The Ostracoda of the Kalambaina Formation (Paleocene), northwestern Nigeria[1)]

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The Kalambaina Formation of northwestern Nigeria in the southernmost extension of the Iullemeden Basin has yielded a rich association of ostracods which are of fundamental significance for understanding the palaeogeographical evolution of the trans-Saharan epicontinental sea. The ostracod assemblage of the Kalambaina Formation contains roughly equal proportions of southern Atlantic and Tethyan elements, thus indicating that there was a marine connexion between the Iullemeden Basin and the Tethys, to the north, and the Nigerian coastal sedimentary basin in the Paleocene. The age of the Kalambaina Formation is Paleocene, but not Early Paleocene. This conclusion is illuminated by reference to comparative ostracod material of Danian (Paleocene) and Late Maastrichtian age from Ghana and southwestern Nigeria. Important ostracod genera in the present connexion are *Iorubaella*, *Buntonia*, *Phalcocythere*, *Trachyleberis*, *Brachycythere* and *Dahomeya*. Remarkable relationships with the Paleocene of western Pakistan are proved and hitherto unsuspected connexions with the South African Paleocene indicated.

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Introduction

Most of the ostracods described in this paper were obtained from samples from the quarry of the Cement Company of Northern Nigeria; this is also the type section of the Kalambaina Formation (see Fig. 1 and Fig. 2). The material was collected in June, 1980. Additional samples from the northerly extension of the Kalambaina Formation into Niger Republic (the quarry at Malbaza) were kindly made available for study by Professor Cornelius A. Kogbe, Ahmadu Bello University, Zaria, Nigeria. I also made use of some of the material I collected in July 1963 from the type section of the Dange Formation and from exposures in the Kalambaina Formation.

In order to clarify the dating of the Kalambaina Formation, I found it necessary to refer to material from two boreholes drilled in sediments located in time near the Cretaceous-Tertiary boundary. The first of these boreholes was drilled at Epunsa in western Ghana, from which material was kindly made available by the Geological Survey of Ghana. The second sample comes from a borehole drilled by the Geological Survey of Nigeria at Wasimi, a village in southwestern Nigeria, and of Maastrich-to-Danian age (Reyment, 1966).

The present work is a complementary study to the regional geological analysis I made recently (Reyment, 1980) in which the specific natures of the epicontinental transgressions in the Saharan domain were treated in detail, including quantitative palaeobiogeographical analyses of key associations. It also provides, on palaeobiogeographical grounds, irrefutable evidence of the existence of a marine connexion in the Paleocene between the Tethys and the South Atlantic via the area marked by the present-day Niger River. Although the ostracods figured in this paper give a reasonable representation of the richness of the fauna, no claim is laid to the coverage being complete and several of the species recorded in Reyment (1980) were not found in the samples studied here. It is expected that further fieldwork could well bring to light much more extensive assemblages than those presented here.

Unfortunately, the preservation of the material from the limestone (which is more in the nature

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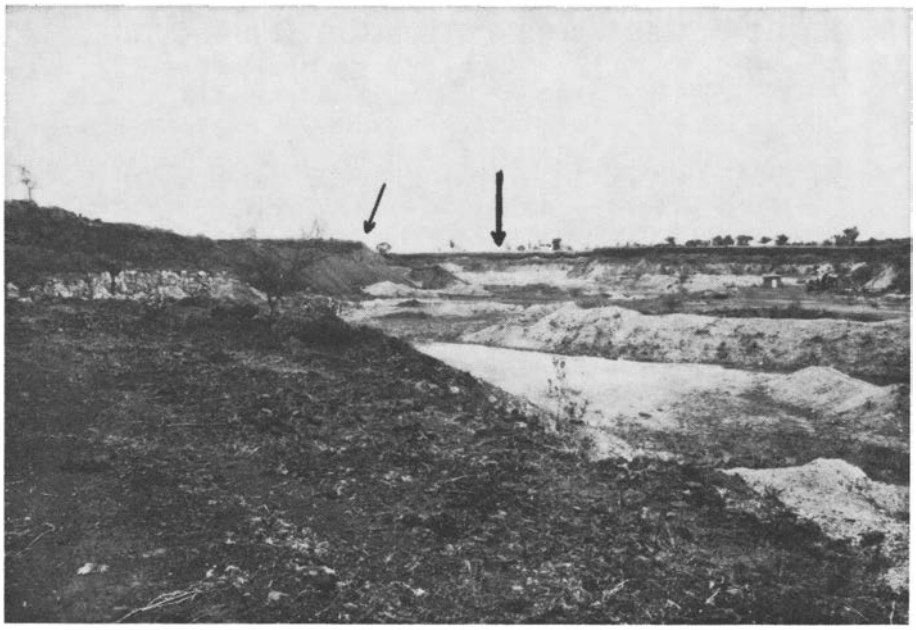

Fig. 1. Photograph of the quarry at Kalambaina, taken in June, 1980. The arrows denote the two sections sampled (left: KA1—KA3; right: KA4—KA6).

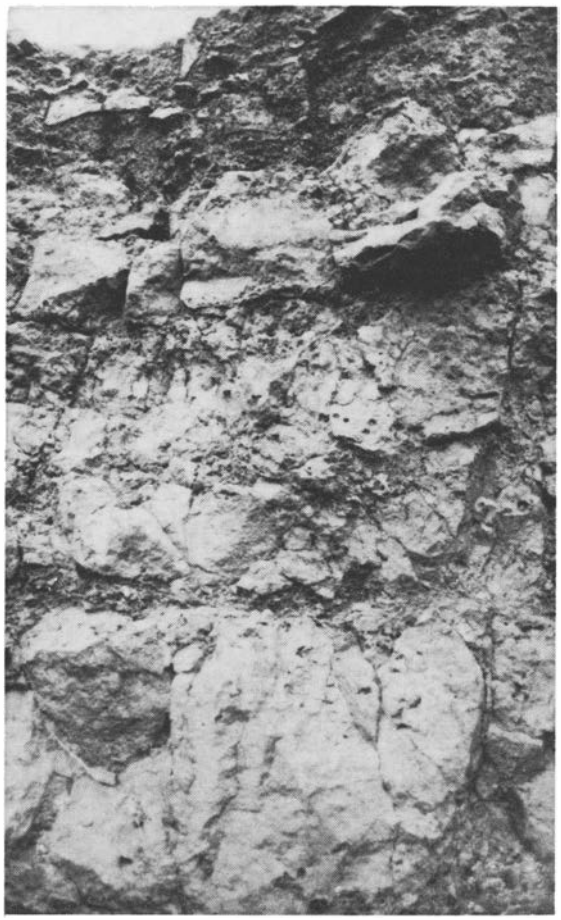

Fig. 2. The quarry face at Kalambaina from which samples KA4—KA6 were collected in June, 1980.

of lime mud) is not good. All specimens are recrystallized and the internal features of the shells have been entirely obliterated.

Regional geological setting

The Kalambaina Formation is located in the southernmost extension of the Iullemeden Basin. Three major stratigraphical subdivisions are recognized in the Nigerian section of the basin (sometimes termed the Sokoto Basin): (1) a lower sequence of continental sediments of Late Jurassic to Early Cretaceous age, (2) marine and brackish water deposits of Late Cretaceous to Paleocene age and (3) continental deposits of approximately Eocene to Miocene? age. The sequence in the Sokoto embayment of the Iullemeden Basin is summarized in Table 1.

The Paleocene formations widen successively northwards and form a band some 20 km wide near the border with Niger Republic (Fig. 3).

Table 1. Summary of the geological succession in northwestern Nigeria

Age	Formation	Group	Environment
Pleistocene	sandy drift, laterite	—	continental
Eocene to "Miocene"	Gwandu Formation	"Continental Terminal"	continental
	unconformity		
Paleocene	Gamba Formation Kalambaina Formation/Dange Formation (part lateral equivalents)	Sokoto Group	marine: shallow epicontinental hazard environment
	unconformity		
Maastrichtian	Wurno Formation Dukamaje Formation Taloka Formation	Rima Group	brackish water with brief marine intercalations
	unconformity		
Late Jurassic to Early Cretaceous	Illo and Gundumi Formations	"Continental Intercalaire"	continental
	major unconformity		
Precambrian	Basement Complex		

Southward, the outcrops narrow and finally pinch out near Jega. The lithology consists of blue-grey shale, yellowish marl and brown limestone. The formation is locally quite fossiliferous and at the type locality, it contains a good ostracod assemblage.

The Kalambaina Formation consists of white, locally clayey limestone, shale and marl. The type section of the formation is located at the quarry of the cement factory, near the village of Kalambaina, some 6 km to the west of Sokoto town. The thickness of the formation varies considerably owing to erosion and sub-surface dissolution of the limestone, which is usually more in the nature of a lime-mud. At the quarry, the limestone attains a high level of purity (around 90 % $CaCO_3$ or more). The maximum thickness recorded in boreholes is 20 m but only about 12 m are exposed in the quarry.

The Kalambaina Formation continues into Niger Republic, where it also widens. The material exposed in the quarry at Malbaza, Niger Republic is said to be purer than that in the Kalambaina quarry. The thickness at Malbaza varies between 6 and 18 m.

Outcrops of the marine Maastrichtian-Paleocene sediments stretch in a wide arc from northwestern

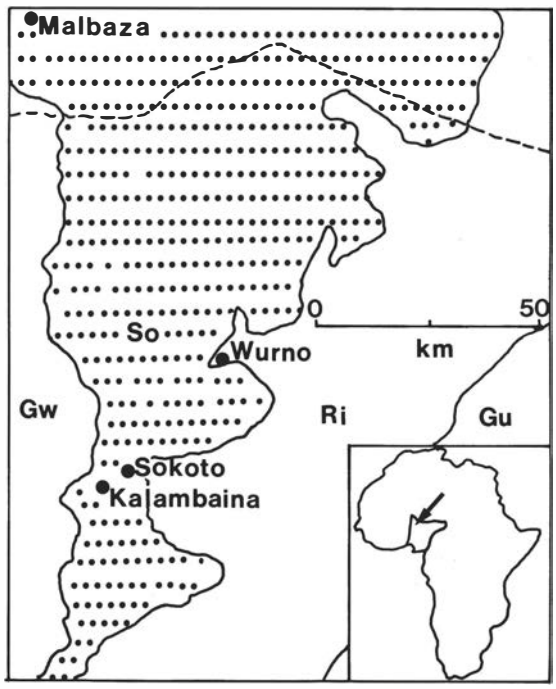

Fig. 3. Sketch map of the geographic distribution of the Paleocene formations in northwestern Nigeria and the adjacent part of Niger Republic. Gu = Gundumi and Illo Formations; Ri = Rima Group; So = Sokoto Group; Gw = Gwandu Formation. See also Table 1.

Nigeria, through Niger Republic to Mali, where they pass laterally into the marine sequences of North Africa (Reyment & Reyment, 1981). The palaeontological analysis shows without doubt that the southern Atlantic Ocean must have been in contact with the Tethys, through Niger and northwestern Nigeria, in the Paleocene.

Palaeobiogeographical considerations

The Kalambaina ostracod association has proven remarkable in several respects. There is not only its highly significant status of transitional fauna between the northern epicontinental ostracod associations of Libya and Mali (Reyment & Reyment, 1981) but there are also clear relationships with Pakistan, on the one hand, and southeastern South Africa, on the other.

South Africa. — Dingle (1976) recorded interesting connexions between the Palaeogene of West Africa and the continental shelf off Natal. He noted the occurrence of the typical West African elements *Mehesella* sp., *Leguminocythereis? senegalensis* Apostolescu, *Leguminocythereis?* cf. *lokossaensis* Ap. (which is a junior synonym of *Mehesella biafrensis* Reyment) and *Costa?* cf. *C. dahomeyi.* He also referred some of his material to the Pakistani genera *Alocopocythere?* and *Stigmatocythere.* A further relationship with western Pakistan is indicated by the presence of *Acanthocythereis* cf. *postcornis* Siddiqui in the Natal association. The west African connexions are not unexpected and there was no barrier to coastal migration once the Walvis Ridge had foundered towards the close of the Danian (Reyment, 1980).

Pakistan. — A relatively large number of West African ostracods have turned out to have affinities with the Palaeogene associations of western Pakistan. Thanks to the monographs of Sohn (1970) and Siddiqui (1971) we are now in a position to sketch the outline of a connexion which will doubtless prove to have far-reaching palaeoecological significance.

Uroleberis teiskotensis Apostolescu is close to the form established as *Uroleberis? chamberlaini* by Sohn (1970). *Buntonia virgulata* Apostolescu, likewise from the Sahara, is identical with *Buntonia devexa* Siddiqui. Sohn's (1970) genus *Annomatocythere* is represented in the Paleocene of West Africa — *Mehesella biafrensis* Reyment (synonym "*Leguminocythereis lokossaensis* Apostolescu" from Togo) seems to possess the properties ascribed to *Annomatocythere*). The genus is in a somewhat confused state. Sohn (1970) stated it to lack eye tubercles; however, such are clearly visible on his figure and even more clearly on the better figures of Siddiqui (1971). "*Leguminocythereis frescoensis* Apostolescu" from the Ivory Coast is another form qualifying for admission into *Annomatocythere.*

The Pakistani genus *Stigmatocythere* is represented in the central Sahara and coastal Nigeria by *S. teiskotensis* (Apostolescu) (= "*Bradleya teiskotensis*").

We note also the occurrence of *Quadracythere* cf. *subquadrata* Siddiqui, *Phalcocythere cultrata*

Table 2. Distribution of Kalambaina ostracods in coastal West Africa and the northern Iullemeden Basin

Species	Coastal West Africa	Northern Iullemeden	Remarks
1. *Bairdia ilaroensis* Reyment & Reyment	1	1	
2. *Bythocypris kalambainaensis* sp. nov.	—	—	
3. *Paracypris sokotoensis* sp. nov.	—	—	
4. *Cytherelloidea saharaensis* sp. nov.	—	—	
5. *Dahomeya alata* Apostolescu	5	5	
6. *Habrocythere teiskotensis* (Apostolescu)	—	6	
7. *Iorubaella ologuni* Reyment	7	7	
8. *Nucleolina tatteulensis* Apostolescu	—	8	
9. *Brachycythere ogboni* Reyment	9	—	
10. *Alocopocythere? teiskotensis* (Apostolescu)	—	10	
11. *Exophthalmocythere? usmandanfodioi* sp. nov.	11	—	
12. *Limburgina praecrassa* (Apostolescu)	—	12	
13. *Limburgina sehouensis* (Apostolescu)	—	13	
14. *Phalcocythere vesiculosa* (Apostolescu)	—	14	Related species in Pakistan
15. *Phalcocythere tubra* sp. nov.	—	—	
16. *Phalcocythere cultrata* (Apostolescu)	—	16	Occurs in Pakistan
17. *Quadracythere lagaghiroboensis* (Apostolescu)	17	17	
18. *Trachyleberis teiskotensis* (Apostolescu)	18	18	
19. *Buntonia apatayeriyerii* Reyment	19	19	
20. *Buntonia pulvinata* Apostolescu	20	—	
21. *Buntonia tenuipunctata* Apostolescu	21	21	

(Apostolescu) (recorded by Sohn (1970) as *Quadracythere ? reticulospinosa*) and *Phalcocythere* aff. *dissenta* Siddiqui.

There can be little doubt that the Paleocene sea of the Iullemeden Basin stood in contact with the Pakistanian region (palaeogeographically uncertain owing to unresolved drift interpretations), presumably through the Sirte Basin in Libya. This fascinating problem can here only be very superficially touched upon but it is clear that much detailed micropalaeontological work remains before it will be possible to present a coherent account of the palaeobiogeographical evolution of the West and North African realms at the beginning of the Tertiary Era.

Saudi Arabia. — Al-Furaih (1980) has demonstrated close affinities to exist between the Paleocene of Saudi Arabia and the Paleogene of Pakistan, which is not unexpected in the light of the results obtained by the present investigation. It is rather remarkable that not one species is identified as being in common with the material described by Sohn (1970) and Siddiqui (1971). Nonetheless, several of the genera described by Siddiqui (1971) were reported to occur and many new genera proposed, the delineation from existing taxa being still rather unclear for some of the names erected. Al-Furaih (1980) observed the connexions with the Saharan collections described by Apostolescu (1961) and also observed that "*Bradleya cultrata*" and "*Bradleya praecrassa*" might be eligible for admission into one of his new genera. I have, however, preferred other assignations for these species.

Just as in Nigeria and north-central Africa, the Late Cretaceous is characterized by species of *Brachycythere* of a rather distinct type. Notwithstanding the apparent lack of agreement between Pakistan and Saudi Arabia at the species level, on the one hand, and Nigeria and Saudi Arabia, on the other, it can be expected that further work may bring to light closer agreements than are known at the present time.

Table 2 summarizes the distributional relationships for the Kalambaina association in the context of the northern part of the Iullemeden Basin and the Nigerian coastal sedimentary basin. It will be seen that about half of the species recorded from the Kalambaina Formation are through-going forms, that is, ones that occur in the Iullemeden Basin and coastal Nigeria. The full number of mutual species is actually much greater (Barsotti, 1963; Reyment and Reyment, 1981).

Collecting sites in the Kalambaina quarry

Six samples were collected from the 12 m of limestone exposed in the Kalambaina quarry. There are three levels of shelly limestone exposed in the quarry wall and each was sampled at two locations in the quarry. Series KA1 (oldest), KA2 and KA3 was collected in the left-hand wall and series KA4 (oldest), KA5 and KA6 taken from the wall facing the entrance to the quarry. The sites (A, respectively, B) are marked in the photograph of the quarry shown in Fig. 1.

A seventh sample KA7 was taken from a large block lying in the middle of the quarry. This sample turned out to be the most fossiliferous of all.

The ostracod contents of the individual samples are listed below:

Sample KA1	Sample KA4
Nucleolina tatteulensis	*Nucleolina tatteulensis*
Dahomeya alata	*Dahomeya alata*
	Bairdia ilaroensis
	Bythocypris sp.
	Habrocythere teiskotensis
	Iorubaella ologuni
	Phalcocythere cultrata
	Buntonia tenuipunctata
Sample KA2	**Sample KA5**
Habrocythere teiskotensis	*Uroleberis* sp.
Ovocytheridea ? sp. indet.	*Phalcocythere cultrata*
Iorubaella ologuni	*Buntonia apatayeriyerii*
Uroleberis aff. *glabella*	
Limburgina praecrassa	
Limburgina sehouensis	
Phalcocythere vesiculosa	
Phalcocythere cultrata	
Phalcocythere aff. *dissenta*	
Trachyleberis teiskotensis	
Sample KA3	**Sample KA6**
Alocopocythere ? aff. *teiskotensis*	*Habrocythere teiskotensis*
Exophthalmocythere ? usmandanfodioi	*Limburgina praecrassa*
	Phalcocythere vesiculosa
	Buntonia pulvinata
Sample KA7	
Bythocypris sp.	*Bythocypris kalambainaensis*
Paracypris sokotoensis	*Cytherelloidea saharaensis*
Dahomeya alata	*Habrocythere teiskotensis*
Iorubaella ologuni	*Nucleolina tatteulensis*
Uroleberis ? sp.	*Brachycythere ogboni*
Limburgina praecrassa	*Limburgina sehouensis*
Quadracythere lagaghiroboensis	*Phalcocythere tubra*
	Buntonia aff. *sehouensis*
Phalcocythere vesiculosa	*Buntonia pulvinata*
Phalcocythere cultrata	
Buntonia apatayeriyerii	
Buntonia tenuipunctata	

Malbaza Quarry, Niger Republic
Nucleolina tatteulensis
Alocopocythere ? teiskotensis
Limburgina praecrassa
Quadracythere lagaghiroboensis
Aurila sp. indet.
Quadracythere ? cf. *subquadrata*
Phalcocythere vesiculosa
Phalcocythere cultrata
Trachyleberis teiskotensis

Systematic notes

General. — The Kalambaina Paleocene is very rich in ostracods. The most common elements are species of *Bairdia* and *Cytherella*, which in some samples constitute more than 60 % of the association. As regards the zoo-microfauna in the quarry at Kalambaina, although foraminifers occur, they are very subordinate to the ostracods.

The preservation is unfortunately poor. The specimens are always recrystallized and it has not been found possible to study finer shell details of any of the specimens in the present collection.

An interesting palaeoecological feature of the material is the occurrence of muricid drill-holes in an admittedly low percentage of the associations studied. Normally, where ostracods have been attacked by drills, it is species of the Naticidae which have been responsible. Muricids are epibiontic and attack only forms living on the surface of the sediment, whereas the endobiontic naticids burrow to their prey. It is obviously much more difficult for a muricid to overcome such a lively organism as an ostracod than for a naticid, which operates on endobiontic prey (Reyment, 1971).

It is well known that muricids are scavengers and it seems likely that the bored individuals in the Kalambaina collection were dead at the time of drilling. A specimen of *Cytherella* sp. with a muricid hole is shown in Pl. 1, Fig. 16. A drilled *Bairdia* cf. *ilaroensis* Reyment & Reyment is illustrated in Plate 1, Fig. 18.

The SEM photographs of plates 1 to 10 were made by Eva Reyment.

Bairdia ilaroensis Reyment & Reyment

Plate 9, Figs. 6, 7

A carapace is shown in Plate 9, Fig. 9 and an example of the marginal denticulation usually associated with *Bairdoppilata* (Plate 9, Fig. 7), but which is found in only a part of any association of *B. ilaroensis.*

Occurrence. Epunsa 1 borehole, Ghana. Maastrichtian.

Bythocypris sp.

Plate 1, Fig. 1

This form is rare in the samples studied. It possesses a rather acutely angled anterior margin and an obtusely rounded posterior margin with a sharp posteroventral angle.

Occurrence. Kalambaina quarry, level KA4. Paleocene.

Bythocypris sp. B

Plate 1, Fig. 5

This species of *Bythocypris* is rare. It has a strongly arched dorsal margin and a concave ventral margin. The broadly rounded posterior is wider than the anterior margin.

Occurrence. Kalambaina quarry, loose block (KA7). Paleocene.

Bythocypris kalambainaensis sp. nov.

Plate 1, Figs. 2—4

Holotype. The carapace figured in Plate 1, Fig. 3, No. PMAf913.

Description. A species of *Bythocypris* with a markedly "parallelogramoid" shape. The dorsal margin is almost straight and the ventral margin slightly concave. The valves are of almost equal size. The anterior margin is very broadly rounded, whereas the posterior is broadly rounded in its upper half, becoming more sharply turned ventrally.

Material. More than 50 specimens.

Occurrence. Kalambaina quarry, loose block(KA7). Paleocene.

Paracypris sokotoensis sp. nov.

Plate 1, Figs. 7—10; Plate 2, Figs. 2L, 2R

Holotype. The carapace figured in Plate 1, Fig. 7, No. PMAf 916.

Description. A species of *Paracypris* with a regularly arched dorsal margin and a sharply rounded posterior margin, which varies in the degree of acuteness developed. The general details of an inner right valve are shown in the stereo-illustration in Plate 2, Fig. 2 and in Plate 1, Fig. 10.

The greatest overlap lies along the central third of the ventral margin.

Remarks. This species is most similar to *Paracypris nigeriensis* Reyment, a specimen of which is illustrated for comparison (Plate 1, Fig. 6). The posterior of *P. nigeriensis* is more sharply pointed and the dorsal region of the carapace more regularly and broadly rounded.

Material. More than 50 specimens.

Occurrence. Kalambaina quarry, loose block (KA7). Paleocene.

Cytherelloidea saharaensis sp. nov.

Plate 1, Fig. 17; Plate 2, Figs. 1L, 1R

Holotype. The carapace figured in Plate 1, Fig. 17 and Plate 2, Figs. 1L, 1R, No. PMAf921.

Description. A species of *Cytherelloidea* with an acutely rounded anterior margin and extremely inflated posterior. The lateral ornament consists of vague ribs or bulges, one of which crosses the shell diagonally.

Material. Five specimens, all of which seem to be females.

Occurrence. Kalambaina quarry, loose block (KA7). Paleocene.

Dahomeya alata Apostolescu

Plate 1, Figs. 11, 12; Plate 2, Figs. 3L, 3R

This strongly dimorphic species occurs in coastal west Africa, with its main development in western Nigeria and Bénin Republic. The material recorded from Sokoto Province differs slightly from the forms figured by Apostolescu (1961) and known to me from western Nigeria (Reyment, 1963) in the following minor characteristics. The anterodorsal angle of the Saharan individuals is sharper, the dorsal margin slightly more arched, the posterior tends to be more pointed and the posterior overlap is somewhat greater.

Females are stubby and round, males are longer and somewhat thinner.

The true status of *Dahomeya* is still unresolved. Compared with *Bosquetina, Dahomeya* differs only in the non-coincidence of the inner lamella and the line of concrescence (Fig. 4). *Incongruella* (and *Lixuoria*) of the Neogene to Recent of the eastern Mediterranean, are to all intents and purposes closely related to, or identical with *Dahomeya* (cf. Sissingh, 1972, p. 108).

Occurrence. Kalambaina quarry, localities KA1, KA4 and float (KA7), type locality of the Dange Formation, Paleocene.

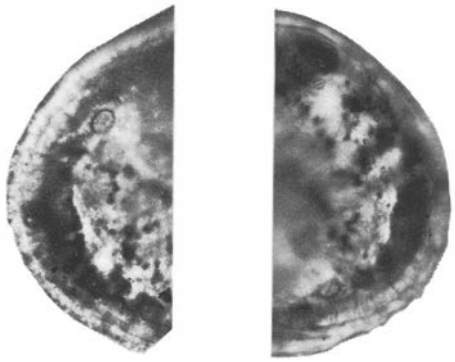

Fig. 4. Posterior (left) and anterior (right) marginal zones of *Dahomeya alata* showing the presence of vestibules. × 110.

Habrocythere teiskotensis (Apostolescu)

Plate 1, Figs. 13—14; Pl. 3, Fig. 1

This species was made the type of *Isohabrocythere* by Apostolescu (1961, p. 794, pl. I, Figs. 15—17; pl. 15, figs. 297, 298). Careful examination of the large collection available indicates that the differences attributed generic significance by Apostolescu on differentiating his new taxonomic category from *Habrocythere* Triebel are hardly of species-level validity.

Habrocythere teiskotensis displays a fairly wide range of variation, particularly with respect to the degree of pointedness attained by the posterior. Apostolescu (1961, p. 794) observed the species to be provided with pits over the lateral surface of the shells; however, completely smooth specimens also occur and it seems that the species shows discrete ornamental variation of the kind recorded by Reyment (1963) and analyzed by Reyment & Van Valen (1969). An example of the smooth variant is given in Plate 1, Figs. 13—14 and one of a pitted individual in Plate 2, Fig. 1.

Males are very rare; they have a lower height/length ratio than females.

Occurrence. Kalambaina quarry, levels KA2, KA4, KA6 and from loose material (KA7). Paleocene.

Ovocytheridea? sp. indet.

Plate 1, Fig. 15

A poorly preserved left valve is referred here.

Occurrence. Kalambaina quarry, level KA2. Paleocene.

Iorubaella ologuni Reyment

Plate 3, Figs. 2—7

One of the interesting results obtained by the

present study is that *Iorubaella ologuni* occurs in abundance in the Kalambaina Formation. It was originally described from western Nigeria (Reyment, 1963) and it is known to occur in eastern Nigeria, Cameroun and the Bénin Republic.

The Saharan material displays a fully normal morphological development in relation to coastal individuals and the sexual dimorphism is identically expressed, with the males having a lower height/length ratio. Males are also very much less common than females.

Quantitative palaeobiogeography. A sample of females of the Saharan material was compared biometrically by the method of robust canonical variate analysis (Reyment, 1980a), using the dimensions of length and height of carapace, with samples of females from levels 710, 711 and 721 metres in the borehole Gbekebo I, western Nigeria (Reyment, 1963). The results are expressed graphically in Fig. 5.

The first canonical variate does not differentiate between the Gbekebo samples, but it sharply separates the individuals from Kalambaina. The second canonical variate does separate the coastal samples (which it does by contrasting variation in length with variation in height). The Gbekebo individuals lived in a lime-poor environment, whereas the Kalambaina environment was characterized by the precipitation of lime-sludge. These two markedly different environments lie at the root of the morphometrical differences unveiled by the present analysis.

Occurrence. Kalambaina quarry, levels KA2, KA4, and loose (KA7). Paleocene.

Nucleolina tatteulensis Apostolescu

Plate 3, Figs. 8—12

Apostolescu (1961, p. 814, pp. 175—179) only erected *Nucleolina* as an afterthought and in the section on "remarks". The species was described under the provisional generic assignation of *Ambocythere?* The present collection contains abundant material from Malbaza, Kalambaina and surface outcrops. There are two main variants to be seen, analogous to the variation described by Reyment (1963) and Reyment & Van Valen (1969). The first of these is characterized by concentrically pitted ornament (Plate 3, Fig. 12) and a rather sharply pointed posterior. The second ornamental variant (Plate 3, Fig. 11) has long riblets which curve slightly to follow the allure of the dorsal, respectively, ventral margin. These variants have a broad, smooth posterior zone, broader than in the case of the first variant, and a more bluntly rounded posterior.

There is pronounced sexual dimorphism in the carapaces.

Deroo (1966, figs. 32—33 and 377—379) accepted *Nucleolina* as a valid genus and assigned a species to it from the Maastrichtian of the Low Countries.

Occurrence. Kalambaina quarry, level KA4 and loose (sample KA7), the Malabaza quarry, the type locality of the Dange Formation. Paleocene.

Uroleberis? sp.

Plate 3, Fig. 13

Occurrence. Kalambaina quarry, loose block (KA7). Paleocene.

Uroleberis sp.

Plate 3, Figs. 14, 15

Occurrence. Kalambaina quarry, level KA5. Paleocene.

Uroleberis aff. *glabella* Apostolescu

Plate 3, Fig. 16

The form referred here differs somewhat from *A. glabella* Apostolescu in outline. It is rather close to *Uroleberis? chamberlaini* Sohn (1970, pl. 3, fig. 5) from the Palaeogene of western Pakistan. There is an even closer relationship with *Uro-*

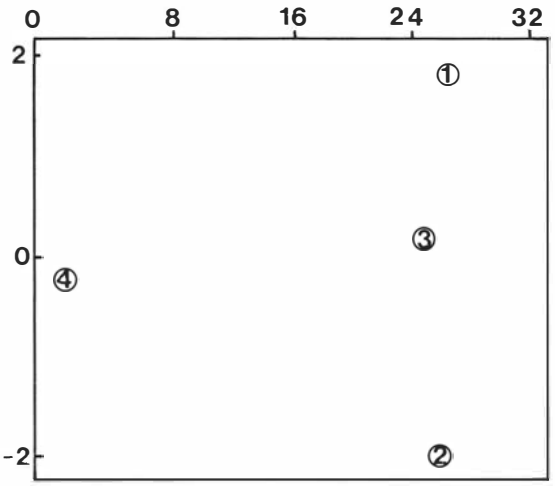

Fig. 5. Canonical variate analysis of data for three samples of *Iorubaella ologuni* in the borehole at Gbekebo, western Nigeria (1—3) and one sample from the Kalambaina quarry (4). Horizontal axis = first canonical variate axis; vertical axis = second canonical variate axis.

leberis stagnosa Al-Furaih from the Lower Paleocene of Saudi Arabia (Al-Furaih, 1980, pl. 64).

Occurrence. Kalambaina quarry, level KA2. Paleocene.

Brachycythere ogboni Reyment

Plate 3, Figs. 17, 18

This species was originally described from western Nigeria (Reyment, 1963). It is of rare occurrence in northwestern Nigeria. The specimens recorded here are mostly close to the type as far as can be ascertained on surface characters and the fact that the shell substance is not preserved.

I have taken this opportunity of figuring several internal details of the Late Maastrichtian to Early Paleocene species *Brachycythere armata* Reyment. Hitherto unfigured material from Ghana and Wasimi, western Nigeria has been used. A left valve is shown in lateral view in Plate 8, Fig. 9. A stereographic pair of a specimen from Wasimi, western Nigeria is given in Plate 6, Fig. 4.

Occurrence. Kalambaina quarry, loose block (KA7). Paleocene.

Alocopocythere ? teiskotensis (Apostolescu)

Plate 4, Fig. 1

1961 *Leguminocythereis ? teiskotensis*, Apostolescu, p. 824, pl. 10, figs. 206—208.

The specimen recorded here is close to the material figured by Apostolescu (1961). It does not seem permissible to retain it in *Leguminocythereis*, *Alocopocythere* Siddiqui being a more likely assignation for the species. Apostolescu (1961) only doubtfully referred his species to *Leguminocythereis*. The type is a male. The present specimen seems to be a female. Dingle (1976) referred the species in question to *Alocopocythere*, a genus erected for a group of west Pakistani species.

Occurrence. Malbaza quarry. Paleocene.

Alocopocythere ? aff. *teiskotensis* (Apostolescu)

Plate 4, Fig. 3

The specimen referred here is seemingly close to *teiskotensis* but differs in the mesh of the reticulations and somewhat in outline.

Occurrence. Kalambaina quarry, level KA3. Paleocene.

Leguminocythereis ? apostolescui sp. nov.

Plate 4, Fig. 2; Plate 9, Fig. 2

Holotype. The carapace figured in Plate 4, Fig. 2, No. PMAf949.

Description. A species probably referable to the genus *Leguminocythereis* with the following characteristics: Oval outline with a broadly rounded anterior margin and a bluntly pointed posterior. The dorsal and ventral margins are almost roughly equally convex. There is a concavity anterior of the faint eye spot, at the anterodorsal angle. The lateral ornament consists of an outer border of concentrically arranged riblets, united by reticulations and a main central field of longitudinal riblets superimposed on reticulations.

Remarks. This species is from the Early Paleocene or latest Maastrichtian section of the Wasimi borehole (Reyment, 1966). It is included in the present connexion for reasons of completeness in illustrating the Cretaceous-Tertiary faunas of West Africa. It is unlike any *Leguminocythereis* of comparable age.

Occurrence. Wasimi borehole, western Nigeria. Latest Maastrichtian or Early Paleocene.

Exophthalmocythere ? usmandanfodioi sp. nov.

Plate 4, Figs. 4—6; Plate 10, Fig. 4

1963 *Idiocythere ?* sp. Reyment, p. 179, pl. 5, figs. 1, a—b.

Holotype. The carapace figured on Plate 4, Fig. 6, No. PMAf954.

Description. A species possibly belonging to *Exophthalmocythere* with the following characteristics. Trianguloid outline, with very prominent anterior and posterior spines. A ventral spine-like projection. The dorsal margin is slightly sinuous, the ventral margin is faintly convex. The eye tubercles are prominent, particularly on late moults (Plate 10, Fig. 4).

Remarks. The type comes from the Nauli Limestone, Ghana, presumably of Maastrichtian age (borehole Epunsa 1, 323 metres). What seems to be the same species occurs sporadically in western Nigeria (Reyment, 1963, p. 179) and a few juveniles from Kalambaina have also been referred here.

Occurrence. Epunsa, western Ghana, boreholes at Araromi and Gbekebo, western Nigeria, Kalambaina quarry, level KA3. Maastrichtian to Paleocene.

Limburgina praecrassa (Apostolescu)

Plate 4, Figs. 7—10

1961 *Bradleya praecrassa*, Apostolescu, p. 818, pl. 9, figs. 227—229.

The present material agrees reasonably well with

the species described as *Bradleya praecrassa* by Apostolescu (1961) in borehole collections from the "Sudan", although most of the specimens are more strongly ornamented. Apostolescu (1961) referred several of his species to the genus *Bradleya*, none of which would qualify for admission by the criteria set up by Benson (1972). These species are in a very confused state and there is need for a very thorough revision of the taxonomy of the material with due regard paid to palaeobiogeographical considerations. The status of the present species is somewhat uncertain, not the least because of the confused differential diagnosis accompanying its description (Apostolescu, 1961, p. 818).

Occurrence. Malbaza quarry, Kalambaina quarry at sampling levels KA2 and KA6 and loose (KA7).

Limburgina sehouensis (Apostolescu)

Plate 2, Fig. 2L, 2R; Plate 4, Fig. 11

1961 *Bradleya sehouensis*, p. 818, pl. 12, figs. 233—234.
1961 *Bradleya tessalitensis*, Apostolescu, p. 819, pl. 12, figs. 250—252.

This is one of the species referred by Apostolescu (1961) to *Bradleya*, but which is more closely related to the *Limburgina*-group as conceived by Deroo (1966). The species described as "*Bradleya tessalitensis*" is very close indeed to *L. sehouensis* and it seems almost certain that it comprises males of this species. The individual shown stereographically (Plate 2, Fig. 2) lacks the dorsal protruberances of the figured type of Apostolescu. *Phalcocythere hebes* Al-Furaih is similar in general lateral ornament (Al-Furaih, 1980, pl. 48).

Occurrence. Type section of the Dange Formation, Kalambaina quarry, level KA2 and in loose block (KA7), Paleocene.

Quadracythere (*Hornibrookella*) *lagaghiroboensis* (Apostolescu)

Plate 4, Fig. 12

1961 *Bradleya lagaghiroboensis*, Apostolescu, p. 817, pl. 11, figs. 224—226.
1963 *Quadracythere lagaghiroboensis* (Apostolescu), Reyment, p. 152, pl. 3, figs. 2, a—c, 3; pl. 14, figs. 1, 2.

Benson (1972, p. 28) has expressed the opinion that *Hornibrookella* and *Hermanites* could be synonymous. The material recorded here seems to fit in with the concept of *Hornibrookella*, as a subgenus of *Quadracythere*, as presented by Moos (1966). The species is common in the Paleocene of coastal Nigeria and it is also found in the Paleocene of the Sirte Basin, Libya.

Occurrence. The Malbaza quarry; the Kalambaina quarry, loose block (KA7). Paleocene.

Aurila sp. indet.

Plate 4, Figs. 13, a—b

This rather remarkable ostracod occurs very sporadically in the present material. It has a subquadrate form with a strongly underslung anteroventral zone. It is ventrally inflated and the surface ornamented with coarse reticulations. It resembles some species of living *Mutilus* in general shape although there is no real caudal process.

Occurrence. Malbaza quarry. Paleocene.

Quadracythere ? cf. *subquadrata* Siddiqui

Plate 4, Fig. 14

A few individuals from the Malbaza quarry are tentatively referred to his species from West Pakistan. In particular, Siddiqui's (1971) plate 34, fig. 7 is close to the Saharan forms.

Phalcocythere vesiculosa (Apostolescu)

Plate 5, Figs. 2, 3, 5, 6; Plate 10, Fig. 5

1961 *Bradleya vesiculosa*, Apostolescu, p. 820, pl. 12, figs. 246—249.

This is the most common trachyleberidid species in the whole material. It is common throughout the entire sequence at Kalambaina and also occurs at Malbaza. The degree of spinosity of the lateral ornament tends to vary considerably but most typically, the basic pattern of reticulations is covered by a profusion of stout, stubby tubercles. Sexual dimorphism is very strongly developed with males having a low height/length ratio and attaining a significantly greater size than females.

There are strongly developed eye tubercles and a strong spine at the posterodorsal angle.

The hinge (Plate 10, Fig. 5) consists, in the right valve, of an anterior, pointed tooth, a postjacent socket, a bar and a low, elongated posterior tooth.

Siddiqui's (1971) genus *Phalcocythere*, erected for a group of species from the Palaeogene of West Pakistan, seems to be the correct location for this material. The Saharan species is particularly close to *P. sentosa* Siddiqui in ornament and habitus.

Occurrence. Malbaza quarry; Kalambaina quarry, levels KA2, KA5, KA6 and loose (KA7).

Phalcocythere tubra sp. nov.

Plate 5, Figs. 1, 4

Holotype. The carapace figured in Plate 5, Fig. 1, No. PMAf963.

Description. A species of *Phalcocythere* with the following characteristics: Anterior margin well rounded, posterior truncated and projected posteroventrally. A well developed hinge-ear is present. The dorsal and ventral margins converge posteriorly. The ventral ridge typical of the genus is prominent and strongly ornamented. The lateral ornament consists of coarse reticulations on which stubby, prominent tubercles are randomly distributed. The dorsal surface bears three to four prominent tubercles.

Remarks. P. tubra sp. nov. differs from the most closely related species *P. vesiculosa* (Apostolescu) in having a sparser though coarser lateral tuberculation, a prominent hinge-ear, and a more strongly denticulated and posteroventrally produced posterior.

Material. Fifteen specimens.

Occurrence. Kalambaina quarry, loose block (KA7). Paleocene.

Phalcocythere cultrata (Apostolescu)

Plate 5, Figs. 7—9; Plate 6, Figs. 1L, 1R

1961 *Bradleya cultrata*, Apostolescu, p. 816, pl. 12, figs. 238—240.
1970 *Quadracythere? reticulospinosa*, Sohn, p. 64, pl. 2, figs. 29—33.

This species is rather common in the Saharan Paleocene. It has a straight dorsal margin, with two prominent tubercle-like swellings in the posterior half of the dorsal surface. The posterior is sharply rounded with its centre above the midpoint of the carapace and with a broadly rounded ventral half of the posterior margin. One specimen referred here, figured in Plate 5, Fig. 8, has a remarkably pointed posterior but this could be the result of imperfect preservation, or it could be the outcome of salinity effects (cf. Reyment, 1966, p. 143).

The Saharan material does not differ significantly in size of carapace from the type and there are no noticeable differences in the nature of the lateral ornament. Sohn (1970) recorded a species from the Palaeogene of West Pakistan as *Quadracythere? reticulospinosa.* As far as can be ascertained from his poor figures, it is identical with *P. cultrata.*

Occurrence. Malbaza quarry; Kalambaina quarry, levels KA2, KA4, KA5 and from the loose sample (KA7). Paleocene.

Phalcocythere aff. *dissenta* Siddiqui

Plate 5, Fig. 10; Plate 10, Fig. 3

The specimen referred here seems to be related to *Phalcocythere dissenta* Siddiqui but differs in the rounding of the anterior margin and in the exceptionally strongly developed eye tubercle with its prominent eye-tube (Plate 10, Fig. 3). It differs from *P. cultrata* in having a proportionally short dorsal margin in relation to the height of the carapace and in having almost parallel dorsal and ventral margins.

Occurrence. Kalambaina quarry, level KA2. Paleocene.

Trachyleberis teiskotensis (Apostolescu)

Plate 7, Figs. 10—14

1961 *Actinocythereis modesta*, Apostolescu, p. 813, pl. 13, figs. 259—263.
1961 *Actinocythereis teiskotensis*, Apostolescu, p. 814, pl. 13, figs. 253—258.
1963 *Trachyleberis teiskotensis* (Apostolescu), Reyment, p. 165, pl. 4, figs. 3, a—b, 4, a—c; pl. 14, figs. 7—11, pl. 15, figs. 3, a—b.

This species, which is extremely abundant in the Paleocene of western Nigeria, is far less common in the Saharan sequences. It will be noted that the name *Actinocythereis modesta* has page-priority over *A. teiskotensis.* However, by the principle of first revision I decided (Reyment, 1963) to select *teiskotensis* as the reference as it is better described and represents the normal state of the species (the forms referred to *modesta* are advanced larval stages).

Sexual dimorphism is strong. There is some variation in the development of the posterior of the carapaces which I believe could be the outcome of salinity variations.

Occurrence. Malbaza quarry; Kalambaina quarry, sampling level KA2; type locality of the Dange Formation. Paleocene.

Buntonia aff. *sehouensis* Apostolescu

Plate 5, Fig. 11

The material referred here possesses the general shape of *B. sehouensis,* but lacks the anterior rim shown in Apostolescu's (1961, pl. 4, figs. 84—87) illustrations and the postjacent furrow to the rim.

Occurrence. Kalambaina quarry in loose block (KA7). Paleocene.

Buntonia apatayeriyerii Reyment

Plate 5, Figs. 12—14

1963 *Buntonia apatayeriyerii*, Reyment, p. 239, pl. 7, figs. 5, a—b.

This species occurs abundantly in coastal Nigeria. It is the most abundant *Buntonia* in the present collection. The individuals recorded here agree in all respects with the types, although the ornamental details have been slightly "simplified" by the mode of preservation of the material. Sexual dimorphism is very strong.

Occurrence. Kalambaina quarry, level KA5 and loose (KA7).

Buntonia pulvinata Apostolescu

Plate 7, Figs. 1—3

1961 *Buntonia pulvinata*, Apostolescu, p. 803, pl. 5, figs. 113—115.

This is a widely distributed species of *Buntonia.* It is common in the Paleocene of the Gulf of Guinea and it is among the more common species in the Saharan sequences. Some of the individuals in the present collection tend to have a more arched dorsal margin than Apostolescu's (1961, pl. 7, figs. 113, 115) specimens. In this respect they are closer to the development shown by the species in southwestern Nigeria (cf. Reyment, 1963, pl. 5, fig. 5).

Occurrence. Kalambaina quarry, level KA6 and loose (KA7).

Buntonia tenuipunctata Apostolescu

Plate 7, Figs. 4—9; plate 10, Fig. 2

1961 *Buntonia tenuipunctata*, Apostolescu, p. 804, pl. 5, figs. 94—96.
1961 *Buntonia tichittensis*, Apostolescu, p. 805, pl. 5, figs. 91—93.

The material recorded here is close to the figures given by Apostolescu (1961), although the ornamental details are more clearly developed for the Nigerian material. Moreover, the concentric pattern is here more clearly expressed. *Buntonia tenuipunctata* and *B. tichittensis* are synonyms, the former having page-priority. Apostolescu (1961) noted their close similarity but referred to differences in shape and punctation which cannot be of greater than normal variational significance. The descriptions given by Apostolescu are confusing as the differential diagnoses are repetitions in detail of each other.

The hinge of a left valve of *Buntonia tenuipunctata* is figured in Plate 10, Fig. 3, and in lesser magnification in Plate 7, Fig. 8. The anterior socket is rather shallow, the postjacent tooth is strong and bilobate. The hinge-bar is not visibly notched (but this could be due to the mode of preservation); it terminates at a minute tooth. The posterior socket is large and shallow.

Occurrence. Kalambaina quarry, level KA4 and in the sample of loose material (KA7).

Antibythocypris wasimiensis sp. nov.

Plate 8, Figs. 1—5; Plate 9, Figs. 1L, 1R

Holotype. The specimen figured in Plate 1, Fig. 1, No. PMAf992.

Description. A species of *Antibythocypris* of roughly trianguloid shape and with the highest point of the carapace at the anterodorsal angle. The anterior margin is more sharply rounded in its ventral half than in the dorsal half. The posterior margin is bluntly pointed and with an angular shape, the midpoint of which lies at about the lower fifth of the carapace-height. The surface is ornamented with coarse, irregularly dispersed pits of varying size. The anterodorsal area of the shell has the finest pits. There are three anterior riblets which continue around to mid-point of the ventral margin. The anterior margin bears fine serrations. The hinge is shown in Plate 8, Fig. 4 and Plate 9, Fig. 1 (stereomicrophotograph).

Remarks. The properties of *Antibythocypris* have been clarified by Brouwers & Hazel (1978). The species recorded here is most like *Antibythocypris multilira* (Schmidt) from the Severn Formation, Maryland, USA. There are undoubted similarities with *Cytheridea*; however, the inner lamella and line of concrescence coincide in the case of the present species.

Occurrence. The borehole at Wasimi, Latest Maastrichtian or very early Paleocene (Danian).

"*Camplocythere*" sp.

Plate 6, Figs. 3L, 3R

A single specimen of an almost smooth species of ostracods is very tentatively referred here. Details of the hinge are illustrated in a stereophotomicrograph in Plate 6, Figs. 3L, 3R. The central muscle field consists of four rather elongated oval scars, two mandibular scars in contact and there is a frontal scar (or fused pair of scars).

Occurrence. Wasimi borehole. Latest Maastrichtian or early Paleocene.

Cytheretta ? sp.

Plate 9, Fig. 3

A single specimen is tentatively referred to the genus *Cytheretta.* The centrolateral area of the shell is devoid of ornament. Riblets follow the anterior and ventral margins and there are riblets on the posterior fourth of the shell. The habitus is like that of *Cytheretta* but the internal characteristics are unknown.

Occurrence. Epunsa 1 borehole, western Ghana. Maastrichtian.

Paracosta ? antedahomeyensis sp. nov.

Plate 6, Figs. 2L, 2R; Plate 8, Fig. 15; Plate 9, Fig. 4; Plate 10, Figs. 1L, 1R

Holotype. The specimen figured in Plate 8, Fig. 15, No. PMAf999.

Description. A species probably belonging to *Paracosta* with the following characteristics. Shape reminiscent of *Costa dahomeyi* (Apostolescu) but with coarser reticulations and a very clearly developed post-ear nick and a strong "hinge-ear". The anterior margin is broadly rounded and between two thin marginal riblets there is a row of fine pits. The posterior margin is sharply and somewhat irregularly rounded. There are four lateral ribs, one running along the laterodorsal edge, two, anteriorly convergent ribs and a fourth indistinctly developed along the lateroventral edge.

The left hinge consists of an anterior socket, a postjacent tooth which veers down in the direction of the interior of the valve, a median list and an elongated posterior socket (Plate 6, Fig. 2). The median hinge element is notched (Plate 10, Fig. 1).

Remarks. The taxonomic situation of the "costine" ostracods is still unclear despite the work of Bassiouni (1969), van den Bold (1970), the elaborate study of Benson (1977) and Siddiqui's monograph (1971). Some of the forms placed by me in *Veenia* (Reyment 1960, 1963) are probably more likely to be better located with some early "costine" group. The species here described has been tentatively referred to *Paracosta* Siddiqui, although the taxonomic status of that genus is far from clear.

Material 15 specimens.

Occurrence. Borehole at Wasimi. Latest Maastrichtian or early Paleocene.

Paracosta ? warriensis (Reyment)

Plate 8, Fig. 14; Plate 9, Figs. 5L, 5R

1960 *Veenia warriensis*, Reyment, p. 180, pl. 12, figs. 2, a—c, 3; pl. 18, figs. 1, a—b.
1963 *Veenia* (*Veenia*) *warriensis* Reyment, p. 186, pl. 5, figs. 3, a—c.

Some specimens of the species considered here show more or less clear longitudinal rib patterns, there being a dorsal rib, two lateral ribs (which, however, may be absorbed into the reticular ornament) and a weakly developed dorsal riblet. In the light of recent work on Late Cretaceous ostracods it is hardly likely that *warriensis* can be a genuine *Veenia*; Siddiqui's (1971) *Paracosta* seems to be the most readily available genus, although it may eventually prove necessary to separate the Nigerian coarsely reticulated, indistinctly costate species into a separate group.

A left hinge of *Paracosta ? warriensis* (Reyment) is shown in a stereomicrophotograph in Plate 9, Fig. 5. Noticeable features are the very elongated anterior tooth, the breached anterior socket, the posterior widening of the hinge bar and the breached posterior socket.

Occurrence. Wasimi borehole, western Nigeria. Latest Maastrichtian or early Paleocene.

Mosaeleberis ornatoreticulata (Reyment)

Plate 8, Fig. 12; Plate 9, Fig. 8

1963 *Veenia* (*Veenia*) *ornatoreticulata*, Reyment, p. 188, pl. 2, fig. 6; pl. 6, figs. 1, a—c; pl. 16, fig. 7.
1974 *Reticulocosta ornatoreticulata* (Reyment), Gründel, p. 81, fig. 5.

Gründel (1974) made this species the type of a new genus *Reticulocosta* which, however, does not differ in any manner. I can make out from *Mosaeleberis* Deroo. *M. ornatoreticulata* shows considerable variation in the lateral ornament and it is hardly possible to use subordinate characteristics of the ornamental pattern as a major taxonomic property. *Mosaeleberis interrupta* (Bosquet) is not unlike the present species.

Occurrence. Ghana, the Epunsa 1 borehole. Maastrichtian.

Veenia reticulocostata Reyment

Plate 8, Fig. 10

Occurrence. Wasimi borehole, western Nigeria, Latest Maastrichtian or early Paleocene.

Loxoconcha samueljohnsoni sp. nov.
Plate 8, Fig. 8

Holotype. The specimen illustrated in Plate 8, Fig. 8, No. PMAf893.

Description. A species of *Loxoconcha* with the following characteristics. Dorsal margin straight, ventral margin slightly convex and sweeping evenly into the posterior margin, the midpoint of which is obtusely pointed. The posterodorsal section of the posterior margin is very slightly convex. The anterior margin is broadly rounded. The surface of the shell is ornamented with a network of reticulations upon which an irregular pattern of riblets is superimposed. The anterior margin bears a thin anterior riblet.

Material. 5 specimens.

Occurrence. The Epunsa 1 borehole, Ghana. Maastrichtian.

Pellucistoma? sp.
Plate 8, Fig. 6

A single specimen is referred doubtfully to *Pellucistoma.*

Occurrence. Wasimi borehole, western Nigeria. Latest Maastrichtian or early Paleocene.

Paijenborchellina sp. A
Plate 8, Fig. 11

A single specimen of a species with the characteristics of *Paijenborchellina* is referred here, although the diagnostic details of the posterior pore canals could not be determined.

Occurrence. Wasimi borehole, western Nigeria, Latest Maastrichtian or early Paleocene.

Paijenborchellina sp. B
Plate 8, Fig. 13

A single specimen with some of the ornamental properties of *Paijenborchellina ijuensis* from the Eocene of southwestern Nigeria is referred here. *Occurrence.* Wasimi borehole, western Nigeria. Latest Maastrichtian or early Paleocene.

Cytheropteron sp.
Plate 8, Fig. 7

This individual seems to belong to a new species of *Cytheropteron*, marked by a pattern of lateral ornament consisting of scooped reticulations.

Occurrence. Wasimi borehole, western Nigeria. Latest Maastrichtian or early Paleocene.

REFERENCES

Al-Furaih, A. A. F., 1980: *Upper Cretaceous and Lower Tertiary Ostracoda (Superfamily Cytheracea) from Saudi Arabia.* University Libraries, University of Riyadh, Saudi Arabia, 211 pp.

Apostolescu, V., 1961: Contribution à l'étude paléontologique (Ostracodes) et stratigraphique des bassins crétacés et tertiaires de l'Afrique Occidentale. *Inst. fr. Pét., Rev. 16* (7—8), 779—867.

Barsotti, G., 1963: Paleocenic ostracods of Libya (Sirte Basin) and their wide African distribution. *Inst. fr. Pét., Rev. 18*, 1520—1528.

Bassiouni, M. A. A., 1961: Einige *Costa-* und *Carinocythereis* (*Reticulina*)-Arten aus dem Paleozän und Eozän von Jordanien (Ostracoda). *Neues Jahrb. Geol. Paläontol. Abh. 134*, 1—16.

Benson, R. H., 1972: The *Bradleya* problem, with descriptions of two new psychrospheric ostracode genera, *Agrenocythere* and *Poseidonomicus* (Ostracoda: Crustacea). *Smithsonian Contrib. Paleobiol. 12*, 138 pp.

Benson, R. H., 1977: Evolution of *Oblitacythereis* from *Paleocosta* (Ostracoda: Trachyleberididae) during the Cenozoic in the Mediterranean and Atlantic. *Smithsonian Contr. Paleobiology* 33, iii+47.

Bold, W. A. van den, 1970: The genus *Costa* (Ostracoda) in the Upper Cenozoic of the Caribbean region. *Micropaleontol. 16*, 61—75.

Brouwers, E. M. & Hazel, J. E., 1978: Ostracoda and correlation of the Severn Formation (Navarroan; Maestrichtian) of Maryland. *SEPM Paleontological Monographs 1*, 52 pp.

Deroo, G., 1966: Cytheracea (Ostracodes) du Maastrichtien de Maastricht (Pays-Bas) et des régions voisines: résultats stratigraphiques et paléontologiques de leur étude. *Meded. Geol. Sticht. Ser. C, 2*, 197 pp.

Dingle, R. V., 1976: Palaeogene ostracods from the continental shelf off Natal, South Africa. *Trans. r. Soc. S. Africa 42*, 35—79.

Gründel, J., 1974: Zur Taxonomie und Phylogenie der Cytherettidae Triebel 1952 (Ostracoda, Crustacea). *Freiberger Forschungshefte C298*, 81—99.

Moos, B., 1965: Die Ostracoden-Fauna des Unteroligozäns von Bünde (Bl. Herford-West, 3817) und einige verwandte jüngere Arten (Ostr. Crust.) I. *Quadracythere* (*Hornibrookella*) n. subg., *Pokornyella, Hemicythere, Hermanites. Geol. Jahrb. 82*, 593—630.

Reyment, R. A., 1960: Studies on Nigerian Upper Cretaceous and Lower Tertiary Ostracoda. Part I: Senonian and Maestrichtian ostracods. *Stockh. Contrib. Geol. 7*, 1—238.

Reyment, R. A., 1963: Studies on Nigerian Upper Cretaceous and Lower Tertiary Ostracoda, Part 2: Danian, Paleocene and Eocene ostracods. *Stockh. Contrib. Geol. 10*, 1—286.

Reyment, R. A., 1966: Studies on Nigerian Upper Cretaceous and Lower Tertiary Ostracoda, Part 3: Stratigraphical, paleoecological and biometrical conclusions. *Stockh. Contrib. Geol. 14*, 1—151.

Reyment, R. A., 1971: *Introduction to Quantitative Paleoecology.* Elsevier, Amsterdam, xiii+226 pp.

Reyment, R. A., 1980: Biogeography of the Saharan Cretaceous and Paleocene epicontinental transgressions. *Cretaceous Research 1*, 299—327.

Reyment, R. A., 1980a: *Morphometric Methods in Biostratigraphy.* Academic Press, London, viii+175 pp.

Reyment, R. A. & Reyment, E. R., 1981: The Paleocene trans-Saharan transgression and its ostracod fauna.

Second Conference on the Geology of Libya (Tripoli 1978), *Proceedings*, Vol. 1, 245—254. Academic Press, London.

Reyment, R. A. & Van Valen, L., 1969: *Buntonia olokundudui* sp. nov. (Ostracoda, Crustacea). *Bull. Geol. Inst. Univ. Uppsala N.S. 1*, 83—94.

Siddiqui, Q. A., 1971: Early Tertiary Ostracoda of the family Trachyleberididae from West Pakistan. *Brit. Mus. nat. Hist., Bull. Suppl. 9,* 1—98.

Sissingh, W., 1972: Late Cenozoic Ostracoda of the south Aegean Island Arc. *Utrecht Micropaleontol. Bull. 6*, 187 pp.

Sohn, I. G., 1970: Early Tertiary ostracodes from West Pakistan. *Paleontologia Pakistanica 3*, 1—91.

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PLATES

PLATE 1

1. *Bythocypris* sp. A from level KA4. PMAf910. × 100. Paleocene.
2. *Bythocypris kalambainaensis* sp. nov. from sample KA7. Left valve PMAf 912. × 100. Paleocene.
3. Same species. Right side of carapace. Holotype. PMAf913. From sample KA7. × 100. Paleocene.
4. Same species, from sample KA7. Right side of carapace. PMAf914. × 100. Paleocene.
5. *Bythocypris* sp. B, from sample KA7. Right side of carapace. PMAf 911. × 100. Paleocene.
6. *Paracypris nigeriensis* Reyment. Borehole Epunsa 1, Ghana. Maastrichtian. PMAf 915 × 85.
7. *Paracypris sokotoensis* sp. nov. Right side of carapace. Holotype. PMAf916. × 55. Paleocene. Sample KA7.
8. Same species. Right side of carapace. Sample KA7. PMAf917. × 55. Paleocene.
9. Same species. Right side of carapace. Sample KA7. PMAf918. ×60. Paleocene.
10. Same species. Interior view of a left valve. Sample KA7n PMAf919. × 60. Paleocene.
11. *Dahomeya alata* Apostolescu. Right hand side of a carapace. Level KA4. PMAf922. × 100. Paleocene.
12. Same species. Left hand side of a carapace. Sample KA7. PMAf923. × 100. Paleocene.
13. *Habrocythere teiskotensis* (Apostolescu). Right side of carapace. Level KA4. PMAf926 × 100. Paleocene. Non-pitted variant.
14. Same species. Dorsal view. Level KA1. PMAf927. × 100. Paleocene.
15. *Ovocytheridea?* sp. Level KA2. PMAf928. Paleocene.
16. *Cytherella* sp. Specimen showing hole drilled by a muricid gastropod. Sample KA7. PMAf924. × 55. Paleocene.
17. *Cytherelloidea saharaensis* sp. nov. Angled ventral view of a carapace. Holotype. Sample KA7. PMAf921. × 55. Paleocene.
18. *Bairdia* cf. *ilaroensis* Reyment & Reyment. Specimen showing hole drilled by a muricid gastropod. Level KA2. PMAf925. × 55. Paleocene.

PLATE 1


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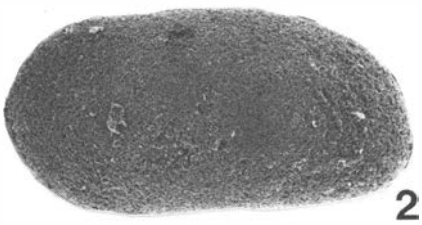
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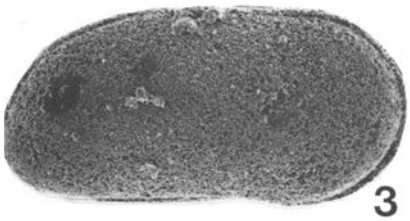
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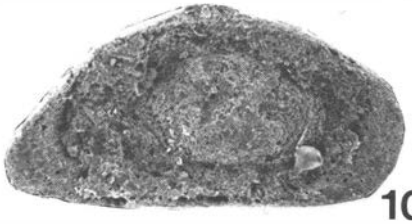
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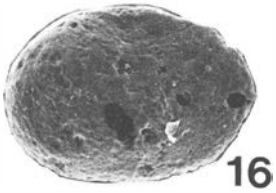
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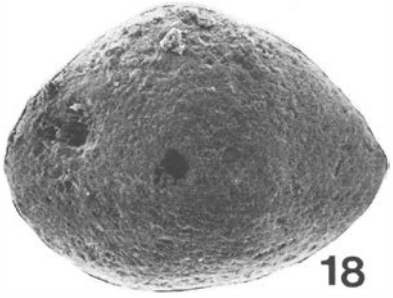
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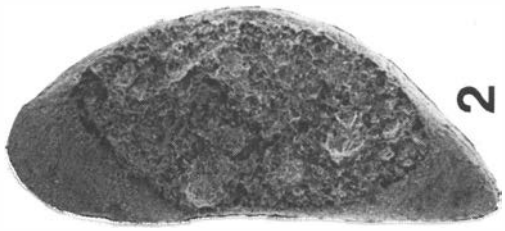
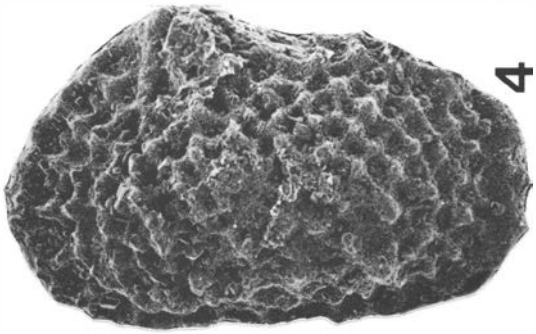
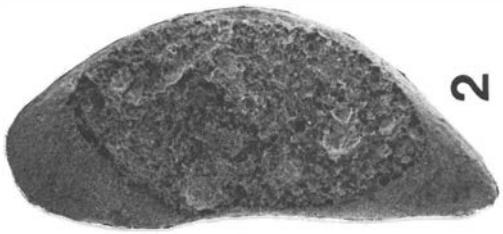
PLATE 2

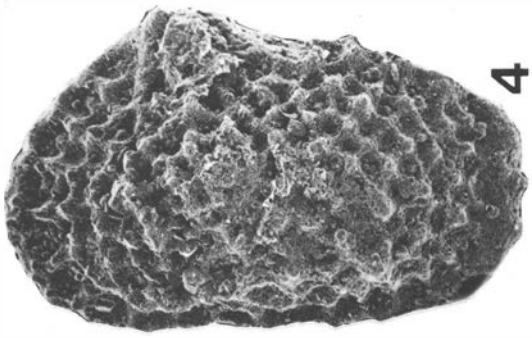
1. *Cytherelloidea saharaensis* sp. nov. Stereophotomicrograph of holotype. Sample KA7. PMAf921. × 60. Paleocene.
2. *Paracypris sokotoensis* sp. nov. Stereophotomicrograph. Sample KA7. PMAf920 × 60. Paleocene.
3. *Dahomeya alata* (Apostolescu). Stereophotomicrograph. Sample KA7. PMAf921. × 110. Paleocene.
4. *Limburgina sehouensis* (Apostolescu). Stereophotomicrophotograph. Sample KA7. PMAf830. × 100. Paleocene.

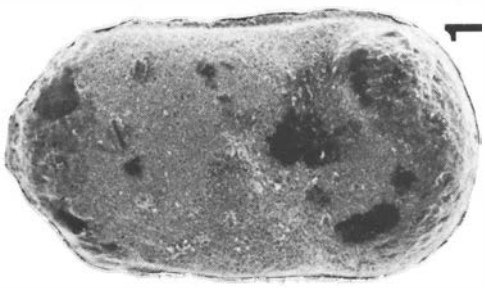
PLATE 2

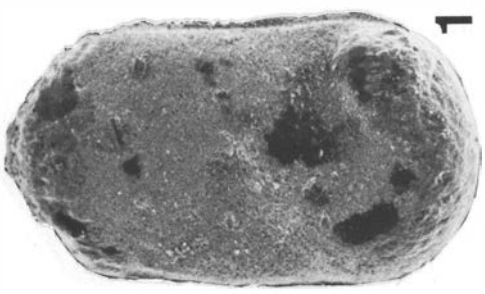












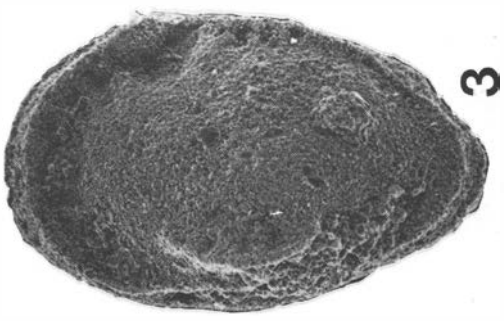


PLATE 3

1. *Habrocythere teiskotensis* (Apostolescu). Right side of carapace, pitted variant. Level KA6. PMAf929. × 100. Paleocene.
2. *Iorubaella ologuni* Reyment. Right side of caparace. Sample KA7. PMAf930. × 55. Paleocene.
3. Same species, a male; left side of carapace. Level KA2. PMAf931. × 55. Paleocene.
4. Same species. Angled ventral view to display ventral costation. Level KA2. PMAf932. × 55. Paleocene.
5. Same species. Right side of carapace. Sample KA7. PMAf933. × 55. Paleocene.
6. Same species. Right side of carapace. Sample KA7. PMAf934. × 55. Paleocene.
7. Same species. Right side of a male carapace. Level KA7. PMAf935. × 55. Paleocene.
8. *Nucleolina tatteulensis* Apostolescu. Right aspect of a carapace. Type locality of the Dange Formation. PMAf936. × 55. Paleocene.
9. Same species. Right side of carapace. Sample KA7. PMAf937. × 55. Paleocene. Ribbed variant.
10. Same species. Pitted variant. Sample KA7. PMAf938. × 55. Paleocene.
11. Same species, ribbed variant. Sample KA7. PMAf939. × 55. Paleocene.
12. Same species. Pitted variant. Sample KA7. PMAf940. × 55. Paleocene.
13. *Uroleberis?* sp. Level KA5. PMAf941. × 55. Paleocene.
14. *Uroleberis* sp. Level KA5. PMAf942. × 55. Paleocene.
15. Same species, illustrated in dorsal aspect. Level KA5. PMAf943 × 55. Paleocene.
16. *Uroleberis* aff. *glabella* Apostolescu. Angled view of right side of carapace. Level KA2. PMAf944. × 55. Paleocene.
17. *Brachycythere ogboni* Reyment. Left side of carapace. Sample KA7. PMAf945. × 100. Paleocene.
18. Same species. Left side of carapace. Sample KA7. PMAf946. × 100. Paleocene.

PLATE 3

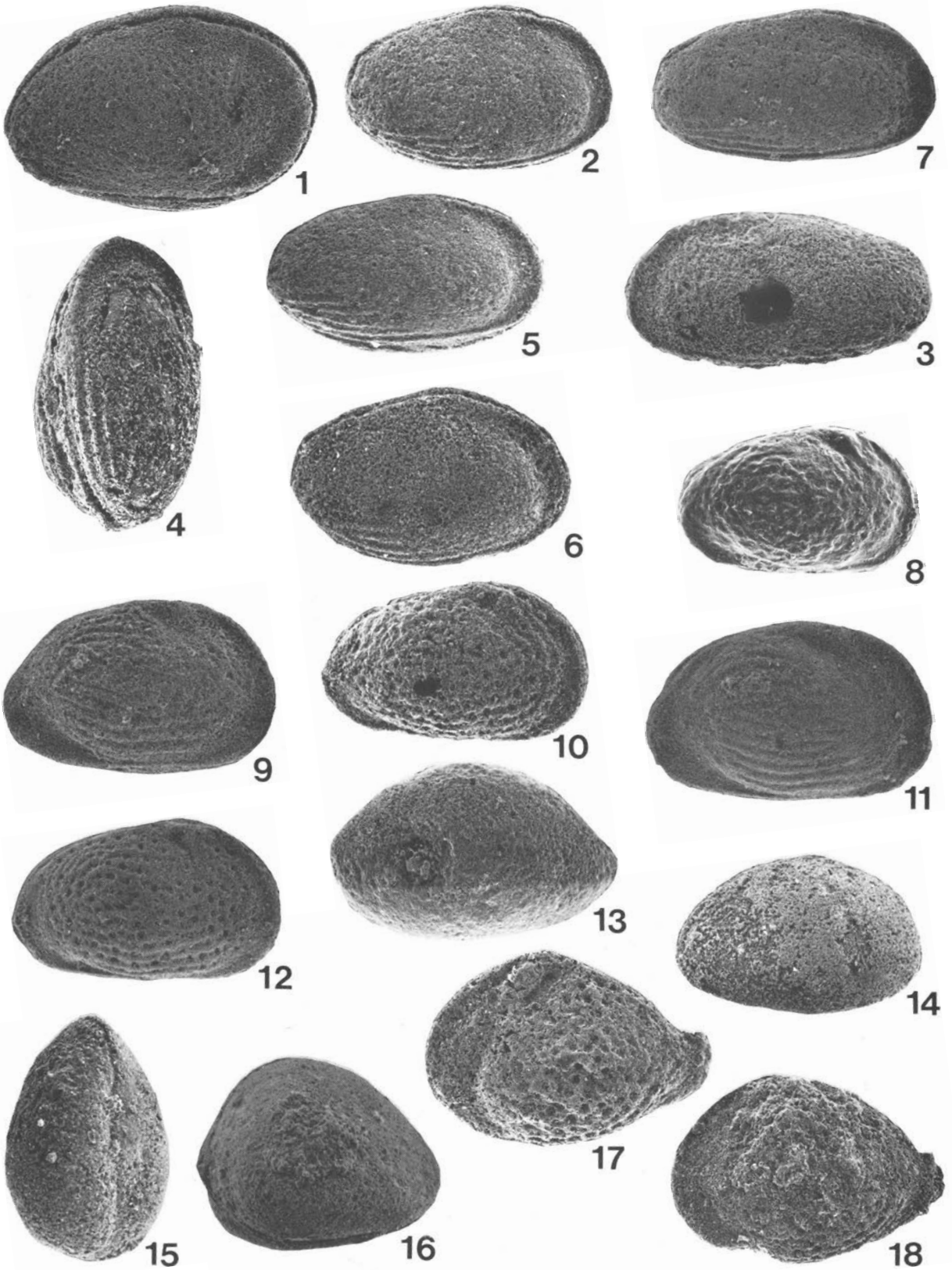


PLATE 4

1. *Alocopocythere? teiskotensis* (Apostolescu). Dorsal view. Malbaza quarry. PMAf948. × 55. Paleocene.
2. *Leguminocythereis? apostolescui* sp. nov. Holotype. Left side of a carapace. Wasimi borehole. PMAf950. × 100. Maastrichto-Paleocene.
3. *Alocopocythere?* aff. *teiskotensis* (Apostolescu). Right side of carapace. Level KA3. PMAf951. × 55. Paleocene.
4. *Exophthalmocythere ? usmandanfodioi* sp. nov. Right valve of a juvenile individual. Level KA3. PMAf952. × 80. Paleocene.
5. Same species. Juvenile individual. Sample KA7. PMAf953. × 80. Paleocene.
6. Same species. Left side of a carapace. Holotype. Epunsa 1 borehole, Ghana. PMAf954. × 55. Maastrichtian.
7. *Limburgina praecrassa* (Apostolescu). Right side of carapace. Sample KA7. PMAf955. × 55. Paleocene.
8. Same species, Right side of carapace. Level KA7. PMAf956 × 55. Paleocene.
9. Same species. Dorsal view of carapace to illustrate the eye tubercles. Malbaza quarry. PMAf957. × 55. Paleocene.
10. Same species. Ventral view of a carapace. Sample KA7. PMAf958. × 55. Paleocene.
11. *Limburgina sehouensis* (Apostolescu). Left side of carapace. PMAf959. × 95. Paleocene.
12. *Quadracythere lagaghiroboensis* (Apostolescu). Right side of carapace. Sample KA7. PMAf960. × 55. Paleocene.
13. *Aurila* sp. indet. a. Right side of carapace; b, angled ventral view of carapace. Malbaza quarry. PMAf961. × 55. Paleocene.
14. *Quadracythere* cf. *subquadrata* Siddiqui. Malbaza quarry. PMAf962. × 55. Paleocene.

PLATE 4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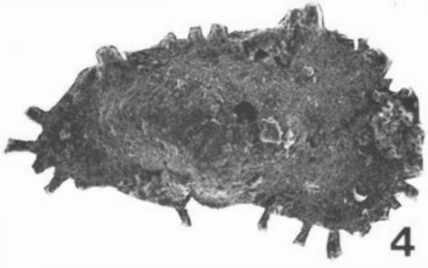
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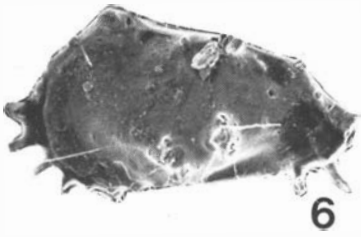
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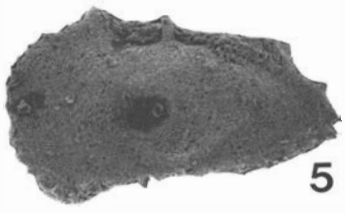
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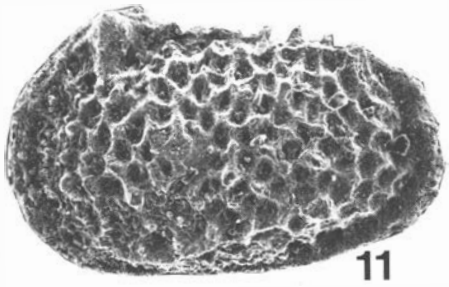
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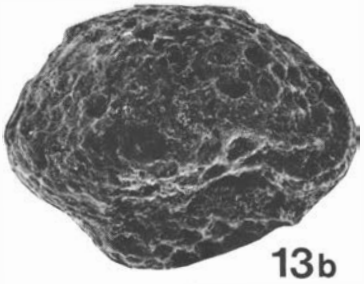
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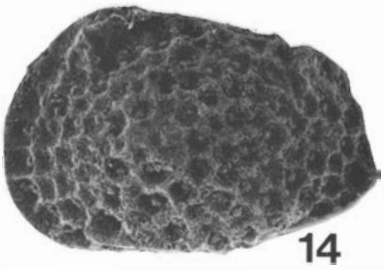
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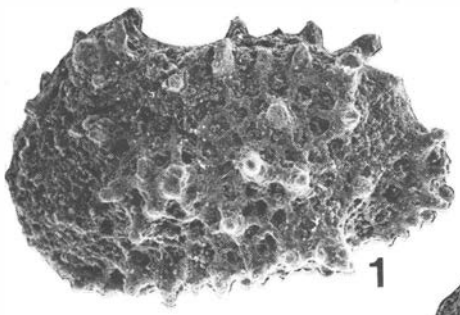
PLATE 5

1. *Phalcocythere tubra* sp. nov. Left side of a carapace, the holotype. Sample KA7. PMAf963. × 100. Paleocene.
2. *Phalcocythere vesiculosa* (Apostolescu). Left side of carapace. PMAf964. × 100. Level KA4. Paleocene.
3. Same species, a male specimen. Sample KA7. PMAf965. × 55. Paleocene.
4. *Phalcocythere tubra* sp. nov. Right side of carapace. Sample KA7. PMAf966. × 100. Paleocene.
5. *Phalcocythere vesiculosa* (Apostolescu). Left side of carapace. Level KA5. PMAf967. × 100. Paleocene.
6. Same species. Right side of carapace. Level KA6. PMAf968. × 100. Paleocene.
7. *Phalcocythere cultrata* (Apostolescu). Right side of carapace. Level KA3. PMAf969. × 55. Paleocene.
8. Same species; individual with a pronouncedly pointed posterior. Malbaza quarry. PMAf970. × 55. Paleocene.
9. Same species. Angled dorsal view of carapace. Malbaza quarry. PMAf971. × 55. Paleocene.
10. *Phalcocythere* aff. *dissenter*. Siddiqui. Left side of a carapace. Level KA2. PMAf972. × 55. Paleocene.
11. *Buntonia* aff. *sehouensis* Apostolescu. Right side of carapace. Sample KA7. PMAf973. × 100. Paleocene.
12. *Buntonia apatayeriyerii* Reyment. Right side of carapace. Male specimen. Level KA5. PMAf974. × 100. Paleocene.
13. Same species. Right side of carapace. Sample KA7. PMAf975. × 100. Paleocene.
14. Same species. Right side of carapace. Sample KA7. PMAf977. × 100. Paleocene.
15. Same species and provenance. PMAf976. × 100. Paleocene.

PLATE 5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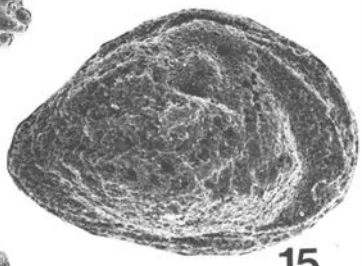
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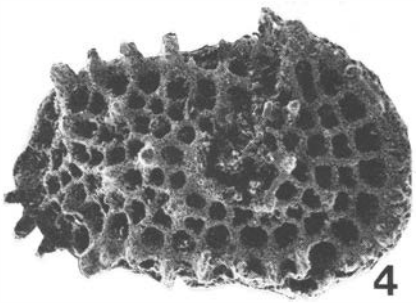
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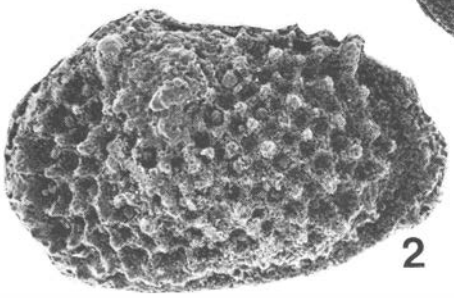
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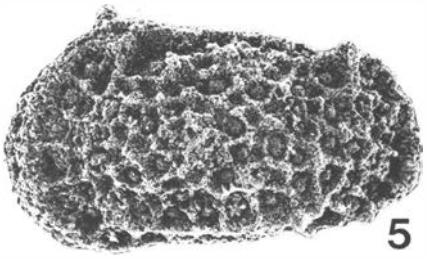
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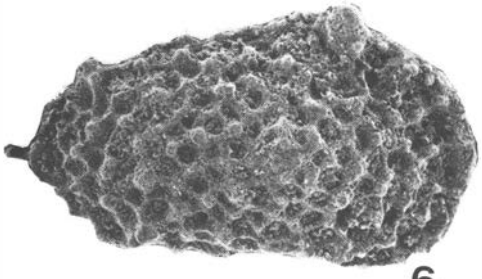
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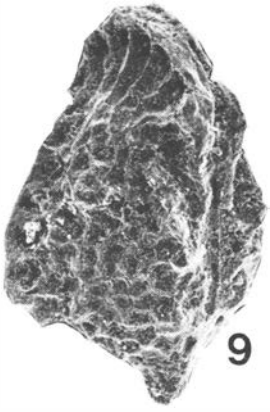
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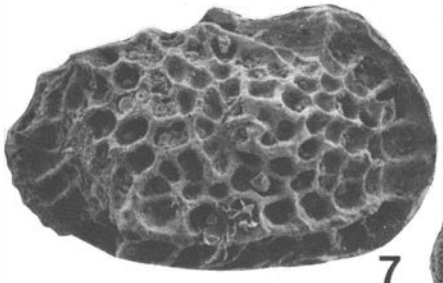
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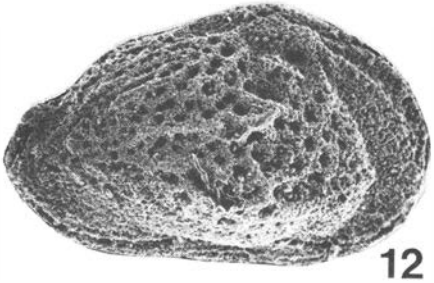
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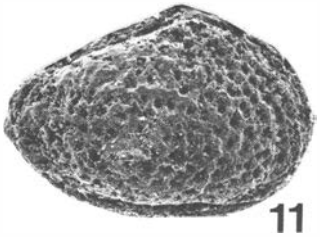
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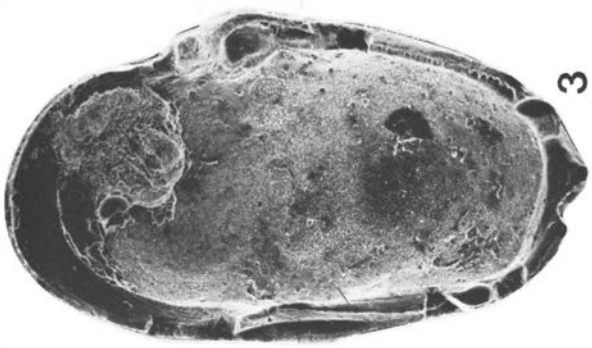
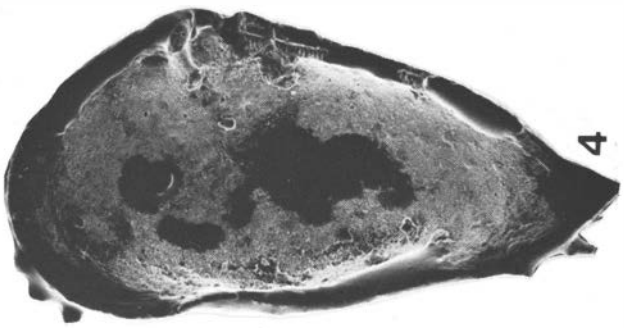
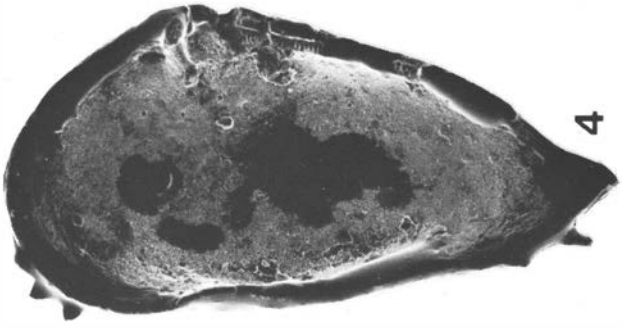
PLATE 6

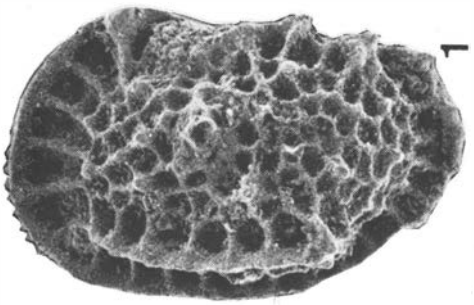
1. *Phalcocythere cultrata* (Apostolescu). Stereophotomicrograph. Sample KA7. PMAf982. × 60. Paleocene.
2. *Paracosta ? antedahomeyensis* sp. nov. Stereophotomicrograph of internal details. Wasimi borehole. PMAf888. × 70. Maastrichto-Paleocene.
3. *Camplocythere ?* sp. Stereophotomicrograph of internal details. Wasimi borehole. PMAf997. × 100. Maastrichto-Paleocene.
4. *Brachycythere armata* Reyment. Stereophotomicrograph. Wasimi borehole. PMAf947. × 65. Maastrichto-Paleocene.

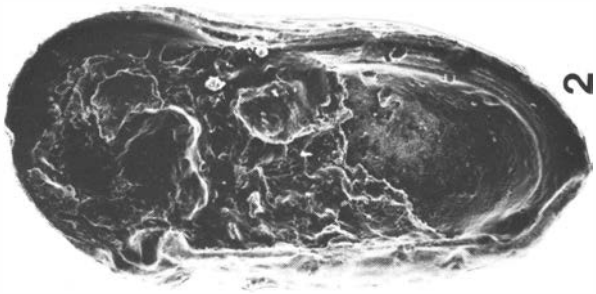
PLATE 6

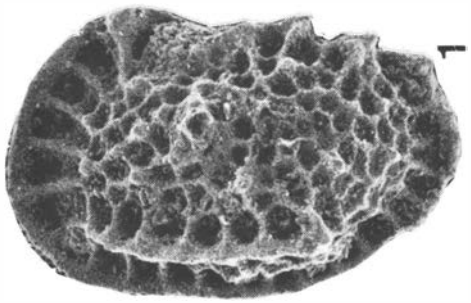












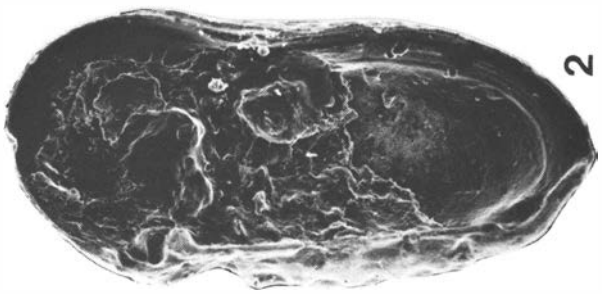


PLATE 7

1. *Buntonia pulvinata* Apostolescu. Right side of a carapace with a markedly convex dorsal area. Level KA3. PMAf983. × 100. Paleocene.
2. Same species. Left side of carapace. Sample KA7. PMAf984. × 100. Paleocene.
3. Same species. Left side of carapace. Sample KA7. PMAf985. × 100. Paleocene.
4. *Buntonia tenuipunctata* Apostolescu. Right side of carapace. Level KA6. PMAf986. × 100. Paleocene.
5. Same species. Level KA4. PMAf987. × 100. Paleocene.
6. Same species. Left side of carapace displaying the concentrically aligned pitting. Level KA4. PMAf988 × 100. Paleocene.
7. Same species. Male specimen. Sample KA7. PMAf989. × 100. Paleocene.
8. Same species. Interior view showing hinge. Sample KA7. PMAf990. × 100. Paleocene.
9. Same species. Sample KA7. PMAf991. × 100. Paleocene.
10. *Trachyleberis teiskotensis* (Apostolescu). Left side of carapace. Malbaza quarry. PMAf978. × 55. Paleocene.
11. Same species. Dorsal margin in angled view. Malbaza quarry. PMAf979. × 55. Paleocene.
12. Same species. Right side of carapace. Type locality of Dange Formation. PMAf980. × 55. Paleocene.
13. Same species. Left side of carapace. Malbaza quarry. PMAf980. × 55. Paleocene.
14. Same species. Type locality of Dange Formation. PMAf981. × 85. Paleocene.

PLATE 7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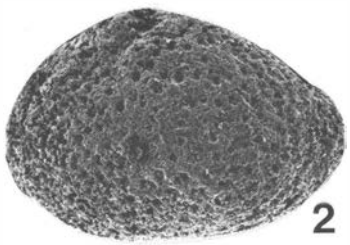
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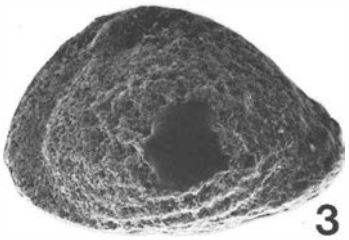
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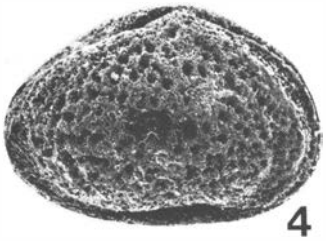
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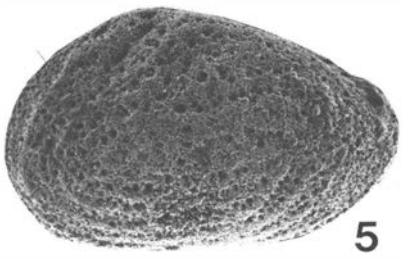
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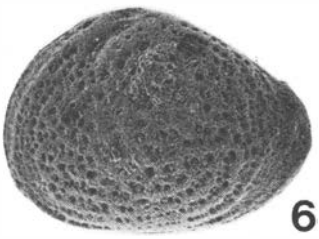
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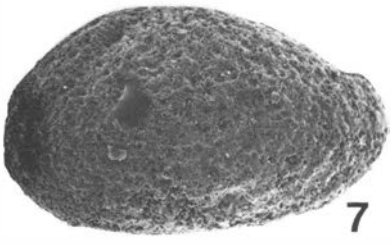
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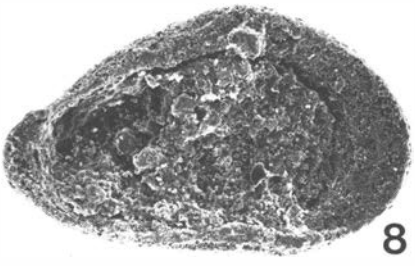
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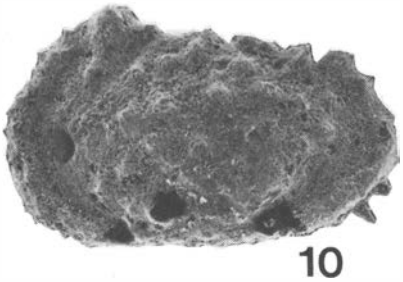
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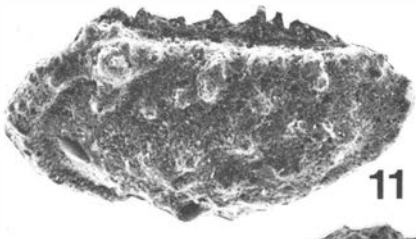
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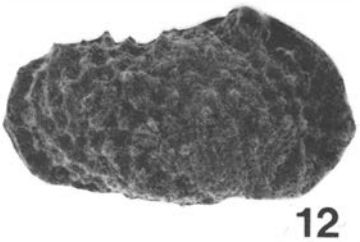
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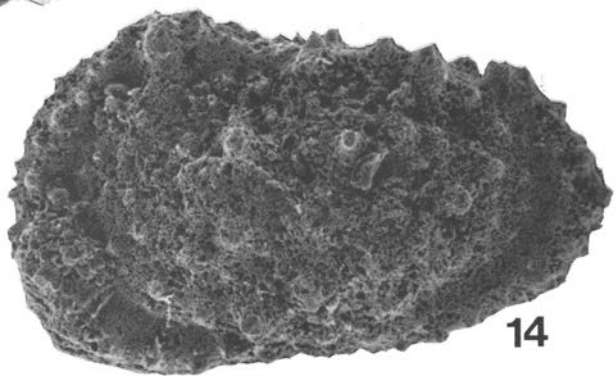
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PLATE 8

1. *Antibythocypris wasimiensis* sp. nov. Right side of carapace. Holotype. Wasimi borehole. PMAf992. × 100. Maastrichto-Paleocene.
2. Same species, provenance and magnification. Right side of carapace. PMAf993. Maastrichto-Paleocene.
3. Same species, provenance and magnification. Right valve. PMAf994. Maastrichto-Paleocene.
4. Same species, provenance and magnification. Internal view of a left valve. PMAf995. Maastrichto-Paleocene.
5. Same species, provenance and magnification. Internal view of a right valve. PMAf996. Maastrichto-Paleocene.
6. *"Pellucistoma"* sp. Wasimi borehole. PMAf895. × 100. Maastrichto-Paleocene.
7. *Cytheropteron* sp. Wasimi borehole. PMAf894. × 100. Maastrichto-Paleocene.
8. *Loxoconcha samueljohnsoni* sp. nov. Right side of carapace. Holotype. Epunsa 1 borehole, Ghana. PMAf893. × 105. Maastrichtian.
9. *Brachycythere armata* Reyment. Left view of carapace. Epunsa 1 borehole, Ghana. PMAf948. × 55. Maastrichtian.
10. *Veenia reticulocostata* Reyment. Right side of carapace. Wasimi borehole. PMAf892. × 55. Maastrichto-Paleocene.
11. *Paijenborchellina* sp. A. Wasimi borehole. PMAf893. × 150. Maastrichto-Paleocene.
12. *Mosaeleberis ornatoreticulata* (Reyment). Epunsa 1 borehole, Ghana. PMAf892. × 55. Maastrichtian.
13. *Paijenborchellina* sp. B. Wasimi borehole. PMAf891. × 120. Maastrichto-Paleocene.
14. *Paracosta ? warriensis* (Reyment). Wasimi borehole. PMAf890. × 55. Maastrichto-Paleocene.
15. *Paracosta ? antedahomeyensis* sp. nov. Left side of carapace. Holotype. Wasimi borehole. PMAf999. × 55.

PLATE 8

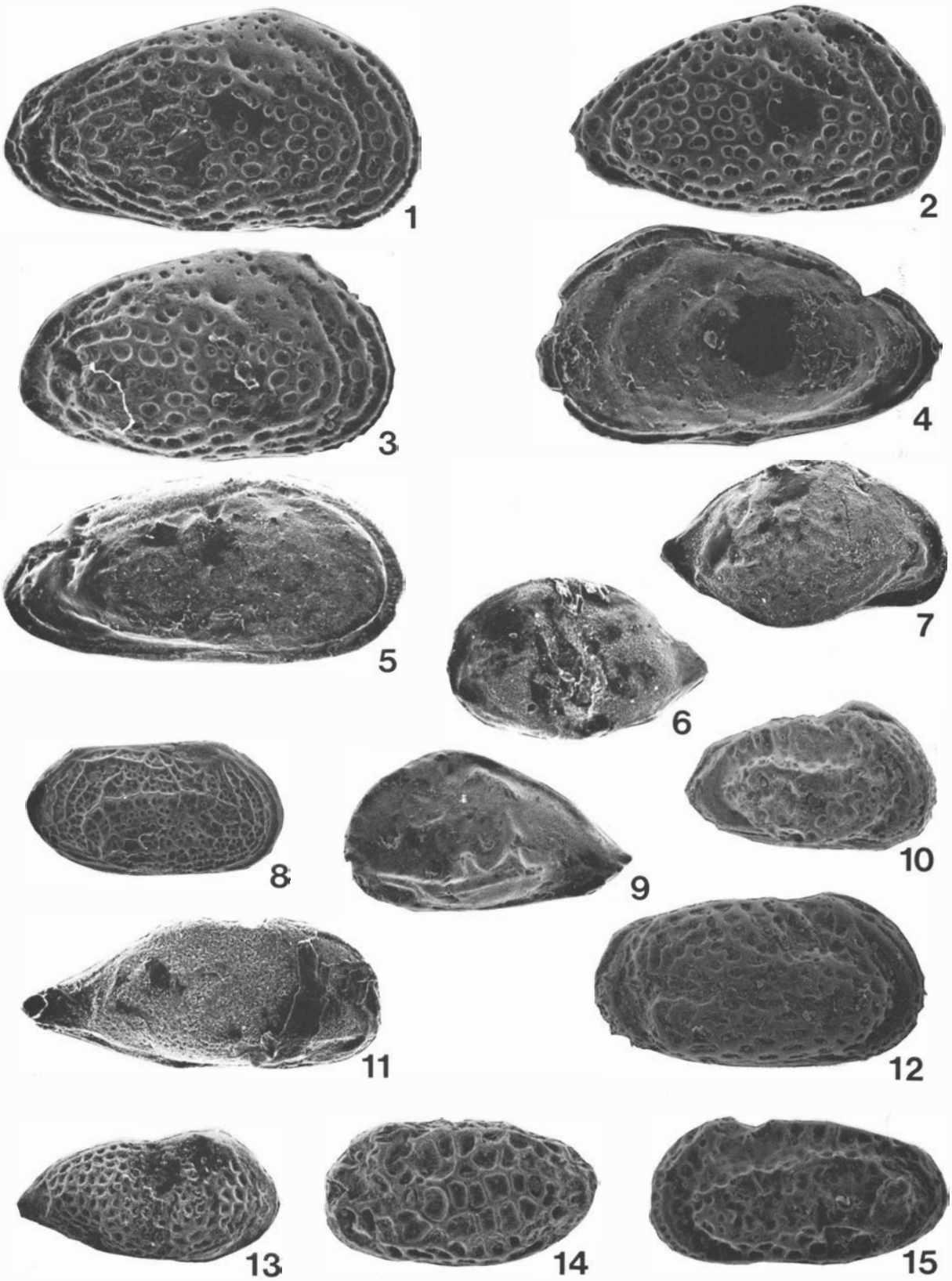
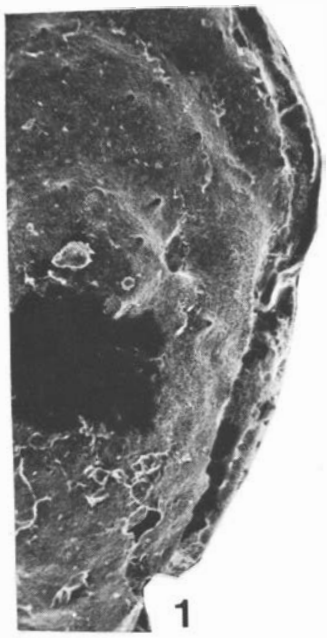


PLATE 9

1. *Antibythocypris wasimiensis* sp. nov. Details of a right hinge. Wasimi borehole. PMAf996. × 160. Stereophotomicrograph. Maastrichto-Paleocene.
2. *Leguminocythereis ? apostolescui* sp. nov. Wasimi borehole. PMAf950. × 110.
3. *Cytheretta ?* sp. Epunsa 1 borehole, Ghana. PMAf998. × 60. Maastrichtian.
4. *Paracosta ? antedahomeyensis* sp. nov. Wasimi borehole. PMAf899. × 60. Maastrichto-Paleocene.
5. *Paracosta ? warriensis* (Reyment). Internal view of a left valve – stereophotomicrograph. Wasimi borehole. PMAf898. × 85. Maastrichto-Paleocene.
6. *Bairdia ilaroensis* Reyment & Reyment. Epunsa 1 borehole, Ghana. PMAf897. × 60. Maastrichtian.
7. Same species and provenance. Details of the terminal dorsal marginal "dentate" element. PMAf828. × 180. Maastrichtian.
8. *Mosaeleberis ornatoreticulata* (Reyment). Final larval stage. Epunsa 1 borehole, Ghana. PMAf896. × 60.

PLATE 9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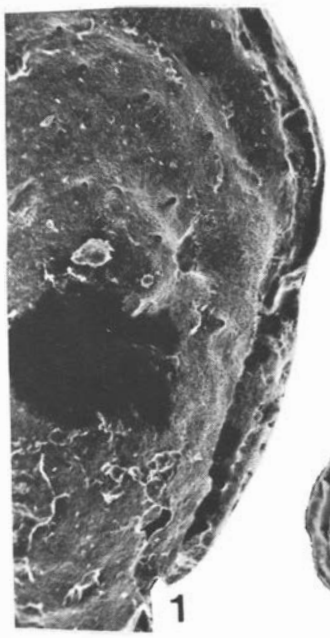
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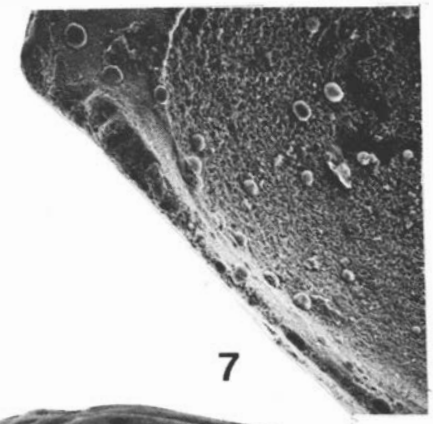
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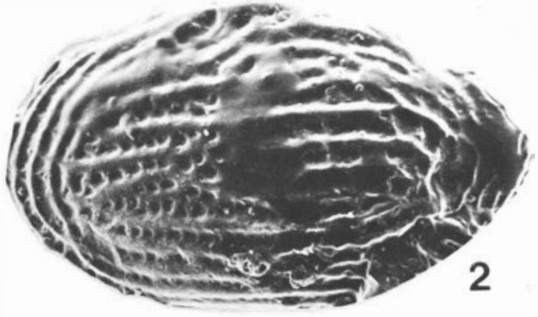
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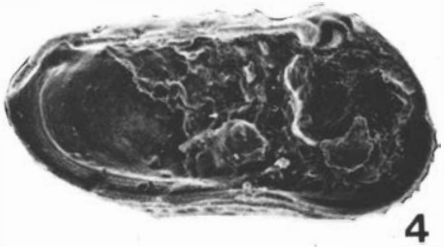
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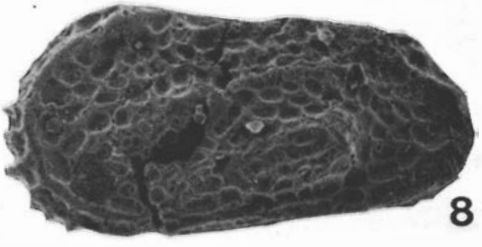
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PLATE 10

1. *Paracosta ? antedahomeyensis* sp. nov. Stereophotomicrograph. Wasimi borehole. PMAf889. × 70. Maastrichto--Paleocene.
2. *Buntonia tenuipunctata* Apostolescu. Hinge details. Sample KA7. PMAf990. × 150. Paleocene.
3. *Phalcocythere* aff. *dissenta* Siddiqui. Details of the ocular area. Level KA2. PMAf972. × 200. Paleocene.
4. *Exophthalmocythere ? usmandanfodioi* sp. nov. Details of the eye tubercle of a juvenile. Sample KA7. PMAf953. × 200. Paleocene.
5. *Phalcocythere vesiculosa* (Apostolescu). Internal view showing the hinge. Sample KA7. PMAf978. × 150. Paleocene.

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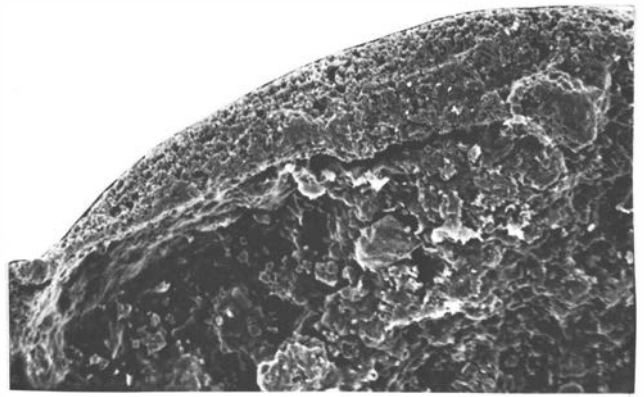

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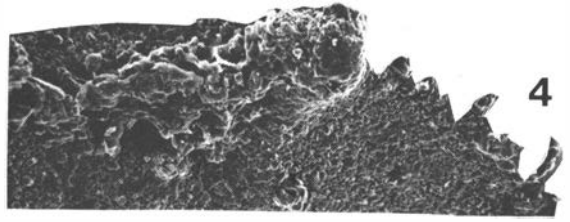

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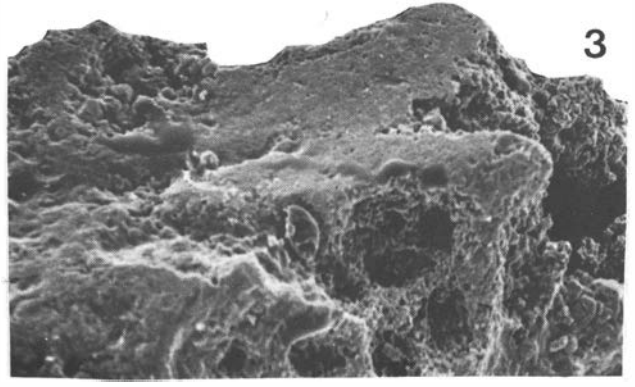

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PLATE 10