacko, 122. Tuzla, 123. Mladenovac, 124. Jacenica, 125. Grúza, 126. Cacak (Gorjevica), 127. Milocaj (Tavnik), 128. Dimitrovgrad, 129. Metohija, 130. Kosovsk, 131. Bunusevci, 132. Tirana

Eastern Alps: 133. Cornuda, 134. Velenje (Wöllan), 135. Wolfsegg.

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(Braunkohle (Düsseldorf), vol.25, no.3, p.13-18)

Complementary Data to the Large Fungi Flora of the Bakony Mts.

László Szemere

The author published “The large fungi of the Bakony Mts.” in 1968 in these Proceedings. Additional species acquired since (both living subterraneous and on the surface) are herewith given to complete the list issued in the major work.

In the listing, the Latin names give lead to the readers as to the fungi flora of the Bakony Mts. Certain species which had already been included into the list in 1968 but with one locality only are again given to show their wider distribution.

Aleuria FUCKEL. (Peziza DILL.)
A. aurantia (FR.) FUCKEL. — 1963. IX. 25. Farkasgyepű. BABOSNÉ és BOHUS.

A. sylvestris BOUD. — 1966. VII. 19. Fenyőfő, DOBOLYI.

Ascobolus PERS.
A. atrojuscus PHILL. et. PLOWR. — 1963. VI. 26. Bakonybél, TÓTH.

Balsamia VITT.
vulgaris VITT. — 1967. VII. 25. Hárskút: Sándor-árok.

Bulgaria FR.
inquinans FR. — 1962. XI. 6—7. Cuha-völgy, Zirc (Tündérmajor), TÓTH. 1969. VIII; 9. Hárskút, Réh-erdő.

Chorosplenium FR.
aeruginosum. (OEDER ex S. F. GRAY) de NOT. VII. 3. Bakonybél (Gáthegy) & Hárskút (Esztergáli-völgy), TÓTH.

Coryne TUL.
cylichnium (TUL.) BOUD. —1962. XI. 6. és 7. Cuha-völgy & Bakonybél, TÓTH.

Cyathicula BULL.
coronata (BULL. ex. FR.) de NOT. 1962. X,. 6. Cuha-völgy, TÓTH.

Cyathus HALL.
C. olla PERS. —1969. VI. 22. Balatonalmádi, MARKÓNÉ.

Dryodon BULL.
D. erinaceus BULL. — Süngomba. 1970. VIII. 4. Hárskút: Hajag.

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Galactinia CKE.
michelii BOUD. —1963. VI. 2. Bakonybél (Márványkőárok) TÓTH. Bakonyszentlászló (Betyárbarlang) 1965. VII. 26. DOBOLYI.

praetervisa (BRES.) BOUD. —1963. VI. 26. Bakonybél (Somhegy), TÓTH.

Geopyxis (PERS.) SACC.

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Mitrophora LEV.
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