

# 西藏南部白垩纪岗巴群的双壳类及其生物地理意义<sup>\*</sup>

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**提要** 描述双壳类化石 42 种, 建立 10 新种: *Grammatodon* (*Nanonavis*) *minum* sp. nov., *Propeamussium* (*P.*) *tibetense* sp. nov., *Plicatula himalayensis* sp. nov., *Pseudolimea duodecicostata* sp. nov., *Pycnodonte* (*Phygraea*) *gambaensis* sp. nov., *Nototrigonia* (*N.*) *himalayensis* sp. nov., *Linearia* (*L.*) *gieumalensis* sp. nov., *Icanotia xizangensis* sp. nov., *Panopea xizangensis* sp. nov., *Cuspidaria tibitica* sp. nov.。它们均产自西藏南部岗巴地区的岗巴群。其中大部分标本产自岗巴群的下中部, 时代为 Aptian 至 Albion 期, 少量产自岗巴群上部, 时代大致为 Cenomanian 至 Coniacian 期。Aptian—Albian 期双壳类有地区性属 *Astartoides* 和 *Yoldioides* 以及众多地区性种 (约占 61%), 标志着—个地区性中心的存在。同时, 它们又表现出与澳大利亚 Aptian—Albian 动物群有密切的联系, 澳大利亚特有的属 *Eyrena*, *Maccoyella*, *Nototrigonia* 和特有的种 (约占 29%) 在岗巴群下中部被找到, 都是在北半球的首次记录。这个动物群与雅鲁藏布江缝合带以北同时期的动物群差别很明显, 后者与东亚、西亚和欧洲的双壳类有密切的联系。这些事实说明, 在 Aptian—Albian 时期, 印度次大陆已经开始向北漂移, 但漂移的距离还不远, 位于印度次大陆北部边缘浅海的岗巴地区的双壳类, 尽管已形成了一个以地区性分子为主体的动物群, 却仍然保持与南极—澳大利—亚动物群之间的联系和交流。

**关键词** 双壳类 古生物地理 白垩纪 藏南

## CRETACEOUS BIVALVES OF KANGPA GROUP, SOUTH XIZANG, CHINA AND THEIR BIOGEOGRAPHY<sup>\*</sup>

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**Abstract:** In this paper 42 bivalve taxa including 10 new species recovered from the Kangpa Group of South Xizang (Tibet) are described. Most of them come from the middle and lower parts of the group which is Aptian—Albian in age, and the others from the upper part belonging to Cenomanian—Coniacian in age. The fauna of the middle and lower parts bearing endemic genera *Astartoides* and *Yoldioides* and numerous endemic species (about 61%), marks the existence of an endemic centre. It is distinctly different from that of the area on the north of the Yarlung Zangbo River Suture Zone which shows close relation with that of East Asia, West Asia and Europe. In the meantime, some of Australian characteristic genera, such as *Eyrena*, *Maccoyella* and *Nototrigonia*, and a number of such species (about 29%) are found from the middle and lower parts of the Kangpa Group, which are recorded in Northern Hemisphere for the first time. This fact indicates that the Indian Subcontinent had already started its drifting northward, but the drift distance should be not far from Antarctica—Australia in Aptian—Albian, with the fauna of the Kangpa Group living in the north epicontinental sea of the subcontinent still could maintain the relation and exchange with that of Australian bivalves in spite of the fauna with a strong local colour.

**Key words:** bivalves, paleobiogeography, Cretaceous, South Xizang

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## INTRODUCTION

Gamba is a county name. According to the Gazetteer of China, it is equal to Kamba, Kampa, Kangpa, Kangba, Gamgpa etc. The Gamba Village ( $88^{\circ}30'E$ ;  $28^{\circ}20'N$ ) is located at about 300 km southwest of Lhasa City and about 25 km north of the border of Sikkim.

In 1916, H. Douvillé published his paper on the Cretaceous fossils collected from the Gamba Area by H. H. Hayden in 1903–1904. It is for the first time that the Cretaceous fossils of this area were described, though only one bivalve taxon, *Inoceramus* sp., was obtained from the Kangpa Group.

Up to 1976, in the paper “Fossil Lamellibranchia from the Mount Qomolangma Region” by the present author *et al.*, only a small number of bivalves from the upper part of the Kangpa Group were dealt with, including *Inoceramya*? *xizangensis* Gu *et* Lan, *Camptonectes* (*Camptonectes*) *curvatus* (Geintz), *Pycnodonte vesiculosa* (Sowerby) and *P.* cf. *vesiculosa* (Sowerby). Whereas most of the species *Laevitrigonia cardiniiformis*? (Kitchin), *Astarte spitiensis* Stoliczka, *A.* cf. *sowerbyana* Holdhaus, *Astartoides gamgpaensis* Wen *et* Lan, *A.*? *jiluensis* Wen *et* Lan, *Meleagrinella* cf. *radiata* Trautschold, *Pleuromya spitiensis* Holdhaus from its lower and middle parts were wrongly identified as a result of an erroneous dating (“late Jurassic”). Unfortunately, Li *et* Grant-Mackie (1994) were still influenced by the erroneous conclusion in their research involving 8 bivalve species of the Kangpa Group.

In 1987, Gou Zonghai also added some new materials to the fauna of the Kangpa Group.

There is only one paper dealing with the bivalve fossils of the Gieumal Sandstone (namely the Giumal Group, Garzanti, 1992) in West Himalayas corresponding to the Kangpa Group, which was published by A. Spitz (1914). While determining these strange specimens, he described with acution 20 taxa altogether, including 10 indeterminate species, 7 affinitive and conformable species, 1 known species and 2 new species.

To sum up, as regards the fossil bivalves from the Kangpa Group and its equivalents, some serious problems and difficulties still exist, such as the identification of genera and species, the determination of geological ages and the explanation of biogeographical relations, though a lot of bivalve materials have been accumulated up to now. The present paper aims at making a further discussion about

these problems, with emphasis laid on description and revision of the bivalve taxa.

## FAUNAL DISCUSSION

The fossil bivalves recovered from several sections (see Text-fig. 1) of the Kangpa Group were collected jointly by the Sino-Germany working Group from the environs of the Gamba Village, South Xizang, in 1983 and 1986. They are much more abundant and varied than ever before. In this paper are described 42 species referred to 38 genera and subgenera, including 16 known, 10 new, 5 conformable and 11 indeterminate species. Their stratigraphical distributions are listed in Table 1.

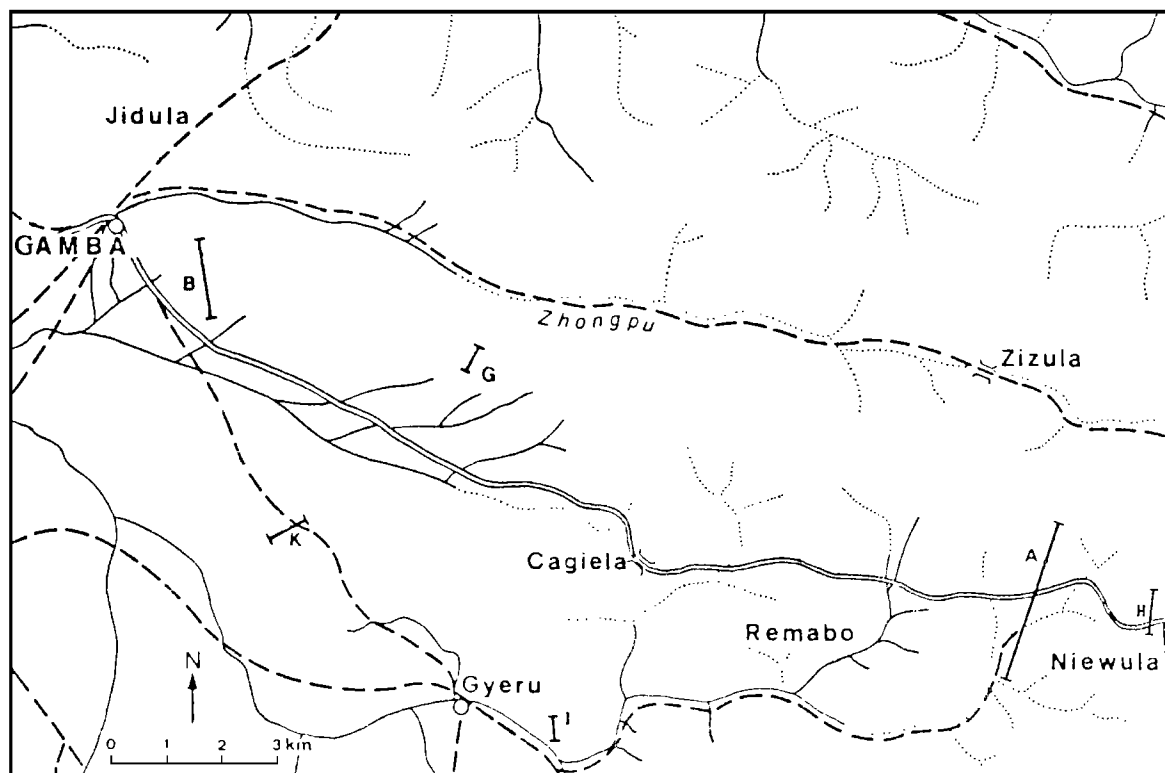
The Kangpa Group is divided into 3 parts, ascendingly the Kangbadongshan Formation, the Chaqiela Formation and the Kangbacunkou Formation (the names are all according to their first nomination) (Mu Antze *et al.*, 1973; Wen Shixuan, 1974; Wang Yigang *et al.*, 1980; Wen Shixuan *et al.*, 1981; Willems and Zhang Binggao, 1993). Most of the fossils dealt with in this paper are from the Kangbadongshan Formation, Chaqiela Formation and the lower part of the Kangbacunkou Formation, only *Inoceramya*? *xizangensis* Gu *et* Lan, *Lyropecten* (*Aequipecten*) sp. 1, *L.* (*A.*) sp. 2, *Plicatula himalayensis* sp. nov., *Pycnodonte* (*Phygraea*) *gambaensis* sp. nov. and *Sergipia*? sp. come from the upper part of the Kangbacunkou Formation.

Many genera and species from the Kangbadongshan Formation, Chaqiela Formation and the lower part of the Kangbacunkou Formation of the Kangpa Group are of vital importance in chronology and palaeogeography. Some of them deserve of special discussion in the following.

In the past, *Eyrena* was only recorded in Australia. The appearance of *E. linguloides* (Hudleston) in the Gamba Area is the first record outside Australia, and its living range is limited in Aptian without exception.

*Maccoyella* is a genus common in the lower Cretaceous rocks in Australia and New Zealand. Its species *M. reflecta* (Moore) and *M.* cf. *substriata* (Moore) known from the Aptian in Australia, are first found from the Himalayas.

*Syncyclonema* appeared in Aptian and became extinct in Maestrichtian in Europe (Dhondt, 1971), North America and Australia. The discovery of *S. gibsonia* Skwarko and *S. territorianum* Skwarko in the Gamba Area is the first two of the genus in the Himalayas, they were derived respectively from Aptian and late Neocomian in Australia.



Text-fig. 1 Sketch map showing the geographical position of the stratigraphical sections  
(After Willems and Zhang Binggao, 1993, with simplification)

The genus *Nototrigonia* (s.s.) and its subgenera were formerly discovered within the limits of Australia, New Zealand and Antarctica (Skwarko, 1963, 1966, 1981b; Fleming, 1987; Kelly, 1995). The appearance of 1 new species and 2 indeterminate species of this genus in the Gamba Area is the first record in Northern Hemisphere. With a limited range in the Early Cretaceous, *Nototrigonia* (*Nototrigonia*) has 5 authentic species in Southern Hemisphere, 2 in late Neocomian, 1 in Neocomian-Albian and 2 in Aptian-Albian.

*Aucellina* is widely distributed in the Aptian-Turonian strata of Europe, Caucasus, Australia, Patagonia and Antarctica. Its two species have been first recorded in the Himalayas. *A. hughendenensis* (Etheridge) is a very important element in the Tambo Formation (upper Albian) of the Great Artesian Basin in Queensland and the Northern Territory, Australia; *A. coquandiana* (d'Orbigny) is also a late Albian element in England and Australia.

Only one new species of *Icanotia* has been found in the Gamba Area, although its geological age remains ambiguous, the genus ranges from the Aptian to Maestrichtian in Europe, South Asia and South America.

Originally, *Camptonectes* (*Camptonectes*) *magnificus* Skwarko appeared in the late Neocomian strata of Australia and *Limatula persimilis* Stoliczka occurred in the Utatur Group (Albian to Cenomanian) in South In-

dia; although the two species from the Himalayas are identified with reservation, they still have some significance in chronology and biogeography.

*Meleagrinnella*, a genus widely distributed in the world, was very flourishing in Jurassic and was believed to have died out completely at the end of Jurassic (Cox *et al.*, 1969). However, we have found reliable representatives of *Meleagrinnella* in the Cretaceous strata. In the Himalayas, there are *M. dongshanensis* and *M. superstes* (Spitz), most abundant in individuals among numerous bivalve taxa of the Kangpa Group. In addition, *Meleagrinnella* cf. *M. superstes* (Spitz) (Brunnschweiler, 1960), ? *M. cf. superstes* (Spitz) and *M. sp.* (Skwarko, 1981a) were described in the Neocomian rocks of Australia, all showing that *Meleagrinnella* extended upward into the Cretaceous period indeed and provided another link between the faunas of the Himalayas and Australia during the Early Cretaceous.

Based on the above analyses, two conclusions can be drawn as in the following:

1. The geological age of the Kangbadongshan Formation, Chagiela Formation and the lower parts of the Kangbacunkou Formation ought to be within the limits from Aptian to Albian as a whole, because most of the known species and even one or two genera of the formations are confined to this time range, though some species

could occur in a time slightly earlier than Aptian or extinted a little later than Albian in other areas.

Table I The bivalve taxa and their stratigraphical position in the Kangpa Group

Taxa	KD	CL	KC	
			LP	UP
<i>Palaeonucula</i> cf. <i>etheridgei</i> (Ludbrook)		*		
<i>Nuculana</i> sp.		*		
<i>Yoldioides sublævigata</i> (Gou)	*	*		
<i>Yoldioides jurianoides</i> Li et Grant-Mackie		*		
<i>Grammatodon</i> ( <i>Nanonavis</i> ) <i>sinensis</i> Li et Grant-Mackie	*	*		
<i>Grammatodon</i> ( <i>Nanonavis</i> ) <i>minum</i> sp. nov.		*		
<i>Eyrena linguloides</i> (Hudleston)		*		
<i>Inoceramus</i> ( <i>Cremnoceramus</i> ? ) sp.		*		
<i>Inoceramus</i> ( <i>Mytiloceramus</i> ? ) sp.		*		
<i>Inoceramya</i> ? <i>xizangensis</i> Gu et Lan				*
<i>Spyridoceramus</i> ? sp.			*	
<i>Sergipia</i> ? sp.			*	
<i>Meleagrinnella superstes</i> (Spitz)		*		
<i>Meleagrinnella dongshanensis</i> Li et Grant-Mackie		*		
<i>Maccoyella reflecta</i> (Moore)		*		
<i>Maccoyella</i> cf. <i>substriata</i> (Moore)		*		
<i>Entolium</i> cf. <i>mangqiongense</i> Wen et Lan		*		
<i>Syncyclonema gibsonia</i> Skwarko		*		
<i>Syncyclonema territorianum</i> Skwarko	*			
<i>Propeamussium</i> ( <i>Propeamussium</i> ) <i>tibetense</i> sp. nov.			*	
<i>Camptonectes</i> ( <i>Camptonectes</i> ) cf. <i>magnificus</i> Skwarko		*		
<i>Lyropecten</i> ( <i>Aequipecten</i> ) sp. 1				*
<i>Lyropecten</i> ( <i>Aequipecten</i> ) sp. 2				*
<i>Aucellina coquandiana</i> (d'Orbigny)			*	
<i>Aucellina hughendenensis</i> (Etheridge)	*			
<i>Plicatula himalayensis</i> sp. nov.				*
<i>Pseudolimea duodecicostata</i> sp. nov.	*			
<i>Limatula</i> cf. <i>persimilis</i> Stoliczka		*		
<i>Pycnodonte</i> ( <i>Phygræa</i> ) <i>gambaensis</i> sp. nov.				*
<i>Nototrigonia</i> ( <i>Nototrigonia</i> ) <i>himalayensis</i> sp. nov.		*		
<i>Nototrigonia</i> ( <i>Nototrigonia</i> ) sp. 1		*		
<i>Nototrigonia</i> ( <i>Nototrigonia</i> ) sp. 2		*		
<i>Astarte</i> ( <i>Astarte</i> ) sp.		*		
<i>Astartoides gambaensis</i> Wen et Lan		*		
<i>Astartoides dingriensis</i> Wen		*		
<i>Astartemya</i> ( <i>Freiastarte</i> ) <i>planissima</i> (Forbes)		*		
<i>Linearia</i> ( <i>Linearia</i> ) <i>gieumalensis</i> sp. nov.		*		
<i>Icanotia xizangensis</i> sp. nov.	*			
<i>Tancredia</i> ? <i>dingriensis</i> (Wen)		*		
<i>Panopea xizangensis</i> sp. nov.	*	*		
<i>Panopea</i> sp.			*	
<i>Cuspidaria tibitica</i> sp. nov.		*		

KD=Kangbadongshan Formation CL=Chaqiela Formation  
KC=Kangbacunkou Formation LP=Lower part UP=upper part

2. The bivalve fauna belonging to Aptian—Albian of the Kangpa Group, characterized by numerous endemic species (about 61%) and two endemic genera *Astartoides* and *Yoldioides*, is a diagnostic local-colour fauna, and marks the existance of an endemic centre, namely the Himalayan Endemic Centre (Wen Shixuan, 1999), belonging to the Himalayan Subprovince of the South Temperate Realm (Kauffman, 1973). In the mean time, some of Australian characteristic genera, such as *Eyrena*, *Maccoyella* and *Nototrigonia* and a number of such species (about 29%) are found in this area. This fact indicates that there must have been close relation between the Himalayan and Australian faunas during Aptian and Albian. This conclusion makes a major advance in the researches on palaeobiogeography and continental drift.

When studying the Jurassic bivalve faunas of the Qinghai-Xizang (Tibet) Plateau and their palaeobiogeography (Wen Shixuan, 1987a), the author pointed out that the faunas can be divided into two branches; the north and the south, both belonging to the same Tethys Realm. The south branch developed in the area on the south of the Yarlung Zangbo River Suture Zone, and has close relation with those faunas of East Africa, Australia and Antarctica belonging to the Gondwanaland during the Middle and Late Jurassic; whereas the north branch mainly spread in the area on the north of the Bangong Lake-Nujiang River Suture Zone, carrying a lot of European elements, but only few occur in common with the contemporaries of the south branch, which are all the taxa capable of extensive distribution. So, the author believed that both branches dominated overwhelmingly by benthonic forms must have been separately limited in different palaeogeographical positions, i. e. the south branch lived in the north epicontinental sea of the Gondwanaland (or precisely speaking, the Indian Subcontinent), and the north branch in the south epicontinental sea of the Eurasia, and that between the two branches a vast and deep Tethys Ocean must have existed and prevented them making contact and exchange with each other.

During the Aptian and Albian the marine bivalve fauna developing in the area on the north of the Yarlung Zangbo River Suture Zone were seen in central Xizang (Gerze, Xainza, Bangoin and Lhasa), including *Gervillaria*, *Xenocardita*, *Caestocorbula* ( *Parmicorbula* ), *Myopholas*, *Ludbrookia*, *Flaventia*, *Fenestricardita* *Isodomella* and *Costocyrena* etc., and shows a close relation with those of Europe, West Asia and Japan (Vokes, 1946; Hayami 1965, 1975; Wen Shixuan, 1987b, 1992, 1999; Gou Zonghai, 1995). In addition, a few species of *Trigonoides*, the characteristic non-marine bivalve ele-

ments in the Asia Continent, also appeared in association with the marine taxa. Thus, it is distinctly different from the bivalve fauna in the Gamba Area on the south of the Yarlung Zangbo River Suture Zone. Evidently, the palaeobiogeographical pattern of the Qinghai-Xizang Plateau and its neighboring areas during the Middle and Late Jurassic kept entering into and through the Early Cretaceous on the whole and the boundary between the south and north faunas was just defined by the Yarlung Zangbo River Suture Zone.

There exist different views for the time when the Indian Subcontinent started its northward drift. According to A. Hallam (1981), Garzanti (1992) and others, the Indian Subcontinent separated from Antarctica-Australia and started drifting northward in Hauterivian or Valanginian. The author is firmly convinced that the Indian Subcontinent had started its drifting northward in Aptian or little earlier than Aptian, but the drift distance should not be very far from Antarctica-Australia at Aptian—Albian. Consequently, the Himalayan bivalve fauna living in the north epicontinental sea of the Indian Subcontinent still could maintain relation and exchange with that of Antarctica-Australia in spite of its strong local colour (Wen Shixuan, 1999).

The bivalves in the upper part of the Kangbacunkou Formation amount to no more than 10 taxa including those described in the past. Most of them are recognized as new, doubtful or indeterminate, but *Camptonectes* (*Camptonectes*) *virgatus* (Nilsson, 1827) (= *sp. curvatus* Geinitz, 1834, after A. V. Dhondt, 1972) and *Pycnodonte* (*Phygraea*) *vesiculosa* (Sowerby) are significant in geological age. The former spread in to Europe, Asia, Africa and North America during the Cenomanian—Maestrichtian, and the latter occupied Europe, North Africa and South India from late Albian to Cenomanian. In terms of geological age, the upper part of this formation ranges approximately from Cenomanian to Coniacian based on the other fossils associated with the bivalves.

## SYSTEMATIC DESCRIPTION

### Family Nuculidae Gray, 1824

#### Genus *Palaeonucula* Quenstedt, 1930

**Type species:** *Nucula hammeri* Defrance, 1825

#### *Palaeonucula* cf. *etheridgei* (Ludbrook)

(Pl. I, figs. 3, 4)

cf. 1966 *Nucula etheridgei* Ludbrook, p. 147, pl. 14, figs. 6—8.

**Material:** Two almost complete internal molds of conjoined valves.

**Description:** Shell large for the genus, horizontally elliptical, equivalve, inequilateral, moderately convex. Umbo at approximately  $1/4$  of shell length in front of posterior extremity. The angle between short postero-dorsal margin and long, straight antero-dorsal margin about  $120^\circ$ ; anterior and posterior margin rounded, ventral margin obtusely rounded. Dentition not complete in preservation, 12 small teeth can counted in anterior series and 5 in posterior series.

**Comparison:** The present specimens are smaller but relatively longer than the Australian original specimens of this species described by Ludbrook (1966, see synonym), but their other characteristics are all identical with those of the original specimens.

**Locality and horizon:** Section A; Chagiela Formation.

**Collected number:** ADQ-Af-29.

### Family Nuculanidae Adams et Adams, 1858

#### Genus *Nuculana* Link, 1807

**Type species:** *Arca rostrata* Chemnitz, 1774

#### *Nuculana* sp.

(Pl. I, figs. 19—26)

**Material:** Some internal molds of left and right valves.

**Description:** Shell very small, bearing rounded anterior margin, produced, subrostrated posterior end. Umbo obtuse, prominent over hinge line, placed at about  $2/5$  of shell length behind anterior extremity. Dentition with about 15 small teeth in anterior series, 24 in posterior series, which being short lamina near umbo and knee-like near ends. A resilifer (a small prominence on internal mold) between both tooth series.

**Locality and horizon:** Section A, H; Chagiela Formation.

**Collected number:** ADQ-Af-7; ADQ-Hf-1.

### Family Mallettiidae Adams et Adams, 1858

#### Genus *Yoldioides* Li et Grant-Mackie, 1994

**Type species:** *Yoldia* (*Yoldia*) *sublaevigata* Gou, 1987

#### *Yoldioides sublaevigata* (Gou)

(Pl. I, figs. 7—13)

1987 *Yoldia* (*Yoldia*) *sublaevigata* Gou, p. 152, pl. 1, figs. 14, 15.

1994 *Yoldioides sublaevigata*, Li et Grant-Mackie, p. 267, figs. 3, 10—13.

**Material:** Several internal molds of left and right valves and an interior of right valve.

**Locality and horizon:** Section A, I, K; Chaqiela and Kangbadongshan formations.

**Collected number:** ADQ-Af-34; ADQ-If-1; ADQ-Kf-3, 4, 9.

***Yoldioides jurianoides* Li et Grant-Mackie**

(Pl. I, figs. 1, 2)

1994 *Yoldioides jurianoides* Li et Grant-Mackie, p. 268, figs. 3, 14—16.

**Material:** Two internal molds of a left and a right valves.

**Locality and horizon:** Section A; Chaqiela formation.

**Collected number:** ADQ-Af-35.

**Family Parallelodontidae Dall, 1898**

**Subfamily Grammatodontinae Branson, 1942**

**Genus *Grammatodon* Meek et Hayden, 1861**

**Subgenus *Grammatodon* (Nanonavis) Stewart, 1930**

**Type species:** *Arca carinata* J. Sowerby, 1813

***Grammatodon* (Nanonavis) sinensis Li et Grant-Mackie**  
(Pl. II, figs. 2—11)

1987 *Grammatodon* (Nanonavis) yakoyamai, Gou, p. 163, pl. 2, figs. 1, 2.

1994 *Grammatodon* (Indogrammatodon) sinensis Li et Grant-Mackie, p. 269, figs. 3, 20—25.

**Material:** Several complete and incomplete specimens including internal and external molds of left and right valves.

**Locality and horizon:** Section A; Kangbadongshan and Chaqiela formations.

**Collected number:** ADQ-Af-29, 63, 71.

***Grammatodon* (Nanonavis) minum sp. nov.**

(Pl. I, figs. 5, 6)

**Material:** A left and a right exteriors.

**Description:** Shell very small (about 9 mm long and 6 mm high), horizontally elliptical, equivalve, subequilateral, weakly convex (by flattening). Umbo broad, prominent over hinge line, subcentral. Posterior ridge strong. Surface ornamented with about 20 narrow, prominent, radial costae separated by much wider intervals than costae; sparse anterior costae curved forward, middle ones quite even, the costae closely to after and before posterior ridge somewhat close and therefrom become sparse backward; numerous small tubercles formed when concentric lines crossing radial costae.

**Comparison:** The present new species is characterized by very small size and sparse, tuberculate costae. It is similar to Australian *G. psittaculum* (Skwarko, 1966, p. 74, pl. 1, figs. 1—4) in small size and outline; but the latter distinguishes itself in having very strong convexity, weak

posterior ridge and numerous close radial costae.

**Locality and Horizon:** Section I; Chaqiela Formation.

**Collected number:** ADQ-If-1.

**Family Mytilidae Rafinesque, 1815**

**Genus *Eyrena* Ludbrook, 1966**

**Type species:** *Modiola linguloides* Hudleston, 1884

***Eyrena linguloides* (Hudleston)**

(Pl. II, figs. 12—14)

1870 *Mytilus inflatus*, Moore, p. 252, pl. 13, fig. 4 (non Costa 1846, Muller 1847).

1884 *Moliola linguloides* Hudleston, p. 341, pl. 11, figs. 6a, 6b.

1966 *Eyrena linguloides*, Ludbrook, p. 162, pl. 19, figs. 1—4, 13.

1987 *Inoceramus* (*Mytiloides*) *pararegularis* Gou, p. 156, pl. 2, figs. 18—20.

**Material:** Three internal molds of conjoined valves, one of them large and complete.

**Description:** Shell linguiform, equivalve, inequilateral, moderately convex. Umbo pointed prominent, beak prosogyrous. Antero-dorsal margin short. Postero-dorsal margin straight and long. Numerous concentric lines and some strong concentric ridges kept on internal molds; their marginal zone surrounded by several distinct concentric folds. Hinge and adductor scars not preserved at all.

**Comparison:** For present specimens, though the interior characteristics are not preserved and the convexity is slightly weaker, their size, outline, umbo and beak are all identical with the Australian original specimens of *E. linguloides*.

**Locality and horizon:** Section A; Chaqiela Formation.

**Collected number:** ADQ-Af-23, 32A.

**Family Inoceramidae Giebel, 1852**

**Genus *Inoceramus* J. Sowerby, 1814**

**Subgenus *Inoceramus* (Cremnoceramus) Cox, 1969**

**Type species:** *Inoceramus inconstans* Woods, 1912

***Inoceramus* (Cremnoceramus?) sp.**

(Pl. II, fig. 1)

**Material:** An internal mold of conjoined valves.

**Description:** Shell small, vertically subsquare (height slightly exceeding length), equivalve, inequilateral. Umbo nearly terminal, prominent over hinge margin. Anterior and dorsal margins straight, ventral and posterior margins rounded. Shell gradually changing its outline, convexity and ornament during growth process; the shell being horizontally elliptical, weakly convex and ornamented with very fine concentric growth lines in the early growth stage; from the middle growth stage on, convexity rapidly

increasing, growth rate toward ventral margin is much rapider than that toward posterior margin, and the vertically subsquare outline gradually formed; at the same time, some irregular concentric ridges appeared. Shell thin, concentric lines and ridges ornamented on surface can be marked on its internal mold. Hinge not preserved.

**Remarks:** The present specimen is somewhat comparable to those of subgenus *Cremnoceramus* in the changes of outline, convexity and ornament during growth process; but it differs from the latter in having equivalve shell and narrow, pointed and high prominent umbo. Therefore it is identified with reservation.

**Locality and horizon:** Section A, Chaqiela Formation.

**Collected number:** ADQ-Af-32.

### Subgenus *Inoceramus* (Mytiloceramus) Rollier, 1914

**Type Species:** *Inoceramus polylocus* Roemer, 1857

#### *Inoceramus* (Mytiloceramus?) sp.

(Pl. I, figs. 16–18)

**Material:** Several incomplete left and right internal molds.

**Description:** Shell medium-sized, obliquely ovate, weakly convex, equivalve or subequivalve. Umbo pointed, not prominent over hinge margin, subterminal. Shell margin before umbo is a sinking, flattened, narrow shoulder, like anterior auricle. Surface ornamented with much strong, irregular and concentric folds. Judging from concentric ornament, the outline horizontally elliptical in early growth stage, later the growth rate toward postero-ventral margin rapidly quickened, at the same time the outline gradually became oblique ovate.

**Locality and horizon:** Section A; Chaqiela Formation.

**Collected number:** ADQ-Af-5.

### Genus *Inoceramya* Ulrich, 1904

**Type species:** *Inoceramya concentrica* Ulrich, 1904

#### *Inoceramya?* *xizangensis* Gu et Lan

(Pl. VI, figs. 15–21)

1916 *Inoceramus* sp., Douvillé, p. 6, pl. 3, figs. 11, 13.

1976 *Inoceramya?* *xizangensis* Gu et Lan, in Gu et al., p. 153, pl. 54, figs. 2, 3.

1976 *Inoceramya?* sp., Gu et al., p. 154, pl. 54, figs. 1, 4.

1976 *Inoceramya?* *xizangensis*, Wen et al., p. 118, pl. 29, figs. 2–5.

1976 *Inoceramya?* sp., Wen et al., p. 118, pl. 36, figs. 3, 6, 7.

1985 ? *Inoceramya xizangensis*, Gou, p. 491, pl. 2, fig. 17.

1987 *Inoceramya?* *xizangensis*, Gou, p. 164, pl. 3, fig. 7.

**Material:** Numerous interiors and exteriors of left and

right valves of varying sizes.

**Description:** Shell very large (the oblique length of the largest up to 120 mm), subcircular in juvenile and obliquely elliptical in adult, equivalve, almost flat except umbonal area where slightly convex. Umbo quite low, situated in the front of straight, long hinge margin. Shell bearing numerous strong, even and concentric folds; in addition, some secondary concentric folds appearing in middle-late growth stage, and all the concentric ridges of exterior accurately corresponding to the concentric grooves of interior. Shell very thin, its exterior or interior or both were evenly covered with CaCO<sub>3</sub> colloid during preservation, and original aspects of concentric folds still kept on the surface of coerture, therefore the valves look like very thick. Triangular postero-dorsal area not distinctly separated from main surface, but concentric folds weakening and changing into concentric lines when they coming into the area. The internal surface of postero-dorsal area also smooth; on the internal surface of one or two specimens, a low carina between the area and main internal surface can be seen. Hinge not preserved at all except a section of ligament area of a left valve. It being 3.5 mm long, having 5 vertically rectangular ligament pits altogether. There are more than 30 pits when complete by inference.

**Remarks:** The present specimens is somewhat similar to those of *Inoceramya*, but it differs from the generic characteristics on front umbo and the lack of distinct antero-dorsal area. So, it is assigned to this genus with a question mark.

**Locality and horizon:** Section A; upper part of Kangbacunkou Formation.

**Collected number:** ADQ-Af-129.

### Genus *Spyridoceramus* Cox, 1969

**Type species:** *Inoceramus tegulatus* Hagenow, 1842

#### *Spyridoceramus?* sp.

(Pl. I, fig. 14)

**Material:** A single left valve with incomplete antero-ventral part.

**Description:** Shell very small, horizontally elliptical (Length exceeding height), very weakly convex. Umbo situated in the front of hinge margin, not prominent over hinge line. The surface layer has fallen in anterior part where only concentric folds are retained; the surface layer is still kept on postero-dorsal area where ornamented with fine radial lines and concentric folds. Ligament area not preserved.

**Remarks:** The present specimen is identical with those of *Spyridoceramus* in horizontally elliptical outline

and radial ornament; but it has a very weak convexity, low umbo and lacks small anterior wing.

**Locality and horizon:** Section A; lower part of Kang-bacunkou Formation.

**Collected number:** ADQ-Af-84c.

### Genus *Sergipia* Maury, 1925

**Type species:** *Inoceramus* (*Sergipia*) *posidonomyaformis* Maury, 1925

#### *Sergipia?* sp.

(Pl. I, fig. 15)

**Material:** A single internal mold of right valve.

**Description:** Shell very small (5 mm long and 3.5 mm high), subelliptical, weakly convex, with a distinct posterior wing. Umbo narrow, not prominent over hinge margin, placed at about  $2/5$  of shell length behind anterior extremity. Postero-dorsal margin straight, long; antero-dorsal margin also straight, slightly oblique; other margins all arched; upper part of posterior margin weakly concave and forming an about  $80^\circ$  angle with postero-dorsal margin. Shell ornamented with about 10 even concentric folds which extending from body of valve into posterior wing without change, each of them forming a crook when crossing the shallow, wide groove between body of valve and posterior wing.

**Remarks:** The main characteristics of present specimen coincide well with *Sergipia*; it may be a juvenile of the genus.

**Locality and horizon:** Section B; lower part of Kang-bacunkou Formation.

**Collected number:** ADQ-Bf-48A.

### Family Oxytomidae Ichikawa, 1958

#### Genus *Meleagrinnella* Whitfield, 1885

**Type species:** *Avicula curta* Hall, 1852

#### *Meleagrinnella superstes* (Spitz)

(Pl. III, figs. 11—22)

1914 *Pseudomonotis superstes* Spitz, p. 201, pl. 18, figs. 6, 7.

1914 *Arca* (?) sp., Spitz, p. 202, pl. 18, figs. 17a, b, c.

1976 *Meleagrinnella* cf. *radiata*, Wen et al., p. 89, pl. 21, figs. 11—13.

1987 *Meleagrinnella* cf. *radiata*, Gou, p. 165, pl. 4, figs. 1, 2.

1987 *Meleagrinnella nienexionglaensis*, Gou, p. 165, pl. 3, figs. 19—21 (non Wen 1976).

**Material:** Numerous valves and their external and internal molds of varying sizes.

**Description:** Shell small, prosoclinic, very inequivalve. Height slightly exceeding length (generally 7—13 mm long, 8—14 mm high). Left valve strong convex; umbo distinctly prominent over hinge margin, beak incurved;

posterior wing small, obtusely triangular; surface ornamented with numerous radial riblets consisting of principal and intercalated secondary and tertiary riblets, can counted about 35 near ventral margin altogether; concentric ornaments poor except that in anterior part where they strengthening into concentric lamellae. Right valve weakly convex; umbo low, not prominent over hinge margin; posterior wing distinct, triangular, anterior auricle very small; surface only ornamented with concentric growth lines. Hinge identical with that of the genus.

**Remarks:** *Arca* (?) sp. described by Spitz (see synonym) characterized by slightly prosoclinic shape, height exceeding length, strong convex left valve with distinct posterior wing and numerous radial riblets of varying thickness, should be classified to this species.

**Locality and horizon:** Section A; H; Chaqiela Formation.

**Collected number:** ADQ-Af-4, 8—12, 17, 20, 24; ADQ-Hf-1.

#### *Meleagrinnella dongshanensis* Li et Grant-Mackie

(Pl. III, figs. 1—6)

1987 *Meleagrinnella wagneri*, Gou, p. 165, pl. 4, figs. 3, 4 (non Gou 1983).

1994 *Meleagrinnella dongshanensis* Li et Grant-Mackie, p. 270, figs. 4, 12—15.

**Material:** Numerous left and right valves and their internal and external molds.

**Locality and horizon:** Section A, H; Chaqiela Formation.

**Collected number:** ADQ-Af-5, 17, 24, 25, 28; ADQ-Hf-1, 2; GBQ-1.

### Genus *Maccoyella* Etheridge jr. 1892

**Type species:** *Avicula barklyi* Moore, 1870

#### *Maccoyella reflecta* (Moore)

(Pl. III, fig. 28)

1870 *Avicula reflecta* Moore, p. 246, pl. 12, fig. 1.

1902 *Maccoyella reflecta*, Etheridge jr. p. 18, pl. 1, figs. 1—5; pl. 2, figs. 1, 2; pl. 3, figs. 1—3; pl. 4, fig. 2.

1966 *Maccoyella reflecta*, Ludbrook, p. 152, pl. 15, figs. 8, 9.

**Material:** An almost complete external mold of left valve.

**Description:** Shell medium-sized (37 mm long and 33 mm high), horizontally elliptical (judging from concentric growth lines), acclinic, subequilateral, moderately convex. Umbo broad, central. Antero-dorsal margin slightly oblique, postero-dorsal margin horizontal and straight. Posterior wing small, without boundary with body of valve. Surface ornament (including posterior wing) consisting of



7 principal and intercalated secondary and more tertiary riblets, can counted about 35 riblets altogether; in addition, also ornamented with fine and close concentric growth-lines.

**Remarks:** The present specimen is closely similar to the Australian holotype (see synonym) in size, outline and ornament; but its concentric lamiae are much poorer.

**Locality and horizon:** Section H; Chaqiela Formation.

**Collected number:** ADQ-Hf-1.

### *Maccoyella cf. substriata* (Moore)

(Pl. II, figs. 15–17)

cf. 1870 *Avicula substriata* Moore, p. 247, pl. 11, fig. 6.

**Material:** Two incomplete internal and an external molds of left valves.

**Description:** Shell small, horizontally elliptical (length slightly exceeding height), moderately convex, acclinic. Posterior wing distinctly produced, without boundary with body of valve. Ornament consisting of about 24 principal and secondary radial riblets which showing no difference in thickness and taking place at umbonal area, and much finer tertiary riblets which spreading in anterior and posterior surface and at middle-late growth stage; concentric lines even and intermittently developing in the intervals between radial riblets. Ligamental area broad, horizontally lengthening, chiefly placed the limits after beak; a tooth scar marked before ligamental area. Little is known about right valve.

**Comparison:** The present specimens quite resemble the Australian specimens of *M. substriata* in size, outline and ornament, however, they differ from them in having shorter posterior wing, earlier appearance of the secondary riblets and stronger and even concentric lines. The ornament of our specimens is also very similar to an Australian specimen named *M. corbiensis* (Moore) (Etheridge, 1907, pl. 61, fig. 6); but the left valve in the latter is vertically arched (height distinctly exceeding length).

**Locality and horizon:** Section H; Chaqiela Formation.

**Collected number:** ADQ-Hf-1.

## Family Entoliidae Korobkov, 1960

### Genus *Entolium* Meek, 1865

**Type species:** *Pecten demissus* Phillips, 1829

### *Entolium cf. mangqiongense* Wen et Lan

(Pl. III, fig. 8)

cf. 1976 *Entolium mangqiongense* Wen et Lan, in Gu et al., p. 210, pl.

47, figs. 21–23.

cf. 1976 *Entolium mangqiongense*, Wen et al., p. 92, pl. 22, figs. 12–14.

**Material:** A single external mold of left valve.

**Description:** Shell larger for the genus (42 mm high, 35 mm long), slightly prosoclinic, weakly convex. Auricles equal, narrowly triangular, demarcated from body of valve by narrow auricular sulcus. Surface ornamented with very fine and even concentric growth lines which strengthened in late growth stage.

**Comparison:** The present specimen is relatively higher (length/height = 83%) than the original specimens (length/height = 95%).

**Locality and horizon:** Section I; Chaqiela Formation.

**Collected number:** ADQ-If-1.

## Genus *Syncyclonema* Meek, 1864

**Type species:** *Pecten rigida* Hall et Meek, 1854

### *Syncyclonema gibsonia* Skwarko

(Pl. III, fig. 10)

1967 *Syncyclonema gibsonia* Skwarko, p. 17, pl. 1, figs. 1–3.

1987 *Entolium* sp. A, Gou, p. 165, pl. 3, fig. 17.

**Material:** A single internal mold of right valve.

**Description:** Shell small (13 mm long, 17 mm high), Entolium-like, weakly convex. A narrow, long area from umbo to central ventral margin being the most prominent, and flattened laterally. Auricles small, anterior one larger than posterior one. Two oblique costae separately extending from anterior and posterior sides of umbonal cavity to anterior and posterior sides of body of valve. Pallial impression and a circular adductor scar distinct.

**Locality and horizon:** Section A; Chaqiela Formation.

**Collected number:** ADQ-Af-1.

### *Syncyclonema territorianum* Skwarko

(Pl. III, figs. 29, 30, 32)

1966 *Syncyclonema territorianum* Skwarko, p. 83, pl. 1, figs. 13–17.

1987 *Entolium kimurai*, Gou, pl. 3, fig. 16.

1987 *Entolium* sp. B, Gou, p. 165, pl. 3, fig. 18.

1994 *Entolium dongshanensis* Li et Grant-Mackie, p. 273, figs. 4, 16–20.

**Material:** Three right internal molds, one left internal mold and two left interiors.

**Description:** Shell very small (one of two complete specimens 11 mm high, 9.5 mm long; another 10 mm high, 9 mm long), Entolium-like, subcircular, weakly and evenly convex or nearly flat. Auricles small, narrowly triangular, anterior one larger than posterior one. Pallial impression and a large, circular adductor scar distinct.

**Locality and horizon:** Section I, K; Kangbadongshan

Formation.

**Collected number:** ADQ-If-3; ADQ-Kf-4.

**Family Pectinidae Rafinesque, 1815**

**Genus *Propeamussium* de Gregorio, 1884**

**Subgenus *Propeamussium* (*Propeamussium*)**

**Type species:** *Pecten* (*Propeamussium*) *ceciliae* d'Gregorio, 1884

***Propeamussium* (*Propeamussium*) *tibetense* sp. nov.**  
(Pl. III, figs. 23–27)

**Material:** 5 specimens including an internal mold and an external mold of left valves in better preservation.

**Description:** Shell very small (the largest 9 mm high and 8 mm long; the holotype, a left internal mold 8 mm high and 6.5 mm long), pecten-like, slightly prosoclinic, very weakly convex. Auricles subequal, narrowly triangular, no sinus at their outside and inferior margins. Umbonal angle about  $100^\circ$ . Exterior surface ornamented with about 15 relatively coarse radial riblets and some very fine radial lines; interior surface evenly sculptured with 10–12 radial riblets which taking place from umbonal area and discontinuing to a zone about  $1/3$  of valve height above ventral margin, their extremities swelling and strengthening. The characteristics described above are all based on left valves.

A very small specimen may be a right valve: it is circular, 3.5 mm high, nearly flat. Auricles subequal, similar to those of left valve, no byssal notch. Surface ornamented with concentric growth lines, but without internal radial riblets.

**Comparison:** The left valve of present new species with height distinctly exceeding length, internal radial riblets discontinuing at middle-lower part of valve body, and subequal auricles is very similar to a left valve of *Pecten* (*Propeamussium*) *cowperi* (Waring, 1917, p. 63, pl. 7, fig. 1) found from North America; but the latter bears lower auricles and fewer (only 4–8) internal radial riblets. *Parvamussium kattoi* (Tashiro and Matsuda, 1986, p. 378, pl. 76, figs. 1, 2, 10) and *Parvamussium* sp. (Tashiro, Matsuda and Tanaka, 1985, p. 8, pl. 1, figs. 26, 27) from Japan are also quite similar to the present new species in small size and high outline; but their internal radial riblets extend to ventral margin, therefore they should belong to another subgenus *Parvamussium* of genus *Propeamissium*.

**Locality and horizon:** Section B; lower part of Kangbacunkou Formation.

**Collected number:** ADQ-Bf-48.

**Genus *Camptonectes* Agassiz in Meek, 1864**

**Subgenus *Camptonectes* (*Camptonectes*)**

**Type species:** *Pecten lens* J. Sowerby, 1818

***Camptonectes* (*Camptonectes*) cf. *magnificus* Skwarko**  
(Pl. III, fig. 33)

cf. 1966 *Camptonectes magnificus* Skwarko, p. 85, pl. 2, figs. 1–9.

**Material:** A single external mold of left valve.

**Description:** Shell very small, circular, 12 mm long and 13 mm high. Surface ornamented with fine punctate curved (toward both anterior and posterior margins) striae which forming a  $\Lambda$ -shaped pattern along the central line of valve. Posterior auricle narrowly triangular, ornamented with striae which continuously coming from body of valve; anterior auricle not preserved.

**Comparison:** The present specimen differs from Australian original specimens of *C. (C.) magnificus* (see synonym) in having more circular outline, wider angle of  $\Lambda$ -shaped striae, more curved striae and more distinct puncta on striae. It may be a juvenile of this species.

**Locality and horizon:** Section A; Chaiqiela Formation.

**Collected number:** ADQ-Af-42.

**Genus *Lyropecten* Conrad, 1863**

**Subgenus *Lyropecten* (*Aequipecten*) Fischer, 1887**

**Type species:** *Ostrea opercularis* Linné, 1758

***Lyropecten* (*Aequipecten*) sp. 1**  
(Pl. III, figs. 7, 9)

**Material:** An interior and an internal mold of right valve.

**Description:** Shell small (internal mold 12 mm long, 12 mm high; interior 6.5 mm high, 7 mm long), circular, acclinic, moderately convex. Anterior, ventral and posterior margins all rounded, hinge margin straight, long. Anterior auricle long, its anterior extremity almost equal to anterior margin of valve body, a deep, cuneiform byssal sinus below it; posterior auricle small, its posterior damaged. A pair of auricular crura and cardinal crura separately extending between auricles and body of valve and near hinge margin. A resilifer placed at centre of hinge margin. Surface ornament, adductor scar and pallial impression not preserved at all.

**Discussion:** The present specimens are identical with those of subgenus *L. (Aequipecten)* in having length equal to height, cuneiform byssal sinus, auricular crura and cardinal crura. It is a great pity that its surface ornament is not preserved. Consequentially, it is impossible to give it a species name.

**Locality and horizon:** Section B I; Chaiqiela Forma-

tion and upper part of Kangbacunkou Formation.

**Collected number:** ADQ-Bf-54; ADQ-If-1.

### *Lyropecten* ( *Aequipecten* ) sp. 2

(Pl. III, fig. 31)

**Material:** A single internal mold of left valve.

**Description:** Shell very small, circular except auricles (11 mm long, 11 mm high), aclinic, very weakly convex. Hinge margin straight, its length slightly exceeding  $1/2$  of the length of valve body, cardinal crura not seen (or not existent). Auricles equal, triangular; posterior margin of posterior auricle perpendicular to hinge margin; anterior margin of anterior auricle perpendicular to antero-dorsal margin of valve body. The tracks of numerous fine, weak, concentric and radial lines kept on internal mold.

**Remarks:** The present specimen is comparable to the specimens of subgenus *L.* ( *Aequipecten* ) in circular outline (height not exceeding length); but it differs from the latter by the absence of cardinal crura.

**Locality and horizon:** Section A; upper part of Kangbacunkou Formation.

**Collected number:** ADQ-Af-137a.

### Family Buchiidae Cox, 1953

#### Genus *Aucellina* Pompeckj, 1901

**Type species:** *Avicula gryphaeoides* J. de C. Sowerby, 1836

#### *Aucellina coquandiana* (d'Orbigny)

(Pl. IV, figs. 3—9)

1836 *Avicula gryphaeoides*, Sowerby, p. 335, pl. 11, fig. 3 (non Sedgwick, 1828).

1846 *Inoceramus coquandianus* d'Orbigny, p. 505, pl. 403, figs. 6—8.

1905 *Aucellina gryphaeoides*, Woods, p. 72, pl. 10, figs. 6—13.

1966 *Aucellina gryphaeoides*, Ludbrook, p. 155, pl. 18, figs. 4—6.

1969 *Aucellina coquandiana*, Cox et al., p. N376, figs. C96, 3a—d.

**Material:** Several internal molds of single or conjoined valves and a right exterior.

**Description:** Shell very small (the largest 25 mm high, 20 mm long), very inequivalve. Left valve obliquely arched, height distinctly exceeding length; umbo standing high above the hinge margin; beak pointed, strong incurved, high hanged over umbo of right valve; posterior auricle triangular, slightly broad, not differentiated from body of valve, a broad and shallow groove extending from umbo to postero-ventral margin. Right valve obliquely elliptical, roughly equal in length and height, basically flat from umbo to ventral margin and weakly convex from anterior margin to posterior; umbo pointed, slightly prominent over straight hinge margin; posterior auricle broad, not differentiated from body of valve, anterior auricle

small, quite long, triangular; byssal notch deep, cuneiform; ctenolium, a row of tubercles arranged on antero-dorsal margin (i.e. the inferior margin of byssal notch) can be seen; surface ornamented with rather fine, weak and radial lines, especially in anterior part.

**Locality and horizon:** Section A, G; lower part of Kangbacunkou Formation.

**Collected number:** ADQ-Af-91A, 147, 149; ADQ-Gf-13.

#### *Aucellina hughendenensis* (Etheridge)

(Pl. IV, figs. 15—17)

1872 *Avicula hughendenensis* Etheridge, p. 346, pl. 25, fig. 3.

1907 *Aucellina hughendenensis*, Etheridge jr, p. 321, pl. 58; pl. 61, figs. 7—12.

1966 *Aucellina hughendenensis*, Skwarko, p. 81, pl. 1, figs. 9—12.

1966 *Aucellina hughendenensis*, Ludbrook, p. 155, pl. 18, figs. 3, 7, 8.

**Material:** A complete external mold of right valve and three incomplete exterior and external molds.

**Description:** Shell quite large for the genus, inequivalve. Right valve subcircular, very weakly convex; posterior auricle obtuse, triangular, not differentiated from body of valve; anterior auricle small, arched, byssal notch with ctenolium arranged along both upper and inferior margins of notch very narrow, deep; surface ornament consisting of fine, weakly radial and slightly strong concentric lines. Left valve also circular except umbon, much more convex than right valve, surface also ornamented with very fine, weak radial lines, but concentric lines seem to be weaker than those of right valve.

**Remarks:** This species seems to have a variant range in outline among its individuals from varied places. The present specimens are especially identical with those from the Northern Territory of Australia (Skwarko, 1966, see synonym).

**Locality and horizon:** Section K; Kangbadongshan Formation.

**Collected number:** ADQ-Kf-9, 16.

### Family Plicatulidae Watson, 1930

#### Genus *Plicatula* Lamarck, 1801

**Type species:** *Spondylus plicatus* Linné, 1758

#### *Plicatula himalayensis* sp. nov.

(Pl. IV, figs. 13, 14)

**Material:** An exterior of left valve and an external mold of right valve.

**Description:** Shell very small, elliptical, slightly proclitic, weakly convex. Moderately large attachment area placed in umbonal area. Surface ornamented with about 8 low, rounded (in cross section), indivergent, radial riblets

with flat, long spinules on them (at least on their extremities); riblets gradually narrowing and strengthening from anterior part to posterior. Left valve bearing rather pointed umbo; <sup>9</sup> tubular, indivergent, radial riblets which carrying short, even spinules on their top and also strengthened from anterior part to posterior.

**Discussion:** The two valves (a left and a right) are not the homologue of a same shell, but they must belong to a same species judging by size, outline and especially their 8—9 spiny radial riblets which strengthened from anterior part to posterior. The present new species is quite similar to a specimen of *P. carteroniana* d'Orbigny of France (d'Orbigny, 1847, p. 680, pl. 462, figs. 5—7) in small size, few and indivergent radial riblets which are more or less different in both valves, but the latter can be distinguished from the former in having subcircular outline, angular radial riblets which are equal and even in thickness and distribution. The specimens of England also named *P. carteroniana* d'Orbigny by Woods (Woods, 1901, p. 135, pl. 25, figs. 5—12) bear higher and more oblique outline and commonly divergent radial riblets, so can be distinctly distinguished from new species.

**Locality and horizon:** Section B; upper part of Kangbacunkou Formation.

**Collected number:** ADQ-Bf-53, 54.

## Family Limidae Rafinesque, 1815

### Genus *Pseudolimea* Arkell, 1932

**Type species:** *Plagiostoma duplicata* J. de C. Sowerby, 1827

### *Pseudolimea duodecicostata* sp. nov.

(Pl. IV, figs. 1, 2)

**Material:** Two external molds of right valve.

**Description:** Shell medium-sized for the genus, obliquely elliptical, distinctly opisthoclinic, moderately convex. Hinge margin short and straight, other margins rounded. Surface ornamented with about 12 angular principal radial ribs as wide as intervals, about 12 fine radial riblets separately placed in the grooves between each two principal ribs, and also about 12 fine riblets placed on anterior part and anterior auricle; in addition, numerous fine, even and concentric lines covering all the surface of valves.

**Comparison:** The present new species is characterized by few radial ribs. European *P. parallela* (Sowerby) (Woods, 1904, p. 28, pl. 5, figs. 14, 15) is slightly similar to this new species in outline and few radial ribs; but it can be readily distinguished from the latter by more number (18—20) of radial ribs being lowered, narrowed and rarefied from anterior part to posterior.

**Locality and horizon:** Section K; Kangbadongshan Formation.

**Collected number:** ADQ-Kf-1, 4.

### Genus *Limatula* Wood, 1839

**Type species:** *Pecten subauriculata* Montagu, 1808

### *Limatula* cf. *persimilis* Stoliczka

(Pl. IV, fig. 12)

cf. 1871 *Radula* (*Limatula*) *persimilis* Stoliczka, p. 420, pl. 29, figs. 4, 5.

**Material:** An almost complete exterior of right valve.

**Description:** Shell small (18 mm high, 12 mm long), obliquely elliptical, distinctly opisthoclinic, weakly convex. Middle part of surface ornamented with 15 narrow principal radial riblets separated by wider intervals than themselves, and several intercalated secondary riblets appearing in ventral margin; in addition, two or three very fine and weak radial lines placed after the principal riblets; radial ornament entirely disappeared in posterior surface where irregular concentric fold developed.

**Comparison:** The present specimen is close to those of *Radula* (*Limatula*) *persimilis* Stoliczka (see synonym) in outline and surface ornament; it differs from the latter only in smaller size.

**Locality and horizon:** Section A; Chaqiela Formation.

**Collected number:** ADQ-Af-28.

## Family Gryphaeidae Vyalov, 1936

### Subfamily Pycnodonteinae Stenzel, 1959

### Genus *Pycnodonte* Fischer de Waldheim, 1835

### Subgenus *Pycnodonte* (Phygraea) Vyalov, 1936

**Type species:** *Gryphaea* (*Gryphaea*) sec. *Phygraea frauscheri* Vyalov, 1936

### *Pycnodonte* (Phygraea) *gambaensis* sp. nov.

(Pl. V, figs. 1—4)

1976 *Pycnodonte* (*Phygraea*) cf. *vesiculosa*, Wen et al., p. 124, pl. 32, fig. 4; pl. 36, figs. 4, 5.

**Material:** Two left valves with incomplete ventral part; two internal molds of right valves.

**Description:** Shell small to medium-sized, inequilateral, strong inequivalve. Left valve arched, height about twice the length; a arched area extending from umbo to middle part of ventral margin, and sloping down to anterior and posterior margins by steep slopes; radial posterior sulcus broad, shallow and posterior flange auricular; umbo incurved, rising well above hinge line; attachment area

small, at the top of umbo; ligament area quite low, within a small limits below umbo; umbonal cavity wide, shallow. Right valve vertically subtriangular (height distinctly exceeding length), slightly convex. Chomata consisting of 3—5 horizontal, short ridges placed at the upper commissural borders, i.e. after and before umbonal cavity of both valves. Commissural shelf surrounding internal ventral border.

**Comparison:** The present new species can be distinguished from *P. (P.) vesiculosa* (Sowerby) (Wen *et al.*, 1976, p. 123, pl. 35, figs. 5—10) derived from the same area and horizon, by higher shape, much more prominent umbo of left valve, more developing commissural shelf and more distinct chomata. The species *Gryphaea oldhami* (Noetling, 1897, p. 1, pl. 1, figs. 1—3) of Pakistan is very similar to our new species in shape, but its posterior radial sulcus and posterior flange are all poorer in development and especially the ligamental area is much higher than that of our new species.

**Locality and horizon:** Section B; upper part of Kangbacunkou Formation.

**Collected number:** ADQ-Bf-53.

## Family Trigoniidae Lamarck, 1819

### Genus *Nototrigonia* Cox, 1952

#### Subgenus *Nototrigonia* (*Nototrigonia*)

**Type species:** *Trigonia cinctuta* Etheridge, 1902

#### *Nototrigonia* (*Nototrigonia*) *himalayensis* sp. nov.

(Pl. V, figs. 7, 8)

1976 *Laevitrigonia cf. cardiniiformis*, Gu *et al.*, p. 50, pl. 43, fig. 25.

1976 *Laevitrigonia cardiniiformis*?, Wen *et al.*, p. 75, pl. 17, fig. 12.

**Material:** An internal mold of left valve and an incomplete external mold of left valve.

**Description:** Shell small for the genus, length exceeding height, moderately convex. Umbo low, nearly terminal. Anterior margin rounded, ventral and dorsal margins a little convex, postero-ventral angle pointedly rounded. Oblique ribs substraight, rounded in cross-section, limited in upper part of wide flank, counted up to 8; upper 4 of them extending to posterior margin of flank, and swelling into prominent tubercles at their extremities; the others not extending to posterior margin of flank and without tubercles at their extremities. No oblique ribs on antero-ventral surface where only concentric growth-lines developed. Sulcus smooth, shallowly arched in cross section, extending from narrow to wide from umbo to postero-ventral margin where a sinus formed. Area narrow, forming a 130° angle with sulcus, a median groove dividing the area into different two portions; the portion near ventral side is wider

than the portion near dorsal side, one radial riblet on each portion. Escutcheon carina very distinct, with some tubercles on its top; three very fine radial threads on escutcheon except growth-lines. Dentition trigonid formula. Anterior and posterior adductor scars clear; a small but distinct retractor scar placed above the posterior one.

**Discussion:** The internal and external molds are not the homologue of a same individual, but they come from the same horizon and show no difference from each other in outline (judging by concentric growth-lines), shallow arched sulcus, postero-ventral sinus and the angle between sulcus and area, so it is undoubted that both specimens belong to a same species. The present new species is characterized by rounded anterior margin and pointedly rounded posterior margin, shallowly arched sulcus, postero-ventral marginal sinus, oblique ribs limited in upper part of flank, rare radial riblets in area and escutcheon carina with tubercles. This new species and *N. (N.)* sp. 1 all belong to a same group that their oblique ribs are limited in a narrow area, i.e. the antero-dorsal part of a shell. The former can be differentiated from the latter by rounded anterior part and pointedly rounded posterior part and wider limits occupied oblique ribs with tubercles at their extremities in part. The other species of *N. (Nototrigonia)* are all provided with oblique ribs or combination of oblique and concentric ribs occupying whole flank in the main, and can be evidently differentiated from the present new species.

**Locality and horizon:** Section A; Chaqiela Formation.

**Collected number:** ADQ-Af-6.

#### *Nototrigonia* (*Nototrigonia*) sp. 1

(Pl. V, figs. 5, 6)

1976 *Laevitrigonia cf. cardiniiformis*, Gu *et al.*, p. 50, pl. 43, figs. 23, 24, 28.

1976 *Laevitrigonia cardiniiformis*?, Wen *et al.*, p. 75, pl. 17, figs. 13, 17.

**Material:** An internal mold of left valve and its external mold with incomplete postero-ventral part.

**Description:** Shell medium-sized, length much exceeding height. Umbo subterminal. Flank wide, most part of surface ornamented with concentric growth-lines and 4—5 laps of concentric ridges, 4 short oblique ribs extending in antero-dorsal area. Marginal carina low-rounded, ornamented with concentric growth ridges. Sulcus quite broad, flat, shallow and smooth. Area very narrow, even a little narrower than sulcus and forming an about 110° angle with sulcus; the postero-upper part of area damaged but its inferior part complete, there two fine and rolling radial

ribs (by extrusion) on the middle-upper part before median groove and one after median groove, only numerous transverse lines on the lower part of area. Dentition trigonid formula. Anterior and posterior adductor scar and pedal retractor scar all distinct.

**Locality and horizon:** Section A; Chaqiela Formation.

**Collected number:** ADQ-Af-1.

### *Nototrigonia* (*Nototrigonia*) sp. 2

(Pl. V, fig. 13)

**Material:** A single almost complete internal mold of left valve.

**Description:** Mesium-sized shell, horizontally long cuneiform outline with rounded anterior and antero-dorsal margins, slightly convex ventral margin, long and straight postero-dorsal margin and narrowly rounded posterior margin, weak convexity. Umbo nearly terminal. Flank quite broad. Sulcus broad flat, shallow and smooth. Upper part of marginal carina angularly prominent; lower part lowly rounded in cross section, the angle between sulcus and area about  $120^\circ$ . Area quite narrow, Dentition trigonid formula.

**Remarks:** The present specimen is slightly similar to those of *N.* (*N.*) sp. 1 in elongate outline and shallow, flat and somewhat broad sulcus, but its umbo more anterior, postero-dorsal margin longer and more straight. It is rather difficult for the author to give a species name for the lack of surface ornament, especially oblique ribs in the present specimen.

**Locality and horizon:** Section A; Chaqiela Formation.

**Collected number:** ADQ-Af-30.

### Family Astartidae d'Orbigny, 1844

#### Subfamily Astartinae d'Orbigny, 1844

#### Genus *Astarte* J. Sowerby, 1816

#### Subgenus *Astarte* (*Astarte*)

**Type species:** *Venus scotica* Maton et Rackett, 1807

### *Astarte* (*Astarte*) sp.

(Pl. IV, figs. 10, 11)

**Material:** Two external molds of a same shell with incomplete postero-ventral part.

**Description:** Shell circular, weakly convex (by flattening). Umbo prosoclinic, a narrow and long lunule (a shallow concave) before it. Concentric ridges even, highly prominent and narrow (its breadth about  $1/3-1/2$  of flat interval), about 15 laps altogether; in addition, about 4 fine concentric lines placed in the intervals between each

two concentric ridges. Even inner marginal denticulations can be seen from antero-dorsal margin to ventral margin.

**Locality and horizon:** Section A; Chaqiela Formation.

**Collected number:** ADQ-Af-36.

### Genus *Astartoides* Wen et Lan, 1976

**Type species:** *Astartoides gangbaensis* Wen et Lan, 1976

**Diagnosis:** Shell small, circular or subcircular, equivalve, subequilateral, weakly or moderately convex; umbo prosoclinic and slightly front, beak prosogyrate; lunule distinct; surface ornamented with irregular concentric lines and ridges. Hinge with 2 cardinals (a broad, another thin) on each valve, the broad one being front in left valve and posterior in right valve, the median cardinal is on left valve; laterals differently developing, one posterior lateral on each valve at least, one anterior lateral usually on left valve. Posterior adductor scar larger than anterior one, all vertically ovate; pallical sinus not seen; umbonal cavity very shallow, with the result that the cast of hinge on internal molds can be exposed at all; a very deep, small cave, i.e. the scar of pedal elevator muscle placed at the top of umbonal cavity, and represented by a thornlike umbonal protuberance on internal molds; inner margin smooth.

**Discussion:** The deep scar of pedal elevator is a stable and common characteristic for every individual of *Astartoides*, and it is unique for Astartidae, but this genus should be still assigned to Astartidae according to its shape, umbo, ornament and basic dental formula. It can be distinguished from *Astarte* by poorer cardinals, very shallow umbonal cavity, very deep scar of pedal elevator muscle and the absence of inner marginal denticulations.

**Notes:** The umbonal protuberance on internal molds is so high to the extent that its height (when complete) can reach  $1/2-2/3$  of shell thickness. So it is easy damaged, and usually only its rootage can be preserved.

**Age and distribution:** Early Cretaceous. South Xizang (Tibet), China.

### *Astartoides gangbaensis* Wen et Lan

(Pl. V, figs. 11, 12)

1976 *Astartoides gangbaensis* Wen et Lan, in Gu et al., p. 87, pl. 44, figs. 11, 12.

1976 *Astartoides gambaensis*, Wen et al., p. 84, pl. 19, figs. 8, 9.

1987 *Astartoides gambaensis*, Gou, p. 163, pl. 1, figs. 37, 38.

**Material:** A single internal mold of right valve.

**Description:** Shell small (9.5mm long, 9mm high), subcircular, antero-ventral margin rounded, slightly pro-

truded; umbo pointed, prosoclinic, prominent over hinge line; lunule deep. Other characteristics coincided with the genus diagnosis.

**Locality and horizon:** Section A; Chaqiela Formation.

**Collected number:** ADQ-Af-29.

### *Astartoides dingriensis* Wen

(Pl. V, fig. 14)

1976 *Astartoides dingriensis* Wen, Wen *et al.*, p. 84, pl. 19, figs. 4—6.

**Material:** A single internal mold of right valve.

**Description:** Shell small (12.5 mm high, 12 mm long), circular; umbo slightly broad, not prosoclinic, lunule shallow; hinge plate narrower than that of *A. gambbaensis*. Other characteristics identical with genus diagnosis.

**Locality and horizon:** Section A; Chaqiela Formation.

**Collected number:** ADQ-Af-29.

### Subfamily Eriphyllinae Chavan, 1952

#### Genus *Astartemya* Stephenson, 1941

#### Subgenus *Astartemya* (Freiastarte) Chavan, 1952

**Type species:** *Astarte coelata* Müller, 1847

### *Astartemya* (Freiastarte) planissima (Forbes)

(Pl. V, fig. 9)

1846 *Astarte planissima* Forbes, p. 143, pl. 15, fig. 23.

1847 *Astarte coelata* Müller, p. 22, pl. 2, fig. 3.

1871 *Gouldia planissima*, Stoliczka, p. 289, pl. 10, fig. 3.

**Material:** A single internal mold of right valve.

**Description:** Shell very small (6 mm long, 5.5 mm high), subtriangular, weakly convex. Antero-dorsal margin concave, postero-dorsal margin substraight, ventral margin obtusely rounded, anterior and posterior margins all slightly rounded. 7 high prominent concentric ridges kept on internal mold, and separated by intervals equal in breadth. Umbonal cavity very shallow, with the result that the cast of the large, triangular cardinal 2 and thin 3a, 3b on internal mold can be exposed at all.

**Comparison:** The present specimen is closely similar to the specimen from the Ootatoor Group of South India (Stoliczka, 1871, p. 289, pl. 10, fig. 3) in small size, subtriangular shape and high prominent concentric ridges except for slightly weaker convexity (maybe by flattening).

**Locality and horizon:** Section A; Chaqiela Formation.

**Collected number:** ADQ-Af-42.

### Family Tellinidae de Blainville, 1814

#### Subfamily Tellininae de Blainville, 1814

#### Genus *Linearia* Conrad, 1860

#### Subgenus *Linearia* (Linearia)

**Type species:** *Linearia metastrata* Conrad, 1860

### *Linearia* (Linearia) gieumalensis sp. nov.

(Pl. V, fig. 10)

1914 *Tellina* cf. *strigata*, Spitz, p. 204, pl. 18, fig. 18.

**Material:** A single internal mold of left valve with remaining piece of shell around margins.

**Description:** Shell very small (6 mm long, 5 mm high), horizontally elliptical, quite equilateral, weakly and evenly convex. Umbo central, more or less broad, prominent over hinge line. Anterior and posterior margins rounded and equal in height; ventral margin obtusely rounded; antero-dorsal and postero-dorsal margins all oblique, substraight and equal in length. Posterior ridge low but distinct. Surface covered with concentric growth-lines; radial ornament not seen. Dentition, adductor scars and pallial impression not exposed.

**Comparison:** The present specimen is identical with that described by Spitz (1914) under the name *Tellina* cf. *strigata* in all characteristics except smaller size. This specimen is much shorter than that of *Tellina strigata* (Goldfuss, 1840, pl. 147, fig. 18) of Aachen, Germany. It resembles ? *Palaeomoera* ? *mariaeburiensis* (Etheridge) of Australia (Skwarko, 1967, p. 22, pl. 4, figs. 6, 7, 9) in some ways, including the lack of radial ornament, but it can be distinguished from the latter by shorter shape and more distinct posterior ridge. The new species also resembles *Linearia cornea* Casey (Casey, 1961, p. 581; Woods, 1907, p. 175, pl. 27, fig. 9) and the specimens named *Tellina* (*Linearia*) sp. (Woods, 1907, p. 177, pl. 27, figs. 14—16), but it differs from the latter two in having shorter shape and more distinct posterior ridge. *Linearia* (*Linearia*) is always ornamented with some radial lines on its anterior and posterior surfaces. It is possible that the lack of such radial lines in the Himalayan specimens is resulted from damaging.

**Locality and horizon:** section A; Chaqiela Formation.

**Collected number:** ADQ-Af-36.

### Family Icanotiidae Casey, 1961

#### Genus *Icanotia* Stoliczka, 1870

**Type species:** *Psammobia impar* Zittel, 1865

### *Icanotia xizangensis* sp. nov.

(Pl. V, figs. 15—17)

**Material:** Two internal molds of left valves and one internal mold of right valve.

**Description:** Shell small to medium sized (the largest 31 mm long, 13 mm high; other two all 25 mm long, 11 mm high), long-horizontally elliptical, very weakly convex to subflat. Umbo broad, low, not protruding over hinge margin, placed at  $1/4-1/3$  of shell length behind anterior extremity. Postero-dorsal and ventral margins straight, parallel each other; antero-dorsal margin short and oblique; posterior margin higher than anterior margin, all rounded. Shell thin. Some very weak radial and concentric lines kept on internal molds. Dentition not seen. Anterior adductor scar obliquely ovate; posterior one larger, weak, obliquely elliptical. Pallial impression not preserved.

**Comparison:** In outline and size, the present new species (height about 44% of length) is quite similar to *I. impar* (Zittel) (Zittel, 1913, p. 494, fig. 814) and *I. elicita* (Stoliczka, 1870, p. 168, pl. 4, fig. 16), but it differs from them in having a shorter shape, lower anterior part and more oblique antero-dorsal margin.

**Locality and horizon:** Section K; Kangbadongshan Formation.

**Collected number:** ADQ-Kf-4, 5.

## Family Tancrediidae Meek, 1864

### Genus *Tancredia* Lycett, 1850

**Type species:** *Tancredia donaciformis* Lycett, 1850

### *Tancredia?* *dingriensis* (Wen)

(Pl. VI, figs. 1-5)

1982 *Quenstedtia?* *dingriensis* Wen, p. 231, pl. 1, figs. 1-4.

1987 *Thracia longusa* Gou, p. 158, pl. 4, figs. 26, 27.

**Material:** A left and a right exteriors and three internal molds of single or conjoined valves.

**Description:** This is a synthetical description based on reexamination of the type specimens described in 1982 and examination of the present specimens. Shell medium to slightly large, horizontally subelliptical (posterior part more or less pointedly rounded), equivalve, inequilateral, weakly convex. Umbo pointed, prosodonic, placed at about  $2/5$  of shell length behind anterior extremity. Posterior umbonal carina rounded (in cross section), extending from umbo to upper part of posterior margin. Escutcheon narrow, long, forming a right angle with main surface. Surface covered with concentric growth lines.

Cardinal formula as  $\frac{3a}{2} \frac{3b}{4b}$ ; 2 large, triangular, high prominent, bending upward at extremity; 4b small, low, laminal backward oblique; 3a and 3b all laminal,

separately forward and backward oblique. One anterior lateral on each valve; posterior lateral poorly developed, only one cast seen on a right internal mold. Opisthodontic, ligamental area somewhat broad, behind 4b. Anterior adductor scar vertically ovate, smaller than circular posterior one; they separately placed near extremities. Pallial sinus rounded, moderately deep.

**Discussion:** *Quenstedtia?* *dingriensis* (Wen, 1982) established with the specimens collected from a bed of calcareous sandstone (then included in the middle Jurassic) of the Dingri Area. It is now ascertained that the sandstone belongs to Early Cretaceous (Aptian-Albian), not Jurassic, and an equivalent bed also exists in the Gamba Area and contains same bivalve fossils.

The present specimens are identical with those of *Tancredia* in number and form of cardinals; but they differ in having poorly developed posterior lateral, adductor scars nearer extremities rather than dorsal position, distinct pallial sinus and closed posterior margins. Consequently, they are temporarily assigned to *Tancredia* with reservation.

**Locality and horizon:** Section A; Chaqiela Formation.

**Collected number:** ADQ-Af-31; GBQ-1.

## Family Hiatellidae Gray, 1824

### Genus *Panopea* Menard, 1807

**Type species:** *Panopea faujasi* Menard, 1807

### *Panopea xizangensis* sp. nov.

(Pl. VI, figs. 10-14)

1976 *Pleuromya spitiensis*, Wen *et al.*, p. 109, pl. 26, fig. 1; p. 126, pl. 32, fig. 5 (non Holdhaus, 1913).

1987 *Panopea* cf. *gurgitis*, Gou, p. 166, pl. 4, fig. 19.

**Material:** Four almost complete and incomplete internal molds of conjoined valves.

**Description:** This is a synthetical description based on reexamination of the specimens described in 1976 and examination of the present specimens. Shell medium-sized, horizontally elliptical, slightly strong convex. Anterior margins closed and posterior margins gaping; anterior margin slightly convex, forming an about  $90^\circ$  roundly angle with straight, even slightly concave, anterior part of ventral margin; posterior part of ventral margin somewhat convex; posterior margin narrowly round. Umbo broad, prominent over hinge line, placed at about  $2/5$  of shell length behind anterior extremity; beak incurved. Anterior umbonal carina rounded (in cross section), distinctly prominent; posterior umbonal carina not distinct. Surface ornamented with irregular concentric ridges which weak-



ened through anterior umbonal carina. A high prominent tooth just blow beaks on each valve.

**Comparison:** This new species much resembles *P. orientalis* Forbes of South India (Stoliczka, 1870, p. 89, pl. 2, figs. 1–4) in outline, especially straight, even slightly concave anterior part of ventral margin; but the latter differs in having distinctly gaping anterior margins, larger size and fronter umbo. The new species can be distinguished from *P. gurgitis* (Brongn.) (Woods, 1909, p. 222, pl. 35, figs. 9–14; pl. 36, figs. 1–8) by more convex anterior margin, more narrowly rounded posterior margin and more distinct anterior umbonal carina; and from *P. maccoyi* (Moore) of Australia (Moore, 1870, p. 253, pl. 13, fig. 8; Ludbrook, 1966, p. 170, pl. 21, fig. 3; pl. 22, figs. 1–5) by smaller size and weaker concentric ridges.

**Locality and horizon:** Section A; Kangbadongshan and Chaqiela formations.

**Collected number:** ADQ-Af-29, 71.

### *Panopea* sp.

(Pl. VI, fig. 9)

**Material:** A single flattening exterior of left valve.

**Description:** Shell small, horizontally subelliptical. Umbo placed at about 1/3 of shell length behind anterior extremity. Postero-dorsal margin straight, long; antero-dorsal margin short, oblique; anterior margin narrowly rounded and lower than rounded posterior margin; ventral margin slightly convex. Anterior umbonal carina low and gentle; lack of posterior umbonal carina. Surface ornamented with irregular concentric ridges.

**Comparison:** The present specimen somewhat resembles those of *P. xizangensis* sp. nov. in outline; but it can be distinguished from the latter by higher posterior part and fronter umbo.

**Locality and horizon:** Section A; Chaqiela Formation.

**Collected number:** ADQ-Af-36.

## Family Cuspidariidae Dall, 1886

### Genus *Cuspidaria* Nardo, 1840

**Type species:** *Cuspidaria typus* Nardo, 1840

### *Cuspidaria tibetica* sp. nov.

(Pl. VI, figs. 6–8)

**Material:** Two exteriors of right valves and one internal mold of conjoined valves.

**Description:** Shell small (but somewhat large for the genus), equivalve, inequilateral, moderately convex, better closed surround all margins of both valves. Umbo a lit-

tle opisthoclinic, subcentral or slightly posterior; beak incurved. Anterior margin rounded; antero-dorsal and ventral margins all slightly convex; postero-dorsal margin a little concave, and forming an about 80° rounded angle with posterior part of ventral margin. Shell thin, its surface ornamented with fine concentric growth lines. Dentition not seen. Anterior adductor scar subcrescent; posterior or one weak, circular, near posterior extremity of valve. Pallial impression poorly distinct.

### Measure (mm):

specimen	length	height	thickness
110714(paratype)	23	17	13(both valves)
110713(paratype)	25	18	
110715(holotype)	22	16	

**Comparison:** The present specimens are identical with genus diagnosis of *Cuspidaria* in high anterior part, narrowing posterior part, pointedly rounded posterior extremity and subcrescent anterior adductor scar, though the hinge plate is not seen. *C. pulchra* (Sowerby) from the Upper Chalk of England (Woods, 1911, p. 261, pl. 44, figs. 5, 6) slightly resembles our new species in size and outline; but it can be distinguished from the new species by straight and somewhat long antero-dorsal margin, wider antero-dorsal area and even concentric ridges which are weakened toward both sides of valve surface.

**Locality and horizon:** Section A; Chaqiela Formation.

**Collected number:** ADQ-Af-31, GBQ-1.

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- Plate I
- 1, 2. *Yoldioides jurianoides* Li *et* Grant-Mackie
    - 1a. left internal mold,  $\times 2$ ; 1b. hinge,  $\times 5$ ; Col. no. ADQ-Af-35; Reg. no. 110554.
    - 2a. right internal mold; 2b. hinge,  $\times 5$ ; Col. no. ditto; Reg. no. 110555.
  - 3, 4. *Palaeonucula cf. etheridgei* (Ludbrook)
    3. left internal mold; Col. no. ADQ-Af-36; Reg. no. 110556.
    4. ditto; Col. no. ADQ-Af-29; Reg. no. 110557.
  - 5, 6. *Grammatodon (Nanonavis) minum* sp. nov.
    - 5a. right exterior; 5b.  $\times 3$ ; holotype; Col. no. ADQ-If-1; Reg. no. 110558.
    - 6a. left exterior; 6b.  $\times 3$ ; paratype; Col. no. ditto; Reg. no. 110559.
  - 7—13. *Yoldioides sublaevigata* (Gou)
    7. left internal mold; Col. no. ADQ-If-1; Reg. no. 110560.
    8. right internal mold; Col. no. ADQ-Af-34; Reg. no. 110561.
    9. left internal mold,  $\times 3$ ; Col. no. ADQ-Kf-4; Reg. no. 110562.
    10. ditto; Col. no. ADQ-Kf-3; Reg. no. 110563.
    11. right interior; Col. no. ADQ-Kf-4; Reg. no. 110564.
    12. left internal mold; Col. no. ADQ-Kf-9; Reg. no. 110565.
    13. right internal mold; Col. no. ADQ-If-1; Reg. no. 110566.
  14. *Spyridoceras*? sp.
    - left exterior  $\times 2$ ; Col. no. ADQ-Bf-48C; Reg. no. 110567.
  15. *Sergipia*? sp.
    - right internal mold,  $\times 5$ ; Col. no. ADQ-Bf-48A; Reg. no. 110568.
  - 16—18. *Inoceramus (Mytiloceras?)* sp.
    16. right internal mold; Col. no. ADQ-Af-5; Reg. no. 110569.
    17. ditto; Col. no. ditto; Reg. no. 110570.
    18. left internal mold (fragment); Col. no. ditto; Reg. no. 110571.
  - 19—26. *Nuculana* sp.
    19. right internal mold,  $\times 3$ ; Col. no. ADQ-Hf-1; Reg. no. 110572.
    20. ditto,  $\times 5$ ; Col. no. ditto; Reg. no. 110573.
    21. right exterior,  $\times 3$ ; Col. no. ADQ-Af-31; Reg. no. 110574.
    22. ditto,  $\times 3$ ; Col. no. ditto; Reg. no. 110575.
    23. right internal mold,  $\times 5$ ; Col. no. ADQ-Hf-1; Reg. no. 110578.
    24. left internal mold,  $\times 3$ ; Col. no. ADQ-Af-7; Reg. no. 110579.
    25. right internal mold,  $\times 5$ ; Col. no. ADQ-Hf-1; Reg. no. 110580.
    26. left internal mold,  $\times 5$ ; Col. no. ditto; Reg. no. 110581.
- Plate II
1. *Inoceramus (Cremnoceras?)* sp.
    - 1a. right internal mold; 1b. dorsal view; 1c. anterior view; 1d. postero-dorsal view; 1e. left internal mold; Col. no. ADQ-Af-32; Reg. no. 110582.
  - 2—11. *Grammatodon (Nanonavis) sinensis* Li *et* Grant-Mackie

## Explanation of Plates

All the figures are photoed with natural size unless otherwise stated.

The figured specimens are all deposited in Nanjing Institute of Geology

2. right internal mold,  $\times 2$ ; Col. no. ADQ-Af-29; Reg. no. 110583.
3. ditto,  $\times 5$ ; Col. no. ditto; Reg. no. 110584.
4. left external mold; Col. no. ADQ-Af-71; Reg. no. 110586.
5. ditto; Col. no. ditto; Reg. no. 110587.
6. left internal mold,  $\times 5$ ; Col. no. ADQ-Af-29; Reg. no. 110585.
- 7a. left external mold,  $\times 3$ ; 7b. latex cast (left exterior)  $\times 3$ ; Col. no. ditto; Reg. no. 110588.
8. right internal mold; Col. no. ditto; Reg. no. 110589.
9. dorsal view of external mold of conjoined valves,  $\times 5$ ; Col. no. ditto; Reg. no. 110590.
10. right external mold; Col. no. ADQ-Af-63; Reg. no. 110591.
11. left internal mold; Col. no. ADQ-Af-29; Reg. no. 110592.
- 12—14. *Eyrena linguloides* (Hudleston)
12. left internal mold; Col. no. ADQ-Af-23; Reg. no. 110593.
- 13a. right internal mold; 13b. left internal mold; 13c. posterior; Col. no. ditto; Reg. no. 110594.
- 14a. right internal mold; 14b. left internal mold; 14c. anterior view; 14d. posterior; Col. no. ADQ-Af-32A; Reg. no. 110595.
- 15—17. *Maccoyella cf. substriata* (Moore)
15. left internal mold,  $\times 3$ ; Col. no. ADQ-Hf-1; Reg. no. 110596.
16. left external mold,  $\times 3$ ; Col. no. ditto; Reg. no. 110597.
17. left internal mold (being the homologue of a same valve with fig. 16),  $\times 3$ ; Col. ditto; Reg. no. 110598.

### Plate III

- 1—6. *Meleagrinnella dongshanensis* Li et Grant-Mackie
1. left external mold; Col. no. ADQ-Af-25; Reg. no. 110650.
2. right internal mold; Col. no. ADQ-Af-31; Reg. no. 110576.
3. right internal mold,  $\times 2$ ; Col. no. ADQ-Hf-1; Reg. no. 110651.
4. left internal mold; Col. no. ADQ-Hf-1; Reg. no. 110655.
5. right internal mold; Col. no. ditto; Reg. no. 110663.
- 6a. left internal mold; 6b. showing ligamental area,  $\times 10$ ; Col. no. ADQ-Af-25; Reg. no. 110654.
- 7, 9. *Lyropecten (Aequipecten)* sp. 1
- 7a. right internal mold,  $\times 2$ ; 7b. hinge showing resilifer,  $\times 5$ ; Col. no. ADQ-Hf-1; Reg. no. 110643.
- 9a. right interior,  $\times 2$ ; 9b. latex cast (right internal mold),  $\times 2$ ; Col. no. ADQ-Bf-54; Reg. no. 110644.
8. *Entolium cf. mangqiongense* Wen et Lan
- left external mold; Col. no. ADQ-Hf-1; Reg. no. 110648.
10. *Syncyclonema gibsonia* Skwarko
- right internal mold; Col. no. ADQ-Af-1; Reg. no. 110647.
- 11—22. *Meleagrinnella superstes* (Spitz)
11. right internal mold,  $\times 3$ ; Col. no. ADQ-Af-17; Reg. no. 110616.
12. ditto,  $\times 2$ ; Col. no. ADQ-Af-8; Reg. no. 110620.
13. right internal mold,  $\times 3$ ; Col. no. ADQ-Af-17; Reg. no. 110613.
14. right internal mold,  $\times 2$ ; Col. no. ADQ-Af-24; Reg. no. 110634.
15. ditto,  $\times 3$ ; Col. no. ADQ-Af-24; Reg. no. 110626.

16. ditto,  $\times 2$ ; Col. no. ADQ-Af-4; Reg. no. 110627.
17. ditto,  $\times 2$ ; Col. no. ADQ-Af-8; Reg. no. 110622.
18. left external mold; Col. no. ditto; Reg. no. 110631.
19. right internal mold; Col. no. ADQ-Hf-1; Reg. no. 110632.
20. right internal mold; Col. no. ADQ-Af-24; Reg. no. 110619.
21. ditto,  $\times 2$ ; Col. no. ADQ-Af-9; Reg. no. 110623.
22. two right internal molds and one left exterior (see figs. 12, 17); Col. no. ADQ-Af-8; Reg. no. 110620—110622.
- 23—27. *Propeamussium (Propeamussium) tibetense* sp. nov.
23. right exterior (?),  $\times 5$ ; paratype; Col. no. ADQ-Bf-48; Reg. no. 110669.
- 24a. left internal mold; 24b.  $\times 3$  holotype; Col. no. ditto; Reg. no. 110670
25. left exterior,  $\times 3$ ; paratype; Col. no. ditto; Reg. no. 110671.
26. left external mold,  $\times 3$ ; paratype; Col. no. ditto; Reg. no. 110673.
27. left exterior,  $\times 3$ ; paratype; Col. no. ditto; Reg. no. 110672.
28. *Maccoyella reflacta* (Moore)
- 28a. left external mold; 28b. latex cast (left exterior); Col. no. ADQ-Hf-1; Reg. no. 110646.
- 29, 30, 32. *Syncyclonema territorianum* Skwarko
29. left interior; Col. no. ADQ-Hf-3; Reg. no. 110636.
30. right internal mold,  $\times 2$ ; Col. no. ADQ-Hf-3; Reg. no. 110639.
- 32a. left interior; 32b. latex Cast (left internal mold); Col. no. ditto; Reg. no. 110640.
31. *Lyropecten (Aequipecten)* sp. 2
- left internal mold,  $\times 2$ ; Col. no. ADQ-Af-137a; Reg. no. 110645.
33. *Camptonectes (Camptonectes) cf. magnificus* Skwarko
- left external mold,  $\times 3$ ; Col. no. ADQ-Af-42; Reg. no. 110674.

### Plate IV

- 1, 2. *Pseudolimea duodecicostata* sp. nov.
- 1a. right external mold; 1b. showing surface ornament,  $\times 5$ ; 1c. latex cast (right exterior); paratype; Col. no. ADQ-Kf-1; Reg. no. 110675.
2. right external mold; holotype; Col. no. ADQ-Kf-4; Reg. no. 110676.
- 3—9. *Aucellina coquandiana* (d'Orbigny)
- 3a. posterior,  $\times 1.2$ ; 3b. right internal mold,  $\times 1.2$ ; 3c. left internal mold,  $\times 1.2$ ; Col. no. ADQ-Gf-13; Reg. no. 110677.
4. left internal mold,  $\times 2$ ; Col. no. ADQ-Af-149; Reg. no. 110678.
- 5a. right exterior,  $\times 5$ ; 5b. showing ctenidium,  $\times 10$ ; Col. no. ADQ-Af-147; Reg. no. 110679.
- 6a. right internal mold; 6b. showing anterior auricle,  $\times 10$ ; Col. no. ADQ-Gf-13; Reg. no. 110680.
7. left internal mold; Col. no. ditto; Reg. no. 110681.
- 8a. ditto,  $\times 2$ ; 8b. posterior,  $\times 2$ ; 8c. right internal mold,  $\times 2$ ; 8d. showing anterior auricle,  $\times 10$ ; Col. no. ADQ-Af-91; Reg. no. 110682.

9. left internal mold,  $\times 2$ ; Col. no. ADQ-Af-149; Reg. no. 110683.
- 10, 11. *Astarte* (*Astarte*) sp.  
10. right external mold; Col. no. ADQ-Af-36; Reg. no. 110684.  
11. left external mold; Col. no. ditto; Reg. no. 110685.
12. *Limatula* cf. *persimilis* Stoliczka  
right exterior,  $\times 2$ ; Col. no. ADQ-Af-28; Reg. no. 110686.
- 13, 14. *Plicatula himalayensis* sp. nov.  
13a. right external mold,  $\times 2$ ; 13b. latex cast (right exterior)  $\times 2$ ; paratype; Col. no. ADQ-Bf-54; Reg. no. 110687.  
14. left exterior; holotype; Col. no. ADQ-Bf-53; Reg. no. 110688.
- 15—17. *Aucellina hughendenensis* (Etheridge)  
15a. anterior part of right external mold; 15b. showing ctenolium,  $\times 10$ ; Col. no. ADQ-Kf-16; Reg. no. 110689.  
16. a right external mold and a left exterior; Col. no. ditto; Reg. no. 110690.  
17a. right external mold; 17b. showing anterior auricle,  $\times 5$ ; Col. no. ADQ-Kf-9; Reg. no. 110691.

## Plate V

- 1—4. *Pycnodonte* (*Phygraea*) *gambaensis* sp. nov.  
1a. left exterior,  $\times 3$ ; 1b. left interior, 1c.  $\times 3$ ; 1d. showing ligamental area,  $\times 5$ ; holotype; Col. no. ADQ-Bf-53; Reg. no. 110692.  
2. right internal mold; Col. no. ditto; Reg. no. 110693.  
3. ditto; paratype; Col. no. ditto; Reg. no. 110694.  
4a. left exterior; 4b. left interior; paratype; Col. no. ditto; Reg. no. 110695.
- 5, 6. *Nototrigonia* (*Nototrigonia*) sp. 1  
5. left internal mold; Col. no. ADQ-Af-1; Reg. no. 110696.  
6a. left external mold; 6b. latex cast (left exterior); Col. no. ditto; Reg. no. 110697.
- 7, 8. *Nototrigonia* (*Nototrigonia*) *himalayensis* sp. nov.  
7. left internal mold; paratype; Col. no. ADQ-Af-6; Reg. no. 110698.  
8a. left external mold; 8b. latex cast (left exterior); holotype; Col. no. ditto; Reg. no. 110699.
9. *Astartemya* (*Freiastarte*) *planissima* (Forbes)  
right internal mold,  $\times 3$ ; Col. no. ADQ-Af-42; Reg. no. 110700.
10. *Linearia* (*Linearia*) *gieumalensis* sp. nov.  
left internal mold with remaining piece of shell around margins,  $\times 3$ ; holotype; Col. no. ADQ-Af-36; Reg. no. 110701.
- 11, 12. *Astartoides gangbaensis* Wen et Lan  
11. right internal mold,  $\times 3$ ; Col. no. ADQ-Af-29; Reg. no. 110702.  
12. ditto. holotype (quoted from Gu et al. 1976); Reg. no.

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13. *Nototrigonia* (*Nototrigonia*) sp. 2  
left internal mold; Col. no. ADQ-Af-30; Reg. no. 110703.
14. *Astartoides dingriensis* Wen  
14a. right internal mold,  $\times 3$ ; 14b. dorsal view,  $\times 3$ ; Col. no. ADQ-Af-29; Reg. no. 110704.
- 15—17. *Icanotia xizangensis* sp. nov.  
15a. left internal mold; 15b.  $\times 3$ ; paratype; Col. no. ADQ-Kf-4; Reg. no. 110705.  
16. ditto; paratype; Col. no. ditto; Reg. no. 110706.  
17a. right internal mold; 17b.  $\times 3$ ; holotype; Col. no. ditto; Reg. no. 110707.

## Plate VI

- 1—5. *Tancredia*? *dingriensis* (Wen)  
1. left internal mold; Col. no. ADQ-Af-31; Reg. no. 110708.  
2a. ditto; 2b. dorsal view; 2c. right internal mold; Col. no. GBQ-1; Reg. no. 110709.  
3. right exterior; Col. no. ADQ-Af-31; Reg. no. 110710.  
4. left exterior; Col. no. ditto; Reg. no. 110711.  
5. ditto; Col. no. GBQ-1; Reg. no. 110712.
- 6—8. *Cuspidaria tibetica* sp. nov.  
6. right exterior; paratype; Col. no. GBQ-1; Reg. no. 110713.  
7a. left internal mold; 7b. dorsal view; 7c. right internal mold; paratype; Col. no. ditto; Reg. no. 110714.  
8. right exterior; holotype; Col. no. ADQ-Af-31; Reg. no. 110715.
9. *Panopea* sp.  
left exterior; Col. no. ADQ-Af-36; Reg. no. 110716.
- 10—14. *Panopea xizangensis* sp. nov.  
10a. left exterior; 10b. right exterior; holotype; locality and horizon: Cagiela pass of Gamba area, Gamba Group; Reg. no. 30915 (quoted from Wen et al., 1976).  
11a. right internal mold; 11b. left internal mold; 11c. dorsal view; 11d. showing hinge,  $\times 5$ ; paratype; Col. no. ADQ-Af-71; Reg. no. 110717.  
12. right internal mold; paratype; Col. no. ditto; Reg. no. 110718.  
13. left internal mold; paratype; Col. no. ADQ-Af-29; Reg. no. 110719.  
14. ditto; paratype; Col. no. ditto; Reg. no. 110720.
- 15—21. *Inoceramya*? *xizangensis* Gu et Lan  
15. right exterior; Col. no. ADQ-Af-129; Reg. no. 110610.  
16. left exterior; Col. no. ditto; Reg. no. 110609.  
17. right exterior; Col. no. ditto; Reg. no. 110608.  
18. left exterior; Col. no. ditto; Reg. no. 110604.  
19. left exterior; Col. no. ditto; Reg. no. 110611.  
20. left exterior; Col. no. ditto; Reg. no. 110600.  
21. left exterior; Col. no. ditto; Reg. no. 110602.

