

The ostracod genus *Paijenborchella* and some of its species in the Early Tertiary of Pakistan

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ABSTRACT – Six species of the genus *Paijenborchella* are described. Five of these species are new, namely *Paijenborchella* (*Eopaijenborchella*) *angulosa*, *P. (E.) viriosa*, *P. (E.) ventricaudata*, *P. (E.) noar* and *P. (Paijenborchella)* *inponticulata*. The stratigraphic distribution of these species in the Early Tertiary of Pakistan is given; they range from the Lower Eocene to the Upper Eocene in the Sulaiman Range and one species occurs in the Upper Paleocene of the Sor Range. *J. Micropalaeontol.* 25(1): 65–72, April 2006.

KEYWORDS: *Early Tertiary, ostracods, Paijenborchella, biostratigraphy, Pakistan*

INTRODUCTION

The distribution of Early Tertiary rocks in parts of Pakistan is shown in Figure 1. The stratigraphic succession of these rocks in the Rakhi Nala of the southern Sulaiman Range, is that published by Siddiqui (1971, modified after Eames, 1952). These rocks also occur in the northern Sulaiman Range (Fig. 2). For full information on the stratigraphy of the Sulaiman Range and Sor Range and the horizons from which samples were taken, see Siddiqui (1971).

Paijenborchella (Upper Cretaceous–Recent) is a marine genus with an interesting development in its carapace structure. The carapace in this genus is punctate, pitted, reticulate or smooth, rarely spinose (or a combination of these) and always sulcate (with a vertical groove placed slightly anterior to the middle of each valve). The sulcus forms a corresponding raised ridge on the inside of the valve; the adductor muscle scars are located on this. A median longitudinal ridge usually occurs, often forming a bridge over the sulcus. There are also generally one or two ventral longitudinal ridges, which may end in posterior spines or alae.

Paijenborchella is divided into two subgenera: *Paijenborchella sensu stricto*, with smooth carapace; and *Eopaijenborchella* in which the surface is ornamented. In this material from the Sulaiman and Sor ranges of Pakistan, there is one example of the smooth subgenus, *P. (Paijenborchella) inponticulata*. This is the only species which lacks a median longitudinal ridge and is therefore without a bridge over the shallow interrupted sulcus.

The muscle scar field in Cytheridae, found on the inside of the sulcus in sulcate species, is often a weak part of the carapace. This can be seen in *Cythere lutea* when contraction of adductor muscles at death ruptures the valves. In several *Cytherura* species the first signs of erosion occur in the muscle scar field.

In the genus *Paijenborchella*, which has relatively robust carapaces and deep sulci, the reverse side of the sulcus is a raised internal ridge. One to three external longitudinal ridges, one crossing the sulcus and one or two supporting the ventral margin, also serve to oppose any central weakness. The development of a bridge crossing the sulcus is an interesting feature of a family in which ornamentation is prominent and varied. It invites speculation as to the arrangement of the appendages inside these carapaces, and the environmental conditions which elicit such adaptations.

All the specimens described in this paper are deposited in the Natural History Museum, London and the specimen numbers

quoted are those identifying them in the fossil ostracod collection of that institution.

SYSTEMATIC DESCRIPTIONS

Subclass **Ostracoda** Latreille, 1806

Order **Podocopida** Müller, 1896

Suborder **Podocopina** Sars, 1866

Superfamily **Cytheracea** Baird, 1850

Family **Cytheridae** Baird, 1850

Subfamily **Cytherinae** Baird, 1850

Genus ***Paijenborchella*** Kingma, 1948

Subgenus ***Eopaijenborchella*** Keij, 1966

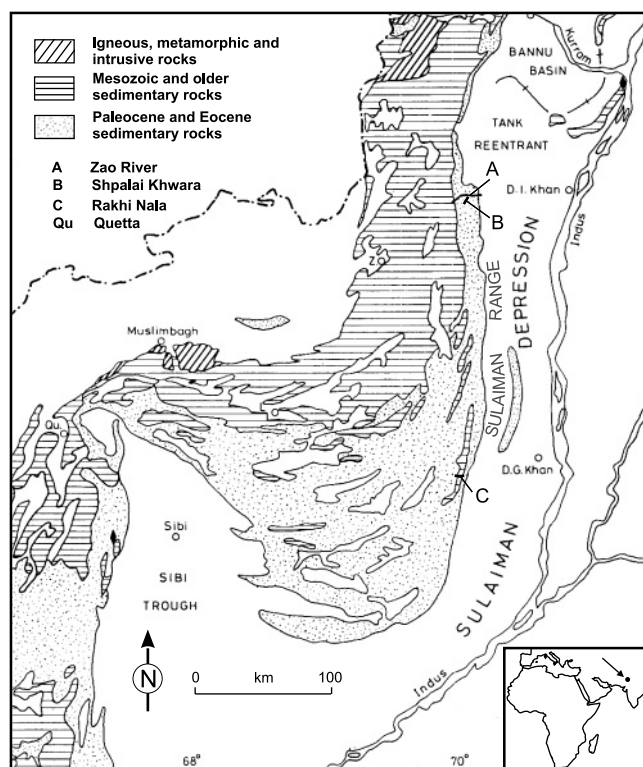


Fig. 1. Location map (modified; after the German Advisory Group HDIP, 1985–7, in Köthe *et al.*, 1988).

Age	Formation	Sulaiman Range						Sor Range
		Rakhi Nala Succession		Rakhi Nala		Zao River		
		Thickness (Feet)	Sample Numbers	Species	Thickness (Feet)	Sample Numbers	Species	
Upper Eocene	Kirthar	<i>Pellatispira</i> Beds	60	3666	<i>P.(E.) noar</i> <i>P.(E.) ventricaudata</i> <i>P.(P.) inopunctulata</i> <i>P.(E.) viriosa</i>	1796	24210	<i>P.(E.) ventricaudata</i> <i>P.(E.) viriosa</i> <i>P.(E.) noar</i>
		Upper Chocolate Clays (upper part)	485-550	3666 3628			24161	
Middle Eocene	Kirthar	Upper Chocolate Clays (lower part)	420-490	3627 3604	<i>P.(E.) angulosa</i>	>332	24160	<i>P.(E.) ventricaudata</i> <i>P.(E.) viriosa</i>
		White Marl Band	40	3603 3600			24137	
		Lower Chocolate Clays	930	3499			24134	
		Platy Limestone	70	3478 3477 3476			24133	
Lower Eocene	Ghazij	Shales with Alabaster	750	3473 3439	NO OSTRACODS	24120	24119	
		Rubbly Limestones	410	3438 3143			24114	
		Green and Nodular Shales	850	3412 3171			24113	
		Upper Rakhi Gaj Shales	1620	3170			24097	
		Lower Rakhi Gaj Shales (topmost portion only = <i>irregularis</i> Limestone)	60	3140 3667 3668				
Paleocene	Ranikot	Lower Rakhi Gaj Shales (max. pars)	775	+3672-70 3139				<i>P.(E.) sp. A</i> ^{460-c}
		Gorge Beds	470	3116 3115 3110				
		<i>Venericardia</i> Shales	95					

Fig. 2. Stratigraphic distribution of *Paijenborchella* species in the Paleocene and Eocene in parts of Pakistan.

Paijenborchella (*Eopaijenborchella*) sp. A
(Pl. 1, fig. 2)

Figured specimen. OS 15993.

Material. Two specimens from the Sor Range section, from one horizon (sample number 460 c).

Locality and horizon. Sor Range section, 8 miles east of Quetta, Pakistan; Upper Paleocene (Siddiqui, 1971: 11).

Description. Carapace subtriangular in lateral view. Sexual dimorphism is present, males being longer, but shorter in height, than females. Anterior margin broadly and obliquely rounded, posterior with short and pointed subventral caudal process. Dorsal margin slightly curved in left valve, almost straight in right valve, postero-dorsal margin nearly straight, ventral margin slightly incurved anterior to the middle, but appears to be sinuous because of ventro-lateral expansion. Left valve larger than the right, over-reaching it at the dorsal, antero-dorsal and postero-dorsal margins. Surface ornamentation consists of reticulations (stronger in the posterior part of the carapace), with a vertical sulcus located slightly anterior to the middle and confined to the upper two-thirds of the carapace. The sulcus is traversed by a short median bridge which merges into the shell

surface on both sides of the sulcus. Anterior marginal rim narrow. Both anterior and posterior marginal areas compressed. Internal features not seen.

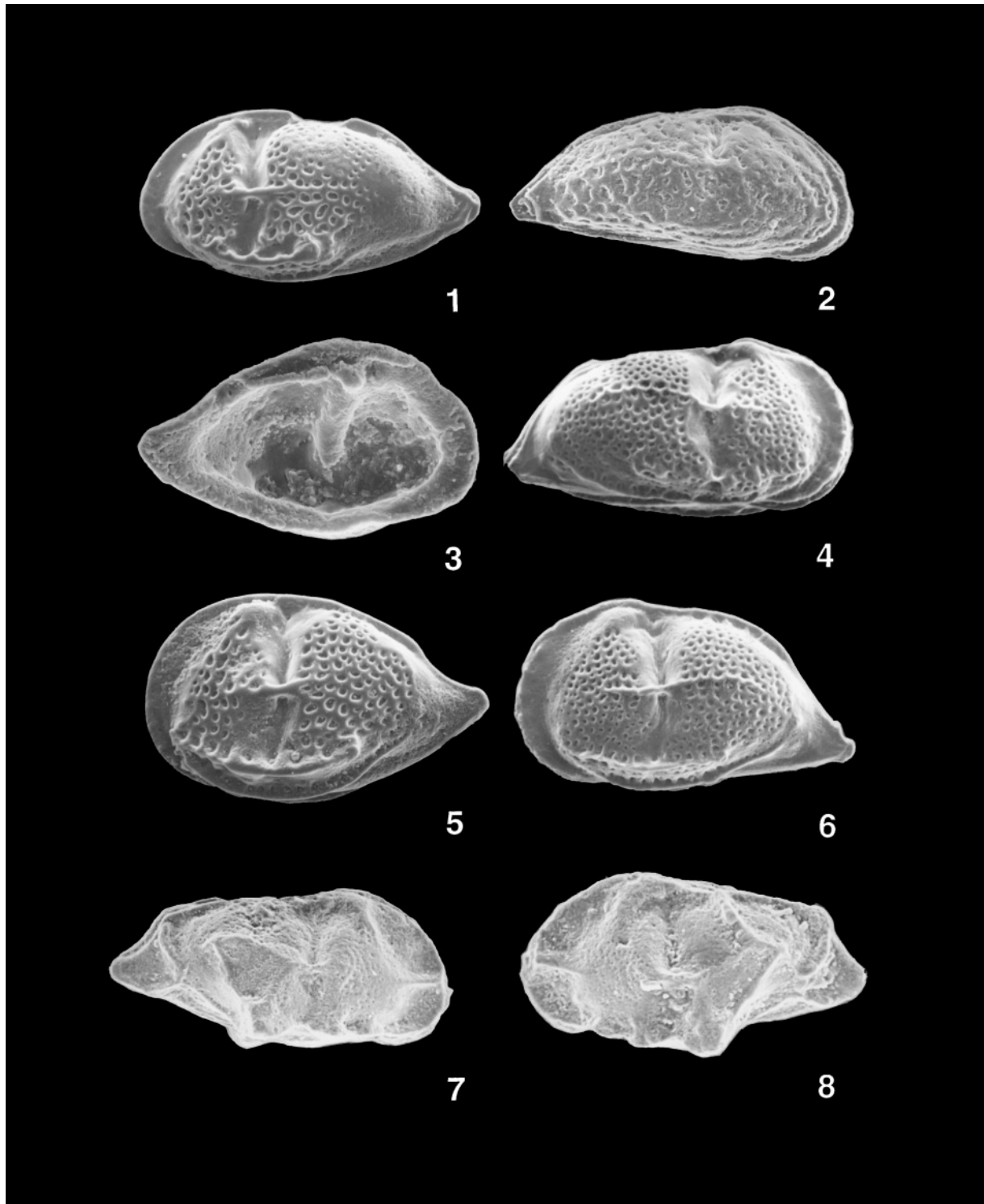
Dimensions.

	L	H	W
	(µm)	(µm)	(µm)
Male carapace, OS 15993	452	221	184
Female carapace, OS 15994	452	221	193

Remarks. This species shows some resemblance to *Paijenborchella* (*Eopaijenborchella*) *dattai* Bhandari, 1992, but differs from it in having a narrower anterior marginal rim and a shorter median bridge. *Paijenborchella indegina* Sarma, 1973 (Pl. 1, figs 1, 2), has a pitted, rather than a reticulate surface, and a shorter and less pointed caudal process than the present species. Since only two carapaces were found, this species has been left with open nomenclature.

Paijenborchella (*Eopaijenborchella*) *angulosa* sp. nov.
(Pl. 1, figs 7, 8)

1996 *Paijenborchella* (*Eopaijenborchella*) *narediensis* Guha (Bhandari: 98, pl 73, figs 1, 2; non Guha, 1974: 170-171, pl. 2, figs 2, 3, 7).



Explanation of Plate 1.

figs 1, 3, 5. *Paijenborchella (Eopaijenborchella) viriosa* sp. nov. Upper Chocolate Clays (lower part), Kirthar Formation, Middle Eocene: **1**, paratype, OS 15990, from Zao River, male carapace left lateral view, $\times 98$; **3**, paratype, OS 15992, from Rakhi Nala, female left valve (juv.), internal lateral view, $\times 133$; **5**, holotype, OS 15989, from Zao River, female carapace, left lateral view, $\times 100$. **fig. 2.** *Paijenborchella (Eopaijenborchella) sp. A.* Upper Paleocene, Sor Range. OS 15993, male carapace, right lateral view, $\times 123$. **figs 4, 6.** *Paijenborchella (Eopaijenborchella) ventricaudata* sp. nov. Upper Chocolate Clays (upper part), Kirthar Formation, Upper Eocene, Rakhi Nala: **4**, paratype, OS 15988, male carapace, right lateral view, $\times 96$; **6**, holotype, OS 15987, female carapace, left lateral view, $\times 99$. **figs 7, 8.** *Paijenborchella (Eopaijenborchella) angulosa* sp. nov. Shales with Alabaster, Ghazij Formation, Lower Eocene, Rakhi Nala: **7**, holotype, OS 15978, male carapace, right lateral view, $\times 130$; **8**, paratype, OS 15982, female carapace, left lateral view, $\times 138$.

Derivation of name. Latin, *angulosus*, full of corners; with reference to surface ornamentation.

Diagnosis. A species of *Eopaijenborchella* in which posterior part of carapace has ridges defining large angular polygons. Median bridge short and connected posteriorly to the corner of a polygon; anterior marginal area divided by a short horizontal median ridge. Valve surface finely punctate.

Holotype. OS 15978, a male carapace (Pl. 1, fig. 7).

Paratype. OS 15977.

Material. 172 specimens from 28 horizons in the Rakhi Nala section (sample numbers 3187, 3190–3193, 3197, 3200, 3401–3403, 3407, 3409, 3410, 3417–3419, 3421–3424, 3426, 3434, 3435, 3438, 3457, 3465 and 3466).

Type locality and horizon. Rakhi Nala section, Sulaiman Range, Pakistan. Shales with Alabaster, Ghazij Formation, Lower Eocene.

Description. Carapace subrectangular in lateral view. Sexual dimorphism apparent, male dimorphs being more elongate than females. Anterior margin broadly and obliquely rounded towards the ventral margin, posterior with a short caudal process with a concavity above. Dorsal margin straight, ventral margin straight but appears convex because of ventral ridge. Greatest length passes through midpoint, and greatest height at the anterior cardinal angle. Anterior cardinal angle rounded, posterior cardinal angle obtuse and well marked. Left valve larger than the right, over-reaching it at the dorsal, antero-ventral and posteroventral margins. Valve surface finely punctate. The posterior part of the carapace has ridges defining large angular polygons. Median bridge short, connected posteriorly to the corner of a polygon. Sulcus well developed, almost vertical, widest near the dorsal margin, lying slightly anterior to the middle. Ventral ridge prominent and alate. Anterior and posterior marginal areas compressed, anterior with a short horizontal median ridge. Internal details unknown.

Dimensions.

	L (μm)	H (μm)	W (μm)
Paratype, female carapace, OS 15977	406	184	203
Holotype, male carapace, OS 15978	424	184	193

Remarks. This species seems to be identical to *Paijenborchella nareadiensis* (Bhandari, 1996; *non* Guha, 1974) from subsurface rocks of Jaisalmer Basin, Rajasthan, of the Khuiala Formation, Lower Eocene. However, the specimen illustrated by Bhandari (1996) appears to be somewhat eroded. *Paijenborchella nareadiensis* Guha, 1974 from the Lower Eocene of Kutch differs from the present species in having a narrower caudal process and a ventral ridge ending posteriorly in a sharp spine. *P. (E.) angulosa* sp. nov. appears to be restricted to the Lower Eocene and is thus a useful horizon marker in the area.

Paijenborchella (Eopaijenborchella) viriosa sp. nov.
(Pl. 1, figs 1, 3, 5)

Derivation of name. Latin, *viriosus*, robust, strong; with reference to carapace.

Diagnosis. *Eopaijenborchella* with robust carapace, sulcus subvertical, deep and narrower in the middle, upper ventral ridge and lower ventral ridge arched convexly downward, more or less concentric in the middle but joining anteriorly.

Holotype. OS15989, a female carapace (Pl. 1, fig. 5).

Paratypes. OS 15990–92.

Material. 350 specimens from the Rakhi Nala section from 19 horizons (sample numbers 3498, 3499, 3604, 3607, 3610–3615, 3617, 3618, 3621, 3631, 3640, 3641, 3645, 3649, 3653 and 3658). 107 specimens from the Zao River section from 15 horizons (sample numbers 24127, 24131, 24132, 24147, 24148, 24150–24152, 24154–24157, 24159, 24175 and 24183).

Type locality and horizon. Zao River section, Sulaiman Range, Upper Chocolate Clays (lower part), Kirthar Formation, Middle Eocene.

Description. Carapace obovate in lateral outline. Sexual dimorphism strong, presumed males more elongate and not as high as females. Anterior end broadly rounded, posterior with a distinct caudal process almost in the middle, dorsal margin curved, posterodorsal margin slightly concave, ventral margin curved (over-reached by lower ventral ridge in lateral view), antero-ventral flange preserved in some specimens. Left valve over-reaches right valve at the dorsal and posterodorsal region. A subvertical deep sulcus extends from the dorsal margin to the ventral ridge. It lies subcentrally in females but within anterior two-fifths in male dimorphs. The sulcus is crossed by a well-developed median bridge which is short but in some specimens extends for a short distance anteriorly, posteriorly or both. The upper ventral ridge is curved convexly downward in the middle; the ventral part of the sulcus ends against this ridge. In some specimens it terminates posteriorly in a marked spine. The lower ventral ridge is also curved convexly downwards and almost follows the upper ventral ridge except in the anterior where it joins the upper ventral ridge. Posteriorly it becomes sinuous and stretches slightly upward. Surface reticulate, except anterior marginal area, caudal process and sulcus, which are almost smooth. Anterior and posterior peripheral areas compressed. Seen internally the valves are deep; duplicature of moderate width. Hinge schizodont. Radial pore canals and muscle scars not seen clearly.

Dimensions.

	L (μm)	H (μm)	W (μm)
Holotype, female carapace, OS 15989	563	341	286
Paratype, male carapace, OS 15990	563	272	277
Paratype, male carapace, OS 15991	627	332	295
Paratype, female left valve (juv.), OS 15992	415	240	

Remarks. *Paijenborchella? reversa* Sohn, 1970 shows some affinity with the male dimorph of the present species but has a reverse overlap and only one, rather than two, ventral ridges. Guha (1968) assigned some specimens from the Middle Eocene of Kutch to *Paijenborchella trisulcata* Rozieva, 1962; his illustration shows a juvenile which is not *P. trisulcata* but is probably conspecific with the present species. This becomes obvious when a large population of the present species is examined. The male dimorph of *P. (E.) viriosa* shows some resemblance to the male dimorph of *P. (E.) bhatiai* Bhandari, but has a slightly upturned caudal process particularly in the right valve, while that of *P. (E.) bhatiai* is horizontal. *P. (E.) viriosa* occurs abundantly in the Middle–Upper Eocene of the Rakhi Nala and Zao River sections.

Paijenborchella (Eopaijenborchella) ventricaudata sp. nov.
(Pl. 1, figs 4, 6)

1991 *Paijenborchella (Eopaijenborchella)* sp. Bhandari: 45, pl. 1, fig. 3.

1996 *Paijenborchella (Eopaijenborchella)* sp. Bhandari: 98, pl. 74, figs 1, 2.

Derivation of name. Latin, *venter*, belly; *cauda*, tail; with reference to the position of the caudal process.

Diagnosis. Species of the subgenus *Eopaijenborchella*, with a well-developed postero-ventral, subtriangular, caudal process; median bridge long and slightly concave upward posteriorly, with a tunnel under the bridge joining the dorsal and ventral parts of the sulcus; ventral ridge slightly arched downward in the middle, joining the arcuate lower ventral ridge in the antero-ventral region.

Holotype. OS 15987, a female carapace (Pl. 1, fig. 6).

Paratype. OS 15988.

Material. 13 specimens from the Rakhi Nala section from seven horizons (sample numbers 3609, 3640, 3641, 3645, 3648, 3651 and 3653) Five specimens from the Zao River section from two horizons (sample numbers 24151 and 24173).

Type locality and horizon. Rakhi Nala section, Sulaiman Range. Upper Chocolate Clays (upper part), Kirthar Formation, Upper Eocene.

Description. Carapace subovate excluding caudal process. Sexual dimorphism strong, males being more elongate and not as high as females. Anterior margin broadly rounded, posterior with a well-marked subventral and subtriangular caudal process, particularly in the left valve. Dorsal margin almost straight in right valve but slightly curved in left valve, ventral margin almost straight. Greatest height at the anterior third with greatest length passing through midventral region. In dorsal view greatest width is almost in the middle. Left valve larger than the right, over-reaching it in the dorsal, posterodorsal, anterodorsal and anteroventral regions. Shell surface reticulate (except for anterior and posterior marginal areas which are

punctate, and the sulcus which is almost smooth). An almost flat tubercle-like elevation is present in both valves in the subantero-dorsal region anterior to the sulcus. The sulcus is deep, slightly curved and lies anterior to the middle. It is crossed by a median longitudinal bridge above and culminates at the upper ventral ridge. The lower ventral ridge is curved convexly downward and joins the ventral ridge anteriorly. Anterior and posterior areas (including the caudal process) are compressed. Anterior margin ornamented with 8 or 9 small tubercles. Internal details unknown.

Dimensions.

	L	H	W
	(μm)	(μm)	(μm)
Paratype, male carapace, OS 15988	591	277	286
Holotype, female carapace, OS 15987	559	304	267

Remarks. This species differs from all other known species of the subgenus *Eopaijenborchella* by its subventral and subtriangular caudal process. The present species has so far been found in the Middle and Upper Eocene of the Rhaki Nala and Zao River sections of the Sulaiman Range, Pakistan, and from subsurface samples of Late Eocene from Rajasthan, India (Bhandari, 1991, 1996).

Paijenborchella (Eopaijenborchella) noar sp. nov.
(Pl. 2, figs 5–8)

Derivation of name. Greek, *noar*, phantom; with reference to the ghost-like remnants of the reticulation.

Diagnosis. Species of the subgenus *Eopaijenborchella* with mildly reticulate shell surface, fossae finely punctate, median bridge short and crossing over a shallow sulcus, valves with a flat anterodorsal tubercle lying above the sulcus, ventral ridge not well developed, but ending in a posteroventral tubercle.

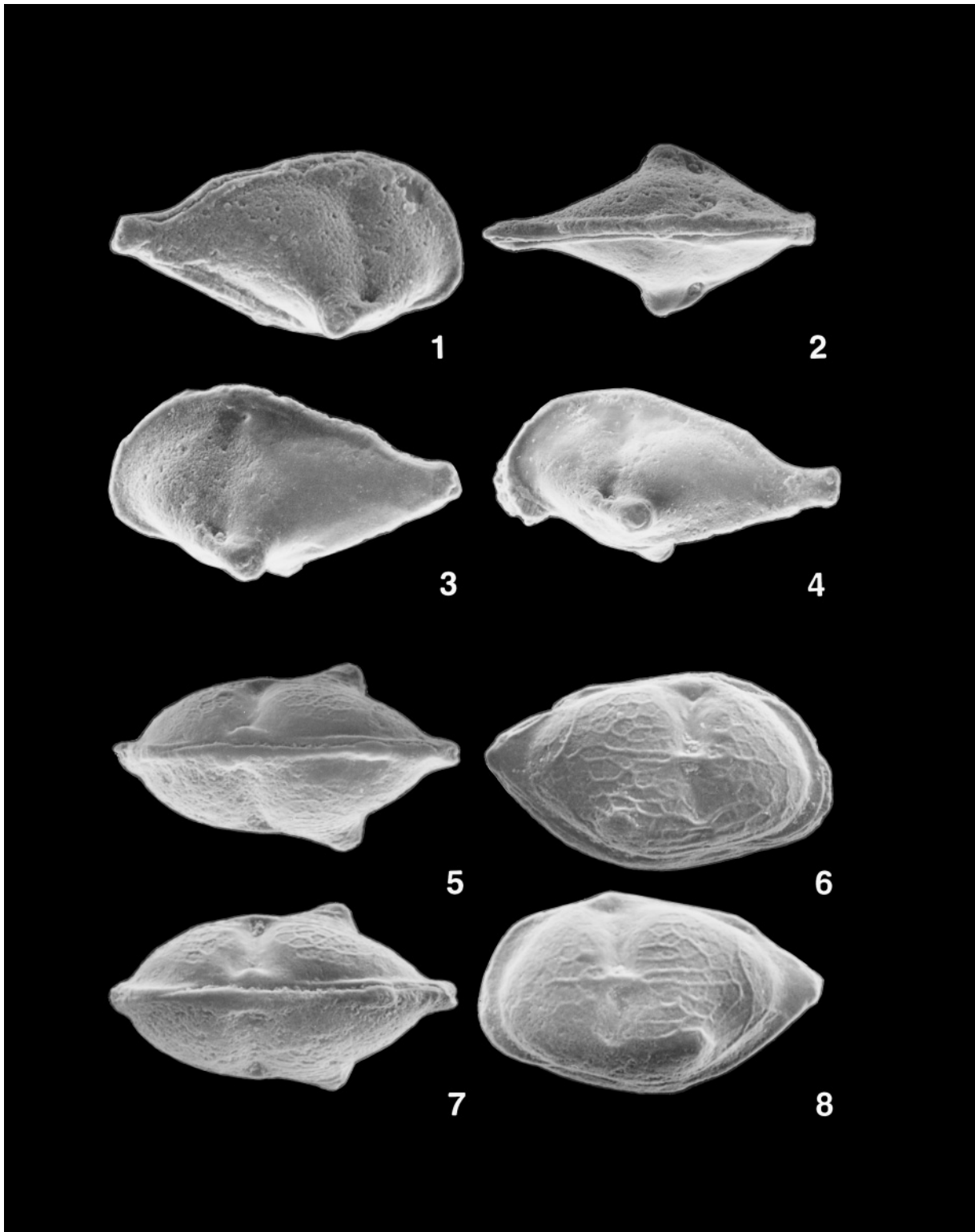
Holotype. OS 15983, a male carapace (Pl. 2, fig. 6).

Paratypes. OS 15984–86.

Material. 26 specimens from the Rakhi Nala section from three horizons (sample numbers 3661, 3662 and 3664) Eight specimens from the Zao River section from four horizons (sample numbers 24187, 24191, 24193 and 24195).

Type locality and horizon. Rakhi Nala section, Sulaiman Range, Pakistan. *Pellatispira* Beds, Kirthar Formation, Upper Eocene.

Description. Sexual dimorphism present, females being wider in proportion than males. Carapace subrhomboidal in lateral outline. Anterior margin broadly and obliquely rounded, posterior with a short caudal process slightly above midline. Dorsal margin almost straight with a flat anterodorsal tubercle. Posterodorsal corner with an obtuse cardinal angle, ventral margin slightly convex. Left valve larger than right, over-reaching it at anteroventral, anterodorsal and posterodorsal margins. In dorsal view the greatest width lies at the posterior third, in the region of the posteroventral tubercle. Shell surface



Explanation of Plate 2.

figs 1–4. *Paijenborchella (Paijenborchella) inponcticulata* sp. nov. Upper Chocolate Clays (lower part), Kirthar Formation, Middle Eocene, Rakhi Nala: 1, paratype, OS 15981, female carapace, right lateral view, $\times 126$; 2, paratype, OS 15979, male carapace, dorsal view, $\times 106$; 3, paratype, OS 15982, female carapace, left lateral view, $\times 124$; 4, holotype, OS 15980, male carapace, left lateral view, $\times 109$. **figs 5–8.** *Paijenborchella (Eopaijenborchella) noar* sp. nov. *Pellatispira* Beds, Kirthar Formation, Upper Eocene, Rakhi Nala: 5, paratype, OS 15984, male carapace, dorsal view, $\times 89$; 6, holotype, OS 15983, male carapace, right lateral view, $\times 81$; 7, paratype, OS 15988, female carapace, dorsal view, $\times 88$; 8, paratype, OS 15985, female carapace, left lateral view, $\times 89$.

Early Tertiary ostracods of Pakistan

mildly reticulate, with finely punctate fossae. A wide and shallow sulcus lies in the anterior third. It is crossed by a short median bridge; ventrolateral ridge not well developed but culminates in a distinct rounded tubercle. Internal features not seen.

Dimensions.

	L (μm)	H (μm)	W (μm)
Holotype, male carapace, OS 15983	692	367	314
Paratype, male carapace, OS 15984	677	341	277
Paratype, female carapace, OS 15986	599	351	304
Paratype, female carapace, OS 15985	646	359	314

Remarks. *Neomonoceratina khariensis* Khosla & Pant, 1989, shows some resemblance to the present species, but has an upturned, well-developed, subdorsal caudal process and a well-marked reticulated shell, absent from the present species. *Neomonoceratina monocornuta* Khosla & Nagori, 1989, has a shorter subdorsal caudal process and a pointed alar prolongation. The present species occurs only in the Upper Eocene of the Rakhi and Zao River sections.

Paijenborchella (Paijenborchella) inponticulata sp. nov.
(Pl. 2, figs 1–4)

Derivation of name. Latin, *in*, not, without; *pons*, bridge.

Diagnosis. A species of *Paijenborchella sensu stricto* without a median bridge; ventral ridge short and alate; carapace arrow-shaped in dorsal view; caudal process long and truncated.

Holotype. OS 15980, a male carapace (Pl. 2, fig. 4).

Paratypes. OS 15979, 15981–82.

Material. 11 specimens from the Rakhi Nala section from three horizons (sample numbers 3613, 3614 and 3618)

Type locality and horizon. Rakhi Nala section, Sulaiman Range, Pakistan; Upper Chocolate Clays (lower part), Kirthar Formation, Middle Eocene.

Description. Sexual dimorphism apparent, males being more elongate and not as high as females. Carapace subovate in lateral outline. Anterior margin broadly and obliquely rounded towards the venter, anteroventral margin with a flange (preserved in some specimens), posterior with a well-developed truncate caudal process. Dorsal margin almost straight with a posterodorsal concavity, ventral margin convex downward, but appears to be sinuate because of venterolateral ala. Greatest length passes through midpoint and greatest height at anterior third. Left valve greater than the right, over-reaching it at the dorsal and posterodorsal margins. Surface smooth. A shallow almost vertical sulcus which lacks a median bridge lies at the anterior third; it is shallower in the middle. Ventral ridge ends posteriorly in an ala which is rounded at its extremity. Internal features not seen.

Dimensions.

	L (μm)	H (μm)	W (μm)
Holotype, male carapace, OS 15980	507	203	194
Paratype, female carapace, OS 15981	452	194	184
Paratype, male carapace, OS 15979	507	203	184
Paratype, female carapace, OS 15982	457	194	184

Remarks. This species somewhat resembles *Paijenborchella caudata* (Lienenklaus), Triebel, 1949 but lacks a median bridge. The caudal process in the present species is blunter at the posterior end and is situated at midline rather than being subventral. *Paijenborchella (Paijenborchella) solitaria* Ruggieri (Keij, 1966) also lacks a median bridge, but has a more prominent alar process and a longer caudal process than *P. (P.) inponticulata* sp. nov. The present species is currently known from the Middle Eocene of the Rakhi Nala section. This may be the oldest species of the subgenus.

STRATIGRAPHIC OCCURRENCE

Paijenborchella (Eopaijenborchella) species A from the Upper Paleocene of the Sor Range section (Fig. 2) is currently the oldest known species of the genus from Pakistan. All five of the newly described species occur in the Rakhi Nala section of the Sulaiman Range but only three of them are found in the Zao River section. *Paijenborchella (Eopaijenborchella) angulosa* is restricted to the upper part of the Lower Eocene. *Paijenborchella (Paijenborchella) inponticulata* occurs only in the Middle Eocene and has been found only in the Rakhi Nala section. *Paijenborchella (Eopaijenborchella) viriosa* and *Paijenborchella (Eopaijenborchella) ventricaudata* range through the Middle and Upper Eocene. *Paijenborchella (Eopaijenborchella) noar* occurs only in the uppermost Eocene. Since these *Paijenborchella* species have short vertical ranges, they make good horizon markers.

CONCLUSIONS

Paijenborchella is a marine unisulcate genus with a world-wide distribution. It ranges from the Upper Cretaceous to Recent. It is divided into two subgenera: *Paijenborchella sensu stricto* in which the surface is smooth and *Eopaijenborchella* in which the surface is ornamented. In the material from Pakistan only one species of *Paijenborchella sensu stricto* and five species of *Eopaijenborchella* occur. These range from the Upper Paleocene to the Upper Eocene.

ACKNOWLEDGEMENTS

This work is funded by Saint Mary's University Research Committee. Ursula Grigg prepared the text and Randolph Corney made the plates and figures. The author is indebted to Drs R. H. Bate, E. M. Brouwers and F. J. Gregory for their helpful comments on the manuscript.

Manuscript received 5 July 2004

Manuscript accepted 27 November 2005

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