Palaeontology. — *Smaller Foraminifera from the Marl Zone between Sonde and Modjokerto (Java).* By L. BOOMGAART and J. VROMAN. (Communicated by Prof. L. RUTTEN).

(Communicated at the meeting of February 29, 1936).

The present paper is based upon collections, made on the island of Java by the Government Geological Survey, which sent a collection of Mollusca, containing also some smaller Foraminifera, to the Geological Institute at Utrecht.

The Miliolidae and Globigerinidae have been studied by J. VROMAN, who also described the new Quinqueloculina; the other families by L. BOOMGAART.

Our thanks are due to Mr. H. E. THALMANN (Palembang), who had the kindness to look over some species, and who gave valuable remarks about them.

The material has been collected in the Marl-zone between Sonde and the meridian a little E. of Modjokerto. The age of the Formations is youngest Tertiary to Quaternary. The succession is as follows:

Kaboehformation		young.
Poetjangan	„	
Ngronan	„	
Pinggir	„	
Soembermiri	„	
Klitik	„	old.

The results of our determinations are given in Table 2, the findspots are pointed out in Table 1. For the depths we have taken the extreme values given by BRADY (Challenger Report) and CUSHMAN (Lit. 2 and 3). Only the depth of *Spiroloculina costata* HADA has been taken from the publication of Y. HADA (Lit. 7). From the fauna we determined 80 species and varieties. Most of these are recent, except the following:

1. *Quinqueloculina thalmanni* VROMAN n. sp.
2. *Lenticulina inornatus* (D'ORB.).
   ALC. D'ORBIGNY: Foraminifères fossiles du bassin Tertiaire de Vienne. Paris 1846, p. 102, Pl. 4, fig. 25 and 26.
3. *Dentalina ?pomuligera* STACHE.
   Novara-Expedition, Geol. I. 2. p. 204, Pl. 22, fig. 31.
4. *Nodosaria fistuca* SCHWAGER.
   Novara-Expedition. Geol. II. p. 217, Pl V, fig. 36.
5. *Nodosaria ?parexilis* CUSHM. a STEWART.
   Novara-Expedition, Geol. II. p. 223, Pl. V, fig. 52. Lit. 6. p. 55. Pl. 2. fig. 13—15.
6. *Globigerina bulloides* D'ORB., var. *tripartita* KOCH.
   Ecl. geol. Helv., Bd. 19, 3, 1926.

TABLE 1.

	Sheet-numbers of the Topogr. Map of Java (1 : 50 000)	Formation	Sample-Numb. (Geol. Surv. Java)	Localities	Coordinates S. from NW corner of map.	Coordinates E. from NW corner of map.
1	50—XLI B	Riverdeposit.	256	Batang Solo, S E of Sonde	3750	2500
2	" "	Klitikformation	258	Batang Solo	3750	2000
3	51—XLI B	Ngronanformation	14	Kali Djoerit	11250	13500
4	" "	" "	15	Path NW of Klino	11500	14250
5	52—XLI A	" "	29	Kali Kedoengtroetjoek	12100	13250
6	" "	" "	32	S. of Kampong Ngloejoe	14000	16100
7	" "	Kaboehformation	37	Kali Senantok	16750	7000
8	52—XLI B	Soembermiriform.	42	Kali Garoetan	16100	3800
9	" "	" "	43	Kali Garoetan	16150	3950
10	" "	" "	44	Kali Banjoeoerip	14250	6900
11	" "	" "	48	Kali Beng	15250	10900
12	" "	Ngronanformation	53	Kali Garoetan	16300	4500
13	" "	" "	57	Kali Bangle	15750	6500
14	53—XLI A	" "	79	Kali Soendo	12750	1100
15	" "	" "	83	Path to Kendajakan	11400	4200
16	" "	" "	102	G. Goewo	4600	14100
17	" "	Poetjanganformation	106	Kali Tjoepak	4250	17250
18	" "	" "	107	Kali Soemberan	5750	18200
19	" "	Pinggirformation	111	Kali Kedoengringin	5100	15400
20	" "	Poetjanganformation	123	Near Kamp. Soemberringin	6000	11600
21	" "	" "	130	Kali Kepoehredjo	6500	17400
22	" "	" "	139	Kali Doeren	6000	14000
23	53—XLI B	Pinggirformation	151	Left-branch Kali Banjoeasin	3600	2900
24	" "	Poetjanganformation	157	Kali Belikdandang	4300	6250
25	" "	" "	158	Banjoebanger	4400	7050
26	" "	" "	165	Kali Gondang	4300	2100
27	" "	" "	170	Kali Belikdandang	4900	6900
28	" "	" "	179	Kali Ngembak	6700	150
29	54—XLI A	" "	216	N. of Kamp. Klagenblandoeng	5400	700

TABLE 2.

FAMILY	GENUS	SPECIES ETC.	DEPTH FATHOMS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
MILIOLIDAE	Quinqueloculina	agglutinans d'Orb.	10-500								×																					
		akneriana d'Orb.	till 3000									×	×																			×
		auberiana d'Orb.	25-2435										×								×	×						×				
		bicostata d'Orb.	1584																							×						×
		curta Cushm.	14-400										×	×			×				×		×									×
		lamarckiana d'Orb.	12-1560								×	×	×								×							×				
		linnaeana d'Orb.										×																				
		aff.pulchella d'Orb.					×																					×				
		aff.reticulata d'Orb.									×																					
		reticulata d'Orb.	17-303								×		×						×	×	×		×				×					×
		? reticulata d'Orb.										×																				
		reticulostriata Cushm.	18-260																		×		×									×
		? rugosa d'Orb.	18-375					×																								
		thalmanni Vroman n.sp.																								×	×	×				
		sp.									×										×				×	×		×				×
	Spiroloculina	canaliculata d'Orb.	15-1262										×	×																		
		costata Hada	3-25												×																	
		depressa d'Orb.	26-340																													×
		? depressa d'Orb.									×																					
		aff.grata Terq.											×																			
		milletti Wiesner.	40-305								×									×							×	×				×
		sp.																										×				
	Schlumbergerina	alveoliniformis (Br).	420										×																			
	Triloculina	circularis (Born).	20-554																							×						
		rupertiana (Br).	2-28																	×												×
		? terquemiana (Br).	12																	×												
		tricarinata (d'Orb.).	10-1850								×	×		×		×				×												×
		trigonula (Lam).	12-2300								×	×														×						
	Flintina	bradyana Cushm.	18-752																	×	×		×	×								×
		grata (Terq.).	15-2900												×					×			×				×		×			×
	Pyrgo	bulloides d'Orb.		×																												
		depressa (d'Orb.).	78-3000					×			×	×		×																		
		lucernula (Schw.).	93-2750	×																												
		serrata (Bailey).	51-1750	×																												
	Miliolidae	ind.														×				×	×											×
LAGENIDAE	Lenticulina	costata (F.a M.).																				×										
		iota (Cushm.).	37-2435									×																				
		? iota (Cushm.).										×										×										
		inornatus (d'Orb.).										×																				
		lucida (Cushm.).	24-766																									×				
		orbicularis (d'Orb.).	38-1625																									×				
		rotulata Lam.	19-2200											×							×	×		×				×				
	Planularia	? gemmata (Br.)	135-340																									×				
	Dentalina	emaciata Reuss.	50-1375		×	×		×																			×					
		? pomuligera Stache.						×																								
		soluta Reuss.	51-1360		×	×		×				×															×					
	Nodosaria	fistuca Schw.			×							×																				
		? insolita Schw.	260-494		×	×																										
		? parexiles Cushm.a Stewart.			×																											
		vertebralis (Batsch).	26-554			×																										
		sp.sp.			×	×		×																								
	Lagena	laevis (Montagu).	254-2435					×																								
POLYMORPHINIDAE	Guttulina	problema d'Orb.	19-340																													×
		regina (Br.).	6-865																							×						
		sp.																														×
	Sigmoidella	? elegantissima (P.a.J.).	7-340			×															×											
NONIONIDAE	Nonion	boueanum (d'Orb.)	7-2615																					×				×				
		scapha (F.a M.).	84-1907																					×					×			
		umbilicatulum (Montagu).	30-3125																									×				×
	Nonionella	sp.											×																			
	Elphidium	crispum (L.).	9-859				×	×		×	×			×	×		×	×			×	×							×	×		×
		craticulatum (F.a.M.).	3-565				×	×		×	×	×	×	×	×	×	×		×		×		×	×	×	×	×	×		×		×
		craticulatum (F.a.M.)Monstrum.																					×									
CAMERINIDAE	Operculina	sp.									×		×	×							×									×		×
BULIMINIDAE	Bolivina	hantkeniana Br.	26-1262				×					×	×								×			×								×
		karreriana Br.	23-1468										×																			
		schwageriana Br.	37-1262								×			×																		
	Uvigerina	farinosa Hantk.	40-1900									×																				
		mediterranea Hofker.	2-2600										×																			
	Siphogenerina	striata (Schw.).	3-1618									×																				
ROTALIDAE	Discorbis	araucana (d'Orb.).																														×
		globularis (d'Orb.).																														
		var.bradyi Cushm.	106-450																													×
		orbicularis (Terq.).	20-435																													×
		procera (Br.).	3-500											×																		
		vilardeboana (d'Orb.).	19-1274																													×
	Gyroidina	soldanii d'Orb.	78-<2000		×			×																								
	Eponides	berthelotianus (d'Orb.).	16-859																		×	×										
		haidingeri (d'Orb.).	23-1776				×											×									×					
		praecinctus (Karrer).	15-770				×			×	×		×		×		×				×					×				×		×
	Rotalia	? beccarii (L.).	12-805															×														
		conoides (d'Orb.).	50				×			×	×	×	×		×	×			×	×	×	×	×	×	×	×	×	×	×			
		gaimardi (d'Orb.).	50				×	×			×		×			×			×	×	×	×	×	×	×	×					×	×
		ijzermanni Boomgaart.					×	×																		×						
		indopacifica Thalm.	14-375											×	×	×	×		×	×	×	×				×	×	×	×	×		
		margaritifera (Br.).	10-241									×		×								×					×	×				
		trispinosa Thalm.						×	×	×				×			×				×				×	×	×	×	×		
		sp.											×								×							×				
AMPHISTEGINIDAE	Amphistegina	sp.									×	×		×				×														×
CHILOSTOMELLIDAE	Pullenia	sp.																				×										
GLOBIGERINIDAE	Globigerina	? bulloides d'Orb.												×																		
		bulloides d'Orb.	24-2543	×																												
		bulloides d'Orb., var.quadripartita Koch.				×	×			×						×		×						×							×	
		bulloides d'Orb., ? var.tripartita Koch.											×									×										
		inflata d'Orb.	34-2543						×	×	×	×	×								×	×					×	×				×
		triloba Reuss.				×	×		×	×	×	×	×	×				×			×	×		×		×	×			×	
	Globigerinella	aequilateralis (Br.).	26-2615									×																				
	? Globigerinoides	conglobatus (Br.).	18-1850					×																								
		sacculiferus (Br.).	24-2552				×	×		×	×	×		×		×					×						×	×			×	
	Orbulina	universa d'Orb.	20-885		×		×	×		×	×	×	×	×	×	×				×	×	×		×			×	×				
	Pulleniatina	obliquiloculata (P.a.J.).	7-2675								×		×																			
	Sphaeroidinella	dehiscens (P.a.J.).	80-2175		×		×	×				×	×	×							×	×		×				×				
GLOBOROTALIDAE	Globorotalia	menardi (d'Orb.).	20-2750				×		×	×	×	×	×								×											
		tumida (Br.).	10-2750				×	×		×	×	×	×	×					×	×	×					×	×	×				
		tumida (Br.).? var.											×																			
		tumida (Br.).var.flexuosa Koch.					×					×																				
ANOMALINIDAE	Cibicides	refulgens (Montf.).	25-2400								×																					
		? refulgens (Montf.).											×																			
PLANORBULINIDAE	Planorbulinella	larvata (P.a.J.).	15-805																									×				

7. *Globigerina bulloides* D'ORB., var. *quadripartita* KOCH.
Ecl. geol. Helv., Bd. 19, 3, 1926.
8. *Globorotalia tumida* (BRADY), var. *flexuosa* KOCH.
Ecl. geol Helv., Bd. 18, 2, 1923.
9. *Rotalia beccarii* (L.) var. *atjehensis* V. D. VLERK.

It is remarkable that formations, which contain already such a great number of fossil Mollusca, have such a low percentage of fossil smaller Foraminifera. Total 89 % recent species!

The following species have not been found up to now in fossil state in the Dutch East Indies: *Quinqueloculina bicostata* D'ORB.; *Q. curta* CUSHMAN; *Q. linnaeana* D'ORB.; *Q. aff. pulchella* D'ORB.; *Q. reticulostriata* CUSHMAN; *Q. ?rugosa* D'ORB.; *Q. thalmanni* VROMAN; *Spiroloculina costata* HADA; *Sp. milletti* WIESNER; *Triloculina circularis* (BORNEMANN); *Tr. rupertiana* (BRADY); *Tr.? terquemiana* (BRADY); *Flintina bradyana* CUSHMAN; *Pyrgo bulloides* D'ORB.; *P. serrata* (BAILEY); *Lenticulina inornatus* (D'ORB.); *L. lucida* (CUSHMAN); *Planularia ?gemmata* (BRADY); *Dentalina ?pomuligera* STACHE; *Nodosaria ?parexilis* CUSHM. a. STEWART; *Guttulina problema* D'ORB.; *G. regina* (BRADY); *Nonion boueanum* (D'ORB.); *Discorbis globularis* (D'ORB.), var. *bradyi* CUSHMAN; *D. vilardeboana* (D'ORB.); *Rotalia beccarii* (L.) var. *atjehensis* V. D. VLERK; *Globigerina inflata* D'ORB.

The living-depth of recent species, as indicated in Table 2, shows clearly that in many cases it is very difficult to use smaller foraminifera as "facies-indicators". This argument is strengthened by the following facts. Without any doubt our fauna is derived from neritical deposits, as is proved by the accompanying mollusks. In general this agrees well with the living-depths of our recent foraminifera, as 67 species or varieties have been found in depths less than 100 fathoms, whilst 5 of these have been collected exclusively in shallow water. On the other hand there are 3 forms which up to now have been found only in deep water, viz.: *Quinqueloculina bicostata* (1584 f.), *Schlumbergerina alveoliniformis* (420 f.) and *Lagena laevis* (254—2435 f.). This indicates that our knowledge of the habitat of these living species is still imperfect and that we must be very prudent, when determining the facies of a deposit from its fauna of smaller foraminifera.

Quinqueloculina thalmanni VROMAN, n. sp. (figs. 1—5).

On one side 3, on the other side 4 chambers visible. The individuals are rather strongly compressed; section of chambers oval-oblong, with tendency to triangularity. The chambers are ornamented with a fine network of costae, which is developed best on the outer edge of the youngest chamber. Some individuals (worn off?) show this network to a much smaller extent. The dimensions of the youngest chamber may exceed those of the older ones very strongly. It is somewhat protruding at the base, having there an obtuse point, while its top is provided with a well-developed neck, furrowed longitudinally. These furrows are the

natural continuations of the costae. The aperture is rounded; lip mostly absent. The mouth shows one definite singular claviform tooth. Length up to 1,4 mm; breadth up to 0,9 mm.

This *Quinqueloculina* generally resembles *Q. reticulata* D'ORB. (Challenger Report Pl. IX, fig. 4), but differs from it by: 1. neck provided with parallel furrows; 2. protruding youngest chamber on the lower side; 3. more regular build.

The species has affinities with *Q. kerimbatica* HERON-ALLEN and EARLAND, var. *reticulo-striata* CUSHMAN, 1931, from the Philippine Islands (Lit. 3, p. 347, Pl. 89, fig. 1).

Rotalia beccarii (L.), var. *atjehensis* v. D. VLERK. (fig. 6—7).

This species resembles in all respects *Rotalia beccarii* L.; the only difference is the greater number of chambers in the last whorl. For a detailed description we can refer to that of *Rotalia beccarii* L. by CUSHMAN (Lit. 4, part. 8, p. 58—61). Concerning the number of chambers in the last whorl, we calculated the average number of chambers of the last whorl from the specimina, figured by BRADY (Challenger Report) and CUSHMAN (Lit. 2, 3 and 4). The resultant number is 126 chambers in 13 figured specimina, so an average of almost 10 chambers in the last whorl. 22 individuals of the new species gave an average of 291 : 22 = more than 13 chambers in the last whorl; 12 of the 22 specimens have more than 13 chambers in the last whorl. The greatest number of chambers in the last whorl is 18. Length up to 1,5 mm; breadth up to 0,9 mm. (See: v. D. VLERK, Wet. Meded. Mijnb. Ned. Indië, n⁰. 1, p. 25).

fig 1-5. fig. 6,7.

Figs. 1—5. Quinqueloculina thalmanni VROMAN n. sp.

Figs. 6—7. *Rotalia beccarii* (L.) var. *atjehensis* v. D. VLERK.

Lagenidae.

It is desirable to give some remarks about the genera *Robulus* MONTFORT, 1801, and *Lenticulina* LAMARCK, 1804. According to CUSHMAN (Lit. 11, p. 177), the only difference between the two genera consists of an enlarged median slit in the middle of the end of the apertural face with the genus *Robulus*. We only used the name *Lenticulina* in consequence of CUSHMAN's suggestion (lit. 11, p. 177). We feel the more justified to do so, because several forms, which by most characteristics agree perfectly, present some species with *Robulina*-like apertures, others with *Lenticulina*-like apertures.

Bolivina.

It is often very difficult to separate the two species *Bolivina hantkeniana* BRADY, and *Bolivina schwageriana* BRADY. In our collection individuals occur "with a keel of varying width and completeness, and short delicate, longitudinal costae", as well as specimens, with "limbate sutures, the limbation taking the form of raised beds or irregular lines of shell-substance on both sides of the test, chiefly near the points of contact of the two opposing series of segments". For figures and a more detailed description of the two species, see BRADY (Challenger Report, p. 424 and 425. Pl. 53, Fig. 16—18 and 24—25).

Rotalia indopacifica THALMANN.

This species is the same as that, figured by CUSHMAN (Lit. 3, Pl. 73) under the name of *Rotalia schroeteriana* P. and J. THALMANN, however, has divided this species into *Rotalia gaimardi* D'ORB. 1826 and *Rotalia conoides* (D'ORB. 1826) (Lit. 14, p. 428—433). The specimina in question do not correspond with them. Mr. THALMANN had the kindness to draw our attention to his new publication (Lit. 15, p. 605), in which he gives a detailed description of specimens of the same species, and calls it *Rotalia indopacifica* n. sp.

Addendum: In Table II *Rotalia beccarii* var. *atjehensis* has been erroneously indicated as *Rotalia ijzermanni* n. sp.

LITERATURE.

Except the publications, mentioned in:

R. KOCH: die Jungtertiaire Foraminiferenfauna von Kabu (Res. Surabaja, Java). Ecl. geol. Helv. Bd. 18, 2, 1923;

J. H. F. UMBGROVE: Tertiary Foraminifera. Leidsche Geol. Meded. V, 1923, the following publications have been used:

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8. 1932. J. HOFKER: Notizen über die Foraminiferen des Golfes von Neapel III. (Publ. della Stazione Zool. di Napoli, vol. XII, Fasc. I).
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Biology. — *Ueber die Frequenzverteilung des Wachstums in homogenem Material.* II. Von C. D. VERRIJP und E. F. DRION. (Communicated by Prof. L. G. M. BAAS BECKING.)

(Communicated at the meeting of January 25, 1936).

3. *Die Ergebnisse.*

Die bei den neun Längemessungen erhaltenen Zahlen sind in Tafel I bis VIII verkürzt zusammengestellt. Das Wachstum der einzelnen Varianten aus den in der ersten vertikalen Spalte angegebenen Klassen (welche sich auf den Anfang der Periode beziehen), ist in den nächsten Spalten dargestellt; die Totalzahlen der horizontalen Reihen, deren Mittelwerte, dividirt durch die Anzahl Tage der betreffenden Periode, und die Streuungen befinden sich in den letzten drei Spalten. Die Totalzahlen sind etwas verschieden, da einzelne Pflanzen wegen Krümmung usw. nicht immer genau zu messen waren.

Die Tabellen zeigen unmittelbar, dasz Länge und Wachstum zwar verbunden sind, aber locker, im Sinne einer *Korrelation*. Diese Korrelation ist immer schief, in dem Sinne dass die grösseren Pflanzen schneller wachsen als die kleineren, aber weniger schnell als wenn die Korrelation geradlinig wäre.

Die z-Funktionen (KAPTEYN—V. UVEN) der Frequenzverteilungen sind in Fig. 2 gezeichnet. Man sieht sofort, dass *alle Verteilungen brachykurtisch sind.* Die Brachykurtosis wird im Laufe der Entwicklung immer ausgesprochener. Die Reaktionsfunktion einer solchen brachykurtischen Verteilung ist für die niedrigen Werte relativ klein, steigt dann an, und wird für die höheren Werte wieder klein. Wenn nun die Wachstums-