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CONDITIONS OF RENDZINA OCCURRENCE IN THE FLYSCH CARPATHIAN MOUNTAINS

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Investigations on the influence of field relief, erosion, deposition of layers and the character of parent material on the occurrence of flysch rendzinas were carried out in the years 1960—62 in the following Carpathian regions: Ciężkowice Foothills (environs of Brzostek), Dynów Foothills (environs of Babice), Rymanów Hills (environs of Besko).

In the region of Babice were examined rendzinas formed from the chalk layers of inoceramic series which are composed of sandstones, often with a limy binder, argillaceous-marly shales, argillaceous-sandy shales, argillaceous-alcareous sandstones and hard marls [7].

In the environs of Besko and Brzostek the flysch rendzinas examined originate from rocks of Krosno layers which cover in a compact mass the larger part of the investigated area [6]. Beside sandstones and argillaceous shales without carbonate, there occur in these layers also fairly numerous strata containing considerable amounts of calcium carbonate.

During the field investigations material was collected for laboratory analysis and soil cross sections were performed. In the soil samples taken, some chemical and physical properties and mechanical composition were determined. The analysis results are given in tables I, II, III.

RESULTS

Our investigations make it possible to conclude that the argillaceous--marly shales, often interstratified with sandstone silt, are the parent rock from which rendzinas are formed. Rendzinas formed from calcareous and marly sandstones were rarely found. Flysch rendzinas occur in

Table 1

Mechanical composition of Flysch rendzinas*

Nr. of profile	Horizon	Depth cm.	Particles content >1 mm.	Particles content <1 mm.	Diameter of particles in mm.							Soils formed from:
					1-0.1	0.1-0.05	0.05-0.02	0.02-0.006	0.006-0.002	< 0.002	< 0.02	
			%									
V	A_1	2-8	0.0	100	3	14	19	12	12	40	64	argillaceousmarly shales
	B	12-20	0.0	100	1	9	14	15	17	44	76	
	C	50-60	-	-	1	6	13	17	23	40	80	
XI	A_1	5-15	7.5	92.5	14	7	8	11	9	51	71	argillaceousmarly shales
	C	40-50	-	-	0	4	3	8	10	75	93	
I	A_1	5-15	0.0	100	17	31	25	10	3	14	27	argillaceousmarly shales interstratified with sandstones
	B	17-27	0.0	100	13	34	24	10	5	14	29	
	B	46-55	0.0	100	14	31	23	13	5	14	32	
	C	90-100	-	-	1	6	5	17	14	57	88	
II	A_1	5-15	1.5	98.5	8	29	21	13	6	23	42	argillaceousmarly shales interstratified with sandstones
	C	30-40	-	-	1	12	11	17	18	41	76	
VII	A_1	5-15	4.0	96	37	28	13	7	5	10	22	marly and calcareous sandstones
	C	25-35	-	-	51	26	8	5	4	6	15	
VIII	A_1	0-15	6.0	94	43	22	12	8	5	10	23	
	C	30-40	-	-	47	26	9	9	3	6	18	
IV	A_1	5-15	0.0	100	7	31	20	12	8	22	42	deluvial sediments
	AB	40-50	14.0	86	2	16	19	15	10	38	63	
	BG	100-130	2.0	98	9	29	12	10	11	29	50	

* $CaCO_3$ was destroyed by 0,2 N HCl, the results were calculated on noncalcic sample

Table 2

Chemical properties of Flysch rendzinas

Nr.of profile	Horizon	Depth cm.	$CaCO_3$ %	Humus %	pH in KCl	mg./100 g. soil	
						P_2O_5	K_2O
V	A_1	2-8	2.8	7.9	7.5	11.0	30.0
	B	12-20	6.6	1.7	7.5	10.0	27.4
	C	50-60	9.6	-	7.6	9.4	23.3
XI	A_1	5-15	27.7	1.5	7.6	4.7	24.1
	C	40-50	34.7	-	7.6	2.0	16.7
I	A_1	5-15	8.9	1.3	7.5	6.2	6.6
	B	17-27	14.4	0.3	7.7	4.8	4.2
	B	46-55	13.1	0.2	7.8	5.2	5.8
	C	90-100	25.8	-	7.6	3.4	16.7
II	A_1	5-15	5.3	2.1	7.5	9.4	18.4
	C	30-40	15.1	-	7.7	5.2	12.4
VII	A_1	5-15	20.1	1.5	7.8	6.6	12.4
	C	25-35	25.3	-	7.9	0.6	2.5
VIII	A_1	0-15	21.6	0.9	8.0	3.4	6.6
	C	30-40	23.1	-	8.4	3.0	5.8
IV	A_1	5-15	6.3	3.2	7.6	6.6	12.4
	AB	40-50	14.7	2.6	7.7	2.2	11.6
	BG	100-130	11.3	1.0	7.8	4.0	9.1

Table 3

Physical properties of Flysch rendzinas

Nr.of profile	Horizon	Depth cm.	Specific gravity	Volume weigth	Porosity	Capillary capacity		Air capacity	Permeability ml./sec.
						by weigth	by volume		
					%				
V	A_1	2-8	2.58	1.11	56.97	48.76	53.96	3.01	0.0000413
	B	12-20	2.69	1.41	47.58	31.92	44.96	2.64	0.0000396
I	A_1	6-12	2.67	1.55	41.94	25.52	39.62	2.32	0.0000719
	B	20-26	2.71	1.39	45.02	26.24	38.90	6.12	0.0000466
VII	A_1	6-12	2.65	1.38	47.92	30.01	42.74	5.18	0.0005688
IV	A_1	6-12	2.62	1.43	45.42	30.67	44.08	1.34	0.0000045
	AB	42-48	2.67	1.23	54.96	43.28	53.30	1.66	0.0000007

complexes with brown soils and cover small areas, from a few areas to a few hectares. (Fig. 1, 2).

Carbonate soils are mostly found in regions with strong relief exposed to heavy erosion which often is intensified by mechanical cultivation [5]. They occur most frequently on hill tops and steep slopes which are usually under cultivation. Small areas of rendzinas covered with forests occur sporadically.

Considerable influence on the occurrence of flysch rendzinas exerts also the deposition of the rock layers [2]. In regions where flysch rendzinas occur the layer deposition is often close to vertical or inclined at a steep angle. The pelitic character of the rocks, and the steep dip of the flysch strata in this terrain cut by deep valleys favour the formation of fairly extensive landslips which expose those rock layers from which the calcium carbonate has not yet been leached out.

With layer deposition near vertical, the rendzinas occur on rocks which are more resistive to weathering, rich in calcium carbonate and most frequently cover hill tops (Fig. 2).

Carbonate soils formed from Carpathian flysch were classified as the brown rendzina type [4] according to the accepted Polish Soil Science Society classification. Basing on the petrographic classification of flysch formations and the mode of deposition of the strata the following flysch rendzinas were distinguished:

I. Rendzinas formed in situ
   a) from argillaceous-marly shales,
   b) from argillaceous-marly shales interstratified with sandstones,
   c) from calcareous and marly sandstones.

II. Deluvial rendzinas (accumulated).

It is worth remembering that the term "flysch rendzinas" was instroduced by Dobrzański [1] into Polish soil science literature. He also proposed the classification of flysch rendzinas based on the geological age of the rock strata and their petrographic character.

In general it may be stated that carbonate soils formed from argillaceous-marly shales possess mostly a well developed soil profile. They form deep or medium deep soils, shallow ones only exceptionally on very steep slopes under cultivation. Characteristic features of these soils are their heavy mechanical composition, high general porosity, low air capacity and very small transmissivity for water.

The flysch rendzinas formed from marly and calcareous sandstones possess most frequently a weakly developed soil profile; they are usually shallow and contain considerable amount of skeletal fraction. The mechanical composition of those soils is that of light clays (rarely of medium

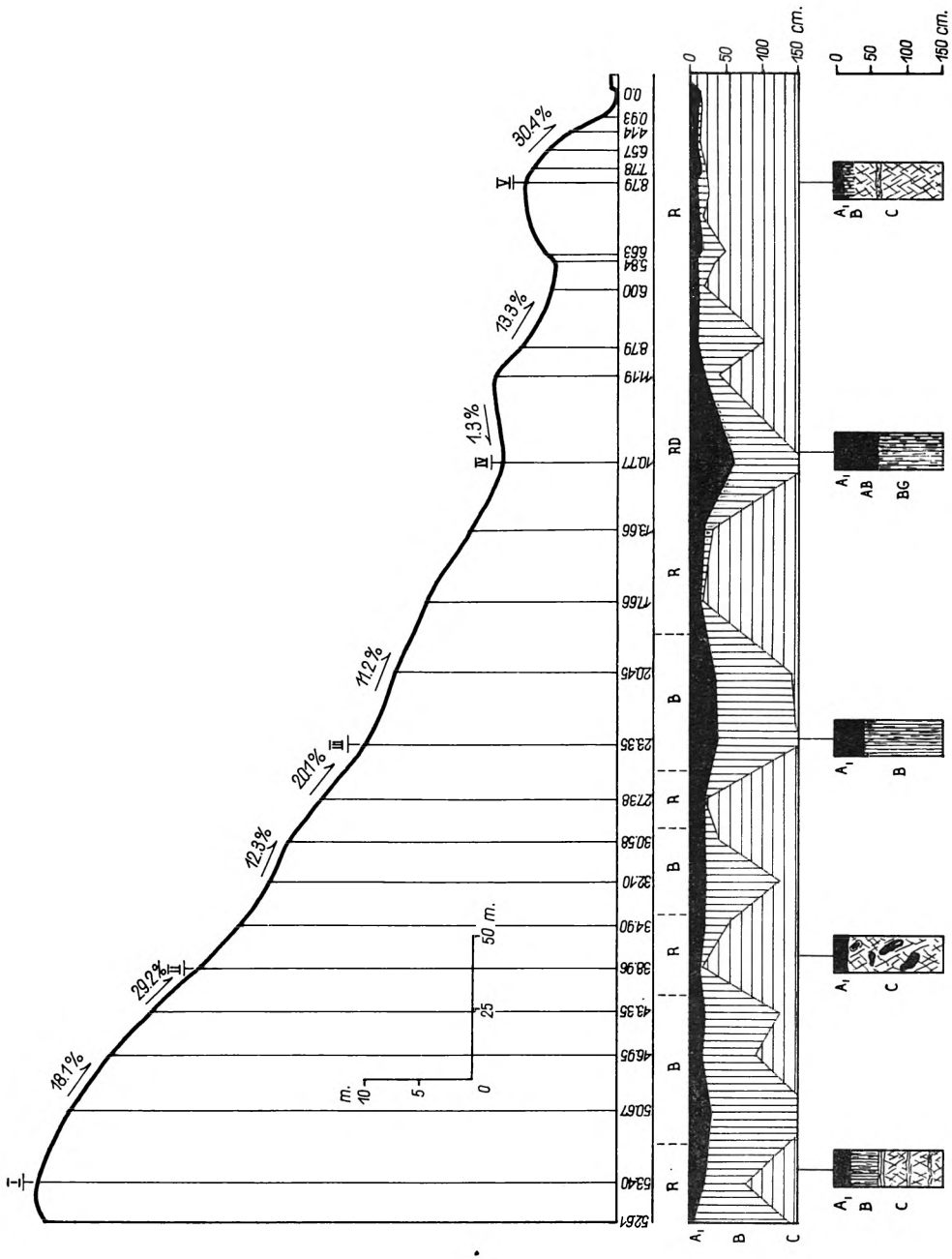

Fig. 1. Soil cross section in Ruszelczyce

R — rendzinas soils, *RD* — deluvial rendzinas, *B* — brown soils

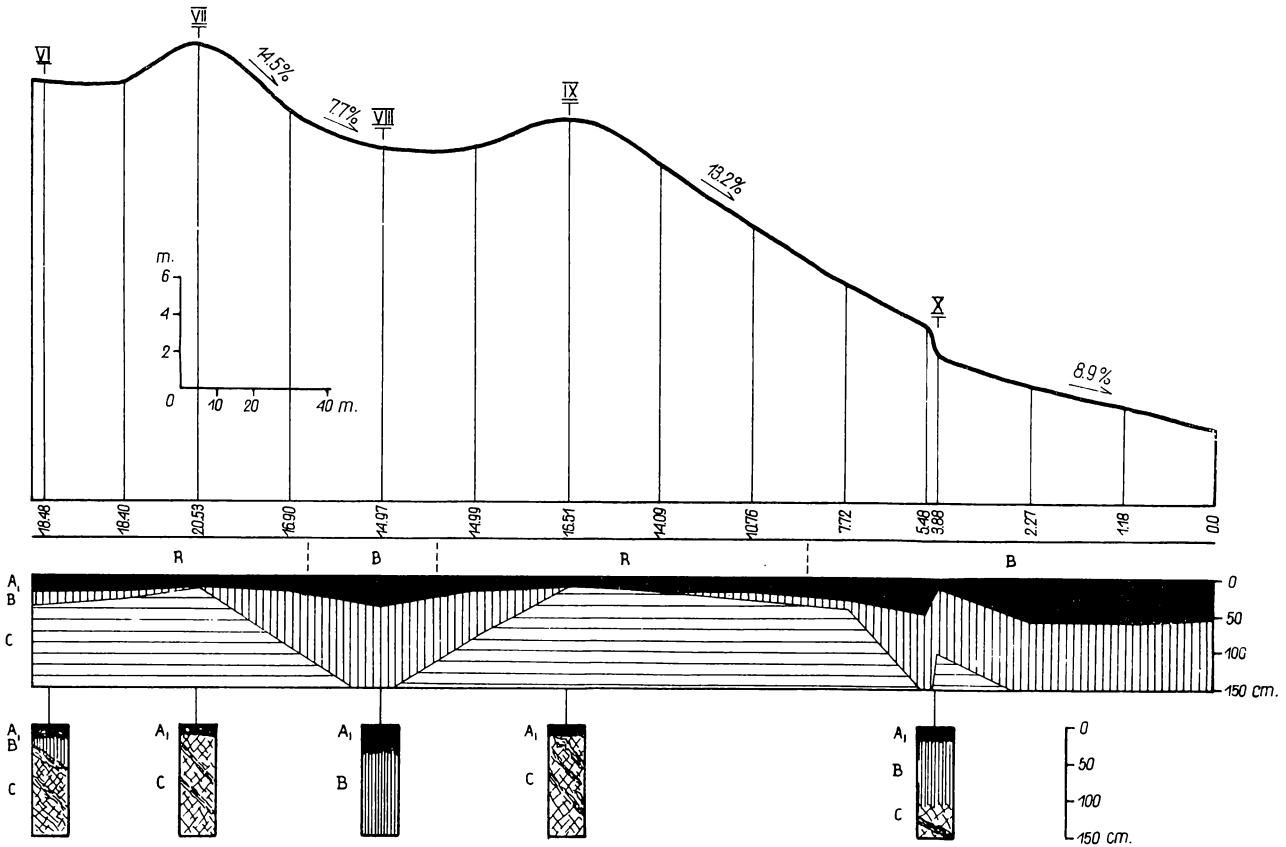

Fig. 2. Soil cross section in Brzostek

R — rendzinas soils, *B* — brown soils

ones) or of clayey sands. They are distinguished by a considerable air capacity and relatively good permeability. The deluvial rendzinas on the other hand show mostly fairly heavy mechanical composition, high general porosity, very low air capacity and very small permeability.

Carbonate soils formed from Carpathian Flysch contain much more available phosphorus and potassium for plants than brown soils formed from the same rocks [3]. Humus content in flysch rendzinas is considerable and usually higher than in brown soils. Flysch rendzinas contain fairly high amounts of calcium carbonate, reaching frequently 40% on an average 20%. Reaction of flysch rendzinas is in most cases slightly basic, whereas brown soils occuring in a complex with rendzinas show acid or slightly acid reaction. Carbonate soils have good granular structure, they are resistant to pulverization and thus are exposed to a considerably weaker erosion than brown soils under the same physiographic conditions.

CONCLUSIONS

The field investigations and analytical data allow to draw following conclusions:

1. Argillaceous-marly shales are most frequently, and marly and calcareous sandstones more rarely, the parent material from which flysch rendzinas are formed.

2. Flysch rendzinas on the terrain investigated occur in complexes with brown soils.

3. Rendzinas appear as a rule on steep slopes or hill tops, most of them under cultivation.

4. Major areas of rendzina soils were found in regions of landslide occurrence, particularly on slopes.

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ERSCHEINUNGSVERHÄLTNISSE VON RENDSINABÖDEN IM GEBIET DER FLYSCHKARPATEN

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Zusammenfassung

Es wurden Untersuchungen über den Einfluss von Reliefformen, Erosion, Schichtenverlagerung und Natur des Muttergesteins selbst auf die Erscheinung von Flyschrendsinen im östlichen Gebiet des Karpatenvorlandes (Pogórze Karpackie) durchgeführt.

Auf Grund der Forschungen im Gelände und der Laborbefunde wird festgestellt, dass vor allem Ton- und Mergelschiefer, seltener Mergel- und Kalkasandstein, als Muttergestein zur Entstehung von Karbonatböden befunden worden sind.

Flyschrendsinaböden treten in Verbindung mit Braunerden auf, an Steilhängen oder Terrainkulminationen, die oft unter Ackerbau stehen. Dies steigert die Erosion und trägt somit in hohem Grade zur Entstehung von Rendsinaböden bei.

In Gebieten wo Erdrutsche auftreten, insbesondere an Hängen, werden auch bedeutende Rendsinaflächen festgestellt. Vereinzelt befand man kleine Rendsinaflecken auch unter Forstkulturen.

Die aus Karpatenflysch gebildeten Karbonatböden sind als braune Rendsina bezeichnet worden. Die weitere Einteilung der Rendsinaböden beruht auf den petrographischen Charakter des Gesteins und der Verlagerungsart dieser Böden.

Die aus Ton- und Mergelschiefern gebildeten Rendsinaböden sind mitteltief und haben eine mechanische Struktur, die jener der leichten Lehmböden ähnelt. Diese Böden sind durch ihre stabile körnige Struktur, ihren bedeutenden Humusgehalt sowie ihren für Pflanzen leicht assimilierbaren Phosphor- und Kaligehalt gekennzeichnet.

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CONDITIONS DE LA PRÉSENCE DE SOLS DE RENDZINE SUR LES TERRAINS DÉ FLYSCH DES KARPATES

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Résumé

Des études sur l'influence du relief du terrain, de l'érosion ainsi que de la stratification et du caractère de la roche-mère elle-même, sur la présence de sols de rendzine de flysch, ont été effectuées sur les terrains de la partie Est du Pogórze Karpackie (avant-monts des Karpates).

Sur la base de ces recherches sur le terrain et d'analyses faites en laboratoire, on est amené à constater que la roche-mère qui produit des sols carbonatés se compose le plus souvent de schistes argileux et marneux, plus rarement de grès marneux et calcaires.

Les rendzines de flysch apparaissent en complexe avec des sols bruns sur des versants raides ou sur les points culminants du terrain qui se trouvent souvent en

exploitation agricole. De ce fait, l'érosion s'accroît, ce qui contribue en une mesure considérable à la formation de sols de rendzine.

D'importantes superficies de rendzine ont été observées dans les régions où il y a des éboulements et en particulier, des éboulements de versants. Parfois, des plaques peu importantes de rendzines ont été trouvées portant une couverture forestière exploitée.

Les sols carbonatés produits du flysch karpatique ont été classifiés comme sols de rendzine bruns. La classification suivante des rendzines repose sur les caractères pétrographiques des roches et sur les types de la position de ces sols.

Les rendzines formées de schistes argileux et marneux sont le plus souvent des sols à structure mécanique argileuse, d'une profondeur moyenne. Les sols carbonatés produits de grès marneux et calcaires sont d'ordinaire des sols peu épais à structure mécanique d'argiles légères. Ces sols sont caractérisés par leur structure granulaire stable ainsi que par leur teneur importante en humus et en phosphore et potasse facilement assimilables par la végétation.

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WARUNKI WYSTĘPOWANIA RĘDZIN W TERENIE KARPAT FLISZOWYCH

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Streszczenie

Badania nad wpływem rzeźby terenu, erozji, układu warstw oraz charakteru samej skały macierzystej, na występowanie rędzin fliszowych, przeprowadzono na terenie wschodniej części Pogórza Karpackiego.

Na podstawie badań terenowych i laboratoryjnych należy stwierdzić, że skałą macierzystą, z której powstają gleby węglanowe, są najczęściej łupki ilasto margliste, rzadziej piaskowce margliste i wapniste.

Rędziny fliszowe występują w kompleksie z glebami brunatnymi na stromych zboczach lub kulminacjach terenowych, znajdujących się często pod uprawą, która zwiększa erozję, a tym samym w dużym stopniu przyczynia się do powstawania rędzin.

Znaczne powierzchnie rędzin spotykano w rejonach występowania osuwisk, szczególnie osuwisk zboczowych. Sporadycznie spotykano niewielkie płaty rędzin pod użytkami leśnymi.

Gleby węglanowe wytworzone z fliszu karpackiego zaliczono do rędzin brunatnych. Dalszy podział rędzin oparto na petrograficznym charakterze skał oraz sposobie zalegania tych gleb.

Rędziny wytworzone z łupków ilasto-marglistych to najczęściej gleby średnio głębokie, o składzie mechanicznym ilastym. Gleby węglanowe wytworzone z piasków marglistych i wapnistych są z reguły glebami płytkimi, o składzie mechanicznym lekkich glin. Rędziny fliszowe charakteryzują się trwałą strukturą ziarnistą, znaczną zawartością próchnicy oraz łatwo dostępnego dla roślin fosforu i potasu.

Ю. ПОМЯН

УСЛОВИЯ ОБРАЗОВАНИЯ РЕНДЗИН В РАЙОНЕ ФЛИШЕВЫХ КАРПАТ

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Р е з ю м е

Исследования по влиянию рельефа, эрозии, расположения слоев, а также качества материнской породы на образование флишевых рендзин проводились в восточной части предгорья Карпат.

Полевые и лабораторные исследования показали, что материнской породой, из которой образуются карбонатные почвы, является преимущественно глинисто-мергелистый сланец, реже мергелистый и известняковый песчаник.

Флишевые рендзины выступают в комплексе с буроземами на крутых склонах или же на водоразделах, часто находящихся под обработкой, которая увеличивает процесс эрозии, содействуя образованию рендзин.

Значительные площади рендзин наблюдались в районах проявления оползневых процессов и особенно склоновых оползней. Спорадически наблюдались небольшие пятна рендзин под лесным покровом.

Карбонатные почвы образовавшиеся из карпатского флиша зачислены к бурым рендзинам. Дальнейшее подразделение рендзин базируется на петрографическом характере пород и на способе их залегания.

Рендзины образовавшиеся из глинисто-мергелистых сланцев это чаще всего средне-глубокие почвы с глинистым механическим составом. Карбонатные почвы образовавшиеся из мергелистых и известняковых песчаников имеют как правило мелкий профиль и механический состав легких суглинков. Эти почвы характеризуются прочной зернистой структурой, значительным содержанием гумуса и подвижного фосфора и калия.