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QUANTITATIVE ANALYSIS OF *Homoctenowakia bohemica bohemica* (TENTACULITOIDS) FROM THE LOCHKOVIAN OF THE VALLE SYNCLINE, OSSA-MORENA ZONE (SW SPAIN)

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ABSTRACT

A quantitative study has been performed on a population of *Homoctenowakia bohemica bohemica* from the Ossa-Morena Zone (SW Spain). A comparison with a population from the Barrandian area shows essential agreement for all important characters, which fully confirms the specific assignement of the Spanish specimens.

Keywords: ***Homoctenowakia bohemica bohemica,*** **tentaculitoids, Lochkovian, Early Devonian, quantitative study, Spain, Bohemia (Czech Republic).**

RESUMEN

Se ha realizado un análisis cuantitativo sobre una población de *Homoctenowakia bohemica bohemica* procedente de la Zona de Ossa Morena (SO de España). Los resultados concuerdan, para los principales caracteres analizados, con los obtenidos a partir de una población procedente de la localidad tipo de la subespecie en la cuenca de Barrande (Bohemia, República Checa), lo cual confirma la asignación subespecífica de los ejemplares españoles.

Palabras clave: ***Homoctenowakia bohemica bohemica,*** **Tentaculitoideos, Lochkoviense, Devónico Inferior, estudio cuantitativo, España, Bohemia (República Checa).**

In the Hercynian Iberian Massif, the Ossã-Morena Zone extends to the south of the Badajoz-Córdoba Shear Zone which represents its northern limit (Fig. 1). In the SE part of the Ossa-Morena Zone, post-Cambrian formations occur in the Cerrón del Hornillo and in the Valle synclines (Fig. 1): the stratigraphical succession is more fully illustrated and more precisely established in the latter unit, where fossiliferous levels are known from thc Lower Ordovician up to the Upper Devonian (Robardet and Gutiérrez Marco, 1990a and references herein).

In the Valle syncline, the Silurian-Devonian boundary (Fig. 2) lies within the "Upper Graptolite Shales" (Pridoli-Lochkovian), which are separated from the "Lower Graptolite Shales" (Llandovery-Ludlow) by the so-called "Scyphocrinites Limestones and Shales" (Jaeger and Robardet, 1979). The overlying Devonian succession constitutes the "Embalse de El Pintado Group", which comprises fossiliferous levels of Pragian (Robardet *et al.*, 1991), probably Emsian (Racheboeuf and Robardet, 1986) and Famennian ages (Weyant *et al.*, 1988).

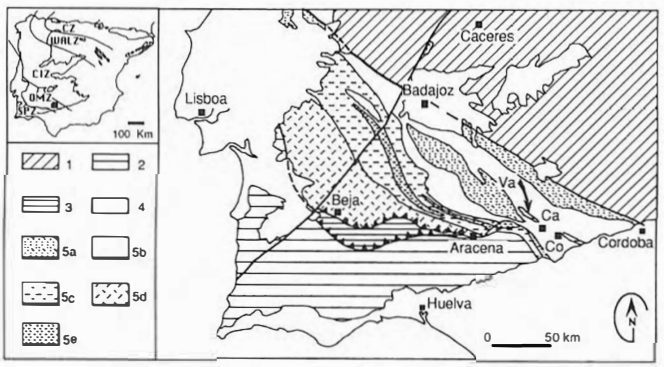

Figure 1. Geographical and geological context of the Ossa-Morena Zone (southwestern Iberian Peninsula). Subdivisions of the Iberian Hercynian Belt after Lotze (1945), Julivert *et al.* (1974), Robardet (1976). CZ Cantabrian Zone; WALZ West-Asturian-Leonese Zone; CIZ Central-Iberian Zone; OMZ Ossa-Morena Zone; SPZ South-Portuguese Zone. 1: Central-Iberian Zone; 2: South-Portuguese Zone; 3: Pulo de Lobo ophiolitic terrane; 4: post-Palaeozoic deposits. 5: Ossa-Morena Zone, 5a: Precambrian, 5b: Cambrian, 5c: Ordovician-Silurian-Devonian, 5d: Evora-Beja Massif, 5e: Upper Devonian-Lower Carboniferous. Va: Valle syncline; Ca: Cazalla de la Sierra; Co: Constantina.

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Homoctenids have been collected from dark limestone lenses included within Lochkovian black shales. The fossiliferous locality (Fig. 3) occurs on the northern edge of the El Pintado dam lake ("Embalse de El Pintado"), SE of the farm "Cortijo del Valle" (cf. section 3 in Figs. 2 and 4 of Jaeger and Robardet, 1979 and section I in Fig. 6 of Racheboeuf and Robardet, 1986). These homoctenids have been assigned to *Homoctenowakia bohemica* (Boucek, 1964) according to the shape, the size, the transversal and longitudinal ornamentation (Plate I). This species, originally named *Paranowakia bohemica* Boucek, 1964, was subsequently assigned to the genus *Homoctenowakia* (Alberti, 1984). Two subspecies, *H. bohemica bohemica* and *H. bohemica titanes*, have been recently distinguished on the basis of the rib density (Alberti, 1993): the first subspecies presents 8-10 longitudinal ribs per 1/2 circumference of the shell in the apertural part and the second 14-18 for the same interval. *H. bohemica bohemica* has a large geographical distribution (Europe, N. Africa, Asia, Australia), while *H. bohemica titanes* is, up to now, only known in Morocco (Rabat-Tiflet area). The studied populations from the Valle syncline and from the Barrandian area belong to *H. bohemica bohemica*.

The occurrence of *H. bohemica*, in association with *Monograptus hercynicus*, has already been mentioned in the Valle syncline (Oczlon, 1989). There was no previous publication about tentaculitoids from the Ossa-Morena Zone, the Devonian fossiliferous localities of

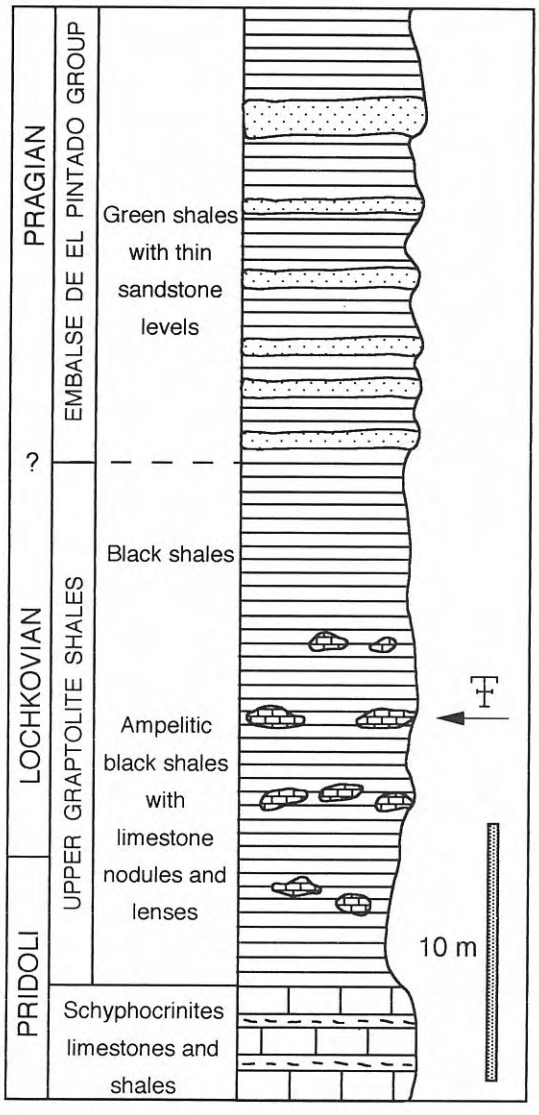


Figure 2. Schematic stratigraphical column of the Silurian-Devonian transition in the Valle syncline.

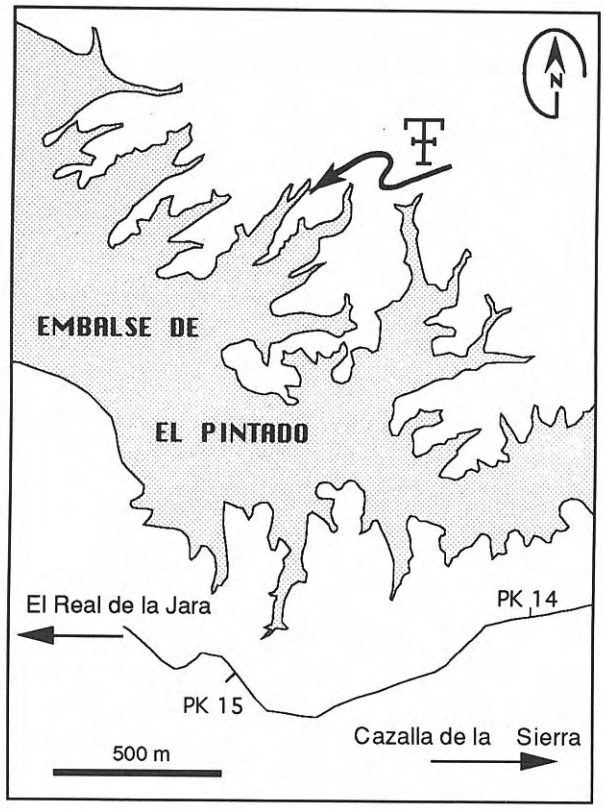


Figure 3. Geographical location of the fossiliferous locality.

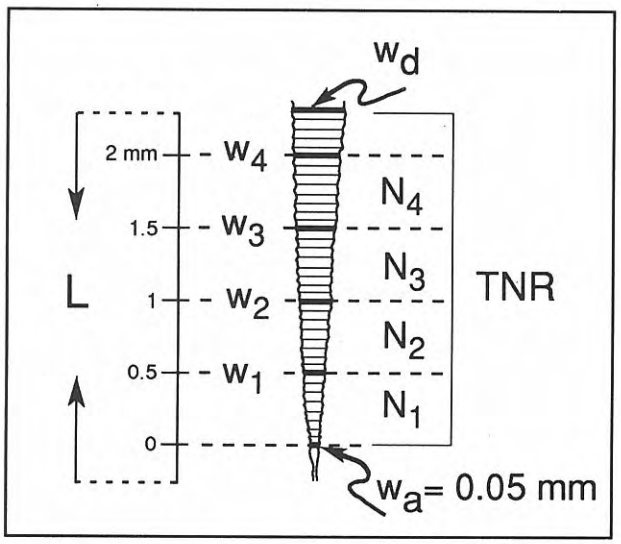


Figure 4. Schematic representation of the different characters measured on the shell of *Homoctenowakia bohemica bohemica*. L = maximum length; w_d = maximum width; wa = minimum width (0.05 mm); w_1, w_2, w_3 = widths measured at a distance of 0.5, 1, 1.5 mm from la; N1, N2, N3 = number of rings within successive segments (0.5 mm each) of the shell.

Espiel, Peñarroya and Alange (Truyols-Massoni, 1988, p. 70 and 82) being located to the north of the Badajoz-Cordoba Shear Zone and thus belonging to the southern part of the Central-Iberian Zone as defined above (Fig. 1).

In the Iberian Peninsula *Homoctenowakia bohemica* was cited (*Paranowakia bohemica* in Alberti, 1970a, p. 165 and *Homoctenowakia bohemica bohemica* in Alberti, 1993, p. 20) at St. Creu d'Olorda and Brugers in the Catalonian Coastal Ranges (NE Spain) and more recently mentionned again *(Homoctenowakia bohemica)* precisely in the lowermost beds of Member B of the Olorda Formation (Truyols-Massoni, 1988, p. 195 and Fig. 79; García-Lopez *et al.*, 1990, p. 150-151).

This paper presents a quantitative study of *Homoctenowakia bohemica bohemica* (Boucek, 1964) from the Valle syncline. A parallel quantitative study has been performed on a sample of *Homoctenowakia bohemica bohemica* collected in the Barrandian area (Cerná rokle gorge: type locality of the species *P. bohemica*, Radotín Limestone of the Lochkov Formation, Chlupác, 1988), which allows Spanish and Bohemian populations to be compared. The biometric study of *Homoctenowakia bohemica bohemica* more fully illustrates the morphological variations within this subspecies.

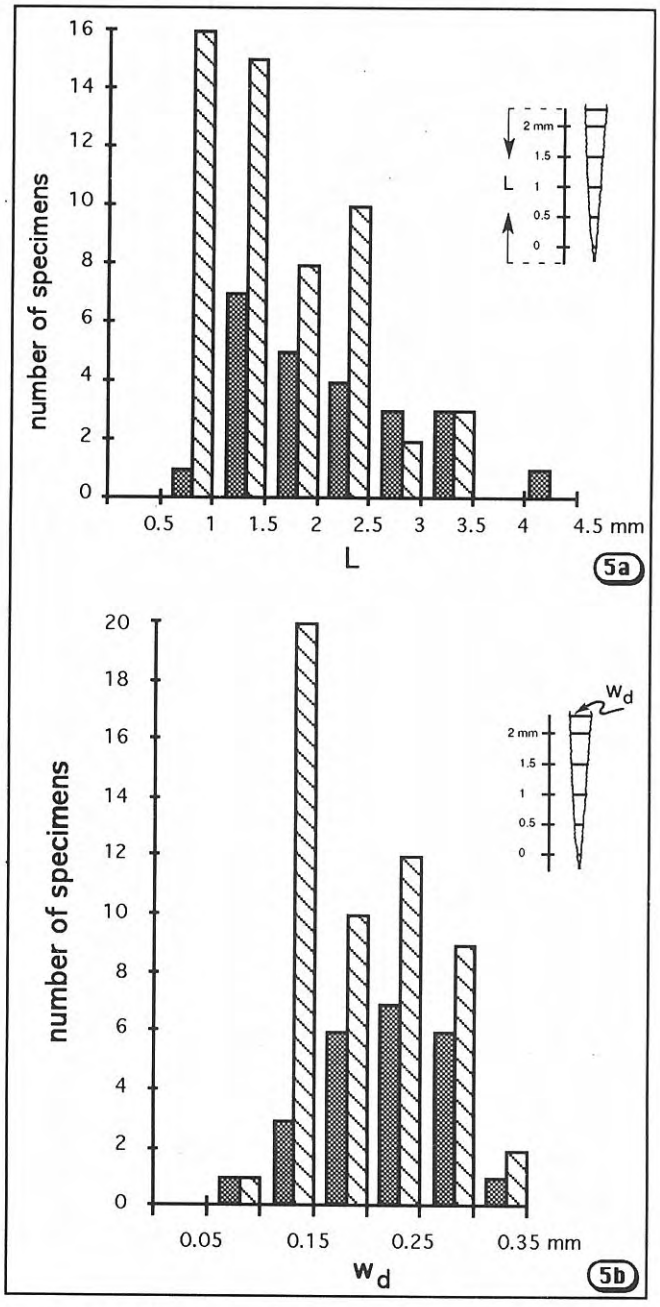


Figure 5. a: Histograms showing the maximum length L of Spanish (black) and Bohemian (hatched) populations of *Homoctenowakia bohemica bohemica*. b: Histograms showing the maximum width w_d of Spanish (black) and Bohemian (hatched) populations of *Homoctenowakia bohemica bohemica*.

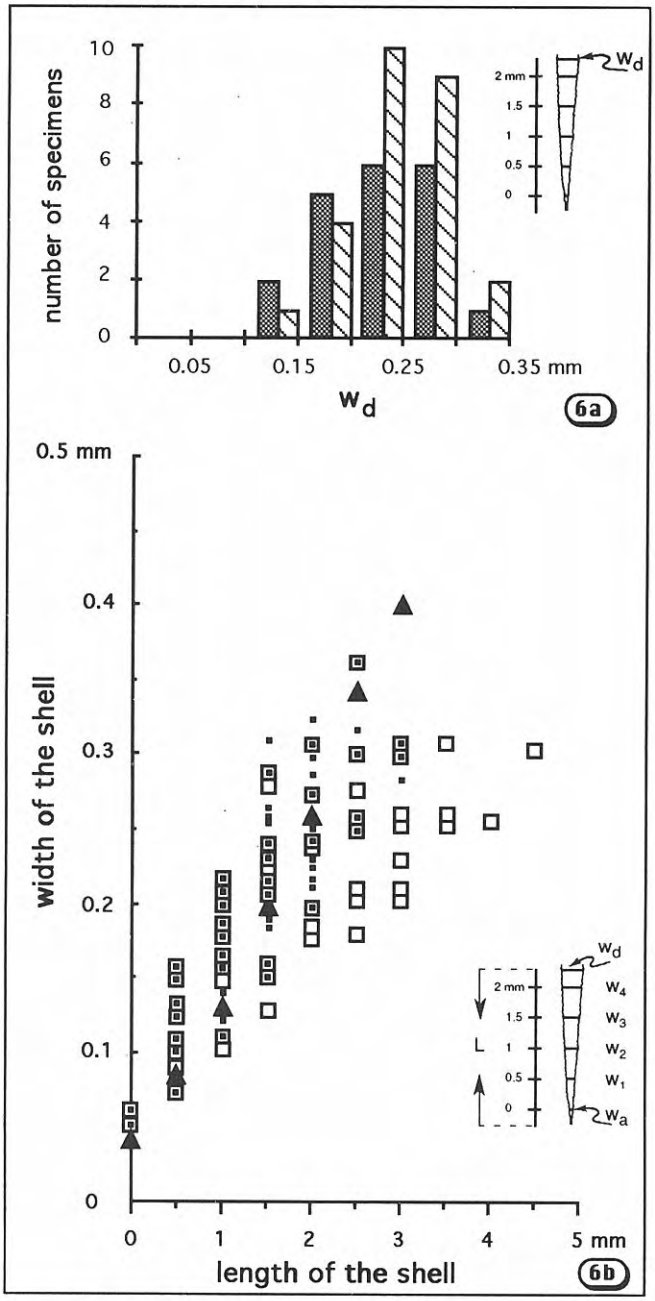


Figure 6. a: Histograms showing the maximum width w_d of Spanish (black) and Bohemian (hatched) specimens with L≧ 1.5 mm. b: Diagram of the widths measured every 0.5 mm along the shell (squares = Spanish specimens, dots = Bohemian specimens, black triangles = holotype, Boucek, 1964).

METHODOLOGICAL PROCESSES AND RESULTS

At the Valle syncline locality the specimens of *Homoctenowakia bohemica bohemica* are exclusively concentrated (up to 20 specimens per cm^2) on bedding surfaces without preferential orientation. The available population comprises about 60 specimens, represented in most cases by internal moulds. When the shell itself is preserved, the number of longitudinal ribs is about 7 in the proximal part and 9-10 in the distal part, which corresponds to the values mentioned in the literature (Boucek, 1964; Lardeux, 1969; Alberti, 1986) for the species *H. bohemica bohemica.*

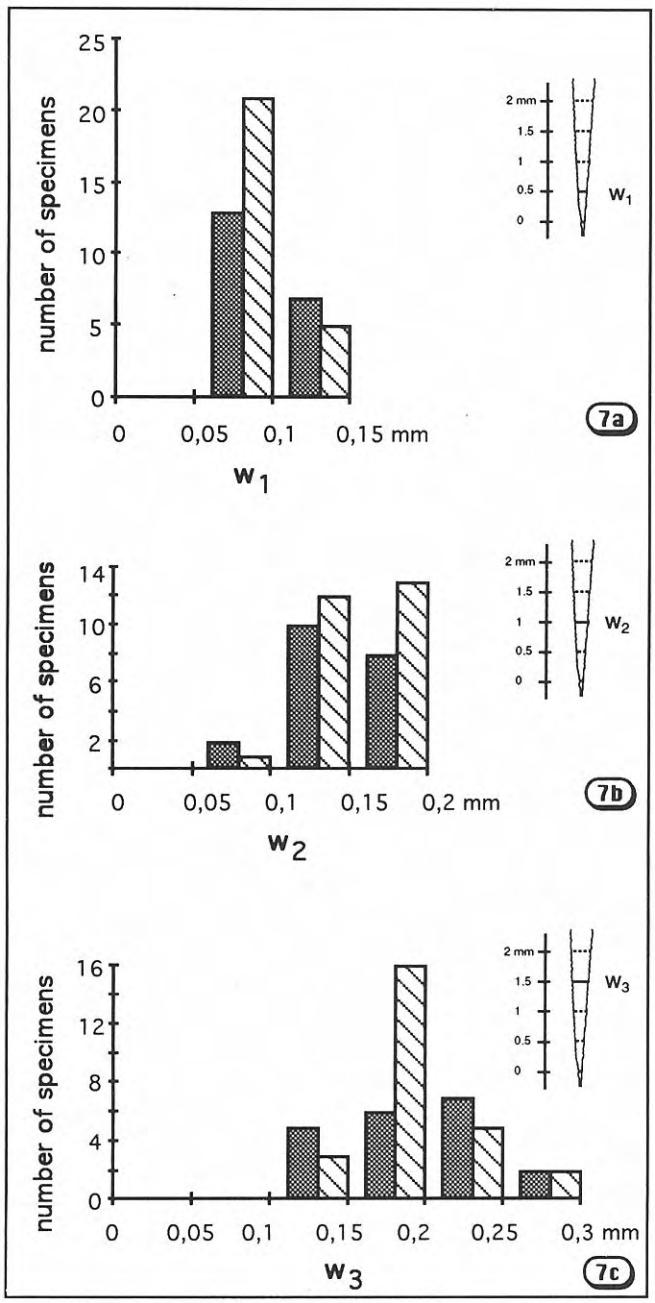


Figure 7. Histograms showing the frequency distribution of w_1 (7a), w_2 (7b), w_3 (7c) of Spanish (black) and Bohemian (hatched) specimens.

In the classical descriptions of tentaculitoids, measured morphological parameters are used for characterizing the species. However there is generally no precision about either the preservation or the completeness of the shells and most of the measures are given without specifying their precise position on the specimens.

In the present study all the specimens, which are undeformed, have been measured exactly in the same way for a precise comparison. The morphological parameters chosen (Fig. 4) are the maximum length (L), the maximum width (w_d), the width (w_1, w_2, w_3) and the number of rings (N_1, N_2, N_3) per 0.5 mm at definite distances from the first ring above the initial chamber. A rather large number of specimens are incomplete in the proximal part. In completely preserved specimens the minimum width (w_a) of the shell, just above the initial chamber, is 0.05 mm: this value has been considered as indicative of the first ring above the initial chamber, when the apex is missing. When this selective criterion is used, the respective sample sizes are 24 for the Valle syncline and 54 for the Barrandian area. These numbers of specimens can be considered sufficient to be representative for a population analysis (see Büttner, 1982).

The first step in the study was to consider the maximum length and width of the specimens from both populations (Fig. 5), keeping in mind that, since some of the shells are probably incomplete in the distal part, these measures cannot be regarded as strictly representative of the living populations. Figure 5a shows that 66 % of the Spanish specimens have a maximum length between 1 and 2.5 mm and that 61 % of the Bohemian individuals fall within the same interval with a maximum of 72 % between 0.5 and 2 mm. A similar distribution appears for the maximum width (Fig. 5b) with 79 % of the Spanish specimens between 0.15 and 0.30 mm and 78 % of the Bohemian individuals between 0.10 and 0.25 mm. In both diagrams, the slight difference between the two populations results from the large number of small-sized individuals in the Bohemian sample. If we remember that both populations occur accumulated on bedding surfaces, this slight difference may be no more than the result of sedimentological factors such as the water energy in the environment of deposition.

All the following diagrams only concern the specimens whose length is 1.5 mm or more: this selection, which eliminates the smallest individuals, reduces the studied populations to 20 Spanish and 26 Bohemian specimens but allows comparisons for a larger number of morphological parameters.

In these selected populations, the diagram concerning the maximum width (Fig. 6a) shows that 85 % of the Spanish specimens and 88 % of the Bohemian individuals are comprised within the 0.15-0.30 mm interval. In order to evaluate the width variation along the shell, the width has been measured every 0.5 mm: Fig. 6b shows the same distribution for both populations and the corresponding values measured by Boucek (1964, Fig. 31) on the holotype of the species clearly fit in this diagram. The histograms schematized on Fig. 7a, b and c show the frequency distribution of w_1, w_2 and w_3 measured at a distance of 0.5, 1 and 1.5 mm above the apex. The ratios w_2/w_1 (Fig. 8a) and w_3/w_2 (Fig. 8b) illustrate the growth variation between two successive

parts of the shell; the combined diagram (Fig. 8c) indicates a small angular variation of the conical shape during the shell growth. In all these diagrams (Figs. 7 and 8) similar results occur for both Spanish and Bohemian populations.

The last character examined is the density of the transverse ornamentation. The total number of rings is not strictly proportional to the total length of the shell (Fig. 9a), as already noted for different species of tentaculitoids (Alberti, 1970b, Lütke, 1974; Sauerland, 1983). The ring density within successive parts of the shell (N_1, N_2, N_3, Fig. 9b-d) decreases during the shell growth; Boucek (1964, Fig. 31) mentionned the same fact for the holotype of this species as well as for different species of *Paranowakia*. The population of *Homoctenowakia bohemica bohemica* from the Valle syncline slightly differs from the Bohemian population by fewer rings for the same considered interval; however the general tendency is the same in both populations.

CONCLUSIONS

The foregoing analysis shows that the two populations differ slightly in some minor morphological manner, but a fundamental agreement exists for all important characters: shape and size of the shell (L, w_a, w_1 w_2, w_3), transversal and longitudinal ornamentation (N_1, N_2, N_3). Table 1 shows the mean and the standard

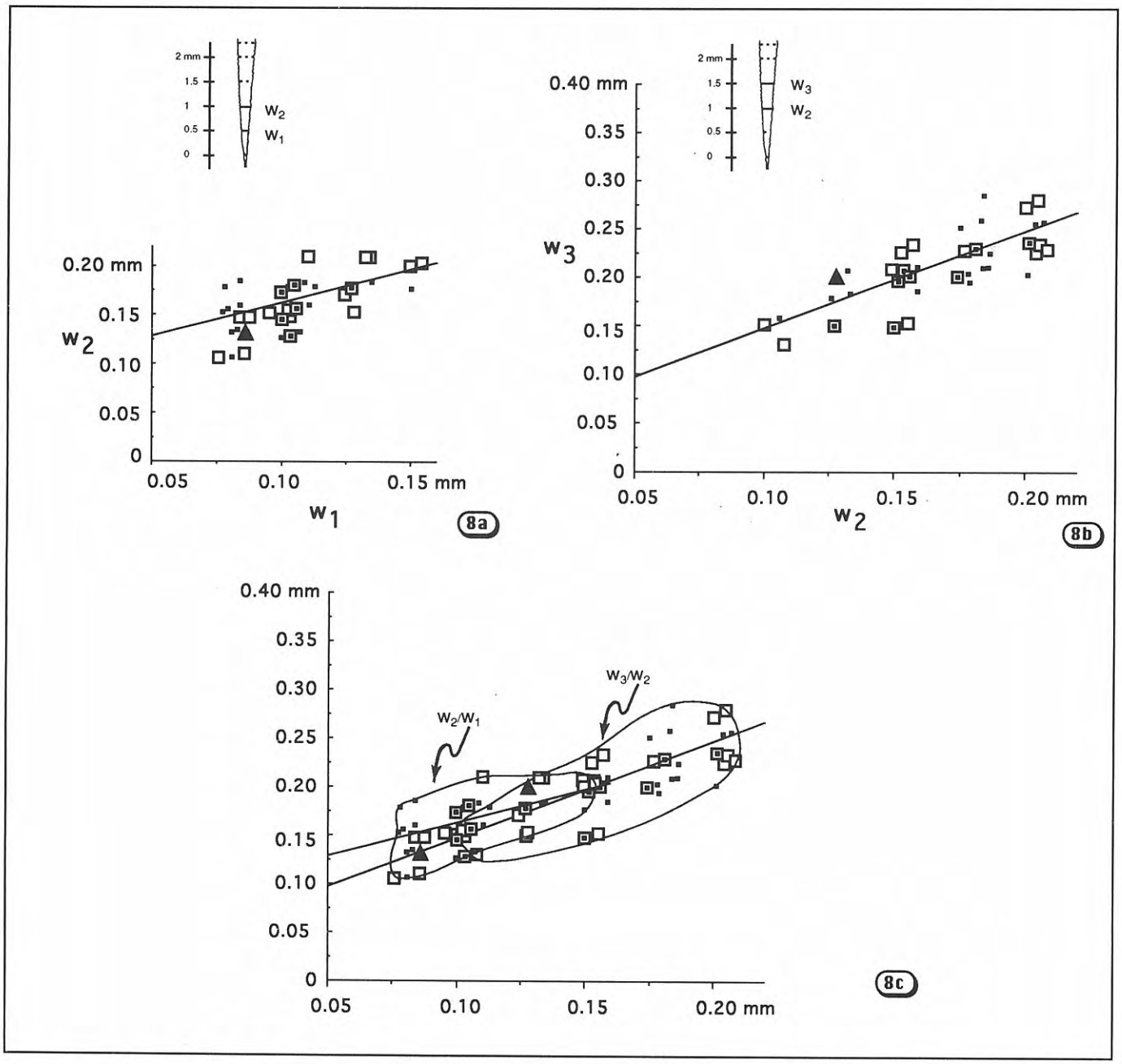


Figure 8. a: Diagram of the w_2/w_1 ratio (squares = Spanish specimens, dots = Bohemian specimens, black triangle = holotype, data from Boucek 1964, Fig. 31). b: Diagram of the w_3/w_2 ratio (same symbols as Fig. 8a). c: Combined diagram of the w_3/w_2 and w_2wl_1 ratio.

variation of the morphological parameters chosen in the present study and confirms a substantial identity of the Spanish and Bohemian populations.

This quantitative analysis fully confirms the specific assignement of the Spanish specimens to *Homoctenowakia bohemica bohemica* and defines the morphological variations within this subspecies.

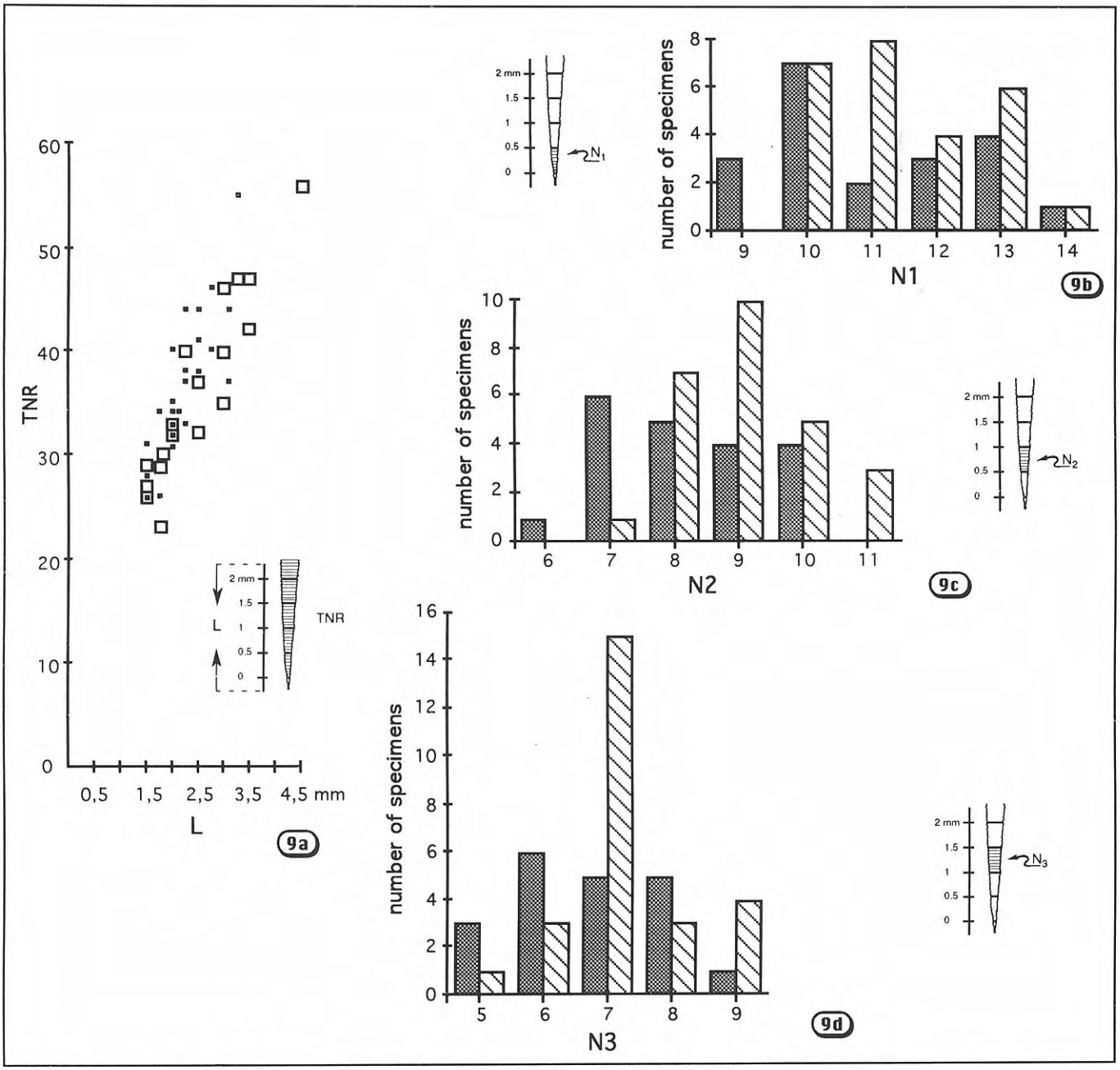


Figure 9. Density of the transverse ornamentation. 9a: Total number of rings (TNR) in relation to the length of the shell (squares = Spanish specimens, dots = Bohemian specimens). 9b, c, d: Histograms showing the variation in the numbre of rings within successive parts of the shell Spanish (black) and Bohemian (hatched) specimens.

Plate I

1-2 *Homoctenowakia bohemica bohemica* population concentrated without preferential orientation on bedding surface, Valle syncline (Fig. 1 sample 83 VA10-1, Fig. 2 sample 83 VA10-4) (× 5).

3 Two internal moulds of *Homoctenowakia bohemica bohemica* from the Valle syncline (sample 83 VA10-1) (× 20).

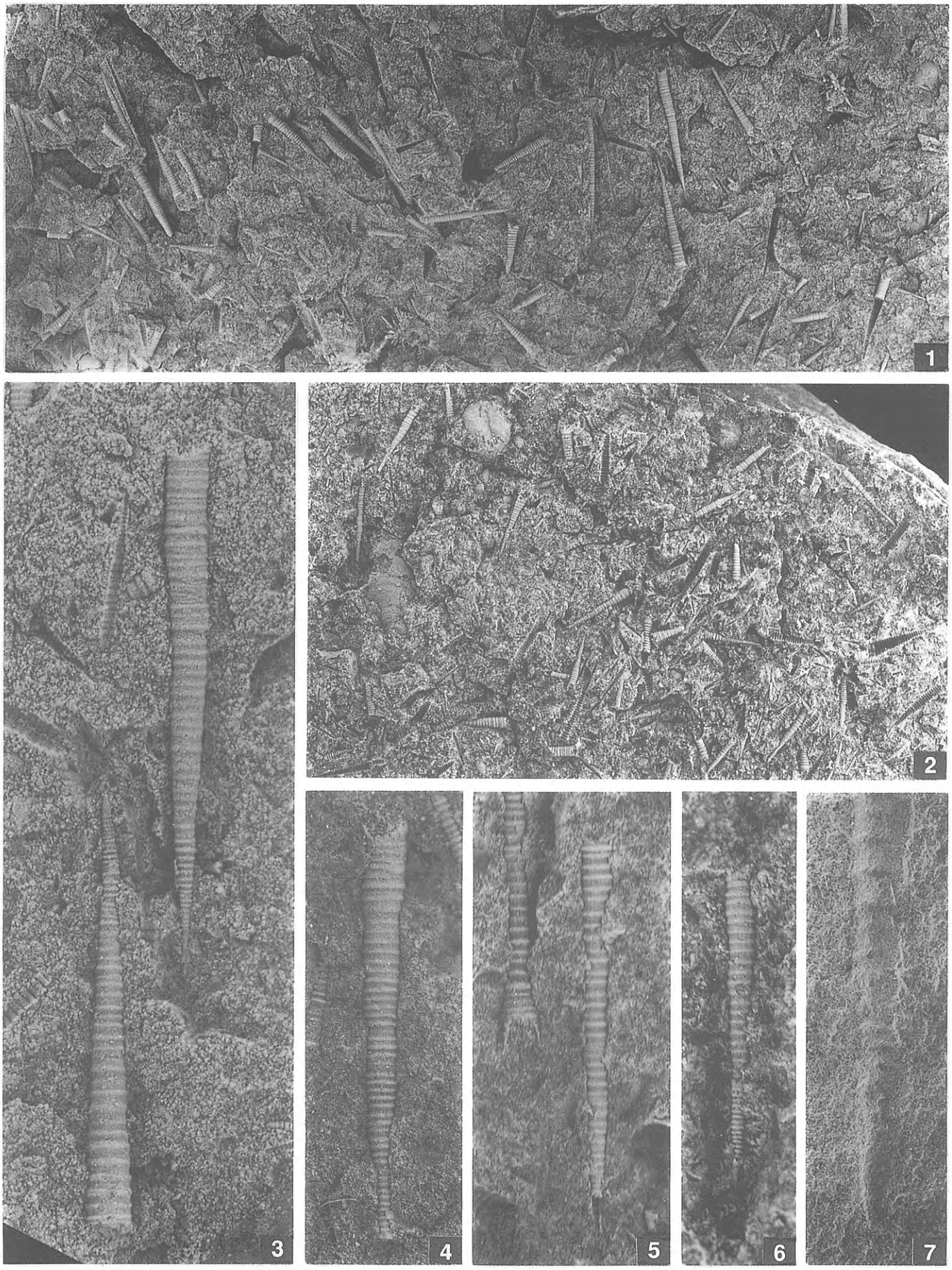
4 Another specimen from the same locality (specimen 83 VA 10-3-2) (× 20).

5 A specimen of *Homoctenowakia bohemica bohemica* from the Valle syncline showing longitudinal ribs (specimen 83 VA10-3-9) (× 20).

6 *Homoctenowakia bohemica bohemica* with longitudinal ribs from the Barrandian area (× 20).

7 Detail of initial chamber of *Homoctenowakia bohemica bohemica* with longitudinal ribs from the Valle syncline (sample 83 VA10-3-13) (× 100).

Plate I



	MEAN			
	Spanish population	Bohemian population	Spanish pop. L≥1.5 mm	Bohemian pop. L≥1.5 mm
w1	0.107	0.1	0.107	0.098
w2	0.156	0.154	0.16	0.16
w3	0.203	0.207	0.203	0.207
N1	10.958	11.426	11.05	11.462
N2	8	9.02	8.2	9.077
N3	6.75	7.231	6.75	7.231
	STANDARD DEVIATION			
	Spanish population	Bohemian population	Spanish pop. L≥1.5 mm	Bohemian pop. L≥1.5 mm
w1	0.0204	0.0172	0.0219	0.0199
w2	0.0316	0.0247	0.031	0.0275
w3	0.0405	0.0371	0.0405	0.0371
N1	1.459	1.2069	1.572	1.2403
N2	1.2158	0.9998	1.2397	1.0554
N3	1.1642	0.9923	1.1642	0.9923

Table 1. Mean and standard variation for the Spanish and Bohemian total and selected populations.

The presence of *Homoctenowakia bohemica bohemica* in limestone lenses of the Lochkovian black shales from the Valle syncline is a precise illustration of the sedimentological and faunal characteristics of the Ossa Morena Zone during the Early Palaeozoic. From the Cambrian up to the Early Devonian, these characteristics are clearly distinct from those of the Central-Iberian Zone (Jaeger and Robardet, 1979 Robardet and Gutiérrez-Marco, 1990a and b) and indicate palaeobiogeographical affinities with other regions of southern and central Europe such as Sardinia, Carnic Alps, Thuringia and Bohemia.

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