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POLLEN ANALYSIS AT THE CUEVA DEL TOLL, CATALONIA: A CRITICAL RE-APPRAISAL

KARL W. BUTZER[1] and LESLIE G. FREEMAN[1]

SUMMARY

The published paleo-environmental data from the Cueva del Toll are discussed. The two pollen profiles by Donner-Kurtén and by Florschütz-Menéndez refer to the same stratigraphic units although there are small but ecologically significant differences between these profiles. The faunal evidence suggests strongly that the pollen sequence covers part or most of the Last Glacial, as suggested by Donner and Kurtén. However, the climatic interpretation suggested by these authors to account for the fluctuations of AP:NAP pollen ratios seems open to question.

I

Few Upper Pleistocene localities in Mediterranean Spain have the potential significance of the Cueva del Toll, near Moyá, about 45 km north of Barcelona. The cave is located at an elevation of 750 meters (according to the 1 : 50,000 topographic series sheet No. 364) along the side of a torrent valley amid a rolling terrain of early Tertiary limestones. It has yielded an abundant faunal series paralleled by a palynological sequence of great interest. At the same time, the uppermost strata of the cave contain Neolithic and later cultural materials.

Studies of late Pleistocene environments in Catalonia at present must rely heavily on the published analyses of materials from the Cueva del Toll. For this reason we feel obliged to point out that the Toll sequence raises some major problems of interpretation, in fact, that some of the published paleo-environmental data are liable to serious questions of identification or evaluation. It is the purpose of this note to point out some of these problems, in order to preclude possible uncritical acceptance of some of the published materials from this site (see, for example, Higgs, 1961).

[1] University of Chicago.

II.

The cave was excavated in part by J. Serra Ráfols, after earlier study by J.M. Thomas and F. Rivira-Luitz in 1948 (Serra et al., 1957). In 1956, pollen samples were removed from the witness section "Sondage B," located at the mouth of the cave ("Galerie Sud," see map by Thomas & Villalta in Serra et al., 1957, Fig. 3), by J.J. Donner and subsequently studied (Donner & Kürtén, 1958). In 1957 a second suite of samples was collected by J. Menéndez-Amor and the late F. Florschütz (1962a) from a section at the entrance of the same cave. The samples were removed from exposures shown to these authors by S. Oller Colomé and there is no question that this was in fact "Sondage B," which is the only true section exposed at the entrance of the cave (Fig. 1).

In Sondage B, Thomas and Villalta recognized 13 distinct levels, which they designated (starting with the most recent) as levels "a" through "n", omitting "c". Donner & Kurtén (1958) analyzed and illustrated pollen from 12 samples, at irregular intervals but at specified depth from -155 cm to -340 cm, in what are beds "b" through "j" of "Sondage B." Menéndez & Florschütz (1962a) studied 19 samples at 10-centimeter intervals from -160 to -340 cm in what are obviously the same beds. Nonetheless Menéndez & Florschütz (1962a), ignoring all the obvious symptoms of duplication - including similar raw results - state "sólo hemos analizado... las muestras por encima de las estudiadas por... Donner...". To avoid confusion in the literature it should therefore be emphasized that *the two sets of pollen data refer to the same beds of the same section.*

A second point that needs to be made is that the two profiles are of unequal value. Donner & Kurtén (1958) analyzed 100 grains only from each sample and their sample intervals vary from 5 to 25 centimeters. Florschütz & Menéndez used regular 10-centimeter intervals and very probably counted

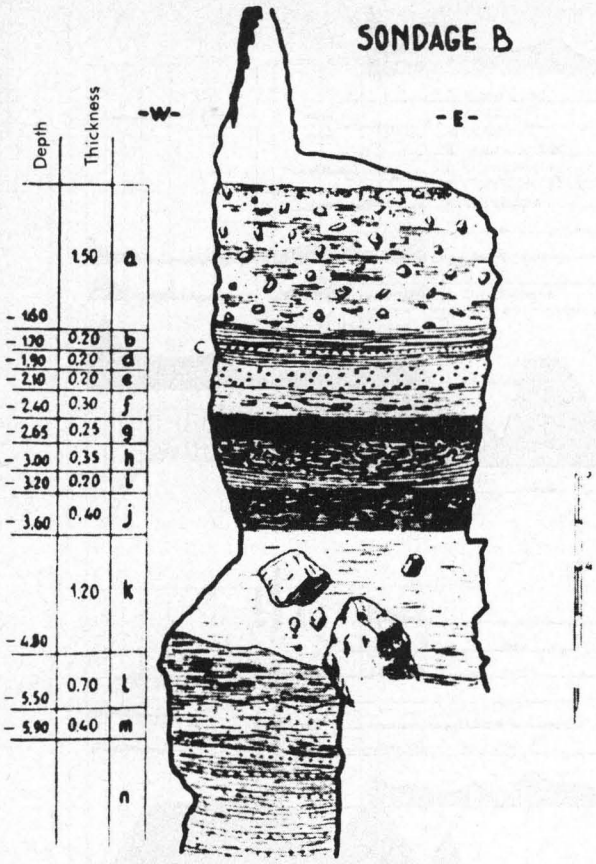

Fig. 1 - "Sondage B" stratigraphic section of the Cueva del Toll, Catalonia after Serra et al. (1957 : Fig. 4).

a minimum of 150 grains per sample.[1] Comparison of the samples, level by level (Figs. 2 and 3), leaves no doubt that the Florschütz-Menéndez diagram picks up a far more detailed profile, with more pronounced and clearly defined fluctuations, some of which are not distinctly defined on the Donner diagram. There are also some small but ecologically significant discrepancies:

a) The Donner diagram shows between 1 and 8 % *Quercus* in 11 of 12 samples, whereas the Florschütz-Menéndez diagram shows *Quercus* in only 9 of 19 samples, never exceeding about 2 or 3 % (estimated from graph).

b) The *Artemisia* of the Donner diagram never exceeds 5 % of the total pollen sum whereas in Florschütz-Menéndez this value attains as much as 18 %. Similarly, the Florschütz-Menéndez *Gramineae* and *Compositae* graphs show higher values as well as greater variations than those of Donner.

[1] Th. van der Hammen (Hugo de Vries Laboratorium, Amsterdam) kindly rechecked the late Franz Florschütz's data sheets from Spain at Velp. The Toll data could not be located but Dr. van der Hammen could confirm that almost all of Florschütz's analyses were based on a minimum tree pollen count of 150, often 200 grains (in litt., April 5, 1067).

c) The Donner diagram shows as much as 12 % *Cyperaceae* attaining significant maxima during the periods of NAP dominance. The Florschütz-Menéndez diagram shows no more than 3 % sedges and the curve shows no systematic relationship at all to the AP : NAP ratio curve.

Thus, although the AP : NAP ratios of both diagrams are generally comparable, the individual details are sufficiently different to warrant different interpretations. In particular:

i) The pollen of deciduous arboreal species (*Quercus*, *Corylus*, *Alnus*, *Betula*, *Salix*-- in that order order of significance -) in the Florschütz-Menéndez profile never amount to more than a trace that can readily (and most logically) be interpreted by long-distance transport. By contrast, Donner & Kurtén (1958) are moved to postulate the local presence of "scattered trees" or "small woods" of deciduous species for certain time-stratigraphic units.

ii) The Florschütz-Menéndez diagram shows two distinct types of alternating pattern: (α) high pine values (60-90%) with grasses, and (β) low pine values (15-45%) with abundant grasses, *Artemisia* and other *Compositae*. The Donner diagram exhibits no really systematic patterns within the NAP curve.

These differences presumably reflect on such factors as sample size, identification of pollen in poor condition, and selective destruction of pollen types through different techniques of sample preparation.

III.

After this discussion of the substantive data provided by the two parallel pollen profiles from the Cueva del Toll it seems pertinent to review and discuss the interpretations offered by Donner and by Florschütz-Menéndez.

Donner suggests that the most reasonable interpretation of the Toll pollen diagram is that the changes between "... forest, dominated by *Pinus sylvestris* and an open vegetation with herbs and a few deciduous trees" probably reflect climatic changes between "... temperate humid periods and warm dry periods" (Donner & Kurtén, 1958 : 76). He equates these temperate-humid periods with Würm stadials and the warm-dry periods with interstadial and postglacial conditions. An immediate problem with such an interpretation is raised by the occurrence of about 45% Pinus in the topmost sample at -155 cm (estimated from Donner & Kurtén, 1958: Fig. 3, not "about" 30% as these authors state, p. 76). By Donner's evaluation this would - rather implausibly - be due to long-distance transport.

Florschütz and Menéndez, on the other hand, interpret their spectra with low AP counts as an indication of temperate, "steppe" conditions, while the spectra with high AP counts are interpreted as de-

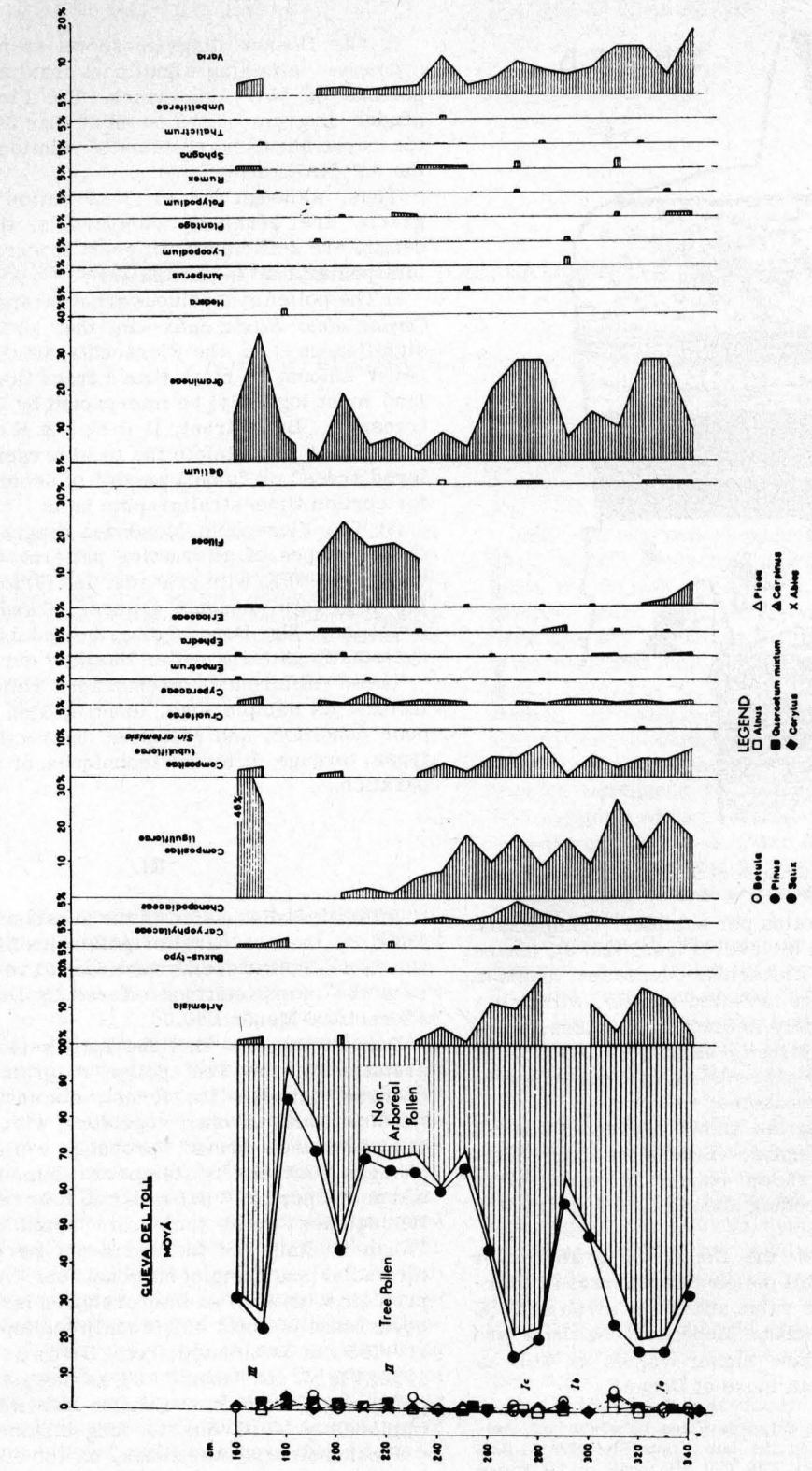

Fig. 2 - Cueva del Toll pollen diagram after Donner & Kurtén (1958: Fig. 3).

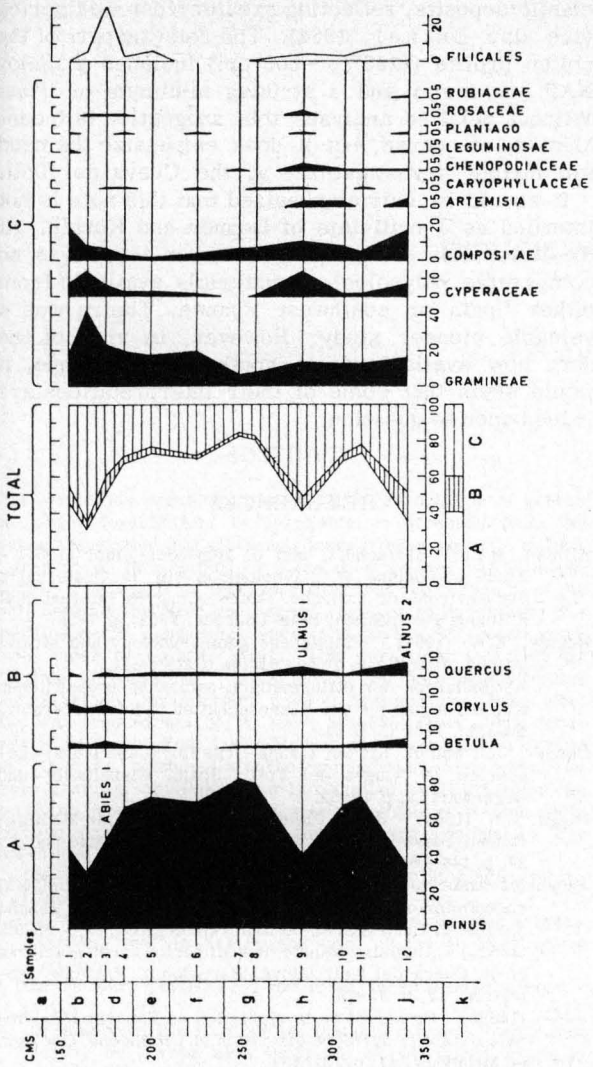

Fig. 3 - Cueva del Toll pollen diagram after Menéndez-Amor & Florschütz (1962a: Fig. 1). Note that the profile depths at the left correspond to those of Figs. 1 and 2.

monstrating relatively warmer and moister conditions. In assessing these contradictory statements it is important to recall that the diagram of Florschütz-Menéndez does not show the coincidence between high values of deciduous tree pollen and high NAP counts that Donner obtained.

If radiocarbon determinations had been available from the Cueva del Toll, at least a part of this discrepancy would have resolved itself. Lacking dates, however, it seems most appropriate to compare the Toll diagrams with radiocarbon-dated full glacial and late glacial pollen diagrams from the Lourdes area of the French Pyrenean foothills at ca. 420 m elevation (Alimen et al., 1964): from the Laguna de las Sanguijuelas near Sanabria, in northwestern Spain at ca. 1000 m (Menéndez & Florschütz, 1961); and from Padul, south of Granada, at ca. 740 m (Menéndez & Florschütz, 1962b). In each case the full glacial ca. 15,000-20,000 B.P. was characterized by an almost exclusive preponderance of pine in the AP and by a high value of NAP, among which *Artemisia* was prominent. This leaves little ambiguity for an interpretation of the NAP maxima in the Toll profile by conditions of maximum, glacial cooling. On the other hand, the pine maxima associated with reduced NAP values at Toll fall within the range of variability of more temperate oscillations in the terminal Pleistocene profiles from the other locales. They would then suggest interstadial-type climates, cooler than that of today, but not as severe as the glacial maxima.

IV.

B. Kurtén, basing himself on a relative frequency list of the Toll fauna as originally identified by J.F. de Villalta (Serra et al., 1957: Tabel 1), attempted to provide an ecological interpretation of the fauna in the Cueva del Toll strata (Donner & Kurtén, 1958). Kurtén devised a simple index of relative frequencies in order to be able to use the relative frequency data of Villalta according to species or genera and levels. Different species were identified as "woodland," "open-country" or "indifferent" ecological forms, and on this basis Kurtén drew up semi-quantitative histograms of the fluctuations of woodland and open-country mammals. These frequency diagrams, at first sight, appear to corroborate Donner's interpretation of the pollen profile.

However, closer examination of the basic data suggests that such correspondences are fortuitous or even misleading. So, for example, Kurtén considers levels "a" and "b" as a single unit, "d" and "e" together as a second, "f" and "g" as a third, with level "h" alone as a fourth unit. The resulting stratigraphic sequence would suggest a change from relatively abundant open-country or "steppe" forms in level "h," to a predominance of woodland forms in levels "d-e" and "f-g", with a return to a more abundant open-country fauna in level "a-b". Assuming that the basic index and its ecological interpretation are valid, the grouping of levels effectively obscures significant faunal fluctuations that appear to be recorded in the successive cave strata. If we apply Kurtén's own index to each level individually, a completely different picture of faunal fluctuations emerges, as follows:

level	woodland forms	open-country forms
a	73.3 %	26.7 %
b	54.5[1]	45.5

[1] Includes *Meles meles*, listed in Thomas and Villalta's text (1957: 18) but omitted from their table as well as from Kurten's count.

level	woodland forms	open-country forms
d	100.0	0.0
f	84.6	15.4
g	66.7	33.3
h	50.0	50.0

Comparing the resulting pattern of fluctuations with the pollen diagram there seems to be no systematic correlation or relationship. Open-country forms fluctuate from relatively high to low frequencies with no determinable relationship to the periods of warm-steppe conditions, as identified by Donner, and the fauna fails to corroborate Donner's overall interpretation.

There is, however, an apparently significant change in faunal composition at the Cueva del Toll that has been overlooked, and which seems to negate the Donner-Kurtén interpretation. In level "i", *Rhinoceros mercki* and *Hippopotamus amphibius* were identified by Villalta, the former species also being present in the underlying bed "k". Both forms are absent in level "h", where they are replaced by *Rhinoceros tichorhinus* and the alpine form *Capra ibex*. According to the dating scheme of Donner-Kurtén level "i" should have been deposited during an Early Würm stadial, level "h" during the succeeding interstadial. According to more conventional interpretations of the climatic significance of hippo and Merck's rhino, as opposed to the woolly rhino, one would expect the first two forms to indicate interglacial or interstadial conditions, which would contradict the Donner-Kurtén interpretation. At the same time, these taxa also preclude a late glacial-post-glacial date for the pollen sequence as originally proposed by Menéndez-Florschütz.

Although systematic sediment analyses have not been carried out at the Cueva del Toll, one sedimentary feature described by Serra et al. (1957) appears to be significant in the context of the present discussion. Level "h" consists of a non-cemented breccia of flat, angular "éboulis" - lacking evidence of chemical weathering. These may well be thermoclastic deposits, reflecting greater frost-weathering (see also Butzer, 1964). The relevant part of the pollen profile (-265 to -300 cm) includes a major NAP maximum and a striking minimum of *Pinus* Without detailed analyses this suggestion is inconclusive, of course, but it does emphasize the need for further investigations at the Cueva del Toll.

It should be duly emphasized that this note is not intended as a criticism of Donner and Kurtén. At the time their study was undertaken there was no comparable palynological materials available from either Spain or southwest France. Theirs was a valuable pioneer study. However, in view of the data now available from southwestern Europe, it would seem that some of their interpretations are indeed open to question.

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