Omelianski, W. L.: Du rôle des microorganismes dans la désegrégation des essences rocheuses. Mél. bot. off. á l'occ. d. s. jubilé. Leningrad, 1927.

Roglič, J.: Korrosive Ebenen im Dinarischen Karst. Erdkunde, VIII, Bonn, 1954.

Skerman, V. B. D.: A quide to the identification of the genera of bacteria with methods and digests of generic characteristics. The Williams & Wilkins Company, Baltimore 2, Maryland, 1959.

Smyk, B. and Drzal, M.: Research on the distribution and role of the microflora occuring on limestone on karst territories of Poland, Czechoslovakia and Switzerland. Sammelband III. Konferenz über die Bodenmikrobiologie 5.—7. XI. 1962. Tschechoslowak. Akad. der Wissenschaften, Prag, 1962.

— i Drzal, M.: Badania nad występowaniem i rolą mikroflory na krasowych terenach wapiennych Polski południowej. Cz. l. Acta Agraria et Silvestria, 2, 71—100, 1962.

— et Ettlinger, L.: Recherches sur les especes d'Arthrobacter fixatrices d'azote isoless des roches Karstiques alpines. Annal. Institut Pasteur (im Druck).

Sperber, J. J.: Solution of mineralphosphates by soil bacteria. Nature, 180, 994—995, 1958.

Tardieux-Roche, A.: Essai d'appréciation quantitative du pouvoir disselvant des bacteries sur les phosphates naturels. Annales de l'Institut Pasteur, 103, 2, 314—317, 1962.

Tesič, Z. P. et Todorovič, M. S.: Sur la question de l'espece des "bacteries silicatées". Atti del VI Congresso internationale di microbiologie. Vol. VI no. 1—99, 356—361. Roma 6—12 Settembre, 1953.

— i Todorovič, M. S.: Prilog poznavanja specifičnih osobina silikatnih bakterija. Zemljiste i biljka, 8, 1—3, 221—224, 1958.

Vintiková, H.: Bakterie, rozkládajici tezkorozpustne alumosilikaty. Vědecké Prace Vyzkumneho Ústavu Rostlinne Vyroby ČSAV v Praze-Ruzyni, 2, 1956.

Webley, D. M., Duff, R. B. and Mitchell, A.: A plate method for studying the breakdown of synthetic and natural silicates by soil bacteria. Nature, 188, 766—767, 1960.

Wissmann, H.: Der Karst der humiden und sommerheißen Gebiete Ostasiens. Das Karstphänomen in verschiedenen Klimazonen, 1953.

"KARST VALLEYS" IN THE DINARIC KARST

With 2 figures

J. Roglic

This problem is as important for the past of exploration as for the successful explanation of the Dinaric Karst. The term "karst valley" (Karsttal), like most of the other terms for karst, was coined during the exploration of the Dinaric Karst and is still in use; attempts are being made to justify it and even examples for it are being mentioned. We think that this is misleading because something is sought that is wished for, instead of explaining what really does exist. A look into the past of karst exploration will be very instructive.

In his first and classical work, J. Cvijic introduced the term "karst valley" as the heading of a chapter and as a common designation for rather undefined in disparate features, and this term has persistently been used since. At the beginning of the chapter thus headed, Cvijic himself, however, says: "Owing to the permeability of limestone, running water disappears in karst country, normal valleys are rare or even completely missing, and their place is taken by blind valleys and different other "basin forms" (Wannenformen)[1]).

Cvijic classifies his karst valleys into a) *sack valleys* (Sacktäler), "such a valley has a cirque-like, sack-shaped valley head", a feature which is, in fact, common to almost all sources in limestone; b) *blind valleys* (blinde Täler), which are "morphologically also characterized by a raised valley end", also a common occurrence with rivers disappearing underground (Schlundflüsse); c) *semi-blind valleys* (halbblinde Täler), "where the raised valley end is so low that accumulated river water sometimes overspills"; and d) *dry valleys* (trockene Täler) "without or with only temporary water courses".

He further divides blind and dry valleys in karst country in primary and secondary ones. Primary is a valley where, "a river from impermeable rock enters strongly porous and jointed limestone, its water disappears in the limestone fissures and, in time, big sinkholes are formed there". Secondary is a valley if "through the formation of sinkholes in the bed of a normal karst river, its valley becomes blind"[2]).

It is surprising that Cvijic affirms that "water does not flow over permeable karst" yet speaks of different types of valleys, but stresses their peculiarities and limited appearance. This indecision and compromising attitude are important and reflect insufficient acquaintance with the conditions of the karst as well as the special circumstances in which his first work was written.

It must be kept in mind that, before writing his "Karstphänomen", Cvijic had only known the karst countries of eastern Serbia and around Trieste[3]). Moreover, the young explorer's general ideas were under the influence of his great teacher,

[1]) J. Cvijić: Das Karstphänomen, Versuch einer morphologischen Monographie, in: Geographische Abhandlungen, Vol. 5, No. 3, p. 283, Vienna, 1893.

[2]) Op. cit., p. 290.

[3]) A Map of Jovan Cvijić's Excursions in the Balkan Peninsula and in the Yugoslav Countries, an annex to No. 11 of: Glasnik Geografskog društva, Belgrade, 1925.

A. PENCK, whose conception of the development of the karst features has persisted to this day. This influence will also be observed in the other initial explorer of the Dinaric Karst, A. GRUND.

A. PENCK's general conception had a decisive influence on his pupils and, consequently, also on CVIJIC. It was important that PENCK became acquainted with the central parts of the Dinaric Karst[4]) before his chief pupils did, and that, based on this knowledge, he published a paper in which he excellently propagated the antecedence of river erosion in the development of land forms in limestone terraine[5]). This scheme of PENCK's would have decisive influence on A. GRUND's later work and also on CVIJIC himself[6]). PENCK's school spread the conception that the karst process followed the period of river erosion in limestone, and now, without any justification, facts are being fitted into this scheme.

A. GRUND's ingenious capacity to observe and to draw logical conclusions already appears in his first work (1903). His theory of the water-table in karst or of "karst water" is in agreement with his great teacher's already formulated conception of the development of land forms in limestone. The weakness of this theory, however, can already be noticed in the same paper, where GRUND, speaking of "karst rivers" (Karstflüsse), says: "In the same way as sources in limestone are possible, provided the earth's surface sinks within or below the changing level of "karst water, the appearance of karst rivers is also possible because their sources (karst sources or vaucluse sources) depend on the same condition"[7]). GRUND did not explain how the flowing of rivers and erosion work are possible at the level of the "stagnating" water-table.

A. GRUND is, however, much more definite and convincing in his morphological observation: "Almost all the rivers in western Bosnia, in the Hercegovina and Dalmatia owe their existence to impermeable layers in the region of their headwaters, such as the Zrmanja, Krka, Cetina, Neretva and Unac."[8]) and later, "The impermeable layers are most often soft, easily erodible rock; here, therefore, the river flows gently and the valley is wide. Limestone, on the contrary, shows steep-sided gorges (Klamm)"[9]). After this statement, GRUND correctly uses the term "Kalkklamm" (limestone gorge).

GRUND's morphological observation agrees with what CVIJIC had said three years before when speaking of the Tara and Piva canyons: "These rivers, as mighty water courses, enter the waterless karst plateaus round Durmitor, which are built up of almost horizontal limestone layers. Only these rivers have been able to resist the intensive karst process. The other rivers, poor in water, have succumbed to this process, and their valleys have become blind valleys. The canyon rivers, rich in water, have deepened their beds down vertically, and the slopes of their valleys have risen canyon-like above them"[10]).

CVIJIC was also unable to resist PENCK's and GRUND's dominating conception of the antecedence of river erosion in limestone. In most of his work, he also propagates this scheme in spite of his own many inner contradictions. In his final work on karst problems, however, CVIJIC, speaking of karst valleys, says: "Neither are those valleys autochthonous; they are allogen or alien valleys, whose drainage areas are in impermeable rock ... their sides are steep because of the permeable limestone, where there is neither slope washing nor sliding"[11]).

Thus, the two most important explorers of the Dinaric Karst know, in limestone, the canyon (J. CVIJIC) or the "Kalkklamm" (A. GRUND) only. Finally, CVIJIC concludes that river erosion in limestone can only cut in canyons with the water and rock waste brought down from impermeable rock.

We consider this conclusion correct and the only possible[12]). Water in karst sinks in and, thus, features are shaped in a vertical sense, isolated from one another. This is the essence of the karst process. There is, thus, harmony between the water circulation and the land forms. In this way, as CVIJIC says, "pit country" (Wannenlandschaft)[13]) is formed. For impermeable rock, on the contrary, morphologically decisive is the water flowing on

[4]) Bericht über das 25. Vereinsjahr 1898/99 des Vereins der Geographen an der Universität Wien.

[5]) A. PENCK: Geomorphologische Studien aus der Herzegowina, in: Zeitschrift des Deutschen und Österreichischen Alpenvereins, No. 31, 1900.

[6]) J. ROGLIĆ: Prilog poznavanju razvoja Cvijićeve misli o kršu (A Contribution to the Knowledge of the Development of CVIJIĆ's Conception of the Karst), a comment on: La Geographie des terrains calcaires (with a summary in French) in: Geografski glasnik, No. 23, pp. 37—65, Zagreb, 1961.

[7]) A. GRUND: Karsthydrographie, Studien aus Westbosnien, in: Geographische Abhandlungen, Vol. 7, No. 3, p. 181, Vienna, 1903.

[8]) Op. cit., p. 188.

[9]) Op. cit., p. 190.

[10]) J. CVIJIĆ: Morphologische und glaciale Studien aus Bosnien, der Herzegowina und Montenegro, in: Abhandlungen der k.k. Geographischen Gesellschaft in Wien, Vol. II, No. 6, p. 92, Vienna, 1900. (The Serb version was published at Belgrad in 1899.)

[11]) J. CVIJIĆ: La Géographie des terrains calcaires, Académie serbe des sciences et des arts. Monographie T. CCCXLI, Classe des sciences mathématiques et naturelles, No. 26, p. 3, Belgrade, 1960.

[12]) J. ROGLIĆ: Das Verhältnis der Flußerosion zum Karstprozeß, in: Zeitschrift für Geomorphologie, Vol. 4, No. 2, pp. 116—128, Berlin, 1960.

[13]) Das Karstphänomen, p. 283.

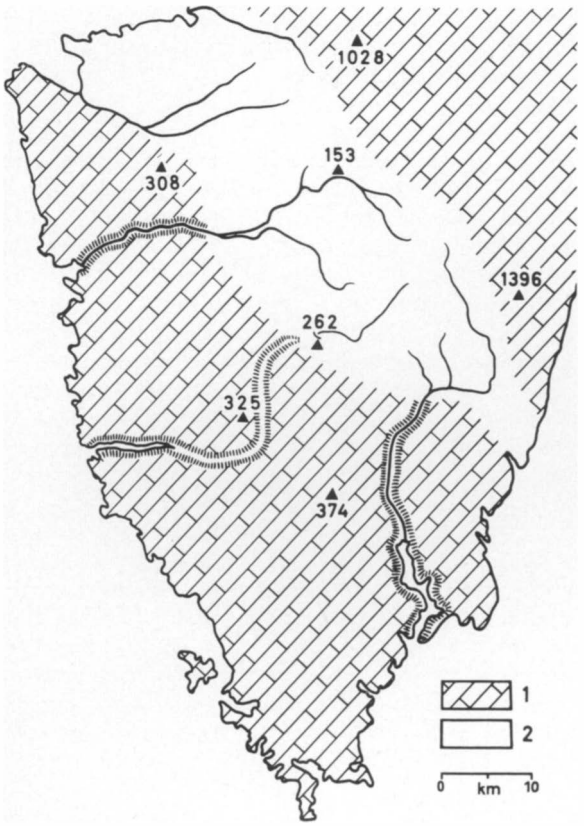

Fig. 1: The valleys of Istrian rivers in limestone (1) are canyons, in the impermeable rocks (2) are removal basins (Ausräumungsbecken). Also the dry valley of Pazinski potok (in the middle of the map) is a canyon.

the surface and the moulding of a connected valley system. This distinction is inevitable and logical.

In typical karst country, composed of pure limestone, canyons are rare and have been cut in by allogen rivers. The canyons are the more strongly developed, the purer the limestone. This rule is valid for all the rivers in the Dinaric Karst. The valleys of these rivers consist of widenings in impermeable rock, and of canyons in limestone (Fig. 1). The features clearly reflect the lithological composition.

We have pointed out that the expressiveness of karst depends on the purity of the local limestone. For this reason, in dolomites, plate-shaped limestone, and in other similar and mixed formations, corresponding transitional land forms appear, the "fluviokarst". Such transitional landforms are found in the Peripannonian rim in western Croatia, where there are more permanent rivers, or between the poljes of Gacko and Nevesinje, where the river Zalomka flows periodically.

During our visit to the Swabian and Franconian Albs, I believe that we shall have opportunity enough to see the transitional features of "fluviokarst". In his first work, CVIJIC already attributed the differences in landforms to differing lithological conditions and to climatic influences. Thus, he thought that complete karst developed only under the conditions of the Mediterranean climat because of its periodical rainfalls [14]). At the end of his work, however, he attributes greater importance to the lithological factor, and believes that "holokarst" develops in pure limestone, and "merokarst" in transitional formations [15]). Merokarst is the same as "halfkarst" (Halbkarst), the latter term having been coined by A. GRUND ten years before [16]). We consider the term "fluviokarst" much more adequate. It also indicates the combination of the two morphogenetic processes.

Two of the features that CVIJIC classified as karst valleys need special mention, the blind and the dry valleys.

The term "blind valley" is very wide. As CVIJIC himself points out, these depressions originated in impermeable rock through the action of rivers which disappeared when entering limestone. To these removal basins (Ausräumungsbecken), the result of differential erosion, also belongs the majority of the poljes. But they are not karst features because they are conditioned by impermeable rock and were moulded by the erosion of later disappearing rivers. These disappearing rivers clearly reflect the essential differences in the morphogenetic evolution of karst and impermeable rock.

The term "dry valley" comprises the most undefined features. We have found it most often used for problematic landforms that are, without sufficient proof, considered valleys, in agreement with the scheme of transition from river erosion to the karst process. Undoubtedly dry valleys have the same properties as those through which rivers still flow today, i.e., they are canyons, such as the dry valley of the river Bregava below Dabarsko polje (Fig. 2).

In karst, there are features which by their general properties remind of valleys and cause their being classified as such, e.g., Popovo polje in the lower Hercegovina, which is partly meander-like. If, however, its forms are more closely examined, they cannot be explained by the laws of river erosion because these features are specific of soluble rock. This apparent valley is closed at its lower end without any traces of younger dislocation.

[14]) Das Karstphänomen, p. 329.

[15]) J. CVIJIĆ: Types morphologiques de terrains calcaires, in: Glasnik Geografskog društva, No. 10, pp. 1—7, Belgrade, 1924.

[16]) A. GRUND: Der geographische Zyklus im Karst, in: Zeitschrift der Gesellschaft für Erdkunde, pp. 621—664, Berlin, 1914.

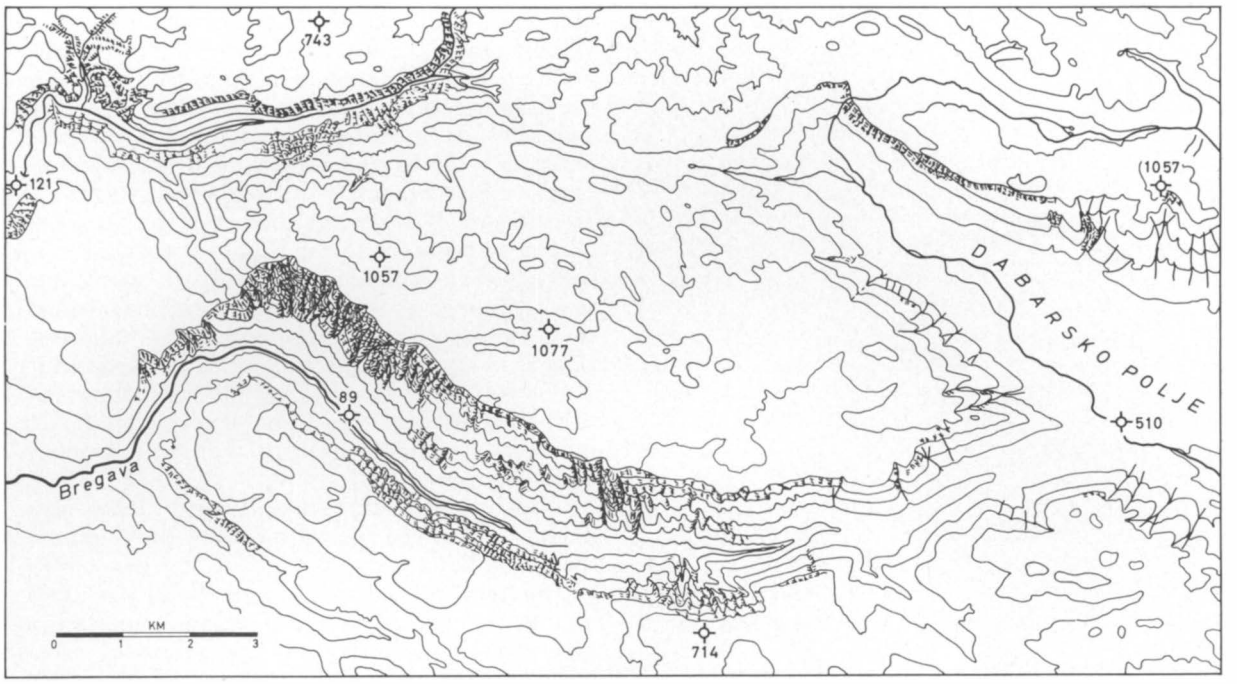

Fig. 2: Dry and deep canyon of Bregava River (Hercegovina) — Contour intervall 100 m. Although this is an old canyon (relative depth about 1000 m) its sides are very steep in spite of younger evolution of the slope. In the higher parts, during a period when the river flowed at surface, by means of differential erosion in the impermeable rocks Bregava River formed Dabarsko polje.

The eroded detritus must, therefore, have been evacuated underground. It is, consequently, a feature created in karst, i.e., in a region where during its creation, deeper fissure-circulation of water took place. Its ideally flat limestone bottom and the sudden transition into steep sides are further specific elements that disagree with the laws of river erosion.

Valley-like depressions as well as level ground in pure limestone cannot be explained with river erosion, which can only cut canyons into this rock. The other valley-like features must be accounted for by changes in the corrosion process in different climats and under corresponding ecologic conditions.

To conclude: Allogen rivers have only cut canyons in pure limestone, and this kind of valley is typical for them. More regular features of river erosion and slope washing appear in regions of mixed lithological composition and do not belong into typical karst scenery. Unusual features of surface levelling and differently moulded limestone slopes are remnants of a period when the climat favoured plane corrosion (Flächenkorrosion). We suggest to discontinue the use of the term "karst valley" because it was adopted at a time of insufficient knowledge and of a mistaken conception of land form development in limestone. Moreover, the term is also illogical.

DRY VALLEYS OF THE SOUTHERN PENNINES, ENGLAND

With 2 figures

GORDON T. WARWICK

Introduction

In the British Isles most attention has been paid to the dry valleys of the chalk of S.E.England, but they are equally important in areas underlain by limestones of Cambrian, Silurian, Devonian, Carboniferous, Permian and Jurassic age. In addition similar features are to be found on many porous sandstones and conglomerates such as Cannock Chase, Staffordshire and even on quartzites (Lickey Hills, Worcestershire) and Keuper Marl, though the latter are usually confined to valley heads and minor gulleys. In this paper the author