GEOLOŠKI VJESNIK	Vol. 43	str. 17–22	Zagreb, 1990.

UDC 578.087:562.593.12 *Izvorni znanstveni članak*

Biometrical study of Discocyclina dispansa hungarica Kecskeméti from Late Lutetian of the Skradin-Dubravice area (SW Croatia)

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Key words: Discocyclinidae (Larger Foraminifera), Biometry, Histograms, Scatter diagrams, Lutetian, Croatia.

As a first contribution to the study of Yugoslav Discocyclinidae, seventeen specimens of Discocyclina dispansa hungarica Kecskeméti from the Skradin–Dubravice area (SW Croatia) were biometrically analysed. These analyses resulted in scatter diagrams which indicate certain regularity between dimensions of the inner structural elements and confirm the monospecifity of the analysed population.

Ključne riječi: Discocyclinidae (Velike foramnifere), Biometrija, Histogrami, Dijagrami osipanja, Lutet, Hrvatska.

Sedamnaest jedinki podvrste Discocyclina dispansa hungarica Kecskeméti iz naslaga Skradin–Dubravice (JZ Hrvatska) biometrijski su analizirane, i to je prvi doprinos proučavanju diskociklina u Jugoslaviji. Konstruirani dijagrami pokazuju određenu pravilnost između pojedinih vrijednosti unutarnjih strukturnih elemenata i potvrđuju monospecifičnost analizirane populacije.

Introduction

Despite their abundance on numerous localities in the Dinarides, Discocyclinidae are less known than other larger foraminiferal genera and families. The reason is probably the very demanding method of their preparation, because oriented sections (both equatorial and axial) are necessary for identification of species. However, exposed equatorial layer is sufficient for biometric measurements. The present investigation is based on isolated forms occuring in equatorial sections, which were prepared by the slightly modified method of Less (1981, 1987).

The analysed sample consisted of 50 specimens of megalospheric forms of Discocyclina dispansa hungarica Kecskeméti, among which 24 were relatively undamaged, but only on 17 specimens biometrical measurements could be made. The difference in the number of examined specimens and of the originally available ones reflects the preparation method applied. (Fig. 1). Therefore the inadequate application of the method, some specimens were damaged (their species specific determinations were based upon external features), but also among the undamaged ones, some had unsatisfactorily preserved inner structural elements. The histograms (Fig. 3) show the relation of number of individuals and different parameters of the embryonic apparatus. The scatter diagrams (Fig. 4) are constructed in order to show the interrelationship between the inner structural elements.

The analysed specimens derive from clastic deposits of the Skradin–Dubravice area (SW Croatia) and were collected in the field by Dr. K. Drobne. The fossil assemblage consists of Asterocyclina stellata (d'Archiac), Discocyclina dispansa hungarica Kecskeméti, Nummulites sp., Assilina sp. and undetermined, smaller foraminifers. The age is late Lutetian.

Preparation method

The internal structural features of the genus Discocyclina Gümbel, with cyclical growth of equatorial layer, sandwiched between symmetrically added lateral layers, conditioned the preparation method applied. Recent ideas of some authors (Less,

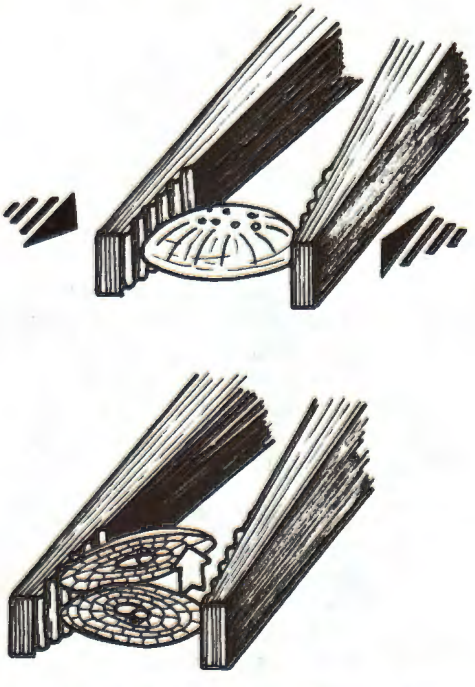

Fig. 1 Steps involved in exposing the equatorial plane of discocyclinids. Before grinding, the test has to be held so to get the equatorial layer placed at right angle of combination cutting plier's jaws.

Slika 1 Način dobijanja odgovarajućeg presjeka diskociklina. Kalanju ljušturica foraminifera prethodi pravilno postavljenje kućice (pod pravim kutem) u odnosu na otvor kliješta.

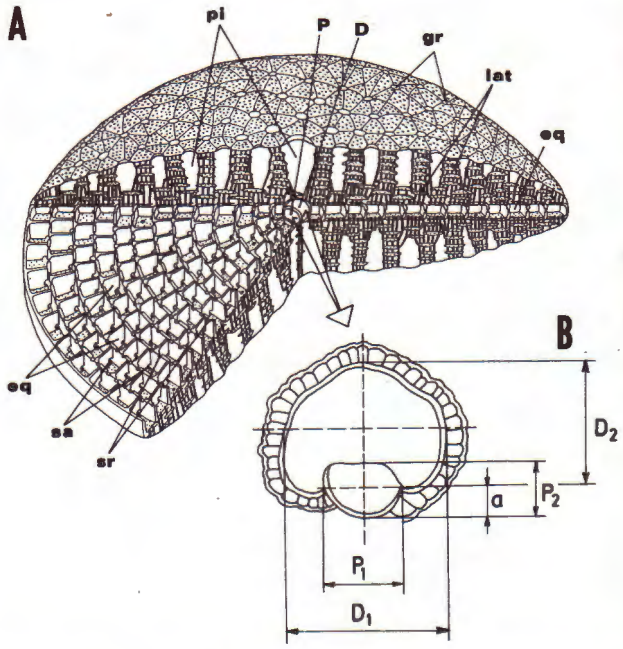

Fig. 2A Reconstruction of Discocyclina sp. with parts cut away presenting internal structures in both, equatorial and axial sections (after Ferràndez i Canadell, 1989). P = protoconch, D = deuteroconch, eq = equatorial chamber or chamberlet, lat = lateral chamber or chamberlet, sa = annular stolon, sr = radial stolon, gr = granule, pi = pillar.

2B Equatorial section (not to scale) of the embryonic apparatus of the Discocyclina dispansa hungarica Kecskeméti showing the way of measuring the paramaters P_1, P_2, D_1, D_2 and a.

Slika 2A Rekonstrukcija grade diskociklinidnih foraminifera u ekvatorijalnom i aksijalnom presjeku (preuzeto od Ferràndez i Canadell, 1989).
P = protokonh, D = deuterokonh, eq = ekvatorijalna klijetka odnosno sekundarna klijetka, lat = lateralna klijetka odnosno sekundarna klijetka, sa = anularna stolona, sr = radijalna stolona, gr = granula, pi = stupić.

2B Detalj embrionalnog aparata Discocyclina dispansa hungarica Kecskeméti pokazuje način mjerenja parametara P_1, P_2, D_1, D_2 i a.

1981,1987; Matteucci & Schiavinotto, 1984; Sirotti, 1982) suggest that the exposed equatorial layer is sufficient for identification of species.

Instead of preparing oriented thin–sections, a new method of exposing the relevant part of foraminiferal test was introduced by Less (1981, 1987); each foraminiferal test has to be splitted by combination cutting pliers (Fig. 1) »... so as to get the equatorial layer placed at right angle of the pliers's jaws« (Less, 1981, p.450). Because of the difference in the sampled material (glauconitized discocyclinids studied by Less in contrast to the calcitized ones in the present case), the original technique had to be modified. This modification consists of repeated heating and cooling of each specimen prior to its splitting by pliers. The advantage of the described method is obvious, because the time consuming and tiresome method is replaced by much faster production of good sections. This method proved successful in 50% cases. The contrast of broken test may be enhanced by staining with Indian ink (Raduga–2, trade name GOST–6–15–78–73). Primary calcite (walls, pillars, granules) remains unstained, while secondary calcite overgrowths and infillings get coloure.

The broken tests obtained in this way need not be moistened during the examination under the stereo-microscope.

Biometry of the subspecies studied

There has been thorough study of the relationship between the morphology of discocyclinids and their sedimentary environment; however, some structural values related to their ontogenetic development and phylogenetic trends have been investigated (Less, 1987; Matteucci & Schiavinotto, 1984). Therefore, most of the parameters used in this paper were already chosen by Less (1987), complemented with certain measurements derived from similar study of nummulitids (Matteucci et. al., 1982; Reguant & Serra-Kiel, 1979; Serra-Kiel & Reguant, 1984). The measured elements used to distinguish various individuals of D. dispansa hungarica are the following (all measured in equatorial sections) (Fig. 2B):

$P_{1,2}$, $D_{1,2}$ – diameters of protoconch and deuteroconch measured along and perpendicular to the axis of symmetry.

n – total number of whorls.

a – distance measured along the axis of symmetry from the bottom of protoconch to the bottom of deuteroconch.

Table 1 Ranges of various paramaters of Discocyclina specimens from the Skradin–Dubravice area.

Tablica 1 Vrijednosti parametara mjerenih na individuuima diskociklinidnih foraminifera s istraživanog područja.

	μm		μm							μm		
	P_1	P_2	D_1	D_2	a	R	E	Q	n	L X H	l X h	$n_{0,5}$
1.	160	/	355	295	/	/	/	/	~25	40 X 55	35 X 60	/
2.	165	155	460	350	15	0,90	0,64	2,50	~35	40 X 50	35 X 70	10
3.	220	200	350	250	120	0,40	1,16	1,41	/	/	30 X 50	/
4.	110	110	300	215	30	0,73	0,76	2,27	/	/	35 X 70	/
5.	190	180	355	290	70	0,61	0,86	1,73	/	/	35 X 70	11
6.	/	/	/	/	/	/	/	/	/	/	/	/
7.	195	170	320	220	35	0,79	0,54	1,46	/	/	30 X 55	12
8.	130	125	260	205	50	0,60	0,878	1,82	/	/	30 X 60	11,3
9.	160	140	210	190	60	0,57	0,89	1,33	~15	45 X 60	30 X 45	11
10.	136	120	300	230	40	/	0,83	2,07	/	/	/	/
11.	/	/	/	/	/	/	/	/	/	/	/	/
12.	210	220	360	350	110	0,50	1,00	1,65	~20	45 X 50	30 X 55	10,5
13.	120	140	260	260	15	0,80	0,58	2,00	~20	45 X 55	30 X 55	10,5
14.	160	130	360	320	10	0,92	0,65	2,35	/	/	35 X 65	11,8
15.	/	/	/	/	/	/	/	/	/	/	/	/
16.	186	170	360	280	70	/	0,89	1,79	/	/	/	/
17.	210	180	390	275	80	0,55	0,93	1,69	~25	40 X 55	35 X 65	9,2
18.	165	150	310	210	55	0,63	0,81	1,62	~18	40 X 60	30 X 60	11
19.	/	/	/	/	/	/	/	/	/	/	/	/
20.	180	150	355	260	50	0,67	0,81	1,85	/	/	30 X 60	11
21.	174	158	340	268	64	/	0,89	1,88	/	/	/	/
22.	/	/	/	/	/	/	/	/	/	/	/	/
23.	140	130	300	250	50	0,61	0,88	2,03	/	/	/	/
24.	/	/	/	/	/	/	/	/	/	/	/	/

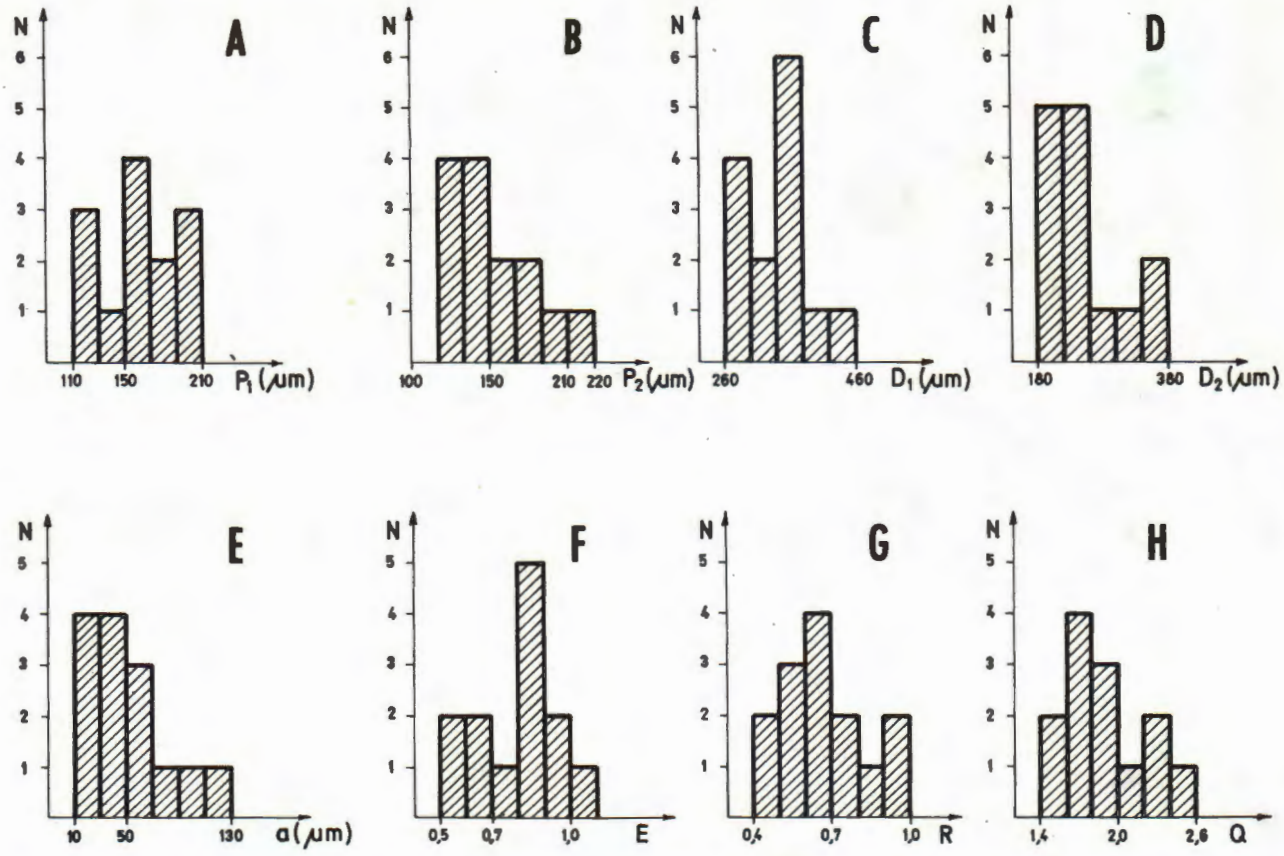

Fig. 3 Histograms of P_1, P_2, D_1, D_2, a, E, R and Q for the Discocyclina dispansa hungarica Kecskeméti from all examined specimens (N = indicate number of individuals).

Slika 3 Histogrami P_1, P_2, D_1, D_2 a, E, R i Q za podvrstu Discocyclina dispansa hungarica Kecskeméti (N = označava broj individua).

$n_{0,5}$ – number of whorls within the first 0,5 mm of the test diameter.

R – degree of enclosure, shows how deeply the protoconch is pushed into the deuteroconch; it is calculated as $R = (a + P_2)/P_2$.

E – excentricity of the embryonic apparatus, calculated as $E = 1 - (2a + P_2/P_2)$.

Q – size relation of the first two chambers, describing the shape of the embryonic apparatus, calculated as $Q = D/P$.

L, H, l, h – size (height and width) of chambers (or chamberlets) in the first nepionic whorl (known as adauxillary chambers) and equatorial chambers (or chamberlets) in the youngest whorl.

The observation data are presented in histograms (Fig. 3) and scatter diagrams (Fig. 4). Most of the features, however, appear to be variable within the subspecies range.

As shown in the histograms, some of them (Fig. 3A and 3C) have small, but defined peaks that correspond to the number of specimens in relation to the diameter of protoconch and deuteroconch (both measured perpendicularly to the axis of symmetry of the embryonic apparatus). The histograms for all observations on E, R and Q (Fig. 3F – H) show distinctly unimodal frequency distribution. The overall means are:

$$\bar{E} = 0{,}82 \qquad \bar{R} = 0{,}67 \qquad \bar{Q} = 184$$

The histograms also reveal the marked deficiency of the larger forms which may be the consequence of a relatively high mortality of older individuals.

From the data obtained by measuring parameters, ten scatter diagrams (Fig. 4) were constructed, each one presenting two variables. The first group of graphs (Fig. 4A – E) illustrates the relationship between the size of the embryonic chambers, while the others (Fig. 4F – I) indicate trends of relationship between the degree of enclosure and the true diameters of the first two chambers.

Different gradients of regression lines originate from the independent increase of the measured elements. The shape of the embryonic apparatus is well defined (semi-nephrolepidine type); it is described in two ways: with a gently inclined regression lines when the diameters of the corresponding embryonic chambers are well correlated (Fig. 4A – B), and with steeply inclined regression lines in cases when diameters of protoconch are compared to the diameters of deuteroconch (Fig. 4C – D).

The second group of diagrams (Fig. 4F – I), illustrating variabilities of the embryonic chambers (defined as the quotient of the degree of enclosure

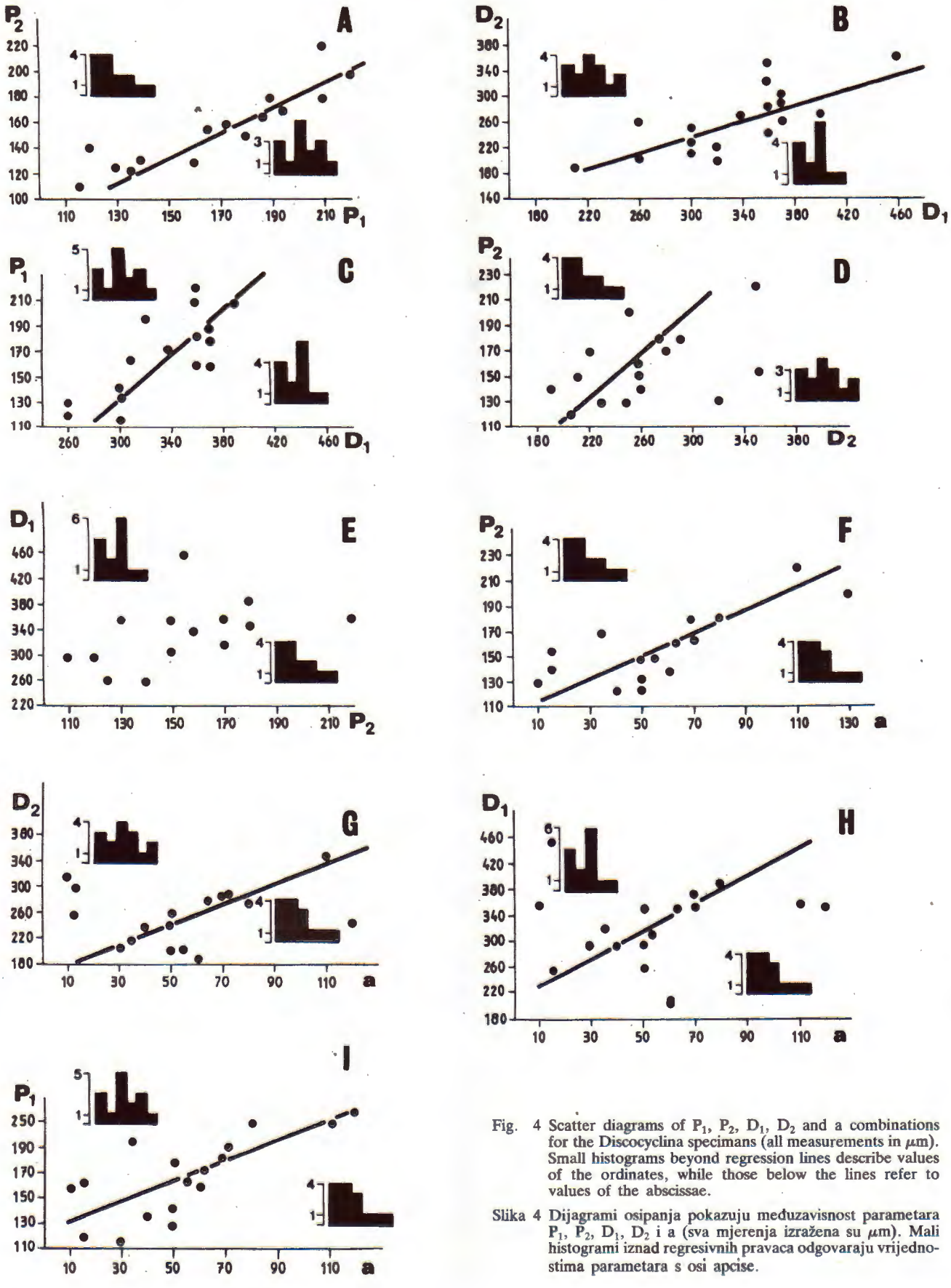

Fig. 4 Scatter diagrams of P_1, P_2, D_1, D_2 and a combinations for the Discocyclina specimans (all measurements in μm). Small histograms beyond regression lines describe values of the ordinates, while those below the lines refer to values of the abscissae.

Slika 4 Dijagrami osipanja pokazuju međuzavisnost parametara P_1, P_2, D_1, D_2 i a (sva mjerenja izražena su μm). Mali histogrami iznad regresivnih pravaca odgovaraju vrijednostima parametara s osi apcise.

and diameters) apper to present an easily detectable dependence. The observed samples indicate an symmetrical frequency distribution which is skewed to the left in most samples (Fig. 4F – I) and an almost parallel position of regression lines.

The irregular frequence distribution in Fig. 4E is probably the result of the small number of available specimens used for correlation.

The population of D. dispansa hungarica in the Skradin–Dubravice area is represented by a whole array of described variables. This confirms that the population is monospecific with a variability of megalospheric forms. Differences in diameters of the test, apart from factors related to the protoplasmatic volume (Reiss & Hottinger, 1984), seem to represent individual adaptations to environmental conditions.

Conclusion

The biometric study of 17 megalosperic individuals of Discocyclina dispansa hungarica Kecskeméti from clastic sedimets in the Skradin–Dubravice area (SW Croatia) confirms the monospecifity of the investigated population.

The histograms for all observation on the diameters of the first two chambers, on the degree of enclosure, on excentricity and on size relation show normal frequency distribution. Scatter diagrams of all the available data were prepared for combinations of all parameters. Distinct positive correlations exist in all cases.

Acknowledgements

Drs. K. Drobne and P. Raffaelli critically reviewed the manuscript and made helpful suggestions for improvements. Special thanks are extended to Dr. I. Gušić for helpful suggestions and support in paleontological questions. The author is much indebted to Mr T. Marjanac for the original drawing (Fig. 1), and thanks are due to A. Truhan for preparation of diagrams and drawings.

Received: 12. XII. 1989.

Accepted: 7. V. 1990.

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Biometrija podvrste Discocyclina dispansa hungarica Kecskeméti iz lutetskih naslaga područja Skradin-Dubravice (JZ Hrvatska)

V. Ćosović

Uvod

Iako su diskocikline česti fosili u paleogenskim naslagama Vanjskih Dinarida, slabije su poznate nego druge skupine tzv. »Velikih foraminifera« (npr. Alveolina, Nummulites). Razlog je, vjerojatno, u zahtjevnom načinu prepariranja, budući da se taksonomsko određivanje na nivou vrste obavlja pomoću orijentiranih presjeka. Međutim, izloženi ekvatorijalni sloj, koji je dovoljan za biometrijske analize, ostvaruje se primjenom nešto izmijenjene Less-ove (1981, 1987) metode.

Uzorak analizirane fosilne zajednice primarno je brojio 50 jedinki megalosferične generacije podvrste Discocyclina dispansa hungarica Kecskeméti, ali zbog neadekvatnog korištenja tehnike prepariranja materijala svega 24 jedinki ostalo je manje-više neoštećeno, a biometrijske analize provedene su na 17 jedinki, na onim formama koje su imale potpuno sačuvane unutrašnje strukturne elemente.

Istraživani materijal potječe iz klastičnih naslaga područja Skradin–Dubravice (sakupila ga je dr. K. Drobne), a uz navedenu podvrstu sadrži još i slijedeće forme: Asterocyclina stellata (d'Archiac), Nummulites sp., Assilina sp. i neodređene sitne foraminifere. Zanimljivo je da nije pronađen ni jedan oblik mikrosferične generacije diskocikline.

Rezultati biometrijskih analiza prikazani su u formi histograma, odnosno dijagrama osipanja. Dok histogrami (sl. 3) sadrže prikaz učestalosti pojavljivanja nekih strukturnih elemenata, njihov međusobni odnos izražen je dijagramima osipanja (sl. 4).

Tehnika pripreme materijala

Specifičnosti u gradnji foraminifera roda Discoclycina Gümbel utječu na izbor metode obrade materijala radi dobivanja odgovarajućih presjeka kućica. Tako, po mišljenju nekih istraživača (Less, 1981, 1987; Matteucci & Schiavinotto, 1984; Sirotti, 1982), ekvatorijalni sloj kriterij je za određivanje vrsta. Stoga umjesto primjene dugotrajne i zamorne tehnike brušenja u svrhu otkrivanja ekvatorijalnog sloja (njihova prosječna debljina kod diskociklina iznosi 0,05 mm) korišten je način obrade koji je opisao Less (1981, 1987) s jednom izmjenom. Njegova tehnika se sastoji u razlamanju izoliranih kućica foraminifera kliještima

(tzv. »kombinirkama«) na dva jednaka dijela, tako što se ekvatorijalni sloj postavi okomito na otvor kliješta (sl. 1). Metoda je pokazala dobre rezultate na glaukonitiziranim kućicama, među utim, na kalcitiziranim uzorcima, kakav je ovo slučaj, primjena iste tehnike dovodi do nepravilnog drobljenja kućica. Za tako dijagenetski izmjenjen materijal trebalo je koristiti nešto drugačiji postupak. Ustanovljeno je, da se dobri presjeci kućica foraminifera mogu postići tako da se kućica prije kalanja višestruko zagrijava i hladi.

Prednost ovakvog pripremanja pred tehnikom brušenja je velika: vrijeme potrebno za ostvarenje traženog presjeka se znatno skraćuje, a uspješnost iznosi oko 50%. Da bi se lakše provelo mjerenje određenih parametara, dobivene polovine kućica se boje ljubičastom tintom (Raduga–2, tvorničko ime je GOST–6–15–78–73). Primarni strukturni elementi (pregradne stijenke, granule, stupići i slično) bojenjem ostaju netaknuti, dok sekundarne kalcitne ispune, obraštanja i slično poprimaju boju tinte. Mirkoskopiranje se obavlja bez dodatnog vlaženja presjeka.

Biometrijska analiza

Ovisnost morfoloških osobina diskociklina o njihovim životnim okolišima uglavnom je nepoznata. Sporadična istraživanja volumena protoplazme analizom veličine embrionalnog aparata (Less, 1987; Matteucci & Schiavinotto, 1984) istakla su vrijednosti nekih parametara unutrašnje građe. Kombiniarjući te parametre s onima koji se primjenjuju prilikom biometrijskih mjerenja kod numulitida (Matteucci et. al., 1982; Reguant& Serra–Kiel, 1979; Serra–Kiel, 1984; Serra–Kiel & Reguant, 1984), a uzimajući u obzir specifičnosti građe foraminifera obaju rodova, izdvojeni su slijedeći mjerljivi elementi (sl. 2B, tabela 1):

$P_{1,2}$, $D_{1,2}$ – dijametri protokonha i deuterokonha mjereni uzduž i okomito na os simetrije embrionalnog aparata.

n – ukupni broj zavoja.

a – dužina uzduž osi simetrije mjerena od dna protokonha do dna deuterokonha.

$n_{0,5}$ – broj zavoja unutar prvih 0,5 mm promjera kućice.

R – stupanj zahvaćenosti (preklapanja) protokonha deuterokonhom.

E – ekscentričnost embrionalnog aparata.

Q – odnos veličina protokonha i deuterokonha.

L, H, l, h – dimenzije (širina i visina) klijetaka, odnosno sekundarnih klijetaka prvog perinepioničkog stadija (tzv. pomoćne klijetke) i najmlađeg zavoja.

Dobiveni podaci prikazani su grafički u vidu histograma (sl. 3) i dijagrama osipanja (sl.4). Samo histogrami koji pokazuju učestalost slijedećih parametara (prikazani na sl. 3A, C, F, G i H): dijametar protokonha i deuterokonha (mjereni okomito na os simetrije), stupanj preklapanja (obuhvaćanja) protokonha deuterokonhom, prosječnu veličinu i ekscentričnost embrionalnog aparata, opisuju mali, ali definirani maksimum. Prorijedenost većih jedinki posljedica je životnog ciklusa foraminifera.

Na temelju izmjerenih parametara konstruirano je 10 dijagrama njihovih međuzavisnosti. Prvu grupu sačinjavaju oni grafovi (sl. 4A – D) koji odražavaju odnos između veličine i oblika embrionalnih klijetki. Druga grupa (sl. 4F – I) obilježena je dijagramima osipanja koji naznačuju međusobni odnos prvih dviju klijetki. Karakteristika prve grupe su regresivni pravci nešto različitijeg položaja. Blaže položeni (sl. 4A i 4B) rezultat su uspoređivanja dijametara jednakih klijetki (uspoređuju se dijametri potokonha, odnosno deuterokonha međusobno), dok su međuzavisnosti dijametara protokonha i deuterokonha definirane strmije položenim regresivnim pravcima (sl. 4C i 4D). Gotovo paralelno položeni regresivni pravci malih koeficijenata nagiba određuju drugu grupu grafova (sl. 4F – 4I), a proizlaze iz međusobnih odnosa stupnja preklapanja klijetaka prema pojedinim dijametrima,

Zaključak

Sva mjerenja potvrđuju monospecifičnost istraživane fosilne zajednice. Razlike u dimenzijama pojedinih strukturnih elemenata posljedica su prilagodbe svake jedinke okolišu kojeg ona nastanjuje,uz obavezno uvažavanje ontogenetskog stadija svake individue.