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The Transitional Changes Between the Fluvial and Marine Environments as Indicated by Holocene Fauna in Siba at Basrah, Southern Iraq

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ABSTRACT

The study is conducted at one point in Siba City, Basrah to describe its fauna content and texture. The current study attempts to reveal the transitional stage between marine and fluvial environments. Variation in sediment texture provides an index of environmental transformation in the Recent (Holocene Epoch). From grain size analysis, we notice an increase in the percentage of silt and a decrease in the percentage of sand in meters (1-3), a gradual increase in the percentage of sand and a gradual decrease in the percentage of silt in meters (4-6), and in meter 7 there is a high increase in sand and a high decrease in silt, and a gradual decrease in clay from meter 1 to meter 7, a decrease in the percentage of Total Organic Carbon (TOC) is also noted. Recent fauna reinforces sedimentary evidence that marine regression began at depths 5 and 7 m, marine species decrease significantly, and one of the most important marine groups is the Miliolina (Suborder) from foraminifera, where Triloculina, Quinqueloculina, and Spiroloculina are found; on the other hand, describe other groups; Nodosariina, Rotaliida, Textulariina, Polymorphinina and Nodosariina in addition to Ostracoda.

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التغيرات الانتقالية بين البيئتين النهرية والبحرية بدلالة مستحاثات الهولوسين في السيبة، البصرة، جنوبي العراق

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الملخص

أجريت الدراسة في نقطة واحدة في السيبة، مدينة البصرة لوصف نسيجها ومحتوياتها من المستحاثات. تحاول الدراسة الحالية الكشف عن المرحلة الانتقالية بين البيئتين النهرية والبحرية. توفر الاختلافات الرأسية في نسيج الرواسب مؤشرًا للتحول البيئي في فترة (الهولوسين) الأخيرة. ومن تحليل حجم الحبيبات نلاحظ زيادة في نسبة الغرين وانخفاض في نسبة الرمل بالأمتار (1-3) وزيادة تدريجية في نسبة الرمل وانخفاض تدريجي في نسبة الغرين بالأمتار (4-6)، وفي المتر 7 هناك زيادة عالية في الرمال وانخفاض كبير في الغرين، وانخفاض تدريجي في الطين من المتر 1 إلى المتر 7، كما يلاحظ انخفاض في نسبة الكربون الكلي العضوي. ومما يعزز الأدلة الرسوبية المستحاثات الحديثة ويدل على أن التراجع البحري بدأ على أعماق 5 و7 م، تناقصت الأنواع البحرية بشكل ملحوظ، ومن أهم المجموعات البحرية هي Miliolina (الحدود الفرعية) من المنخربات، حيث تم العثور على Triloculina, Quinqueloculina, and Spiroloculina. ومن ناحية أخرى، تم وصف المجموعات الأخرى؛ Nodosariina وRotaliida وTextulariina وPolymorphinina وNodosariina بالإضافة إلى Ostracoda.

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Introduction

Sand, silt and clay are components of the Holocene sediments in southern Iraq (Al-Jabberi, 2010; Awadh and Ali, 2011 and Al-Jumaily, 1994). Jassim and Goff (2006) proved that deltaic, aeolian and fluviatile sediments are mostly present in the Mesopotamian plain. Holocene sediments split into marine facies and fluvial recent sediments (Al-Jaberi, 2017); the Holocene freshwater deposits of the lower Mesopotamian plain comprise a thin transgressive marine unit extending inland about 250 km from the present coastline (Hammar Formation) (Plaziat and Younis, 2005). Hudson *et al,* (1957) described the Hammar Formation from well No. 13 where there are recent marine sediments up to 6.5 m thick consisting of clay in the upper part and silt and sand in the lower part. This formation can be considered one of the last Quaternary marine transgressions, which are recorded world-wide during the Middle Holocene (Karim *et al.* 1994).

Al-Hemidawy (2020) identified some species of Ostracoda in Al-Delmaj Marsh area. Abdulwahhab (2023) gave systematics for some of foraminifera and Ostracoda in southern Iraq. Al-Furaiji (2022) named some species of foraminifera and Ostracoda in southern Iraq.

There are extensive published and written articles about Holocene deposits in southern Iraq, such as Salman and Al-Mussawy (1994) and Khan *et al.* (1992) referenced the texture of the Holocene deposits as silt and clay where extended from the surface sediments to 18 m depth, while the sand fraction is dominant after 18 m depth. The present study aims to demonstrate the importance of studying fauna assemblages as an important branch in identifying the environments between the fluvial recent sediments and marine sediments at Basrah City.

Study area

The location of the study area represents the Siba area, southern Iraq between latitudes (30°13'04.9" - 30°20'16.5") north and longitudes (48°15'39.0" - 48°23'03.7") east (Fig. 1). South of the city of Basrah, on the Iraqi bank of the Shatt Al-Arab, sedimentation increases, and erosion increases on the Iranian bank. This region consists mainly of alluvial deposits of the Tigris, Euphrates, and Karun rivers and their tributaries.

Materials and methods

The current study includes depths ranging from 1 to 7 meters at one point. From the core, (33) cutting samples are selected according to the differences in the textures, colors of the beds, and grain size analysis following Folk (1974) and Total Organic Carbon (TOC%) is determined according to methods of Nelson and Sommers (1996). After that, the samples were left in water for three days to soak, then washed under the tap water in 230 mesh sieve to picking the fauna, and they were stored in micropaleontological slide, two groups for this study are identified (foraminifera and ostracod).

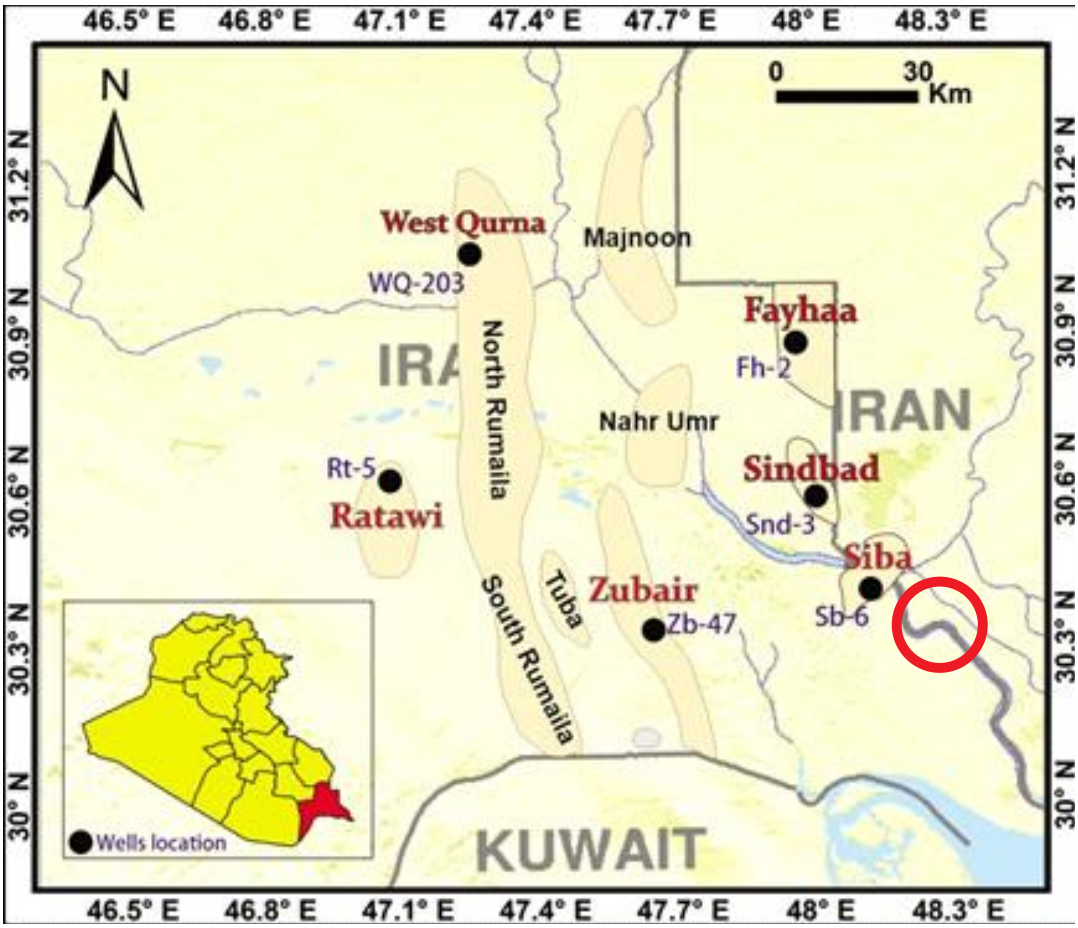

Fig .1. The study area map, Iraq, Basrah City.

Results

Sediments Texture analysis

The study area sediments are dated back to the Holocene. Through the current study, because it is a part of the fresh water of Shatt Al-Arab, they are characterized essentially by sandy silt and clayey silt respectively according to the texture classification of Folk (1974).

After leaving the marshes at Al-Qurna area, Tigris and Euphrates Rivers joined each other to create the river of Shatt Al-Arab, which flows in somewhat winding channels. Hor Al-Hammar feeds Shatt Al-Arab through the Garmat Ali channels north of Basrah (Yacoub, 2011).

The input of the Karun River affects Shatt Al-Arab; as a result of the junction that occurred north of Siba, there is a sudden increase in the amount of mud that was suspended in the water of the Shatt Al-Arab. The tides affect the level of Shatt Al-Arab, principally downstream of Basrah City (Yacoub, 2011). Fine sediments textures are characteristic of tidal flats, sometimes sand and mostly clay and silt. Table (1) summarizes the textural results; it is found that silty sand and clayey silt are the dominant textures.

Table 1: Grain size analysis and TOC% of cutting sediments in Siba area.

NO.	Depth (cm)	Sand%	Silt %	Clay%	TOC%
1	(1m) 4-9	2	75	23	0.79
2	(1m) 22-25	1	81	18	1.05
3	(1m) 37-41	12	70	18	1.15
4	(1m) 49-52	2	78	20	0.55
5	(1m) 63-66	2	88	10	0.46
6	(2m) 127-130	3	82	15	0.55
7	(2m) 145-150	5	77	18	0.45
8	(2m) 166-169	3	62	35	0.86
9	(2m) 187-190	2	83	15	0.49
10	(3m) 200-205	13	79	8	0.70
11	(3m) 219-223	4	91	5	0.63
12	(3m) 245-249	12	78	10	0.46
13	(3m) 272-275	9	81	10	0.21
14	(3m) 292-962	5	77	18	0.58
15	(4m) 300-304	9	76	15	0.57
16	(4m) 327-331	11	81	8	0.57
17	(4m) 344-348	87	5	8	0.39
18	(4m) 370-374	40	42	18	0.40
19	(4m) 393-397	74	11	15	0.37
20	(5m) 400-403	17	68	15	0.37
21	(5m) 423-426	40	48	12	0.36
22	(5m) 452-455	37	48	15	0.29
23	(5m) 472-476	41	49	10	0.23
24	(5m) 495-498	25	62	13	0.39
25	(6m) 510-514	53	42	5	0.27
26	(6m) 534-538	36	54	10	0.33
27	(6m) 555-559	29	63	8	0.44
28	(6m) 572-576	31	61	8	0.42
29	(6m) 590-594	44	46	10	0.41
30	(7m) 600-604	61	31	8	0.25
31	(7m) 619-623	75	15	10	0.43
32	(7m) 638-642	40	52	8	0.41
33	(7m) 669-673	81	16	3	0.21

Recent Faunal Distribution

1. Foraminifera

Foraminifera are among the important groups identified in this area due to its wide environmental range from bottom of sea to continental regions (Boltovskoy and Wright, 1976). Depending on the classification of Loeblich and Tappan (1964), many species are recorded and identified (26 species) belonging to 13 genus as illustrated in Table (2) and Plates (1,2,3,4 and 5). These species are: *Ammonia tepida, A. beccarii, A. dentata, Asterorotalia inflata, Brizalina striatula, Caribeanella polystoma, Elphidium advenum, E. crispum, E. discoidale, E. hispidilum, E. incertum, E. lessonii, Fissurina marginata, Lagena perlucida, Lagena striata, Nonion elongatum, Parrellina hispidula, Quinqueloculina agglutianans, Q. angulta, Q. parvula, Q. polygona, Q. seminulum, Q. stelligera, Triloculina oblonga, S. exima, Spirosigmoilina tenuis.* Near shore or lagoon that are shallow when depth 1-20 m live *Ammonia beccarii, Elphidium incertum* (recent species) (Murray, 1969).

Salinity is the wide range reflected by fauna assemblages, carbonate ions in highly saline water are high, 40% and more is the percentage of salinity, appear to favor the porcelaneous *Miliolina* (especially the Miliolidae and Nubeculariidae, e.g., *Triloculina, Quinqueloculina*).

Table 2: Distribution of Foraminifera species in the 7 meters studied section in Siba (the empty square is fauna-free).

Depth (cm)	*Ammonia beccarii*	*A.dentat*	*A.tepida*	*Asterorotalia inflata*	*Brizalina striatula*	*Caribeanella polystoma*	*Elphidium advenum*	*E.crispum*	*E.discoidale*	*E.hispidilum*	*E.incertum*	*E.lessonii*	*Fissurina marginata*	*Lagena perlucida*	*Lagena striata*	*Nonion elongatum*	*Parrellina hispidula*	*Quinqueloculina agglutianans*	*Q.angulta*	*Q.parvula*	*Q.polygona*	*Q.seminulum*	*Q.stelligera*	*Spiroloculina exima*	*Spirosigmoilina tenuis*	*Triloculina oblonga*
(1m) 4-9	*	*	*				*			*	*	*														
(1m) 22-25	*		*				*				*															
(1m) 37-41																										
(1m) 49-52											*															
(1m) 63-66							*																			
(2m) 127-130	*							*			*	*							*			*	*			
(2m) 145-150	*	*									*												*			
(2m) 166-169	*						*				*											*				
(2m) 187-190	*	*	*				*				*											*				
(3m) 200-205	*		*								*															
(3m) 219-223											*															
(3m) 245-249	*	*		*				*	*				*									*		*		*
(3m) 272-275	*		*				*				*											*				
(3m) 292-962	*		*				*				*								*							
(4m) 300-304	*		*																			*		*		*
(4m) 327-331	*		*													*						*			*	*
(4m) 344-348	*								*			*					*					*		*		
(4m) 370-374	*	*	*			*	*										*		*			*	*		*	*
(4m) 393-397	*	*	*						*		*							*				*	*	*		*
(5m) 400-403	*	*	*						*			*			*		*	*				*				*
(5m) 423-426	*	*	*				*		*			*					*	*	*			*	*			*
(5m) 452-455	*	*	*				*					*		*				*				*	*			*
(5m) 472-476	*		*				*											*		*		*	*		*	*
(5m) 495-498	*	*	*				*		*		*						*	*				*	*			
(6m) 510-514	*		*	*	*	*	*		*								*	*		*		*			*	
(6m) 534-538	*	*	*		*							*						*			*	*		*		*
(6m) 555-559	*	*	*				*		*								*	*	*			*	*	*		*
(6m) 572-576	*	*	*		*		*		*			*						*	*			*	*	*		
(6m) 590-594	*	*	*		*		*		*				*					*				*	*	*	*	*
(7m) 600-604	*	*	*	*	*	*	*		*								*	*		*		*	*	*		*
(7m) 619-623	*	*	*			*	*		*			*					*	*	*	*	*	*	*	*		*
(7m) 638-642	*	*	*			*	*		*			*							*			*	*	*	*	*
(7m) 669-673	*	*	*			*			*									*			*	*	*	*		*

2. Ostracoda

In this research, the second group was the Ostracods, the diagnosed of Ostracoda species is depending on Moore and Pitrat, (1961). 12 species belonging to 9 genus were identify (Table 3 and Pl. 6 and 7), these species are: *Alocopocythere reticulate, Candoniella albicans, Candoniella simpsoni, Carinocythereis indica, Cyprideis torosa, Cyprideis var. torosa, Darwinula cylindrical, Hemicytheridea paiki, Hemicytheridea reticulata, Leguminocythereis*

papuensis, Neomonoceratina delicata, Phlyctenophora orientalis. The species were represented a marine taxon Shareef and Mahdi, (2015) and Moore and Pitrat, (1961).

Table 3: Distribution of Ostracoda species on the 7 meters studied section in Siba (the empty square is valid fauna-free).

Depth (cm)	Alocopocythere reticulate	Candoniella simpsoni	Candoniella albicans	Carinocythereis indica	Cyprideis torosa	Cyprideis var. torosa	Darwinula cylindrical	Hemicytheridea paiki	Hemicytheridea reticulata	Leguminocythereis papuensis	Neomonoceratina delicata	Phlyctenophora orientalis
(1m) 4-9												
(1m) 22-25												
(1m) 37-41												
(1m) 49-52												
(1m) 63-66					*							
(2m) 127-130					*							
(2m) 145-150						*						
(2m) 166-169						*						
(2m) 187-190												
(3m) 200-205												
(3m) 219-223												
(3m) 245-249	*				*			*			*	
(3m) 272-275					*	*						
(3m) 292-962												
(4m) 300-304					*							
(4m) 327-331					*				*	*		
(4m) 344-348	*				*							
(4m) 370-374					*	*						
(4m) 393-397				*	*	*						
(5m) 400-403		*			*				*			
(5m) 423-426	*				*							
(5m) 452-455	*											
(5m) 472-476							*	*	*		*	
(5m) 495-498								*	*			
(6m) 510-514				*	*	*	*	*			*	
(6m) 534-538				*	*	*		*	*			
(6m) 555-559					*	*			*		*	
(6m) 572-576			*	*	*	*	*	*	*		*	
(6m) 590-594			*		*		*	*	*		*	
(7m) 600-604			*		*	*	*	*	*		*	
(7m) 619-623			*		*	*	*	*	*		*	
(7m) 638-642				*	*	*	*	*	*		*	
(7m) 669-673				*	*	*		*	*		*	*

Table 4: Systematic of foraminifera.

Kingdom	Phylum	Order	Family	Genus
Chromista Cavalier-Smith, 1981	Foraminifera d Orbigny, 1826	Rotaliida Delage and Herouard, 1896	Ammoniidae Saidova, 1981	*Ammonia Brunnich, 1771*
				Asterorotalia Hofker, 1950
			Elphidiidae Galloway, 1933	*Elphidium Montfort, 1808*
			Notorotaliidae Hornibrook, 1961	*Parrellina Thalmann, 1951*
			Bolivinitidae Cushman, 1927	*Brizalina Costa, 1856*
			Planorbulinidae Schwager, 1877	*Caribeanella Bermudez, 1952*
			Nonionidae Schultze, 1854	*Nonion Montfort, 1808*
		Polymorphinina Mikhalevich, 1980	Ellipsolagenidae A. Silvestri, 1923	*Fissurina Reuss, 1850*
		Nodosariina Calkins, 1926	Lagenidae Reuss, 1862	*Lagena Walker $ Jacob, 1798*
		Miliolina Williamson, 1858	Hauerinidae Schwager, 1876	*Quinqueloculina d Orbigny, 1826*
				Triloculina d Orbigny, 1826
				Spirosigmoilina Parr, 1942
			Spiroloculinidae Wiesner, 1920	*Spiroloculina d Orbigny, 1826*

Table 5. Systematic of Octracoda.

Kingdom	Phylum	Class	Family	Genus
Animalia Linnaeus, 1785	Arthropoda Siebold and Stannius, 1845	Ostracoda Latreille, 1806	Trachyleberididae Sylvester-Bradley, 1948	*Carinocythereis Ruggieri, 1955.*
				Leguminocythereis Howe, 1936.
				Keijella Ruggieri, 1967.
				Alocopocythere Siddiqui, 1971.
			Cytherideidae Sara, 1925	*Cyprideis Jones, 1857.*
			Cytheridae Baird, 1850	*Neomonoceretina Kingma, 1948.*
			Hemicytheridae Puri, 1953	*Hemicytheridea Kingma, 1948.*
			Candonidae Kaufmann, 1900	*Phlyctenophora Brady, 1880.*
				Candoniella Schneider, 1956.
			Darwinulidae Brady & Robertson, 1885	*Darwinula Brady & Robertson, 1885.*

Discussion

The present study aims to recognize assemblages of fauna during the sedimentation of the Holocene in Basrah City. From grain size analyses in 1m to 4m depth, clay and silt fractions are predominant with clayey silt texture, while sand fraction started to increase from 42% at a depth interval of 4 m to 65 % at 7m, with silty sand texture (Table 1).

The organisms (Ostracoda and Foraminifera) are examined. These are the assemblages of Recent fauna that have been identified and relied upon, three stages are distinguished in this research from bottom to top respectively (Tables 2, 3). Interval depth 7 to 6 m represents the first stage, the facies are silty sand, which resembles the facies of the coastal marine environment. The similarity of fauna also may reflect a combination of sedimentation. Interval depths 6 to 3 m represent the second stage, and facies was (sandy silt), saline water is what assemblages' fauna indicated to like *Quinqueloculina seminulum*, *Hemicytheridea reticulata*, *Triloculina oblonga*, *Carinocythereis indica*. etc. Interval depth 3 to 0 m represents the third stage, which represents the decline of seawater and the advance of river water accompanied with a change in the existing fauna.

Conclusions

1- Many foraminifera and ostracoda species are identified that are indicators for regression.

2- Three sedimentary textures are distinguished in the study area (muddy silt, sandy silt and silty sand).

3- The presence of the species *Ammonia beccari* at most depths indicates the mixed environment in the study area as it refers to the shallow marine environments to the brackish environment, and it is adapted to living in those environments.

4- Marine regression started at 5 m in Siba.

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Plate 1

Scale 1bar = 200 μm.

1- *Ammonia beccarii* Linnaeus, 1758. 40x, side view.
2- *Ammonia tepida* Cushman, 1926. 40x, side view.
3- *Ammonia dentata* Parker and Jones. 40x, side view.
4- *Asterorotalia inflata* Millett, 1904. 40x, side view.
5- *Brizalina striatula* Cushman. 40x, side view.
6- *Caribeanella polystoma* Bermúdez, 1952. 40x, side view.

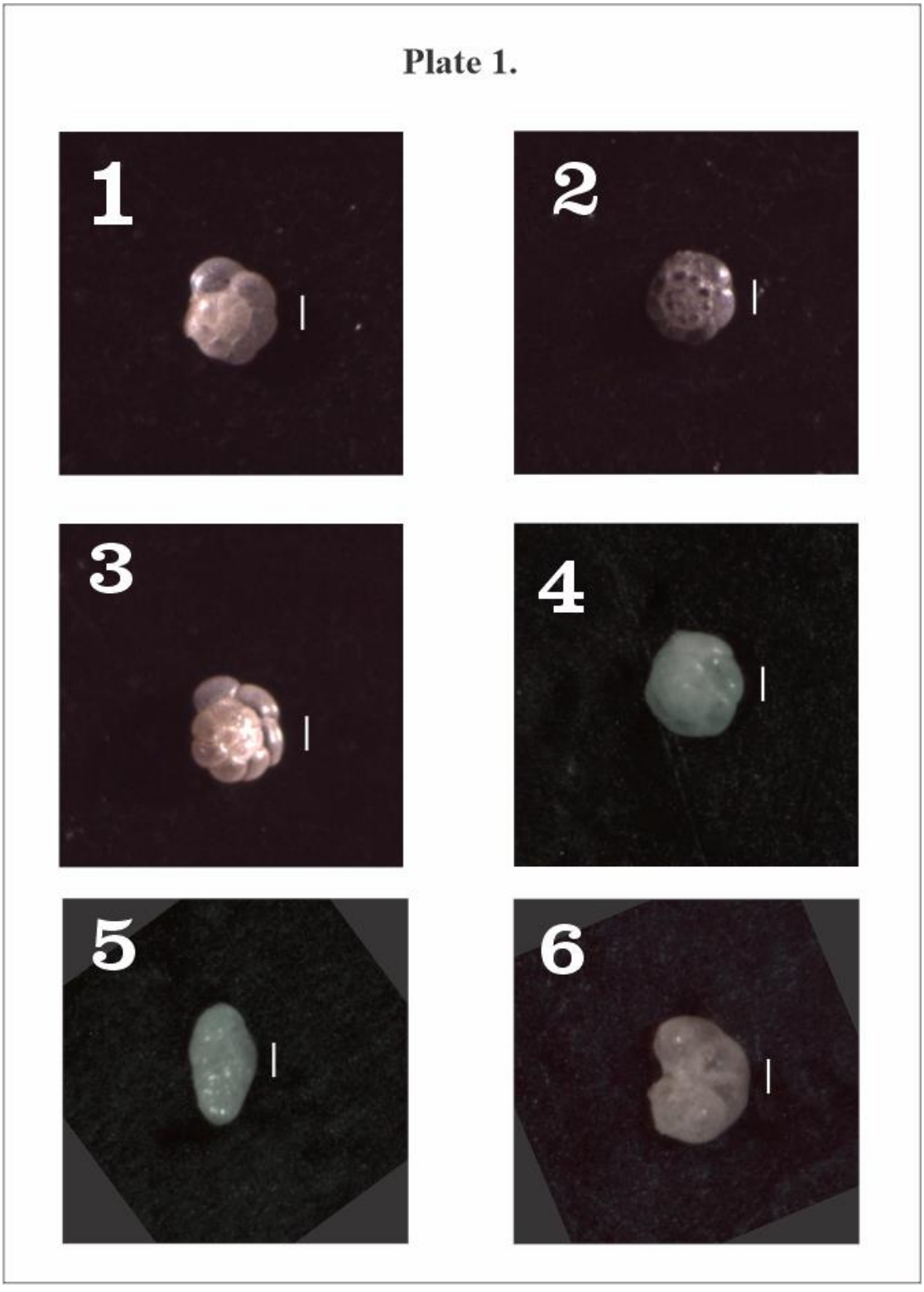

Plate 2

Scale 1bar = 200 µm.

1- *Elphidium advenum* Cushman, 1922. 40x, side view.
2- *Elphidium crispum* Linnaeus, 1758. 40x, side view.
3- *Elphidium hispidulum* Cushman, 1936. 40x, side view.
4- *Elphidium incertum* Williamson, 1858. 40x, side view.
5- *Elphidium lessonii* d'Orbigny, 1839. 40x, side view.
6- *Elphidium discoidale* d'Orbigny, 1839. 40x, side view.

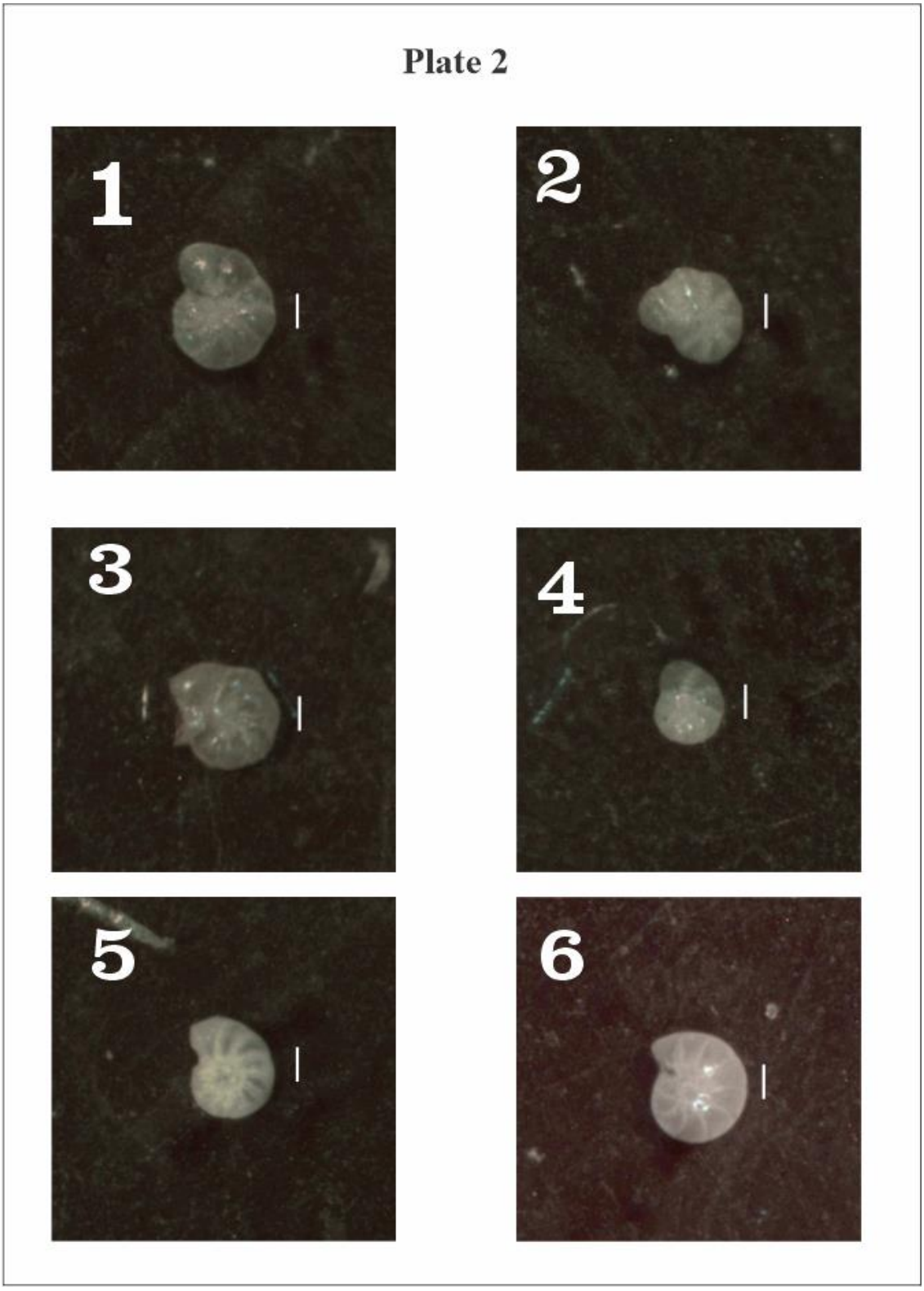

Plate 3

Scale 1bar = 200 µm.

1- *Parrellina hispidula* Cushman, 1936. 40x, side view.
2- *Nonion elongatum* d'Orbigny, 1852. 40x, side view.
3- *Lagena striata* d'Orbigny, 1839a. 40x, side view.
4- *Lagena perlucida* Montagu, 1803. 40x, side view.
5- *Fissurina marginate* Montagu, 1803. 40x, side view.
6- *Quinqueloculina agglutianans* d'Orbigny, 1839. 40x, side view.

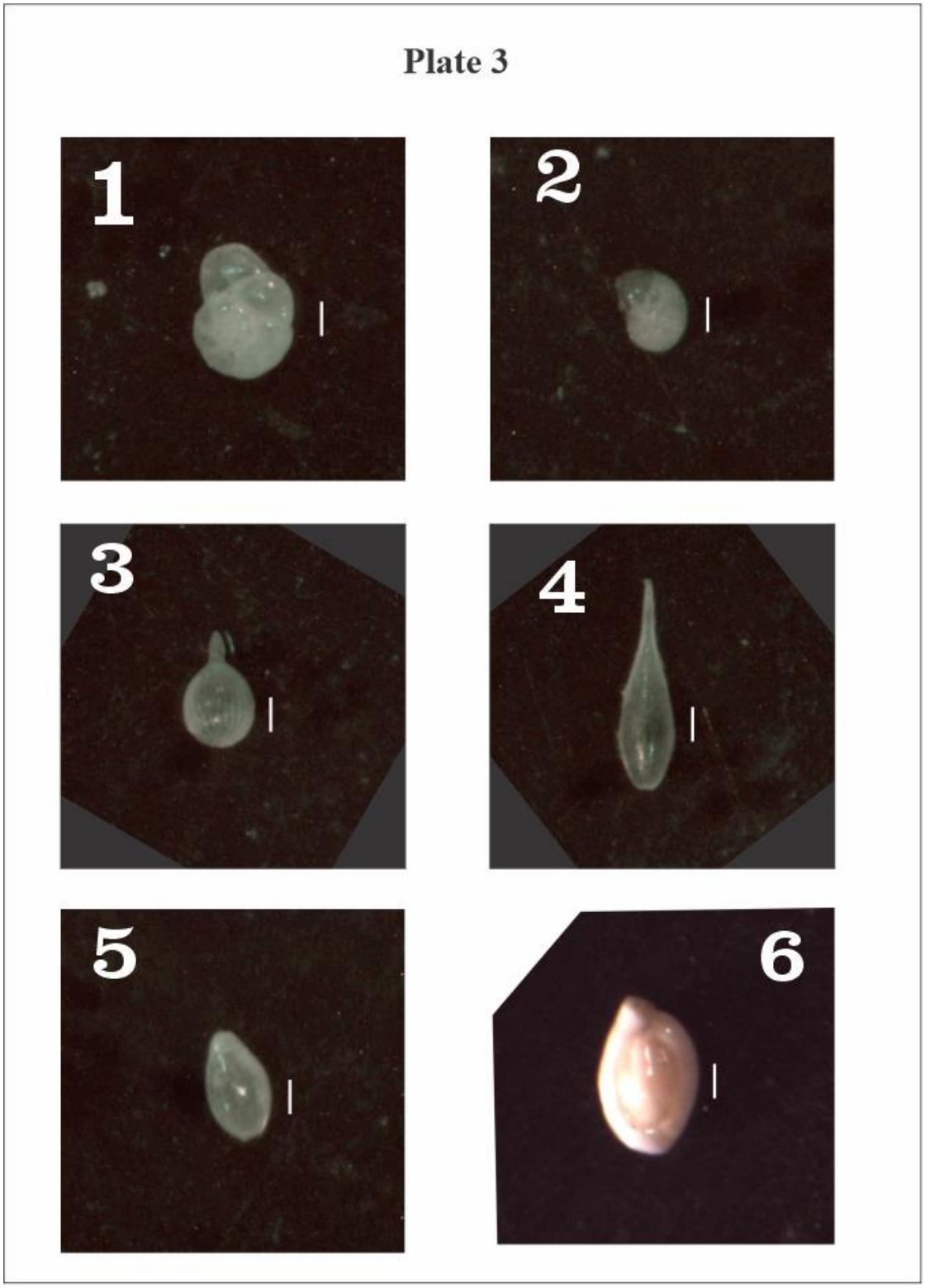

Plate 4

Scale 1bar = 200 µm.

1- *Quinqueloculina polygona* d'Orbigny, 1839. 40x, side view.
2- *Quinqueloculina parvula* Schlumberger, 189440x, side view.
3- *Quinqueloculina angulta* Williamson, 1858. 40x, side view.
4- *Quinqueloculina stelligera* Schlumberger, 1893. 40x, side view.
5- *Quinqueloculina seminulum* Linne, 1758. 40x, side view.
6- *Triloculina oblonga* Montagu, 1803. 40x, side view.

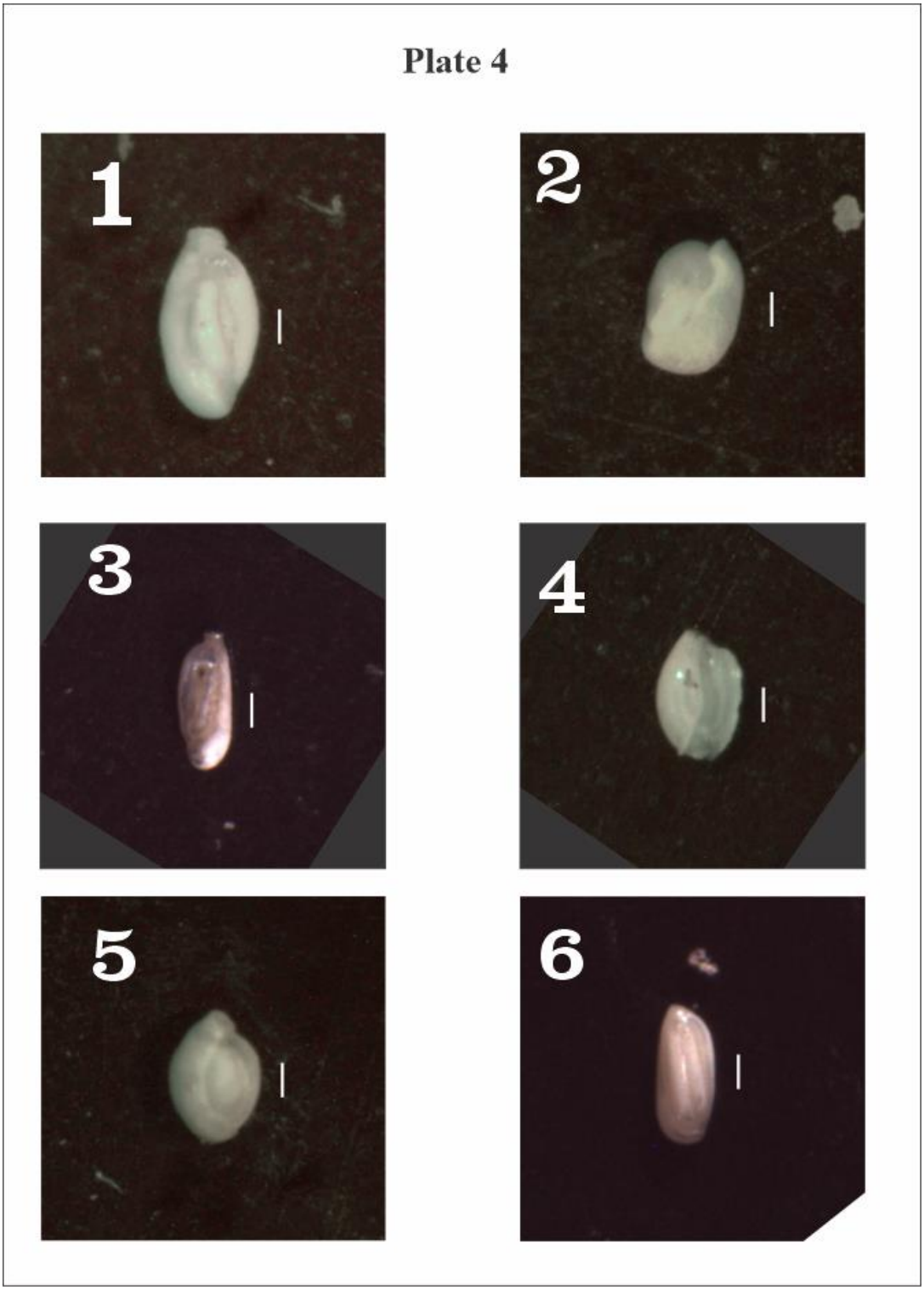

Plate 5: Scale 1bar = 200 µm. **(1)** *Spiroloculina exima* Cushman, 1922. 40x, side view. **(2)** *Spirosigmoilina tenuis* Čžjžek, 1848. 40x, side view.

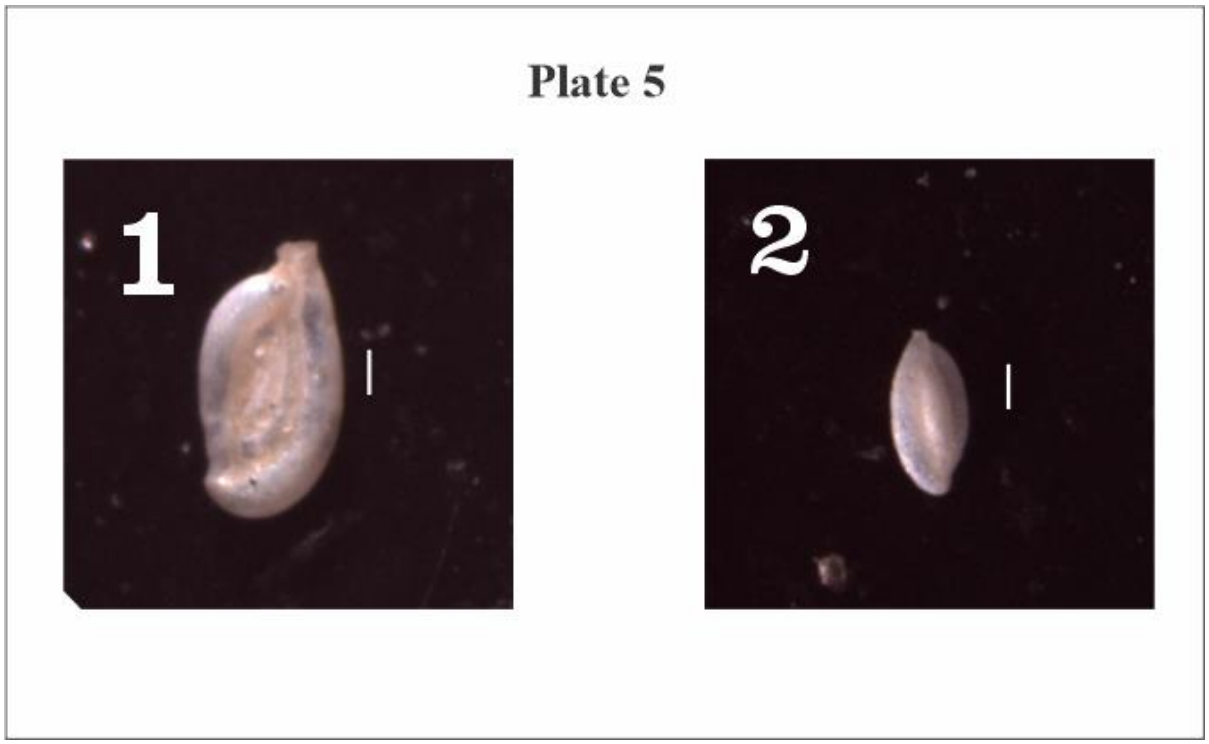

Plate 6

Scale 1bar = 200 µm.

1- *Alocopocythere reticulate* Hartmann, 1964. 40x, side view.
2- *Carinocythereis indica* Jain, 1978. 40x, side view.
3- *Candoniella albicans* Sharpe, 1897. 40x, side view.
4- *Leguminocythereis papuensis* (Brady) Jain, 1978. 40x, side view.
5- *Cyprideis torosa* Jones, 1850. 40x, side view.
6- *Cyprideis Var torosa* Jones 1850. 40x, side view.

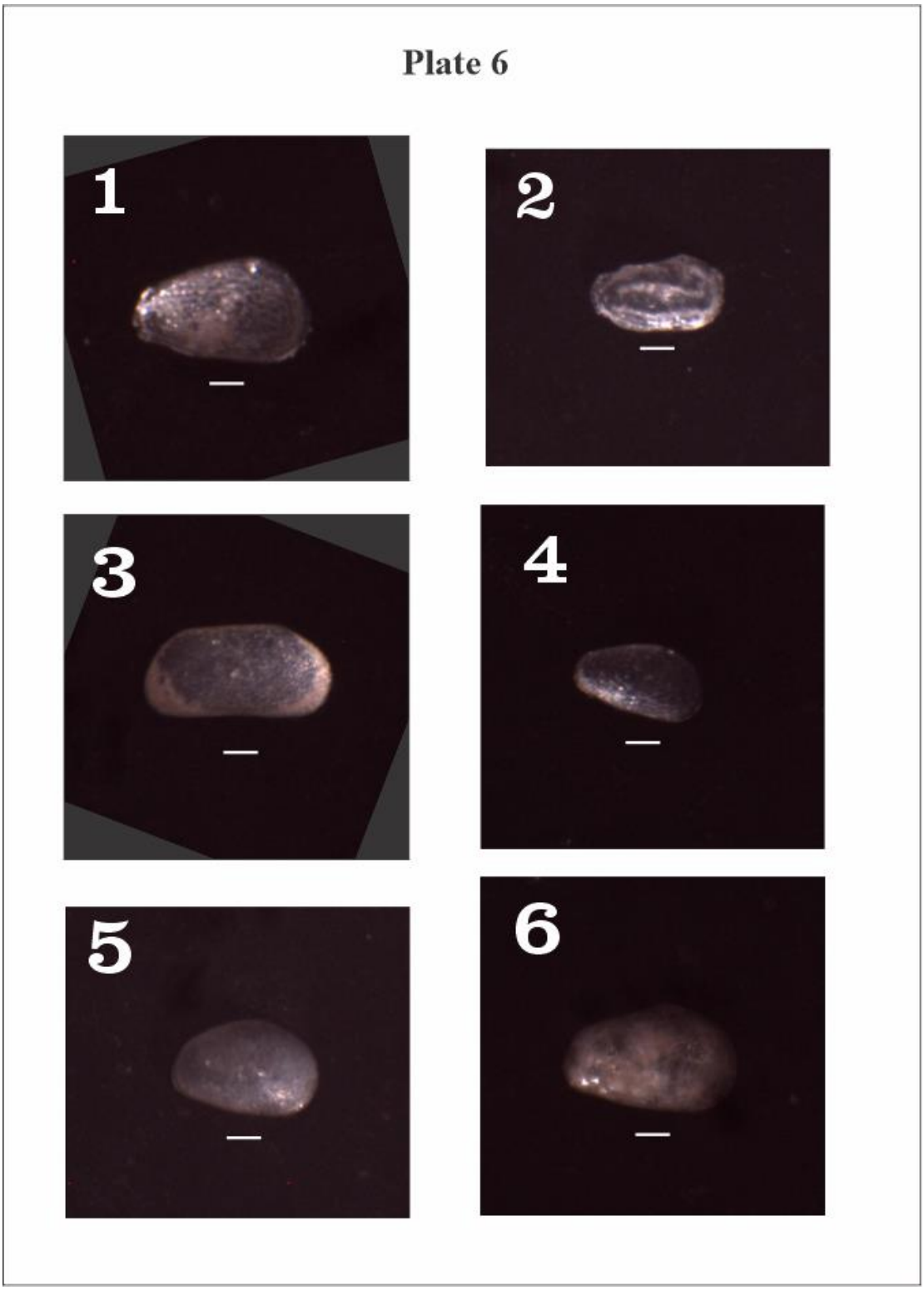

Plate 7

Scale 1bar = 200 μm.

1- *Neomonoceratina delicate* Ischizaki and Kato, 1976. 40x, side view.
2- *Hemicytheridea reticulate* Kingma, 1948. 40x, side view.
3- *Hemicytheridea paiki* Jain, 1978. 40x, side view.
4- *Phlyctenophora orientalis* Brady, 1868. 40x, side view.
5- *Candoniella simpsoni* Sharpe, 1897. 40x, side view.
6- *Darwinula cylindrical* Straub, 1952. 40x, side view.