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中國北部寒武紀動物化石

古生物誌乙種第一號

第四册

孫雲鑄著

中華民國十三年十二月

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CONTENTS:

中國寒武紀動物化石

孫雲鑄著

緒言

中國寒武紀動物化石、外人研究多詳于是紀中下兩期、上寒武紀化石至今尙少研究、民國以來、本所於山東直隸奉天等省之寒武紀地層迭有詳細調查、譚錫疇君安特生博士先後往灤州馬家溝等處採集寒武紀化石多種、其層位較山東之炒米店層爲高、實屬上寒武紀之上部、茲名曰高里層或鳳山層、民國十年春丁文江所長派余與葛利普博士及錢聲駿巴爾博兩君往開平唐山馬家溝一帶研究寒武奧陶兩紀地層、並採集此兩紀化石、歸京後、葛博士擔任研究中國北部奧陶紀動物化石（見葛著 Ordovician Fossils from North China 古生物誌乙種第一卷第一册）余任研究中國北部寒武紀動物化石、是年夏安特生博士因研究奉天錦西縣煤鑛、復得上寒武紀化石多種、產此化石之灰岩下與前寒武系成一間斷、（見 Upper Cambrian Fossils from Fengtien 中國地質學會誌第二卷第二期）民國十二年春、北京大學地質學系古生物學門同學楊鍾健張席禔田奇瑞趙亞曾王恭睦等往山東炒米店泰安大汶口等處實習、由余率領、余藉得研究山東寒武紀地層以與直隸比較、並得次第採集各層化石、濟南炒米店南山上部灰岩產直角石及他種頭足類、並有 Ptychaspis, Eoorthis 及 Dikelocephalinæ 科之 Charngia 新屬同產、此類頭足類化石似屬奧陶紀初期動物、產此殊爲不類、然岩層性質與寒武紀岩層無少差異、且有上寒武紀標準化石 Ptychaspis 證之、時代似當屬上寒武紀、泰安高里山寒武紀化石所中仝人先有所得、余因其性質特異、復親往考察、其所產三葉虫及腕足類等化石

多係新屬及新種、然僅限於該處地層上部、其時代屬上寒武紀上期、其下部岩層似有一部爲竹葉狀礫岩、或屬炒米店層、

大汶口北距泰安五十里、以產蝙蝠石 Drepanura 著、他屬亦有發見、均非新種、

同年秋、余偕北大地質系同學往臨榆開平兩盆地研究地層、並採集中寒武紀及下寒武紀化石、惟新種極少、最近本所趙亞曾田奇璵兩君於直隸臨城發見中寒武紀上期化石、屬崮山期、並見有饅頭頁岩及張夏灰岩兩層、惜未發見化石、產此化石之地層屬中寒武紀上期、上與下奧陶系成一間斷、（即平行不整一）

開灤鑛務局地質技師馬底幼 F. F. Mathieu 君亦曾由灤州等處寄贈寒武紀化石多種、均載入此誌、

是誌所載化石僅限于中國北部、新屬八、新種四十一、

是誌古生物研究葛利普博士殷勤指導、應矢勿諼、本篇編輯如翁文灝章鴻釗何杰諸先生亦嘗有所指示、劉君光誠任繪圖、均深爲感激、謹誌於此、

中國寒武紀化石研究歷史

中國寒武紀化石，首爲德人李希霍芬 Von Richthofen 採集，概爲腕足類及三葉虫兩類，前者經克綏 E. Kayser 鑒定爲下列兩種，

舊名	今名
Orthis linnarssoni Kayser	= Eoorthis linnarssoni Walcott
Lingulella sp.	

後者係德曼 W. Dames 鑒定，共十四種，

Agnostus chinensis Dames	
Dorypyge richthofeni Dames	
Conocephalites frequens Dames	
C. quadriceps Dames	
C. subquadratus Dames	= Anomocare subquadratus Walcott
C. typus Dames	= Ptychoparia typus Walcott
Anomocare latelimbatum Dames	
A. majus Dames	

A. minus Dames

A. nanum Dames

A. planum Dames

A. subcostatum Dames

Liostracus megalurus Dames　　= Anomocare megalurus Walcott

L. talingensis Dames

? Liostracus　（兩種）

兩尾部屬與種名、均不能鑒定、

產上列三葉虫化石爲奉天賽馬集大嶺五路坡三處、德曼曾以此與歐美印度寒武紀化石比較、且謂賽馬集大嶺二處三葉虫羣與斯干的那維亞 Scandinavia 之 Andrarum 灰岩及北美之 Potsdam 層所產者爲同時、惜未採得同種化石、又五路坡產 Dorypyge richthofeni 一種、時代或與美國歐泰省 Utah 之 Quebec 層相當、以該處亦產 Dorypyge 屬故也、

一八八六年、葛特斯 C. Gottsche 于朝鮮東北部渭原等處採集寒武紀化石多種、並謂產此化石之灰岩與斯干的那維亞 Andrarum 灰岩相當、葛氏所定各種名列後、

Anomocare planum Dames

Dorypyge richthofeni Dames　　（亦曾發見于五路坡）

Anomocare majus Dames （亦曾發見於賽馬集）

Lingulella cfr. nathorsti Linnarsson

此外 Theca, Orthis, Lingulella （兩種） Agnostus, Conocephalites, Crepicephalus 及 ? Remnophourides 等屬種名均不易鑒定、

山東奧武紀化石于一八九九年首經皮正龍 M. Bergeron 研究、並鑒定下列六種、

舊名	今名
Agnostus douvilléi Bergeron	
Olenoides leblanci Bergeron	
Drepanura premesnili Bergeron	
Arthricocephalus chauveaui Bergeron	
Dicellocephalus? sinensis Bergeron	= Stephanocare sinensis (Bergeron) Walcott
Calymene? sinensis Bergeron	= Blackwelderia sinensis (Bergeron) Walcott

一九〇三年、麥克 H. Monke 著山東地質誌、並鑒定下列化石、其時代均屬以後所稱爲崮山期者、

Agnostus koerferi Monke

Liostracina krausei Monke

Teinistion lansi Monke

T. sodeni Monke

Drepanura premesnili Bergeron

D. ketteleri Monke

Stephanocare richthofeni Monke

S. sp?

一九〇四年羅倫斯 Th. Lorenz 鑒定類似藻類化石兩種、一爲 Ascosoma phaneroporata Lorenz、一爲 Mitscherlichia chinensis Lorenz、均係新屬且同隸 Ascosomacea 新科、

一九〇五至一九〇六兩年、華可脫 C. D. Walcott 發表中國寒武紀化石論文兩短篇、兼論及美國康迺吉學會調查隊維理士 B. Willis 與勃拉克維達 E. Blackwelder 二氏在華調查之結果、維理士氏等分山東寒武系爲饅頭頁岩及九龍灰岩二部份、而九龍灰岩又自下至上分爲張夏崮山炒米店三層、歷來言中國寒武系者所倚爲不易之標準者也、

一九〇五年、俄德瓦特 H. Woodward 於山東上寒武紀化石三葉虫篇中評論麥根著作、兼論及山東西部及青州府等處三葉虫化石數種、

一九〇六年、勞倫斯 Th. Lorenz 著山東化石誌、所載化石爲彼所採集多屬新屬及新種、並謂萊蕪動物羣可代表瑞典 Andrarum 灰岩底部、且與產 Paradoxides davidus 及 P. forschhammeri 岩層同時、種名列下、

舊名　　今名

舊名	今名
Olenoides (Dorypyge) richthofeni (Dames) Lorenz	= Dorypyge richthofeni Dames, Wal.
Agnostus fallax var. laiwuensis Lorenz	= Agnostus chinensis Dames
A. parvifrons Linnarsson	= A. cf. parvifrons Linnarson
Anomocare commune Lorenz	= Anomocarella chinensis Walcott
Anomocare ovatum Lorenz	= Anomocare temenus Walcott
Alokistocare sp.	
Amphoton steinmanni Lorenz	= Dolichometopus deois Walcott
Ptychoparia (Solenopleura) sp.	= Solenopleura sp.
Hyolithes sp.	
Raphistoma bröggeri Lorenz	= Platyceras willisi Walcott
Acrothele bohemica Barrande	= Acrothele matthewi eryx Wal.

勞氏又謂山東王莊(蒙陰縣附近)化石可分下列三層，下層

舊名

Anomocare speciosum Lorenz

Bathyuriscus asiaticus Lorenz

今名

= Anomocarella speciosa (Lorenz) Wal.

= Dolichometopus deois Wal.

Agnostus fallax Linnarsson	= Agnostus chinensis Dames
Agnostus parvifrons latelimbatus Lorenz	= Agnostus latelimbatus (Lorenz) Walcott
Acrothele granulata Linnarsson	= Acrothele matthewi eryx Walcott
中層	
Teinistion (?) sp.	= Damesella cf. blackwelderi Walcott
Drepanura (?) sp.	= Damesella cf. blackwelderi Walcott
上層	
Shantungia buchruckeri Lorenz	= Chuangia nitida Walcott
Liostracus latus Lorenz	

勞氏於泰安泰山附近採得三葉虫碎片、並定種名爲

舊名	今名
Lioparia blautoeides Lorenz	= Anomocarella baucis Walcott

勞氏又報告山東青州府產下列各種化石、

舊名	今名
Lioparia latelimbata (Dames) Lorenz	= Anomocare latelimbatum Dames
Shantungia monkei Lorenz	= Pagodia monkei (Lorenz) Walcott

Obolella gracilis Lorenz

Orthis sp.

Acrothele sp.

一九二三年華可脫著中國北部寒武紀動物化石最爲詳盡（見 Research in China Vol. III）含下列各類化石有孔虫類一種海綿類二種珊瑚類一種蠕虫類一種腕足類二十六種腹足類十一種鰓足類十一種頭足類一種三葉虫一百七十五種及介形類六種

一九二一年發特生博士自奉天錦西採集上寒武紀化石多種由余鑒定（見 Upper Cambrian Fossils from Fengtien 中國地質學會誌第二卷第二期）種名列下

腕足類

Eoorthis shakuotunensis Sun

三葉虫

舊名	今名
Ptychaspis chinhsihsiensis Sun	= Ptychaspis chinhsiensis Sun
Ptychaspis nodosa Sun	= Ptychaspis walcotti Mansuy
Ptychaspis acamus Walcott	
Ptychaspis cf. campe Walcott	

Ptychaspis sp.

Anomocare leei Sun

一九二三年、余著直隸開平上寒武紀化石、（中國地質學會誌第二卷第二期）多屬新種、分上下兩層、種名列下、

下層（長山層）

三葉虫

Agnostus hoi Sun

Changshania truncata Sun

Changshania conica Sun

Anomocarella transversa Sun

Anomocare cf. minus Dames

Anomocarella sp.

腕足類

Obolus mollisonensis Walcott

Obolus (Bröggeria) salteri (Hall)

Obolus sp.

上層(鳳山層)

三葉虫

舊名	今名
Ceratopyge orientalis Grabau	= Mansuyia orientalis (Grabau) Sun
Anomocare punctatus Sun	
Ptychaspis subglobosa Grabau	
Ptychaspis suni Grabau	
Illaenurus canens Walcott	
Teinistion? sp.	

最近日本青地乙治著大連圖幅地質說明書、論及關東州復州砲台子瓦房店金家城子長興島等處寒武紀化石，種名經鑒定者凡三十八種、(內有一種屬名不能確定六種係與他種比較)均非新種、總之從前華氏等研究中國北部寒武紀動物化石、其標本均採自山東山西及遼東等處、而於直隸各處向未發見、且其時代多屬中寒武及下寒武兩紀、若上寒武紀化石發見尙屬寥寥、近數年來地質調查所於山東奉天直隸各處採集上寒武紀化石甚夥、共得新屬八新種四十一、除 Wongia 一屬屬中寒武紀上期外、餘均屬上寒武紀、由此化石之鑒定、而知于維理氏等所分之張夏崮山炒米店三層外、尙應加入新層、故照現在研究之結果、不特化石種類多所新得、即於地層次序亦應增補、故特先爲紀錄以成此篇、此外江蘇(江北)河南等

省寒武紀地層亦分布頗多、而化石所得尙少、深望後有所得再爲續編、至南方寒武紀地層、惟雲南特多、丁文江所長所採化石、余正在研究中、他日續爲發表、

中國北部之寒武系、分佈於直隸山東山西陝西奉天等省、岩層性質隨處而異、即以上寒武紀而論、南部（山東）多灰岩、北部（直隸）多頁岩及竹葉狀灰岩、東北部（奉天）張夏層之一部爲頁岩、且產 Dorypyge richthofeni 等種、

中國北部寒武系、照現在研究之結果、自上而下可分之如次、

上部層系　下奧陶系

平行不整一層

寒武系

上寒武系

鳳山層（或高里層）（新增）

炒米店層（維理士初定）

中寒武系

崮山層（仝　上）

張夏層（仝　上）

下寒武系

饅頭層（仝　上）

茲復分省詳述如下

直隸省

甲。開平　開平盆地之寒武系、以灤州趙各莊鳳山稱山等處爲發達、岩層自上而下可分之如次、

奧陶系

冶里灰岩

平行不整一層

上寒武系　二百至三百尺

五、鳳山層

四、長山層　一百五十至二百尺

中寒武系

三、崮山層（一部）　〇至五十尺

二、張夏層　三百至四百尺

下寒武系

一、饅頭層　四百至五百尺

震旦系

黑灰岩

饅頭層　此層爲寒武系之最下層、多爲頁岩、呈紫紅色或綠色、常夾有砂質灰岩、灤州及趙各莊均有此層露頭、稱山産下列各種化石、

腕足類

1. Acrothele cheni Sun（新種）
2. Lingulella machuriensis? Walcott
3. Obolus sp.

三葉虫

4. Conokephalina gerardi Sun（新種）
5. Conokephalina kaipingensis Sun（新種）
6. Ptychoparia (Emmrichella) chêngshanensis Sun（新種）
7. Ptychoparia sp.
8. Ptychoparia yohi（新種）
9. Ptychoparia fongi Sun（新種）

張夏灰岩　此層爲鮞狀灰岩及堅質灰岩之互層、趙各莊東北稱山北坡産下列化石、

腕足類

1. Nissusia hayasakai Sun（新種）

三葉虫

2. Solenopleura nodosa Sun (新種)

3. Anomocare flava Walcott

4. Lisania rectangularis Sun (新種)

5. Lisania? hsuchiachuangensis Sun (新種)

6. Damesella blackwelderi var. minor Sun (新種)

7. Dorypyge richthofeni Dames

8. Dolichometopus deois Walcott

9. Crepicephalus sp.

崮山頁岩　或有一部代表此層、惜未發見化石、終難證明、

長山層　此層爲紅紫色頁岩、常夾竹葉狀灰岩七八層、紅頁岩頗似饅頭層、惟化石迥異、且竹葉狀灰岩爲長山層之特徵、化石又多屬新種、顯係新層、考其層位當屬上寒武紀下部、或中寒武紀最上層？余以此層、含有竹葉狀灰岩及 Eoorthis 等化石、暫定此層爲上寒武紀下層、趙各莊北任莊產化石最富、種類列下、

腕足類

1. Obolus mollisonensis? Walcott

2. Eoorthis sp.

三葉虫

3. Changshania conica Sun (新屬新種)

4. Changshania? truncata Sun (新種)

5. Agnostus hoi Sun (新種)

鳳山層　此層爲頁岩及薄層灰岩組成，代表上奧武紀之最上部，以治里村附近鳳山爲最發達，故名鳳山層，此層上與奧陶紀岩層間之間斷極顯，產下列化石，

腕足類

1. Obolus luanhsiensis Grabau (新種)

2. Lingulella kayseri Grabau (新種)

三葉虫

3. Ptychaspis subglobosa Grabau (新種)

4. Ptychaspis suni Grabau (新種)

5. Mansuyia orientalis (Grabau) Sun (新屬新種)

6. Illænurus sp.

7. Anomocare sp.

上列新動物羣中之 Mansuyia orientalis (Grabau) Sun 及 Ptychaspis subglobosa Grabau 兩種、均爲鳳山之特產、亦發見於高里山、又兩處產此同種化石之岩層均爲礫狀灰岩、是其地層時代同隸上寒武紀上部實無疑義、他種 Ptychaspis 及 Illaenurus 屬、兩處均同產之、

乙、臨城　臨城地層層序如次、(見趙亞曾田奇璈直隸臨城地層報告)

上部層系　下奧陶紀

平行不整一層

中寒武系

崮山層　五十至一百尺

張夏灰岩　七百至八百尺

下寒武系

饅頭層　二百至三百尺

平行不整一層

下部層系　前寒武系

僅崮山層發現化石、產下列各種、

腕足類

1. Obolus linchengensis Sun (新種)

三葉虫

2. Wongia triangulata Sun （新屬新種）

3. Blackwelderia tieni Sun （新種）

4. Stephanocare richthofeni Monke

5. Blackwelderia sinensis var. linchengensis Sun （新族）

6. Tienistion subconica Sun （新種）

4 5 爲崮山期之特產、3 6 爲新種、2 爲新屬 Wongia 隸前頰類、爲中國之特產、

山東省

甲・高里山　高里山距泰安城西僅兩里、岩層每爲灰岩礫狀灰岩及頁岩、間有竹葉狀灰岩及鰛狀灰岩、下部極少發見化石、且夾有竹葉狀灰岩、或屬炒米店層之一部、上部多爲礫狀灰岩頁岩及灰岩、全部厚度約一百五十尺、化石層位有四、自下而上列之如左、

最下層

腕足類

1. Syntrophia orthia Walcott

三葉虫

2. Agnostus cyclopygeformis Sun （新種）

3. Kaolishania pustulosa Sun（新屬新種）

4. Mansuyia orientalis (Grabau) Sun（新屬新種）

5. Taianocephalus grabaui Sun（新屬新種）

6. Chuangia batia Walcott

第二層(距第一層高八尺)

腕足類

7. Obolus taianensis Sun（新種）

三葉虫

8. Ptychaspis subglobosa Grabau（新種）

第三層(距第二層高八尺)

三葉虫

8. Ptychaspis subglobosa (Grabau) Sun（新種）

9. Illaenurus pagoda Sun（新種）

最上層(距第三層約高三十七尺)

三葉虫

10. Ptychaspis angulata var. chinensis Sun（新族）

11. Quadraticephalus? convexus Sun (新屬新種)

12. Quadraticephalus walcotti Sun (新屬新種)

華可脫氏定高里山地層爲炒米店層下部、余以此層多爲頁岩及礫狀灰岩組成、迥異炒米店層、層位極高、應另屬一新層、名曰高里層、或高里山層、

Mansuyia orientalis (Grabau) Sun 及 Ptychaspis subglobosa Grabau 二種爲鳳山層之特產、亦爲此層之標準化石、可知鳳山層與高里層實同屬一層已無疑義、

Ptychaspis angulata 曾發見於安南東京上寒武紀之最上層、高里山亦產此種、可知此處地層與安南產此種化石之岩層相當、

Quadraticephalus 新屬隸 Dikelocephalinae 科、盛產北美上寒武紀、中國尙少發見、又從前地質研究所仝人旅行至此曾得筆石一、茲定爲 Clonograptus? cambria、是屬產歐美寒武奧陶過渡層中、中國寒武紀地層從未發見、今於高里山中發現一種、足證此層去奧陶紀地層不遠、

乙・炒米店南山　炒米店爲炒米店層主產地、余於炒米店南山頂部發見一新層、產下列化石、

腕足類

1. Billingsella sp.

頭足類

2. Loxoceras cambria Sun

3. Orthoceras nanshanensis Sun

上列兩種將於古生物誌專論之

三葉虫

4. Changia chinensis Sun（新屬新種）

5. Ptychaspis acamus var. punctata Sun（新族）

6. Ptychaspis (Anderssonia) tani Sun（新種）

5爲上寒武紀標準化石、2 3 兩種似屬奧陶紀、4 6 均新屬及新種、余以此層產 Ptychaspis acamus、似屬上寒武紀上部而與鳳山層相當、

丙・大汶口　此處距泰安城南五十里、產蝙蝠石、（俗又稱燕子石）最著名、去年余領北大同學實習於此、並採集下列各化石、然均非新種、亦未列入此誌、

1. Drepanura premesnili Bergeron

2. Drepanura ketteleri Monke

3. Agnostus douvilli Bergeron

4. Liostracina krausii Monke

5. Shantungia spinifera Walcott

6. Agnostus kushanensis Walcott

7. Stephanocare richthofeni Monke

8. Damesella sp.

9. Blackwelderia sp.

奉天省

僅寒武紀上部發見於奉天錦西縣沙鍋屯、化石爲安特生博士所採集、岩層風化過甚、種名頗不易定、可鑒定者列下、

三葉虫

1. Ptychaspis walcotti Mansuy

2. Ptychaspis acamus Walcott

3. Ptychaspis chinhsiensis Sun (新種)

4. Ptychaspis (Anderssonia) fengtienensis Sun (新屬新種)

5. Agnostus sp.

腕足類

6. Boorthis shakuotunensis Sun (新種)

1爲安南上寒武紀特産化石、3 4 均爲新種、考其地層似與直隸之鳳山層相當、

以上所述中國北部寒武系可總列爲表如次、

奉天	錦西	沙鍋屯灰岩				
直隸	開灤	長山系	鳳山層	長山層	崮山層	張夏層	饅頭層
山東	張夏	九龍系	直角石層	炒米店層	崮山層	張夏層	饅頭層
	泰安		高里層	炒米店層	崮山層	——	饅頭層
			上寒武紀		——中寒武紀		下寒武紀

自上述地層及化石觀之、中寒武紀地層多爲鬗狀灰岩、上寒武紀岩層漸變爲頁岩礫狀灰岩及竹葉狀灰岩、蓋中國中寒武海本屬深海、至上寒武紀則由深而淺、又下寒武海之 Redlichia 屬爲我國及印度特產、從未發見於歐美、可證當時海洋與太平洋及大西洋完全隔斷、至寒武中上兩紀、海洋似漸與美洲西部及大西洋相通、然我國多數寒武紀各屬及各種化石、究與歐美異、

CONTRIBUTIONS TO THE CAMBRIAN FAUNAS OF NORTH CHINA

BY

Y. C. SUN.

INTRODUCTION.

Since the important and extensive studies of Walcott on the Cambrian Faunas of China, no work was done in the field until the systematic collection of Chinese fossils, in connection with the detailed exploration and mapping, was undertaken by the Geological Survey. In 1919 Mr. H. C. T'an of the Survey made a collection of Cambrian fossils from the northern rim of the Kaiping Basin which proved of such interest on preliminary study by Prof. Grabau, that it was decided to make a more detailed examination of the Cambrian as well as other formations of this locality. Accordingly the Survey sent an expedition to the Kaiping Basin, in charge of Prof. Grabau, and of this I was a member. On our return, the Cambrian material was placed in my hands for study and description.

In the same year, Dr. J. G. Andersson studied the Sha-Kuo-Tun 沙鍋屯 deposits in west Fengtien, and brought back a collection of Upper Cambrian fossils from this region, where the Upper Cambrian rests disconformably upon the Sinian rocks.

In the spring of 1923, the National University Expedition, in charge of the author, went to Shantung to study the Cambrian stratigraphy of that province. I was accompanied by several college students (C. C. Yang, S. T. Chang, C. C. Tien, Y. T. Chao, K. M. Wang, P. Tsai) who assisted me in measuring sections and making collections of fossils.

In the upper part of the Chaumitien limestone of Chau-Mi-Tien, we found a new horizon containing many species of *Orthoceras* and other cephalopods. Associated with these are *Ptychaspis*, *Eoorthis* and the new genus *Changia* of the family *Dikelocephalinæ*. The cephalopods probably represent an invasion of an early Ordovician type of fauna

into the region where the Upper Cambrian fauna still persisted. These beds are probably to be regarded as still Cambrian rather than the Lower Ordovician. Nevertheless, this zone should be separated from the Chaumitien limestone.

In the Tai-An 泰安 district, we discovered four horizons in Kao-Li-Shan, 高里山 2 li from the city. Several new genera and species were found in this formation. The fauna is closely related to the *Ceratopyge* beds of Sweden, but it is quite distinct from the Chaumitien fauna. All fossils were obtained from the high beds and belong to the uppermost part of the Upper Cambrian, while the lower part is unfossiliferous, probably representing a part of the Chaumitien limestone.

A large number of well preserved specimens of *Drepanura* and *Damesella* were obtained from Ta-Wen-Kou, 大汶口, 50 li S. of Tai-An.

In the autumn of 1923, the author revisited the Kaiping Basin with two classes of the Geological Institute of the National University; and we made an extensive collection of Middle and Lower Cambrian fossils.

Dr. F. F. Mathieu, geologist of the Kailan Mining Administration, kindly sent me the Cambrian material which he had collected at Lei-Chuang 雷莊 and also joined us in the field at Chao-Kou-Chuang 趙各莊.

More recently Messrs. Y. T. Chao and C. C. Tien, graduates in Palæontology from the National University, and now members of the Survey staff, obtained a large number of well preserved specimens of Cambrian fossils from the Kushan beds in Lincheng 臨城 in southern Chihli, and they recognized also the Manto shale and Changhia limestone in that region, but did not find any fossil in it. The horizon found by them is the *Blackwelderia* zone whjch is essentially of Kushan age, and lies disconformably below the Lower Ordovician. They also found a new genus of the order *Proparia* characterized by having long genal spines on the fixed cheeks.

The present contribution covers the material so far obtained from North China, but it does not exhaust the field. A second contribution will be issued after further extensive collections have been made.

Eight new Genera and subgenera, and forty one new species are described in this paper.

In conclusion, I wish to express my thanks to Mr. K. C. Liu for making the drawings; to Dean C. Ho for his kindness in arranging the university excursions, and to Drs. W. H. Wong and H. T. Chang for suggestions and criticisms. Finally I am under great obligations to Prof. Grabau who has put the material in my hands for study, and given many suggestions and directions.

STRATIGRAPHIC SUMMARY

The Cambrian is known at present from Chihli, Shantung, Shansi and Manchuria. The lithologic character of each formation varies according to the condition of the deposition. Generally the southern regions (Shantung etc.) are characterized by limestones in the Upper Cambrian (Chaumitien), while this formation is represented by shales interbedded with Wurmkalke in Chihli. Farther north-east (Manchuria), a part of the Changhia limestone is replaced by the red shale.

The subdivisions of the Cambrian as now recognized in North China are as follows:

SUPER-FORMATION

Lower Ordovician

Probably a disconformity in all cases; (ascertained in many).

CAMBRIAN

Upper Cambrian

Fêngshan series

Chaumitien formation

Middle Cambrian

Kushan formation

Changhia formation

Lower Cambrian

Manto formation

CHIHLI PROVINCE

A. Kaiping Basin. The Cambrian strata are well developed in the Kaiping Basin and the subdivisions are as follows:

ORDOVICIAN

Yehli limestone

disconformity

Upper Cambrian

5	Fêngshan series	200-300 ft.
4	Changshan series	150-200 ft.

Middle Cambrian

3	Kushan formation (a part)	0-50 ft.
2	Changhia limestone	300-400 ft.

Lower Cambrian

1 Manto shale 400-500 ft.

disconformity

SINIAN

Black limestone

MANTO FORMATION—This is the oldest known Cambrian division of North China. It consists mostly of red, purple and green shales, sometimes interbedded with sandy limestones. It occurs in Chao-Kou-Chuang, 趙各莊 Lei-Chuang 雷莊 and especially in Chêng-Shan, 稱山 where the section was made. The following species are found in this formation:

Brachiopoda

1 Acrothele cheni Sun
2 Lingulella manchuriensis? Walcott
3 Obolus sp.

Trilobita

4 Conokephalina gerardi Sun
5 Conokephalina kaipingensis Sun
6 Ptychoparia (Emmrichella) chêngshanensis Sun
7 Ptychoparia sp.
8 Ptychoparia yohi Sun
9 Ptychoparia fongi Sun

CHANGHIA LIMESTONE—This consists of oolitic limestone and various shades of massive limestone. It is found in the northern slope of Chêng-shan and is usually called cliff limestone. It contains the following species:

Brachiopoda

1 Nissusia hayasakai Sun

Trilobita

2 Solenopleura nodosa Sun
3 Anomocare flava Walcott
4 Lisania rectangularis Sun
5 Lisania? hsuchiachuangensis Sun
6 Damesella blackwelderi var. minor Sun
7 Dorypyge richthofeni Dames
8 Dolinometopus deois Walcott
9 Crepicephalus sp.

KUSHAN SHALE—A part of this formation may be present, but so far no fossils have been found.

Changshan series—This series consists of red or purple shales with seven or eight intraformational (edgewise) limestone conglomerates (wurmkalke). The red shale is richly fossiliferous and is found in Jén-Chuang, 任莊 2 li N. of Chao-Kuo-Chuang, and Chêngshan. The lithological charater of this red or purple shale is not unlike that of the Manto shale, but it can be distinguished by the series of wurmkalk beds interbedded with it. The detail section is given in the bulletin* of the Geological Society of China (Vol. II No. 1-2). p. 91-45. It contains the following species.

Brachiopoda

1 Obolus mollisonensis? Walcott

2 Eoorthis sp.

Trilobita

3 Changshania conica Sun

4 Changshania? truncata Sun

5 Agnostus hoi Sun

Obolus mollisonensis? Walcott is an American species from the Upper Cambrian of North American. *Eoorthis* is one of the Upper Cambrian genera. The other genera and species are new. Lithologically the red fossiliferous shales are interbedded with intraformational conglomerates (Wurmkalke) which are characteristic of the Upper Cambrian. This series corresponds to the lower part of the Chaumitien limestone of Shantung.

Fêngshan series—This series is composed of shales and thin-bedded limestone (calcilutite); and represents the uppermost part of the Upper Cambrian. It is very well developed at Fêng-Shan 鳳山 in the Yeh-li 冶里 region where the disconformable contact between the Fêngshan limestone and the overlying Ordovician limestone was discovered. The Fêngshan limestone is also found in Lei-Chuang, Chihli. The most common species are as follows:

Brachiopoda

1 Obolus luanhsiensis Grabau (Mss.)

2 Lingulella kayseri Grabau (Mss.)

Trilobita

3 Ptychaspis subglobosa Grabau (Mss.)

4 Ptychaspis suni Grabau (Mss.)

5 Mansuyia orientalis (Grabau) Sun

6 Illænurus sp.

7 Anomocare sp.

* The Upper Cambrian of Kaiping Basin by the author.

This is a new fauna and entirely distinct, and may be called the Asiatic Ceratopyge fauna. The most common specis is *Mansuyia orientalis* (Grabau) Sun which is also abundantly found in the Kaolishan formation. *Ptychaspis* and *Illænurus* are not uncommon. The formation is certainly of uppermost Cambrian age.

Ptychaspis subglobosa Grabau also occurs in the Kaolishan formation of Shantung, with which formation this Fêngshan series is to be correlated. The limestone conglomerate in this formation is unlike the wurmkalk (intraformational conglomerate) which is characteristic of the Chaumitien limestone or the Changshan series.

B. Lincheng. In Lin-Cheng, 臨城 S. Chihli, a complete section was studied by Y. T. Chao and C. C. Tien. A large number of well preserved specimens were obtained from the Kushan formation of that region, none being found in the older formations (Manto and Changhia)

The subdivisions are as follows:

Super-formation: Lower Ordovician

(disconformity)

Middle Cambrian

Kushan formation	50-100 ft.
Changhia limestone	700-800 ft.

Lower Cambrian

Manto shale	200-300 ft.

(disconformity)

Subformation: Sinian

The Kushan formation furnishes the following species:

Brachiopoda

1. Obolus linchengensis Sun

Trilobita

2. Wongia triangulata Sun
3. Blackwelderia tieni Sun
4. Stephanocare richthofeni Monke
5. Blackwelderia sinensis var. linchengensis Sun
6. Tienistion subconica Sun

Stephanocare richthofeni Monke and *Blackwelderia sinensis* Walcott are present in this formation, and it is essentially the Kushan shale horizon of Shantung. One new species of *Blackwelderia* and one new species of *Teinistion* are also found in this formation. The most unique form is the new genus *Wongia* of the order proparia. This genus, *Wongia*, is quite distinct from any known type of foreign countries, and is certainly one of the most characteristic genera of the Middle Cambrian of China.

SHANTUNG PROVINCE

A. Kao Li Shan. This a low hill, 2 li west of Tai An, is composed of limestone conglomerate, limestone and shale. The lower part consists of unfossiliferous beds occationally with wurmkalk, and probably represents a part of the Chaumitien formation. The upper part is mostly of shale, limestone and limestone conglomerate which is unlike the wurmkalk (intraformational conglomerate) of the Chaumitien formation. The following section was made by the class of 1923 of the Geological Institute of the National University under the direction of the author.

		Feet	Inches
25	conglomerate limestone (partly covered) F 4..	30	0
24	thin-bedded limestone		6
23	fine oolitic limestone	3	5
22	shale	2	6
21	conglomerate limestone F 3	1	2
20	Shale	2	6
19	conglomerate limestone	1	0
18	shale	3	7
17	Obolus limestone F 2	1	0
16	oolitic limestone	2	6
15	thin-bedded limestone		9
14	conglomerate limestone		4
13	thin-bedded limestone		9
12	oolitic limestone		4
11	thin-bedded limestone	1	2
10	compact and dark gray limestone F 1	1	0
9	thin bedded limestone	11	0
8	ochery limestone	2	3
7	thin-bedded limestone	2	8
6	ochery limestone	2	8
5	thin-bedded limestone	2	8
4	intraformational limestone	11	0
3	ochery limestone	4	4
2	thin-bedded ochery limestone	7	0
1	intraformational conglomerate	20	0

The following species are found in the University collection:

Graptozoa

1. Clonograptus? cambria Sun

Brachipoda

2. Obolus taianensis Sun F_2
3. Syntrophia orthia Walcott F_1
4. Agnostus cyclopygeformis Sun F_1
5. Ptychaspis subglobosa Grabau F_3
6. Ptychaspis angulata var. chinensis Sun F_4
7. Quadraticephalus walcotti Sun F_4
8. Kaolishania pustulosa Sun F_1
9. Mansuyia orientalis (Grabau) Sun F_1
10. Taianocephalus grabaui Sun F_1
11. Chuangia batia walcott F_1
12. Illænurus ceres Walcott F_2
13. Illænurus Pagoda Sun

Dr. Walcott has correlated this formation with the Chaumitien limestone of the Chang-hia region and referred it to the lower part of that formation, but with our present faunal evidence this formation is recognized as younger than the Chaumitien limestone and should be given a separate name.

Ptychaspis subglobosa Grabau also occurs in the same character of limestone (limestone conglomerate) of the Fêngshan formation. *Mansuyia orientalis* (Grabau) Sun is also the most common species in that formation. The succession of the strata and the palæontology clearly indicates that this formation is the equivalent of Fêngshan limestone of Chihli, and certainly belongs to the upper part of the Upper Cambrian.

Agnostus cyclopygeformis Sun is very closely related to the European form *A. cyclopyge* of Sweden. This indicates that the Upper Cambrian sea of China had a close connection with that of Europe. That is why many Chinese and European forms appear to be identical.

Ptychaspis angulata Mansuy is found abundantly in the Upper part of the Upper Cambrian of Tonking, it is also present in this formation. Hence this formation is equivalent to *Ptychaspis angulata* zone of Indo-China.

The discovery of the new genus *Quadraticephalus* of the family Dikelocephalinæ which comprises the characteristic form of the Upper Cambrian of North America is of considerable interest and significance.

The presence of *Clonograptus* and the *Cyrtoceras* figured by Walcott is of significance, because both are more typical of the Ordovician and must at least be regarded as transition types of the Cambro-Ordovician strata. The graptolite was found several years ago by Mr. K. W. Hsu during an excursion to the locality in charge of Dr. H. W. Wong.

I agree with Dr. Walcott in putting this formation in the Upper Cambrian, but I regret that I cannot follow him in including this formation in the Chaumitien limestone. I am disposed to separate this formation under a new name, the Kaolishan (Kaoli) formation, and to refer it to the uppermost part of the Upper Cambrian.

b. Chaumitien. 炒米店 This is the type locality for the Chaumitien limestone which was named by Willis and Blackwelder. Near the top of that limestone, we found a new horizon characterized by a transition fauna. The name of Chaumitien limestone, I think, should be restricted to the lower part of that formation, while the upper beds characterized by the Ordovician types should be given a separate name.

The following species are found in the upper zone:

Brachiopoda

1. Billingsella sp.

Cephalopoda

2. Loxoceras cambria Sun*
3. Orthoceras nanshanensis Sun*

Trilobita

4. Changia chinensis Sun
5. Ptychaspis acamus var. punctata Sun
6. Ptychaspis tani Sun

Ptychaspis and Billingsella are the characteristic fossils of Upper Cambrian while Loxoceras and Orthoceras are apparently Ordovician forms.

Because the presence of Ptychaspis acamus Walcott I am constrained to put this horizon in very late Cambrian rather than basal Ordovician, and consider that the cephalopod element is a new invasion.

It is evident that this formation, characterized by the mixed fauna, should not be included in the Chaumitien limestone which is now restricted to those lower beds characterized by Wurmkalke (intraformational conglomerates). This upper horizon, however, may be the equivalent of the Fêngshan series of Chihli.

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* These will be described in a reparate paper by the Author.

c. TAWENKOU. 大汶口 This place, 50 li south of Tai-An, is well known for Stone-swallows. This formation is very fossiliferous and of Kushan age. The lower part furnishes a large number of Drepanuras while the upper contains some Blackwelderias and Damesellas.

The following species were found in this formation:

1. Drepanura premesnili Bergeron
2. Drepanura ketteleri Monke
3. Agnostus douvillii Bergeron
4. Liostracina krausii Monke
5. Shantungia spinifera Walcott
6. Agnostus kushanensis Walcott
7. Stephanocare richthofeni Monke
8. Damesella sp.
9. Blackwelderia sp.

FENGTIEN PROVINCE

Only the Upper Cambrian is known from Sha-kuo-T'un, Chin-Hsi-Hsien, 錦西縣 west Fengtien. The fossils were collected by. J. G. Andersson, mining adviser to the Chinese Government. The section is given in the Bulletin of the Geological Society of China (Vol. II No. 1-2 p. 101.).

The following species are found in this limestone:

Trilobita

1. Ptychaspis walcotti Mansuy
2. Ptychaspis acamus Walcott
3. Ptychaspis chinhsihsiensis Sun
4. Ptychaspis (Anderssonia) fêngtienensis Sun
5. Agnostus sp.

Brachiopoda

6. Eoorthis shakuotunensis Sun

This formation is characterized by two new species of *Ptychaspis* and certainly belongs to the Upper part of the Cambrian. The Lower and the Middle Cambrian are absent in this region and the Shakuotun limestone lies disconformably upon the pre-Cambrian (Sinian) rocks.

The subdivisions of the Cambrian of N. China are as follows:

	SHANTUNG			CHIHLI	FÊNGTIEN
	TAIAN REGION		CHANGHIA REGION	KAIPING BASIN	CHINHSIHSIEN
U. Є.	Kaolishan limestone Chaumitien limestone?	Kiulung Group	Orthoceras Zone Chaumitien limestone	Fêngshan limestone Changshan series	Shakuotun limestone
M. Є.	Kushan formation		Kushan formation	Kushan shale	
	.....		Changhia limestone	Changhia limestone	
L. Є.	Manto shale		Manto shale	Manto shale	

From the lithological, and stratigraphic relations, and the Palæontology, it is clear that the early Middle Cambrian sea, must have been free from mechanical sediments to permit the formation of oolitic limestone and then become gradually shallow in the late Middle Cambrian and the Upper Cambrian time permitting the formation of shales and intraformational conglomerates.

The Lower Cambrian sea of China had no connection with the Atlantic or the Boreal province; but the Middle Cambrian was to some extent confluent with the Boreal and west American Provinces, and more particularly was this the case in Upper Cambrian time.

A number of American genera, and even species are found in this country, though, on the whole the faunas are quite distinct.

DESCRIPTION OF SPECIES

Class **GRAPTOZOA** Grabau

Genus **CLONOGRAPTUS** Hall

Clonograptus? Cambria Sun (sp. nov.)

Plate I. Fig. 1.

This species is only represented by one stipe slightly curved.

Stipe somewhat rigid and slender. Thecæ fifteen to sixteen in 10 mm., slender tubes inclined 30° or more. Apertural margins concave oblique, conspicuously mucronate. Each theca averages 1.5 mm. in length and 0.5 mm. in width. Maximum width of stipe about 1 mm.

In form this species resembles *Clonograptus tenellus* from the Dictyonema shale of Sweden and England; but it differs in that it has 15 or 16 thecæ in 10 mm. while in *C. tenellus* only 10 thecæ are found in 10 mm. As the generic determination is mainly

based on the number of stipes, and only one stipe of this species is known, the generic determination of this specimen is still somewhat doubtful.

This species occurs in a thin slab of gray limestone which was collected several years ago by Mr. K. W. Hsu (徐偉曼) of National South Eastern University.

HORIZON AND LOCALITY: Upper Cambrian; Kaolishan limestone of Tai-An, Shantung.

Class **ANNELIDA**

Genus **CLIMACTICHNITES** Logan

Climactichnites mathieui Sun (sp. nov.)

Plate I. Fig. 2.

One specimen from Luanchou contains the trails of an annelid, which apparently belongs to *Climactichnites*. The trails of *Climactichnites* were also found in the Upper Cambrian of New York and Wisconsin, N. America.

Woodworth suggests that the animals which made these trails were mollusks capaple of crawling up from the water at low tide, while Walcott thinks the trails were certainly made by annelids.

I agree with Dr. Walcott, because many annelids have been found in the Cambrian strata.

The Chinese form is represented by an impression of the trails on the under side of the rock, which clearly shows the character in relief.

It is small, being only 3.5 mm. in width having 8 grooves in 1 cm, indicating that it was the trail of an annelid of ordinary size.

This species is quite distinct from any known foreign species. I take pleasure in naming it in honor of Dr. F. F. Mathieu, geologist of the Kailan Mining Administration.

Measurements:—

Average width of groove with very narrow ridges separating it ..... 1 mm.

Average length of the groove..... 2 mm.

HORIZON AND LOCALITY: Lower Cambrian, Manto shale of Luanchou; collected by Dr. F. F. Mathieu.

Class **BRACHIOPODA** Duméril

Genus **OBOLUS** Eichwald

Obolus (Westonia) leei Sun (sp. nov.)

Plate I. Fig. 3a-3c.

Shell of medium size, depressed convex; general form broadly ovate, almost subquadrate, with the pedicle valve obtusely acuminate. The frontal margin nearly straight, both sides are nearly parallel, regularly and gently rounded; posterior margins straight on both sides of the beak, meeting at the latter at an angle of about 125°. Shell little longer than the wide.

Surface marked by coarse concentric lines of growth and the characteristic ornamentation. This appears to be formed of a very fine network of oblique depressed lines which divide it into minute diamond-shaped spots, a surface which resembles, under a strong lens, the texture of finely woven cloth.

This species is represented by only one valve of the shell; the measurements are as follows:

Length	9.0 mm.
Width	8.5 mm.

HORIZON AND LOCALITY:—Cambrian; from purple shale of Luan-Chou. Collected by Dr. F. F. Mathieu, geologist to the Kailan Mining Administration of Tang-Shan.

This species is named after Prof. J. S. Lee 李四光 of the National University.

The surface-ornamentation of this species is not unlike that of *Obolus* (*Westonia*) *stoneanus* (Whitfield) from the Upper Cambrian sandstone of Sauk county Wisconsin (U. S. A.) but it differs in the broad form of the shell, and also in size.

This species is characterized by its subquadrate form and reticulated structure of the surface, which is a feature quite distinct from that of any known Chinese species.

Obolus mollisonensis? Walcott

Plate I. Figs. 4a, 4b.

1912 *Obolus mollisonensis* Walcott, Cambrian Geology and Pal. (Smiths. Miscell. coll. Vol. 57) Vol. II No. 7; p. 231, pl. 35, figs. 10-12.

1938 *Obolus mollisonensis* Walcott, Sun. Bull. Geol. Soc. of China. Vol. II No. 1-2 p. 94 (listed).

Shell small, of subovate outline; moderately convex, length and width subequal. Posterior border nearly straight meeting at the beak and forming an obtuse angle (110°). Anterior lateral borders rounded, frontal margin more gently rounded. Convexity most pronounced near the umbonal region, the shell becoming flattened towards the front.

Surface uneven, marked by fine irregular, concentric line of growth, and a few coarse concentric wrinkles.

This shell shows almost exactly the characters of the species described under *Obolus mollisonensis* by Walcott from the Lower Ordovician of Mount Mollison British Columbia, and although the interior characters are not known, I tentatively refer it to that species because of the agreement in form.

This shell also resembles *Obolus* (*Bröggeria*) *salteri* (Holl) of the Upper Cambrian and Lower Ordovician of north western Europe, but the surface features of *Obolus* (*Bröggeria*) *salteri* are absent in our specimens; and the agreement is closer with the Mount Mollison specimen. Only two specimens of this species have been found in China, one of which is poorly preserved.

A comparison of the measurement of our best specimen (Fig. 4 a) and of W. American and European forms give as follows:

	Chinese specimen fig. 4 a	Walcott type	O. (Bröggeria) salteri
Length	5.6 mm.	5.3 mm.	6.0 mm.
Width	6.0 mm.	5.6 mm.	6.8 mm.

Horizon and Locality:—Early Upper Cambrian: from purple shale of Changshan formation of Chao-kou-chuang, Luan-Hsien, Chihli: collected by Survey Expedition.

Obolus linyuensis Sun (sp. nov.)

Plate I. Fig. 5.

Shell small, oval; moderately convex, length slightly greater than the greatest width. Posterior borders nearly straight meeting at the beak approximately in an angle of 80°. Antero-lateral borders rounded.

Surface marked by lines of growth which are regular, giving a smooth and glistering appearance, but becoming more coarse in the anterior part.

This species is represented by only one specimen and characterized by its small glistening shell with concentric lines of growth regularly arranged.

Measurements:—

Length .....4.0 mm.

Width .....3.8 mm.

This species resembles *Obolus willisi* Walcott from the Upper Cambrian and Middle Cambrian of Alabama, in form, but differs in the absence of the punctate character of the surface and also in the character of the umbo and in size.

Horizon and Locality:—Cambrian: from limestone inter-bedded in Manto shale of Hung-shan-T'ou, 紅山頭 Lin-Yu Hsien: collected by University excursion in 1923 under the direction of the author.

Obolus taianensis Sun (sp. nov.)

Plate I, Fig. 6 a, 6 b.

Shell small, ovate in form, pedicle valve obtusely rounded; valves moderately convex, the convexity increasing gradually from the margins to the umbonal portion of the shell.

Surface marked by concentric lines: when the outer layer of the shell is exfoliated, numerous radiating striæ will appear on the surface. The shell is formed of lamellose layers, which make a strong thick shell.

Measurements:—

Length .....5.9 mm.

Width .....6.4 mm.

The shell figured by Walcott on Plate II fig. 2, from Kaolishan and provisionally referred to *O. matinalis* Hall may belong to this species, agreeing with it in general form and size, though the length of Walcott's specimen is slightly greater than the width.

This species is distinguished by its oval shape, moderate convexity of the shell and the lamellose character of the shell surface. It is represented by many individuals which occur abundantly in that zone.

Horizon and Locality:—Upper Cambrian: associated with *Ptychaspis subglobosa* Grabau in the upper beds of Kaolishan limestone (Coll. Y. C. Sun).

Obolus luanhsiensis Grabau (mss.) (sp. nov.)

Plate I, Figs. 7 a-7 c.

1883 *Lingulella* sp. Kayser in Richthofen China, Vol. pl. 111, fig. 2.

1919 *Obolus?* sp. indet. Walcott, Cambrian Brachiopoda p. 62.

1922 *Obolus luanhsiense* Grabau (mss.)

1923 Obolus luanhsiense Grabau, Sun. Bull. Geol. Soc. China, Vol. II, p. 98 (listed).

"Shell moderately large of subtriangular outline and moderate to strong convexity; length slightly less than the greatest width which is in the anterior third of the shell. Posterior borders nearly straight meeting at the beak approximately in a right angle. Antero-lateral borders rounded, front straight or more rarely faintly sinuate. Convexity most pronounced in the umbonal region, the shell becoming flattened towards the front.

"Surface marked by lines of growth which are fine and regular in the young shell giving the surface a smooth appearance, but become coarser and more of the nature of faint concentric wrinkles in the adult portion, where the shell is also sometimes characterized by a few faint radiating wrinkles. Exceedingly fine radiating lines are shown under a high power lens on the young shell.

"*Dimensions.* Three individuals measure respectively: length 7.6 mm., 5.6 mm., 6.4 mm., width 8. mm., 5.1 mm., 6.5 mm.

Horizon and Locality:—Associated with *Lingulella kayseri* Grabau in the thin-bedded limestone layers of the Fêngshan formation of Upper Cambrian age at Yeh-li, Luan-Hsien, Chihli; collected by H. C. T'an.

"This species is not unlike *Lingula petalose* Hicks from the Arenig of Whitesand Bay (Davidson: Silurian Brachiopoda, pl. XLIX, fig. 30, p. 337). That species is described as broadest in the middle, but some of the specimens figured by Davidson show the greatest width in the anterior third. In this respect, as well as in general shape and in size, they agree fairly well with our species." (Grabau).

Genus **LINGULELLA** Salter

Lingulella dimorpha Sun (sp. nov.)

Plate I, Fig. 8a-8b.

Shell of medium size, and subrectangular form; length and width approximately as six to five. Sides of shell nearly parallel, but gently curved, frontal margin rounded at the sides, straight in the center; posterior margins straight on either side of the beak, meeting at the latter at an angle of about 150°.

Surface marked by two stages of growth lines. The young stage is characterized by its undulating growth-lines, while the adult stage is marked by ordinary growth-lines crossed by very fine radiating striæ. A triangular median depression is slightly marked, and outlined by two slightly elevated broad and low ridges which are only seen on the perfect specimen of the shell.

This species resembles *Lingulella kayseri* Grabau in form, but differs in the character of the growth-lines, in the more obtuse beak and also in size.

This species is characterized by two different stages of growth lines, subrectangular form, and the obtuse angle of the beak of the shell.

	1	2
Measurements:—	Luanchou	Yehli
Length	12.00	18.5
Width	10.50	12.8

Horizon and Localities:—Upper Cambrian: from thin-bedded clayey limestone of Luan-chou. Collected by Dr. F. F. Mathieu. Also in lower part of Fêngshan formation near Yeh-li. Coll. by Y. C. Sun.

Lingulella liui Sun (sp. nov.)

Plate I, Figs. 9a-9c.

Shell small, elongate egg-shaped with both posterior and anterior end obtusely rounded: depressed-convex, the frontal margin obtusely rounded; width gradually increases from the frontal margin to the middle of the shell. Beak obtuse with an angle of 110°; greatest width is in the middle of the shell.

The outer surface usually has a glistening appearance and is marked by regular fine but sharp concentric striæ and coarser lines of growth at frequent intervals. When the outer shell is exfoliated, it is distinctly marked by many elongated pustules, and the frontal margin by very fine radiating striæ.

This species is represented by three specimens all apparently ventral valves. It presents quite distinct a form from any known Chinese species.

This species resembles *Lingulella ferruginea* Salter in general appearance, but differs in the character of the shell, in the more elongated form, and in the absence of the distinct radiating striæ. Three specimen measure respectively; length 5.5 mm. 4.9, 5.5, width 3.5, 3.3, 3.4.

HORIZON AND LOCALITY:—from the Cambrian purple shale of Luan-Chou: collected by Dr. F. F. Mathieu. The specific name is given in honor of Mr. C. P. Liu, 劉基磐 dean of the Geological Department of the National Normal College of Peking.

Lingulella kayseri Grabau (mss.) (sp. nov.)

Plate I, Figs. 10 a-10c

1883 Lingulella sp. Kayser, in Richthofen. Vol. IV, p. 35, pl. III, fig. 3.

1919 Lingulella davisii Walcott (non McKoy) Cambrian Brachiopoda p. 489, pl. XXX, figs. 2, 2 a; pl. XXXI, figs. 6, 6a-h.

1922 Lingulella kayseri Grabau (mss.)

1923 Lingulella kayseri Grabau, Sun. Bull. Geol. Soc. China, Vol. II. p. 98. (listed)

"Shell of medium size and subrectangular form; length and width approximately as five to four. Sides of shell nearly parallel and only gently curved, frontal margin rounded at the sides, straight in the center; posterior margins straight on either side of the beak, meeting at the latter at an angle of about 125°.

"Surface marked by growth lines and at intervals by faint concentric wrinkles. Crossing these are radiating striæ which on the posterior lateral margins, where they are most strongly marked, have an obliquely outward and backward direction, giving a pronounced ornamentation to the surface.

"*Dimensions.* The following dimensions show the rate of variation in the length and width of the shell in millimeters.

	1	2	3	Richthofen's, specimens	
Length	10.0	10.2	11.3	17.0	13.0
Width	8.2	8.5	9.0	13.5	10.5

"This species appears to be the same as the specimens noted and figured as *Lingulella* cfr. *nathorsti* Linnarson by Kayser, and which were obtained by von Richthofen in a greenish-gray thin-bedded or somewhat slaty limestone from Sai-ma-ki 寨馬集 Liau-tung, Manchuria. There that species is associated with another shorter and rounder form (*Obolus*) which appears to be identical with the smaller form associated with our species. The associated trilobites in the Liau-Tung region comprise *Conocephalites frequens, Anomocare latelimbatum, Agnostus chinensis.* The last two species are referred by Walcott to the Middle Cambrian whereas our specimens are associated with Upper Cambrian trilobites. It is not impossible that the specimens described by Kayser belong to distinct species. They are larger than our specimens and apparently without their ornamentation but agree closely with them in form and proportions.

"HORIZON AND LOCALITY:—In the Upper Cambrian Fêngshan formation of Yeh-li: collected by Mr. H. C. T'an" (Grabau).

Dr. Walcott referred the specimen figured by Kayser to *Lingulella davisii* (McCoy), from which however our species is quite different. McCoy's species is characterized by relatively greater width, by a more nearly rectangular umbonal region, and by the lack of the characteristic ornamentation found in our species, though this may also be absent in the specimens figured by Kayser.

Genus **ACROTHELE** Linnarson

Acrothele cheni Sun (sp, nov.)

Plate I, Figs. 11a-11b.

All the specimens representing this species are flattened by compression on the argillaceous shale, and are also more or less distorted.

General form subcircular except for the straight posterior margin. Pedicle valve flat due to compression with the apex 2.5 mm. from the posterior margin. A triangular false area extends from the apex to the margin; it is defined by a slight depression and a low ridge at the outer edges; surface marked by numerous more or less regular lines of growth, but not marked by radiating lines.

Nothing is known of the interior characters.

This species is characterized by its subcircular form, numerous concentric growth striæ and the position of the apex.

A shell 10.5 mm. in width has a length of 9.5 mm. while another measures 9 mm. in length and 9.3 in width.

HORIZON AND LOCALITY:—Middle Cambrian: from Changshan shale of Chao-kuo-chuang, Luan-Hsien, Chihli. Collected by S. Chen 陳 旭 of class 1925 of the Geological Institute of the National University.

Genus **NISSUSIA** Walcott

Nissusia hayasakai Sun (sp. nov.)

Plate I, Fig. 12.

Shell semioval with the hinge line a little shorter than the greatest width of the shell; surface of shell marked by radiating ribs and also by a few concentric lines.

Pedicle valve convex, ribs become more pronounced in the frontal part of the shell. Ribs increase by bifurcation and with nodes on their crests; they are broad, the interspaces being narrower than the ribs. A median sinus moderately distinct extends from the umbo to the frontal margin of the shell.

The plications of the shell and the form suggest *Huenella*; but the nodes on the crests of the ribs serve to distinguish it. All species of *Huenella* except *etheridgii* are from the Upper Cambrian.

Nothing is known of the interior of the shell.

This species is characterized by its transverse form, broad radiating ribs with nodes on their crests and the less pronounced median sinus.

Measurements:—

Length ....6 mm.
Width..... .....9 mm.

Horizon and Locality:—Middle Cambrian: from Changhia limestone of Chêng-shan, 2 li from Luan-Hsien, Chihli (Coll. K. S. Hsu 徐光熙).

This species is named after the Japanese Palæontologist Dr. I. Hayasaka. It is represented by several crushed valves. It is associated with *Damesella blackwelderi* var *minor*, *Dorypyge richthofeni* etc.

Genus **EOORTHIS** Walcott

Eoorthis shakuotunensis Sun (sp. nov.)

Plate I, Figs. 13a-13b.

This species is represented by a number of the pedicle valves and one interior of the pedicle valve.

Shell moderately convex, subquadrate in outline with angular cardinal extremities. Hinge line usually forming the greatest width of the shell. Posterior margin on both sides of beak straight, forming an angle of 160 degrees. Median fold faint on the ventral valve.

Surface marked by a few rounded radiating ribs, which where farthest apart measure 3 in 2 mm; there are 4 or 5 fine striæ between each pair of larger ones. The ribs increase in number by interpolation and may appear at any distance from the beak, usually becoming coarser near the frontal margin.

The associated interior of a pedicle valve (Fig. 13 b.) shows the cardinal area, muscular impression and the fracturing and the deflection of the striations along the margin of the interior of the valve.

This species is characterized by a long hinge line, a subquadrate form, and the rounded ribs with 4 or 5 fine ones between.

Measurements:—

	Pedicle valve	Interior of the pedicle valve
Length	13.5 mm.	13.0 mm.
Width	14.5 mm.	14.5 mm.

HORIZON AND LOCALITY:—Upper Cambrian: from the Shaokuot'un limestone of Chin-Hsi-Hsien, Fêngtien; collected by Dr. J. G. Andersson.

Eoorthis sp. indt.

Of this species only a broken specimen was found in the purple shale of the Chang-shan group. It is marked by transverse form, distinct round ribs with broad interspaces, four ribs occupying a space of 2.5 mm. near the frontal margin.

HORIZON AND LOCALITY:—Early Upper Cambrian from purple shale of Chang-shan group of the Kaiping Basin. Associated with this are *Changshania conica*, and *Changshania? truncata:* Collected by Dr. F. F. Mathieu and Y. C. Sun.

Genus **SYNTROPHIA** Hall and Clarke

Syntrophia orthia Walcott

Plate 1, Figs. 14a-14b.

1913 *Syntrophia orthia* Walcott, Research in China. Vol. III. p. 85, pl. 5, figs. 1, 1a, 1b.

Dr. Walcott described and figured the external shell of both valves of this species. His full description is as follows:—

"General form irregularly oval with the ventral view obtusely angular toward the apex; rounded, biconvex, with a deep mesial sinus on the ventral and a strong median fold on the anterior half of the dorsal valves.

"Surface smooth, with the exception of a few concentric striæ and lines of growth.

"The ventral valve has a strong median sinus that occupies about one-third of the width of the valve at the anterior margin and projects forward to fit into the fold in the front of the margin of the dorsal valves; the sides of the median sinus are elevated and, with the downward curving lateral slopes, form a strong rounded ridge on each side of the sinus; none of the specimens in the collection show the area, but from the profile of the valve it must have been of moderate height, with a rather short apex curving over it.

"Dorsal valve with a minute apex from which a narrow, slightly developed median fold extends out to about the center of the shell, where it becomes elevated and projects forward to the front margin; the remaining portions of the surface are uniformly convex, sloping away from the median fold to the margin of the valves" (Walcott 1923).

In our collection, an internal mold of the ventral valve was discovered. I add to the original description the following:

Othoid form, moderately convex, with a strong median sinus which occupies about one third the width of the valve at the anterior margin; the sides of the median sinus are elevated, and with the downward sloping lateral slopes form a strong, rounded ridge on each side of the sinus.

Spondylium free not supported by median septum and marked by subparallel ridges, merging into the median sinus. Hinge line long forming about the greatest width of the shell; postero-cardinal angles angular.

Surface anteriorly marked by a few indistinct strong lines of growth and especially characterized by radiating striæ on both lateral slopes.

Measurements:	Ventral valve	Interior of ventral valve
Length	4.0 mm.	6.5 mm.
Width	5.3 mm.	7.6 mm.

HORIZON AND LOCALITY:—From the Kaolishan limestone of Tai-An-Fu. (Coll. Y. C. Sun).

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class **TRILOBITA** Walcott

Genus **AGNOSTUS,** Brongniart

Agnostus cyclopygeformis Sun (sp. nov.)

Plate II, Figs. 1a-h.

Cephalic shield moderately convex, width and length subequal, semicircular in outline and slightly contracted at the postero-lateral angles; rim narrow with uniform

width; dorsal furrow shallow and distinct; frontal groove shallow and distinct connecting the frontal rim and the glabella.

Glabella cylindrical, about one-third the width of the cephalon, contracted at the middle by slight incurving of the sides. It is divided by two slightly impressed backwards curving furrow into three lobes. The second lobe is distinctly marked by an elongated tubercle; frontal groove shallow and distinct; two small triangular lobes at the postero-lateral margin of the glabella.

Thorax unknown.

Caudal shield moderately convex, little wider than long, with uniformly elevated rim. Axial lobe short, about one third the total length, pentagonal in outline bounded laterally by two strong oblique furrows and posteriorly by two slightly impressed curving furrows which meet at an obtuse reêntrant angle. A large, distinct and elongated tubercle is situated at the middle of the margin of the axial lobe. Limb moderately convex, marked by a median groove from the median tubercle of the axis near to the posterior margin. On either side of the median tubercle and the caudal groove is a row of nine foramina in the form of an elongated elliptical ring. This feature is beautifully shown.

This species is very closely related to *Agnostus cyclopyge* Tullberg of Europe. The cephalic groove of the head, short pentagonal shaped axial lobe suggest *A. cyclopyge;* but it differs in the absence of the distinct lateral spines and the presence of the elliptical ring of foramina of the pygidium.

This is the first species of *Agnostus* found in the Upper Cambrian of China, and it is significant that it is very closely related to *A. cyclopyge* Tullberg, an index fossil of the Upper Cambrian of Europe.

Measurements:	No. 501	No. 502	No. 503	No. 504
Cephalon				
Length	4.0	4.4	4.8	2.5
Width	4.0	4.4	4.8	2.5
Length of the glabella	3.1	3.1	3.51	0.75
Length of the first lobe	1.0	1.0	1.0	0.5
Length of the second lobe	0.8	0.8	0.9	0.5
Length of the third lobe	1.3	1.3	1.6	0.75
Width of the glabella at base.	2.0	2.5	2.5	1.5

Pygidium	No. 507	No. 508	No. 509	No. 510
Length	5.0	3.1	3.0	3.0
Width	5.2	3.4	3.2	3.2
Length of the axial lobe	1.5	1.0	1.2	1.4
Frontal width of the axial lobe	2.3	1.6	1.5	1.5
Posterior width of the axial lobe	1.75	1.2	1.1	1.1

LOCALITY AND HORIZON:—Upper Cambrian: lowar part of the Kaoli limestone of Tai-An-Fu, Shantung. (Y. C. Sun Coll.)

Agnostus hoi Sun (sp. nov.)

Plate II, Figs. 2 a-d.

1923 *Agnostus hoi* Sun, Upper Cambrian of Kaiping Basin, Bulletin of the Geological Society of China. Vol. II, No. 1-2, p. 98. (listed)

Head shield round, gently convex forming about two-thirds of a circle; slightly contracted at base. Glabella conical gently convex, with two small transverse triangular lobes forming the postero-lateral portion of the glabella on each side.

A shallow glabellar furrow curves backwards and separates the small anterior lobe and a large posterior lobe; and immediately in front of this furrow, is situated a small but distinct median tubercle. Dorsal furrow deep and distinct converging toward the front.

Limb of the cephalon moderately convex, sloping down regularly on all sides to the margin and marked by a slightly impressed frontal groove in the front of the glabella. Border of head shield narrow, rounded, and separated by the strong marginal groove.

Thorax unknown.

Pygidium semicircular usually wider than long, moderately convex.

Axis broad and long, about two thirds the width of the pygidium, laterally circumscribed on each side by one strong deep furrow. It is divided by one nearly transverse furrow into two lobes; the anterior lobe is distinctly marked by the median elongated tubercle, especially pronounced near the posterior margin of the lobe; one pair of broad transverse furrows opposite the median tubercle outlines four tubercle-like portions one on each corner of the lobe.

The posterior or second lobe, moderately convex in the anterior portion and sloping down near to the broad groove; and also marked by one pair of oblique crescentic short, broad and slightly impressed furrows.

Limb very narrow, separated from the axis by a very strong deep furrow, broad in the middle part just opposite the transverse furrow which separates the anterior lobe from the posterior lobe.

Pygidium bordered by a very broad groove and very narrow rim with a pair of very short, backwardly projecting spines on the postero-lateral margins.

Measurements:—

	No. 513	No. 514
Cephalon		
Length	2.4 mm.	2.0 mm.
Width	2.3 mm.	1.9 mm.
Length of glabella	1.6 mm.	1.5 mm.
Width of glabella at base	1.3 mm.	1.2 mm.
Pygidium		
	No. 515	No. 516
Length	2.5 mm.	2.0 mm.
Width	2.9 mm.	2.6 mm.
Length of axial lobe	2.0 mm.	1.7 mm.
Width of axial lobe	1.5 mm.	1.4 mm.

The general appearance of the cephalon, and the large axis of the pygidium suggest *A. chinensis* Dames, but it differs from this in the more conical glabella and the detailed character of the axis of the pygidium. Our species, however, is very closely related to that species as figured by Walcott, (Research in China, Vol. III, pl. 7, fig. 5 a) but is nevertheless distinct.

I take pleasure in naming this new species in honor of prof. C. Ho, 何 杰 dean of the Geological Department of the National University.

HORIZON AND LOCALITY:—Early Upper or late Middle Cambrian; abundantly found in the purple shale of the Changshan formation. Collected by Prof. A. W. Grabau and Dr. F. F. Mathieu.

Genus **DORYPYGE** Dames

Dorypyge richthofeni Dames

Plate II, Figs. 3a, d.

1883 *Dorypyge richthofeni* Dames, China, Richthofen, Vol. IV. p. 24, plate 1, fig. 1-6.

1913 *Dorypyge richthofeni* Dames, Walcott, Research in China, Vol. III, p. 108-109 pl. 8 fig. 31 a-f.

Doctor Dames gives a detailed description of this species. This species is most common, being found everywhere in the Changhia limestone of North China.

Doctor Walcott points out the following differences between *Olenoides* and *Dorypyge:*

(a) The glabella of *Olenoides* expands toward the front, while that of *Dorypyge* contracts in front of the pits in the dorsal furrow.

(b) The pleural lobes of the pygidium of *Olenoides* have broad, shallow furrows with sharp, narrow ridges separating them, while those of *Dorypyge* have narrow furrows with broad, rounded ridges between them. The type of *Olenoides, O. nevadensis,* has a finely granulated surface, and the type of *Dorypyge* a coarsely granulated surface.

This species is characterized by a high arched glabella, narrow uptuned frontal border, presence of a large distinct occipital node, pustulose character of the surface; and a pygidium with spinose margin and with two large strong outward and backward pointing spines of the postero-lateral margin.

Measurements:—

Cranidium

	No. 517	No. 519
Length of cranidium	10.0 mm.	13.0 mm.
Anterior width of cranidium	—	12.0 mm.
Posterior width of cranidium	15.2 mm.	20.0 mm.
Length of glabella	7.5 mm.	10.0 mm.
Width of occipital ring	2.0 mm.	2.2 mm.

Pygidium

	No. 518	No. 520
Length	7.5 mm.	10.0 mm.
Anterior width (exclusive of spines)	13.0 mm.	15.5 mm.
Posterior width (exclusive of spines)	8.0 mm.	10.5 mm.
Length of axial lobe	6.5 mm.	8.5 mm.

Horizon and Locality:—Middle Cambrian: from Changhia limestone of Chêng-shan, 8 li from Chao-Kou-Chuang. Collected by University excursion in 1923 under the direction of the author.

Genus **TEINISTION** Monke

Teinistion subconica Sun (sp. nov.)

Plate II, Figs. 4.

cfr. 1903 *Teinistion lansi* Monke. Jahrb. Königl. Preuss. Geol. Landesanstalt und Bergakademie Vol. XXIII, Pl. 1, p. 117, pl. 4, figs. 1-17; plate 9, fig. 3.

ofr. 1913 *Teinistion lansi* Monke Walcott, Research in China, Vol. 3, p. 110, pl. 9, fig. 3.

This species is only represented by a fragmentary cranidium and an associated pygidium. Cranidium moderately convex; glabella strongly elevated, contracted in the upper part, with the sides curving inward, very broad at the base nearly twice the width of the frontal portion, frontal portion regularly rounded; it is not marked by glabellar furrows, but pustuled by scattered granules; occipital furrow very shallow slightly impressed.

Fixed cheeks very broad behind nearly the basal width of the glabella, nearly flat, scarcely rising from the dorsal furrow; palpebral ridge well marked, extending inward and forward from the palpebral lobe to the front of the glabella. Palpebral lobe not well shown in our specimen; frontal border narrow, slightly contracting backward in the front of the glabella. Facial suture cutting the anterior border at a point in front of the anterior base of the palpebral lobe, thence forming a signoid curve to the eye lobe; arching about the palpebral lobe they extend outward and nearly parallel to the posterior margin, then abruptly backward cutting the posterior rim. Dorsal furrows deep and distinct; occipital ring wide separated from the glabella by a very slightly indicated forward-arching occipital furrow; the center of occipital ring broader than the sides.

Associated pygidium referred to this species transversely semicircular, marginal border spinose with the anterior pair of spines very strong and long, gently curved backwards.

This species resembles *Teinistion lansi* Monke in form, but the subconical glabella, the narrow frontal border, the proportionally broader fixed cheeks and the pustulose character of the surface serve to distinguish it from Monke's species.

Measurements:—(Cat. 521)

Length of cranidium ....2.8 mm.
Length of glabella and occipital ring.....2.5 mm.
Width of the glabella at the base.....2.0 mm.

HORIZON AND LOCALITY:—Middle Cambrian: from Kushan formation of Lincheng, Chihli. Collected by Y. T. Chao and C. C. Tien.

Genus **STEPHANOCARE** Monke

Stephanocare richthofeni Monke

Plate II, Figs. 5a-c.

1903 *Stephanocare richthofeni* Monke, Jahrb. Königl. Preuss. Geol. Landesanstalt und Bergakademie, Vol. XXIII, pt. 1, p. 136, plate 7, fig. 1-17, plate 8 fig. 1-11. (Species described and discussed as a new species and the genotype).

1905 *Damesella chione* Walcott, Proc. U. S. Nat. Mus., Vol. XXIX, p. 40. (species described and referred to Damesella).

1913 *Stephanocare richthofeni* Monke Walcott, Research in China, Vol. 3, p. 114, Pl. 7, fig. 17, 17a-f.

Drs. Monke and Walcott described this species very fully. From the Lincheng material only one large cranidium, one hypostoma and a small pygidium probably of this species are known.

Cephalon transversely semicircular, moderately convex. Glabella convex, truncato-conical, slightly rounded in the front, the length is slightly greater than the width at the base; a posterior pair of glabellar furrows strong and deep extending obliquely inward and backward; a second pair of glabellar furrows very slighly impressed and short; the space between the second pair of furrows and the posterior furrows is a little wider than that between the first pair and the second pair. A third pair is faintly indicated. Occipital furrow narrow, transverse, clearly defined; occipital ring not well shown owing to the strongly weathered character of the specimen; dorsal furrow narrow and distinct.

Fixed cheeks less than one half the width of the glabella at the base, and moderately convex; they round up from the dorsal furrow to the palpebral lobe; back of the line of which they slope gently to the furrow of the postero-lateral limb, and to the front furrow within the frontal margin. Palpebral lobe not shown. Postero-lateral limb narrow and extending over a considerable distance to a rather blunt, rounded end; frontal rim in the form of a straight strongly scalloped ridge, with broadly rounded concave scallops pointing forward and separated by spine-like ridges which project at right angle to the frontal margin and are usually seven in number on the cranidium; frontal margin separated from the glabella and fixed cheeks by a narrow furrow which is scalloped forward in conformity with the scallops of the frontal rim. In front of the palpebral lobe the facial suture extends forward and slightly outward to the frontal margin. Postero-lateral furrows broad and distinct. Posterior rim scarcely scalloped.

An associated hypostoma referred to this species is very marked. Central portion subovate and convex; bordered by a narrow ridge on the side and the posterior por-

tion, frontal rim flat and marked by short spines. The posterior third seems to be defined by broad shallow slightly arched backward converging transverse depressions.

Associated pygidium transversely semicircular, with a spinose margin and strongly convex axis narrowing backwards at a moderate rate, and devided by shallow but sharp transverse furrow into four rings and a broader terminal lobe. Only part of the first anterior ring is shown, and the other rings are not well defined.

Limb almost flat except for abruptly decending marginal portion, the furrows crossing the axis prolonged on the limb deviding it into a corresponding number of segments, each of which terminated in the marginal spine, those of the last pair being shorter than the preceeding ones.

Surface of cranidium, hypostoma and pygidium marked by numerous depressed pustules.

Associated with this species are *Blackwelderia tieni*, *Blackwelderia cilix* var. *linchengensis*, *Wongia triangulata*, and *Teinistion subconica* etc.

Measurements:—

Cranidium (cat. 522 a)

Length of glabella	6.3 mm.
Frontal width of glabella	3.5 mm.
Basal width of glabella	6.0 mm.
Width of frontal border	1.3 mm.
Distance between two spines of the frontal margins	1.0 mm.

Hypostoma (associated) (cat. 522 b)

Length	3.7 mm.
Width	3.0 mm.

Pygidium (associated) (cat. 522 c)

Length	3.3 mm.
Anterior width	5.0 mm.

Genus **BLACKWELDERIA** Walcott

Blackwelderia sinensis var. **linchengensis** Sun (var. nov.)

Plate II, Figs. 6a-d.

cfr. 1913 *Blackwelderia sinensis* Walcott, Research in China Vol. 3, p. 121-123, pl. 9 figs. 5, 5a-g.

This species is represented by several cranidia, separated free cheeks, one segment of the thorax and an associated pygidium.

Cephalon transversely semicircular, moderately convex, strongly elevated near the palpebral lobes, frontal margin straight.

Glabella large, truncato-conical in outline, moderately convex, marked by three pairs of glabellar furrows; the posterior pair of furrows very broad extending obliquely inward; the second pair short and slightly impressed; the anterior pair usually not shown on the specimens. Occipital furrow transverse slightly arching forward near the center, broad in the center and slightly impressed at both sides. Dorsal furrow clearly defined extending from the frontal rim to the postero-lateral furrows.

Fixed cheeks nearly two-thirds the width of the glabella opposite the palpebral lobe. They rise from the dorsal furrow to the palpebral lobes and slope with a gentle curvature downward both to the frontal limb, and somewhat more abruptly to the posterior margin. Palpebral lobe strongly elevated, its length nearly equal to the frontal width of the glabella; postero-lateral limbs wider than the width of the glabella at its base; occipital ring transverse with uniform width throughout. The frontal border turn-up into a narrow elevated rim without line of demarkation from the frontal limb.

Facial suture decends to the anterior part of the palpebral lobe directly backward but slightly inward; then, curving around the latter, passes obliquely outward and backward, cutting the border of the cephalon a little back of the postero-lateral angle.

Associated free cheek about the same width of fixed cheeks opposite the palpebral lobe with a strong backward extending spine; the body of the cheek rises with a gentle covexity to the base of the eye-lobe.

The associated thoracic segment has a convex axis about the width of the flat surfaces of the pleural lobe on either side, the outer half of the pleural lobe is abruptly bent downwards forming an angle of about 120 degrees with the inner portion; surface of pleuræ marked by a broad and deep pleural groove which is wider on the flat part than on the depressed part.

Associated pygidium semicircular in outline, with a spinose margin; axial lobe strongly convex, subconical, with a narrow and round posterior end; it is divided by transverse furrows into four rings and a wider terminal portion, which has a faint fifth depression, indicating a fifth ring; the posterior portion of the axis slopes rather rapidly down to the margin; dorsal furrows distinct. Pleural lobes very gently convex for the inner half, the outer portion descending down abruptly. Surface marked by three relatively deep and broad furrows on either side, and one short shallow furrow slightly

impressed in the posterior part; the segments defined by the furrows are broader than the furrows, strongly convex at the center and flattened at the margin.

The border is practically a continuation of the slope of the segments and furrows of the pleural lobes; it is marked opposite the segments by short, backward-pointing flat, broad spines not clearly defined, due to the strong weathering of the specimens, and diagonally opposite the lateral angle of the axis by two long, strong, backward-extending and little outward diverging thick and round spines.

All the cranidia, and the associated free cheek are strongly marked by pustules throughout.

The associated pygidium referred to this species was also strongly pustulose, but because of the weathered character of the surface, the pustules are only found in a few places. The cranidium of this variety is rather similar to that of *B. sinensis* in form, but it differs from the latter in its conical glabella, in the narrower fixed cheeks, in the strongly pustulose character of the whole surface, in the narrow elevated frontal rim and in the character of the pygidium.

The main difference is that in the postero-lateral angle of the glabella the dorsal furrows separate the fixed cheeks from the glabella whereas that of *Blackwelderia sinensis* is replaced by a low ridge which connects the fixed cheeks and the glabella in the form of a small triangular lobe.

The associated pygidium of this species resembles more closely that of *B. cilix;* but it differs entirely from the latter in the strongly pustulose character of the surface, number of axial rings, in the narrow rounded terminal ring and in having the long spines close together at the margin and diverging outward instead of being parallel.

This variety is characterized by its proportionally narrow fixed cheeks, strongly pustulose character of the surface, well defined dorsal furrows, and the postero-lateral angle of the glabella.

Measurements:—

Cranidium	No. 523 a-b	No. 524	No. 525
Length of cranidium	9.0 mm.	8.3 mm.	8.0 mm.
Width of cranidium at the palpebral lobe	12.5 mm.	10.0 mm.	10.5 mm.
Width of fixed cheeks at palpebral lobe	3.5 mm.	3.0 mm.	3.2 mm.
Length of Glabella	6.8 mm.	6.0 mm.	6.0 mm.
Width of glabella at the base	6.0 mm.	5.2 mm.	5.2 mm.

Width of occipital ring	1.5 mm.	1.0 mm.	1.0 mm.
Width of frontal rim	1.0 mm.	0.8 mm.	0.8 mm.
Pygidium (associated)			
Length	6.2 mm.		
Width	11.0 mm.		

HORIZON AND LOCALITY:—Late Middle Cambrian: from thin-bedded limestone in Kushan shale of Lin-Cheng, collected by Y. T. Chao and C. C. Tien.

BLACKWELDERIA TIENI Sun (sp. nov)

Plate II, Figs. 7 a–c.

cfr. 1905 *Olenoides* (?) cilix Walcott, Proc. U. S. Nat. Mus., Vol. XXIX, p. 27, (described and discussed as a new species).

cfr. 1906 *Blackwelderia cilix* (Walcott), *idem*, Vol. XXX p. 573, (description of species extended and more throughly discussed).

cfr. 1913 *Blackwelderia cilix* (Walcott), *idem*. Research in China, Vol. III p. 119.

This is the most common species of the Lincheng material. It is represented by many cranidia, separated free cheeks and the associated pygidia.

Cephalon transversely semicircular and rather strongly convex. Glabella truncato-conical in outline and marked by three pairs of furrows. Posterior furrow is strongly marked and broad, extending obliquely inward and backward. The second furrow is slightly indicated by short faint lateral impressions and the anterior furrow is sometimes shown only by very faint indications. Frontal limb broad and concave; frontal rim very narrow and sharply elevated; occipital furrow strongly marked broadly curving forward at the center; occipital ring broader than the furrow and convex, slightly arching forward at the center; dorsal furrows distinct.

Fixed cheeks narrow, their width being somewhat more than two thirds the width of glabella opposite the palpebral lobe, rising regularly from the dorsal furrow to the palpebral lobe; facial suture cuts the frontal border about at a right angle, extending straight back to the palpebral lobe; palpebral lobe small and elevated.

Associated free cheek subtriangular in outline and divided into an interior convex body and the border, a sharp long genal spine very marked; inside of which the margin of the cheeks forms a broad second spine with the facial suture.

Pygidium semicircular in outline moderately convex and with spinose margin; axial lobe conical with pointed terminal portion nearly reaching to the margin

of the pygidium. Posterior margin with two backward pointing spines, next outer pair only slightly longer.

Surface pustulose under a strong lens.

This species differs from *B. cilix* Walcott in the comparatively narrow frontal limb, in the absence of distinct first and second glabellar furrows, in the pustulose character of the surface, in the absence of the longitudinal ridge and in the conical terminal portion and the comparatively uniform spinose character of the pygidium.

Moreover, the facial suture cuts the front of fixed cheeks nearly at right angles, being approximately parallel to the corresponding portion of the other suture, whereas the facial suture of *B. cilix* cuts the fixed cheeks obliquely toward the anterior palpebral lobe.

This species is named after Mr. C. C. Tien in recognization of the fine collections made by him.

Measurements:—	No. 526
Cranidium	
Length of cranidium	10.0 mm.
Width of cranidium at the palpebral lobe	10.0 mm.
Length of glabella	6.5 mm.
Length of frontal limb and rim	1.6 mm.
Width of occipital ring	1.6 mm.
Pygidium (Associated)	
Length	10.5 mm.
Anterior width of pygidium	18.0 mm.

Horizon and Locality:—Lafe Middle Cambrian: from thin-bedded limestone of Kushan horizon of Lin-Cheng, Chihli (Y. T. Chao and C. C. Tien Coll.).

Blackwelderia gigas Sun (sp. nov.)

Plate II, Figs. 8.

One pygidium was obtained by the University Excursion from the Kushan formation of Ku-Shan, Shantung. This is the largest pygidium of *Blackwelderia* so far found in China, and deserves to be designated by a separate name.

Semicircular in outline, moderately convex, and with a spinose margin; axis moderately convex, conical, tapering to its posterior end; it is divided by four clearly

marked broad and arched transverse rounded furrows into four transverse rings and a long terminal portion which has a slight fifth depression, indicating a fifth ring; the posterior portion of the axis slopes gradually down to the margin.

Owing to strong weathering and abrasion of this specimen, the presence or absence of two long, strong, backward-extending spines can not be determined.

Dorsal furrow shallow and distinct. Pleural lobes flat for a short distance from the axis, and then curve gently downward to the border; they are separated by four shallow furrows which divided the limb into five corresponding segments. The spines of the border are practically continuations of the pleural lobes.

The most interesting fact is that this pygidium occurs in a bed of conglomeratic limestone from the uppermost part of the Kushan formation. Certainly it represents the latest type of the Middle Cambrian.

Measurements:—

	No. 527
Length of pygidium	25 mm.
Anterior width or greatest width	40 mm.

Horizon and Locality:—Middle Cambrian: from conglomeratic limestone of Kushan formation of Kushan; 箭 山 collected by C. C. Tien and Y. T. Chao who were in my party during the University Excursion.

Genus **DAMESELLA** Walcott

Damesella blackwelderi Walcott var. **minor** Sun (var. nov.)

Plate II, Figs. 9 a-c.

cfr. 1905 *Damesella blackwelderi* Walcott Proc. U. S. Nat. Mus., Vol. XXIX, p. 35.

cfr. 1913 *Damesella blackwelderi* Walcott, Research in China, Vol. IV, p. 125-128, plate 10, fig. 1.

This variety is represented by several cranidia.

The type species is fully described by Dr. Walcott as below.

"Glabella large truncato-conical in outline, and marked by three pairs of short furrows, the posterior pair of furrows forms a rounded pit near the margin, and continues obliquely outward as a shallow furrow to the central third of the glabella, separating a short, rounded lobe on each side, the middle pair of furrows is short and very slightly impressed; the anterior pair of furrows is indicated by a short, smooth narrow space at the anterior fourth of the glabella; occipital furrow of medium width, rounded at the bottom, and rather deep; it curves backward slightly at the sides and then arches gently forward

at the middle; occipital ring of medium width, curving slightly backward at the ends and forward at the center, rounded on top; dorsal furrow strongly marked all about the glabella and passing posteriorly into a narrow but well-defined furrow within the posterior margin of the postero-lateral limb; the front of the glabella almost overhangs a strong furrow within the frontal border, that separates the frontal border from the fixed cheeks; frontal border or rim strong, rounded, and arching slightly upward in front of the glabella.

"Fixed cheeks a little more than one half the width of the glabella; they slope gently back to the furrow on the postero-lateral limb and rather rapidly downward, in front of the palpebral lobe, to the furrow within the frontal border; a clearly defined, low, rounded palpebral ridge extends opposite the anterior fourth of the glabella to the palpebral lobe, into the rim of which it merges; postero-lateral limb about one and one-third times as long as the width of the glabella at its base, and back of the palpebral lobe about one third the length of the cephalon elevated at the outer rim, and rather narrow. The facial sutures cut through the rounded frontal margin of the cephalon obliquely and then extend around backward, passing almost directly to the anterior margin of the palpebral lobe; curving around the rather small eye lobe, they pass obliquely outward and backward, cutting the border of the head a little back of the postero-lateral angle".

This variety differs from the type species figured by Dr. Walcott in the shorter glabella, narrow fixed cheeks, less distinct palpebral ridge, the more convex glabella, comparatively broader frontal border, and also in the small size. This variety is particularly characterized by its small form with broad truncato-conical glabella.

Measurements:—	var. minor		B. blackwelderi
	No. 528	No. 529	No. 530
Length of cranidium	6.5 mm.	4.5 mm.	20.0 mm.
Width of cranidium at palpebral lobe	8.5 mm.	5.5 mm.	—
Length of glabella	4.5 mm.	3.2 mm.	14.0 mm.
Anterior width of the glabella	3.0 mm.	2.2 mm.	9.4 mm.
Width of glabella at its base	4.5 mm.	3.0 mm.	—
Width of frontal rim	1.0 mm.	0.8 mm.	3.0 mm.
Width of occipital ring	1.0 mm.	0.8 mm.	—
Width of fixed cheeks on each side at the palpebral lobe	2.5 mm.	1.5 mm.	—

HORIZON AND LOCALITY:—Middle Cambrian: from massive Changhia limestone of Chao-Kou-Chuang, Luan-Hsien, Chihli. Collected by University Excursion under my direction (K. H. Hsü 徐光熙 Coll.).

Genus **PTYCHOPARIA** Corda

Ptychoparia fongi Sun (sp. nov.)

Plate II, Figs. 10 a, b.

This species is represented by several dorsal shields and the cranidia associated with them.

Cranidium moderately convex; length and width are subequal. Glabella moderately convex, becoming narrower toward the front, the front part regularly rounded; it is marked by three pairs of distinct glabellar furrows; the anterior pair (first pair) short, broad and transverse, extending a very short distance from the dorso-lateral furrows; the second pair about the same length and nearly parallel to the first pair, but comparatively broad; the third pair (posterior pair) broad and oblique extending backwards and inwards.

The occipital furrow very deep and very pronounced, transverse and connecting the postero-lateral furrows at both sides. The occipital ring moderately convex, very broad at the center, becoming narrower toward both sides.

Fixed cheek broad about two-thirds the width of the glabella opposite the palpebral lobe; palpebral ridge distinct extending the anterior part of the palpebral lobe nearly to the antero-lateral angle of the glabella; dorso-lateral furrows rounded and distinct.

Frontal limb flat or slightly convex and separated from the frontal rim by a shallow transverse furrow; frontal rim elevated and upturned from the marginal furrow to the margin; its frontal edge very slightly round; its width about the same as the frontal limb.

The facial suture cuts the frontal rim and then turns directly backward and slightly inward toward the palpebral lobe, and curves around this lobe, and finally extends backward and outward to cut the free cheek from the postero-lateral limb which is distinctly marked by a pronounced postero-lateral groove.

The thorax of a small associated individual has thirteen or fourteen segments with a narrow axial lobe and wide pleural lobes. The pleural furrow starts on the inner front side of the pleural lobe of each segment and, widening nearly to the width of the segment, begins to narrow at the point of geniculation and terminates near the posterior margin at the somewhat abrupt falcate termination of the pleuræ.

Pygidium small with a broad axis and pleural lobes indistinctly segmented.

The form of the glabella and the character of the glabellar furrows suggest *P. granosa* Walcott from the Manto shale of Shantung, but the comparatively narrow frontal limb, the more conical glabella, and the character of the surface serve to distinguish it.

This differs also from *P. yohi* in the shorter and less conical glabella, presence of three distinct glabellar furrows and also in the upturned frontal rim.

This species is characterized by the subconical glabella distinctly marked by three pairs of furrows, comparatively narrow frontal limb and the wide fixed cheeks. It is named after Mr. K. L. Fong 馮景蘭, dean of the Geological Department of Chun-Chow University 中州大學, Honan.

Measurements:—	10 a	10 b
Length of cranidium	8.5 mm.	6.5 mm.
Frontal width of cranidium	8.0 mm.	6.2 mm.
Posterior width of cranidium	1.3 mm.	1.0 mm.
Length of glabella	5.0 mm.	3.8 mm.
Anterior width of glabella	3.2 mm.	2.5 mm.
Posterior width of glabella	4.5 mm.	3.5 mm.
Width of frontal rim	1.5 mm.	1.2 mm.
Width of frontal limb	1.0 mm.	0.9 mm.
Width of occipital ring	1.4 mm.	1.1 mm.

Horizon and Locality:—Lower Cambrian: from Manto shale of Chêngshan, 8 li east of Chao-Kou-Chuang, Chihli. (Coll. F. F. Mathieu and Y. C. Sun).

Ptychoparia leichuangensis Sun (sp. nov.)

Plate II, Figs. 11 a, b.

This species is represented by two small fragmentary cranidia.

Head-shield semicircular, usually much wider than long. Glabella short and broad, subconical, rounded in front, decreasing in width anteriorly, its length about one half the length of the head-shield: convex and marked with three pairs of short horizontal distinct glabellar furrows, occipital furrow transverse and distinct; occipital ring broad in the center, becoming narrow at both sides; dorsal furrows deep and well marked.

Fixed cheeks gently convex about two thirds the width of the glabella opposite the palpebral lobe; palpebral ridge distinct and horizontal, extending from the anterior furrow to the palpebral lobe. Frontal limb moderately convex, about one-third the length of the glabella, and separated from the frontal rim by a distinct marginal furrow. Frontal rim narrow and elevated about two-thirds the length of the frontal limb.

The facial suture, after cutting the frontal border, diverges slightly outward down

to the palpebral lobe, curves around this lobe and finally cuts the fixed cheeks in an outward direction. Postero-lateral limb large and marked by a broad postero-lateral furrow.

This species is characterized by its small form, short very broad subconical glabella, convex frontal limb, and the comparatively narrow fixed cheeks.

Measurements:—

	11 a	11 b
Length of cranidium	1.7	2.0
Greatest width of cranidium	2.8	3.2

HORIZON AND LOCALITY:—Late Lower Cambrian: from Manto shale of Lei-Chuang, 雷莊 Luan-Chou; collected by Dr. F. F. Mathieu.

Ptychoparia yohi Sun (sp. nov.)

Plate II, Fig. 12.

This species is represented only by one crushed cranidium slightly broader than long.

Glabella moderately convex, subconical in outline, the front part regularly round; posterior width broad. It is marked by three pairs of very slightly impressed glabellar furrows. Occipital furrow transverse, shallow and very slightly impressed. Occipital ring very broad at the center and becoming narrower at both sides.

Fixed cheek about the same width of the glabella opposite the palpebral lobe; palpebral ridge distinct from the anterior part of the palpebral lobe near to the antero-lateral portion of the glabella. The facial suture cuts the frontal border to the anterior part of the palpebral lobe in a convex curve, bends around the latter and finally cuts the free cheeks from the postero-lateral limb, also with a convex curve.

Frontal limb flat, slightly broader than the frontal rim; frontal rim elevated and with regularly arched outline.

Surface apparently smooth.

The general form of the cranidium resembles that of *P. fongi* Sun, but the differences between them are mentioned after the description of that species.

This species is characterized by the smooth conical glabella with a broad base, comparatively broader fixed cheeks, and less distinctly defined occipital and glabellar furrows. This species is named after Mr. S. S. Yoh 樂森璕 who accompanied me in that region during the University Excursion.

Measurements:—

Length of cranidium	8.5
Width of cranidium opposite the palpebral lobe	10.0
Length of glabella	5.0
Anterior width of glabella	2.7
Posterior width of glabella	5.0
Width of fixed cheek at the palpebral lobe	2.8
Width of occipital ring	2.0
Width of frontal limb and frontal rim combined	2.4

HORIZON AND LOCALITY:—Lower Cambrian: from light micaceous purple shale of Chêng-Shan, 8 li from Chao-Kou-Chuang, Luan-Hsien, Chihli (Coll. Y. C. Sun).

Ptychoparia (Emmerichella) chengshanensis Sun (sp. nov.)

Plate III, Figs. 1 a, b.

This species is represented by several cranidia and associated pygidia probably of this species.

Cranidium usually broader than long, and apparently smooth.

Glabellar moderately convex, short and broad, slightly narraw toward the front; the anterior part regularly rounded. Occipital furrows shallow but distinct, merging into the postero-lateral furrow at both sides.

Occipital ring transverse and comparatively narrow, only slightly broader in the central portion.

Fixed cheek broad, about the same width as the glabella opposite the palpebral lobe; slightly convex near the palpebral lobe and becoming flat toward both the front and the postero-lateral furrow. Palpebral ridge very slightly indicated. The facial sutures first cut the frontal border directly backward to the anterior part of the palpebral lobe; curve around this and then cut the free cheek from the postero-lateral limb with a convex arc. Palpebral lobe of medium size.

Frontal limb flat and somewhat broader than the frontal rim from which it is separated by a shallow marginal furrow. Frontal rim slightly elevated, broader at the center, becoming narrower toward each side; the frontal margin gently rounded.

The associated pygidium is rather transverse; axial lobe very broad, cylindrical, divided by three indistinct furrows into four transverse rings and one terminal portion; pleural lobe also divided by four distinct furrows into five segments.

Surface apparently smooth.

This species is distinguished by its smooth character of the cranidium, short and broad glabella, narrow occipital ring, comparatively narrow frontal limb, and by its transverse form. It differs from *P. fongi* Sun in the absence of distinct glabellar furrows, in the shorter and broader glabella, and the more transverse form. It also differs from *Ptychoparia yohi* Sun in the more transverse form, the shorter and broader glabella and the absence of the glabellar furrows.

Measurements:—

Cephalon		
Length of cranidium	5.5	2.7
Frontal width of cranidium	5.5	2.7
Posterior width of cranidium	9.2	4.0
Length of glabella	3.2	1.6
Greatest width of glabella	3.2	1.7
Width of fixed cheek	2.0	1.0
Width of frontal rim	1.0	0.5
Width of frontal limb	0.5	0.35
Width of occipital ring	1.0	0.50

Horizon and Locality:—Lower Cambrian: from micaceous purple shale of Chêng-Shan, 8 li from Chao-Kou-Chuang, Chihli. (Y. C. Sun Coll.)

Genus **Changshania** Sun

1923 Changshania conica Sun and Chanshania truncata Sun, Bulletin of the Geological Society of China Vol. II, No. 1-2.

Cephalon semicircular in outline, exclusive of genal spine, gently convex. Frontal rim rather narrow about the same width as the postero-lateral limb. Glabella slender, truncato-conical or conical and smooth; occipital furrow straight and distinct; occipital ring nearly transverse and of uniformly width; dorsal furrows shallow and distinct.

Fixed cheeks narrow, the facial suture cuts the frontal border slightly inward and backward straight to the anterior part of the palpebral lobe curves around the latter; and then extends obliquely outward directly to the postero-lateral margin. Palpebral lobe long about two-third the length of the glabella, outlined by the intra-curving furrow.

Frontal limb broad flat or gently concave, its margin slightly rounded. Postero-lateral limb very short and marked by the transverse postero-lateral furrow extending transversely to both extremities.

Free cheeks broad with uniformly narrow border extending into a slender curving genal spine; cheek body flat and broad. An associated hypostoma elongate ovate with a distinct posterior curving furrow.

Only the pleuræ of the thorax are known, these being flat and of uniform width, and separated from each other by parallel furrows.

Pygidium transverse, with uniform narrow border. Axial lobe conical marked by four transverse furrows into four transverse rings and one terminal section which is situated near to the posterior border of the pygidium. Pleural lobe also segmented. Antero-lateral angle extending into a round extension.

The truncato-conical glabella, broad frontal limb and the transverse form of the pygidium may suggest *Ptychoparia* (*Emmerichella*), but the conical glabella, the ratio of the anterior width to the posterior width of the cranidium, comparatively narrow fixed cheeks and the antero-lateral extension of the pygidium serve to distinguish it.

Genotype—*Changshania conica* Sun.

Changshania conica Sun (sp. nov.)

Plate III, Figs. 2 a-k.

1923 *Changshania conica* Sun. Bulletin of the Geological Society of China Vol. II, No. 1—2 (listed).

The generic description of *Changshania* is based on this species.

This species is represented by several cranidia, separated free cheeks, an hypostoma, pleuræ of the thorax and by a number of pygidia.

This species is characterized by its subconical smooth glabella, narrow anterior width of the cranidium, long palpebral lobe, comparatively narrow fixed cheeks and the pygidium with round antero-lateral extensions.

Horizon and Locality:—Early Upper Cambrian: from Changshan shale of Chao-Kou-Chuang.

Measurements:—

Cranidium	A	B	C	D
Length	9.0 mm.	7.5 mm.	6.5 mm.	6.5 mm.
Anterior width	7.5 mm.	5.6 mm.	5.0 mm.	5.0 mm.
Posterior width	17.8 mm.	—	12.5 mm.	—

	2 a	2 b	2 c	2 d
Length of glabella	5.5 mm.	4.5 mm.	4.0 mm.	4.0 mm.
Basal width of glabella	4.5 mm.	3.5 mm.	3.0 mm.	3.0 mm.
Width of frontal rim	1.0 mm.	0.8 mm.	0.75 mm.	0.75 mm.
Width of frontal limb	1.9 mm.	1.5 mm.	1.0 mm.	1.1 mm.
Width of occipital ring	1.0 mm.	0.9 mm.	0.8 mm.	0.9 mm.
Hypostoma	2 e			
Length	6.5 mm.			
Width	4.0 mm.			
Pygidium	2 f	2 g	2 h	2 i
Length	5.0 mm.	4.2 mm.	5.0 mm.	4.5 mm.
Width at the union with thorax	12.8 mm.	10.0 mm.	12.5 mm.	—
Anterior width of the axis	3.5 mm.	2.6 mm.	3.2 mm.	3.5 mm.

Changshania? truncata Sun (sp. nov.)

Plate III, Figs. 3.

1923 *Changshania truncata* Sun. Bulletin of The Geological Society of China Vol. II, No. 1-2 (listed).

This species is represented by several cranidia, free cheeks and pygidia probably of this species.

Cephalon semicircular in outline, with genal angles (of free cheeks) prolonged into slender spines bending inward to the body. Glabella truncato-conical, apparently smooth; occipital furrow slightly curved and distinct; occipital ring of uniform width throughout.

Fixed cheeks very narrow, about one half the width of the glabella at the palpebral lobe. The facial suture cuts the frontal border slightly obliquely to the anterior part of the palpebral lobe, curves around the latter and then extends outward to the postero-lateral margin. Palpebral lobe long and marked by infracurving furrow; postero-lateral limb narrow and marked by a distinct postero-lateral furrow.

Free cheeks and pygidia apparently of the same type as in *Changshania conica* Sun.

This species is characterized by its broad truncato-conical glabella, narrow fixed cheeks and slightly curved occipital furrow and the transverse pygidium with conical axis and antero-lateral rounded extensions.

This species differs from *Changshania conica* Sun in the broad truncato-conical glabella, comparatively narrow fixed cheeks, and narrow postero-lateral limb. Its form lies between *Emmerichella* and *Changshania* and I provisionally place it under *Changshania*.

because it has narrow fixed cheeks, large palpebral lobes, and the antero-lateral extension of the pygidium. The specific name is given in reference to its truncated glabella.

HORIZON AND LOCALITY:—Associated with the preceeding.

Measurements:—

Cranidium

Length	8.0 mm.
Width at the palpebral lobe	8.2 mm.
Length of glabella	5.5 mm.
Anterior width of glabella	3.0 mm.
Posterior width of glabella	5.0 mm.
Width of frontal border	2.0 mm.
Length of palpebral lobe	2.8 mm.
Width of occipital ring	1.0 mm.
Width of fixed cheek at the palpebral lobe	2.0 mm.

Genus **CONOKEPHALINA** Brögger

Conokephalina kaipingensis Sun (sp. nov.)

Plate III, Fig. 4 a-b.

This species is represented by several fragmentary central portions of the cephala. Cephalon semicircular, moderately convex. Glabella subrectangular, becoming narrower anteriorly, front margin slightly rounded; antero-lateral angles also rounded. It is marked by three pairs of the glabellar furrows; the posterior pair distinct, obliquely extending backward and inward from the dorsal furrow; the second pair very short and horizontal opposite to the anterior edge of the palpebral lobe, the anterior pair slightly impressed rarely shown in the specimens. Occipital furrow distinct, bending slightly backward; occipital ring broad in the center, becoming narrow at both sides and also apparently marked by a node at its center.

Fixed cheeks very narrow, less than one half the width of the glabella at the palpebral lobe. The facial suture decends with a convex curve to the anterior edge of the palpebral lobe, curves around the latter and finally extends outward to outline the short postero-lateral limb. Palpebral lobe elongate, separated from the fixed cheek by a curving furrow, and situated opposite the posterior furrows; dorsal furrows rounded and distinctly marked; palpebral ridge indistinct extending obliquely from the anterior part of the palpebral lobe near to the frontal margin of the glabella. Frontal limb narrow and

separated from the frontal rim by a shallow forward curving furrow, frontal rim about the width of the frontal limb, slightly elevated and with regularly rounded margin.

Only one segment of the thorax is known. Axial and pleural segments are both strongly marked by distinct grooves.

Surface marked by strong pustules.

In form this species is similar to *C. vesta* Walcott of Fang-Lan-chön, Shansi, but differs from the latter in the narrow occipital ring, distinct glabellar furrow, indistinct palpebral ridge and the pustulose character of the surface.

The pustulose character of the surface and the narrow fixed cheeks suggests *Conokephalina belus* Walcott from Tai-An, Shantung, but it differs from the latter in the narrow occipital ring and in having the palpebral lobe placed further back and opposite the posterior pair of glabellar furrows.

This species is characterized by the subrectangular glabella, distinct glabellar furrows, pustulose character of the surface and the palpebral lobe placed back of the center of the glabella.

Measurements:—

	4 a
Length of cranidium	8.5 mm.
Width of cranidium at the palpebral lobe	9.5 mm.
Length of glabella	5.5 mm.
Width of glabella	5.0 mm.
Width of frontal limb	1.0 mm.
Width of frontal rim	1.0 mm.
Width of occipital ring	1.3 mm.

HORIZON AND LOCALITY:—Late Lower Cambrian: from Manto shale of Chao-Kou-Chuang, Luan-Hsien, Shantung. Collected by H. T. Yu (余新都).

Conokephalina gerardi Sun (sp. nov.)

Plate III, Figs. 5 a–c.

This species is represented by several fragmentary cranidia and associated pygidia probably referable to it.

Cranidium gently convex, subquadrilateral in outline, exclusive of free cheeks. Glabella subquadrilateral, slightly narrower in front, frontal part rounded, marked by a distinct longitudinal ridge; occipital furrow narrow shallow, slightly curved backward; occipital ring broad in the center, becoming narrow at both sides.

Fixed cheeks little wider than one half the width of the glabella opposite the glabella and nearly flat from the dorsal furrow to the palpebral lobe. Palpebral lobe large about one half the length of the cephalon and situated a little back of the central portion of the glabella; palpebral ridge strong and prominent merging into the anterior edge of the palpebral lobe from the dorsal furrow. Frontal limb flat, of medium width, and separated from the frontal rim by a shallow distinct furrow. Frontal rim about one half the width of the frontal limb and of uniform width throughout, slightly elevated.

The associated pygidium, probably of this species, is small with convex broad axial and segmented pleural lobes.

In form this species resembles *Conokephalina vesta* Walcott from the Middle Cambrian of Shansi, but the broad frontal limb, the absence of the distinct glabellar furrows and the more rounded frontal margin of the glabella serve to distinguish it.

This species is named in honor of Mr. Jacques Gerard engineer and geologist of the Chao-Kou-Chuang Mines.

This species is characterized by the acutely rounded frontal margin of the glabella, the smooth surface of the glabella, presence of the longitudinal median ridge, large and long palpebral lobe and the small pygidium with broad convex axial lobe and segmented pleural lobe.

Measurements:—	6 a	6 b	6 c
Length of cranidium	8.0	5.4	8.0
Width of cranidium at the palpebral lobe	8.0	6.2	—
Length of glabella	5.5	3.5	5.5
Width of glabella at base	5.0	3.0	4.5
Width of frontal limb and rim	1.5	1.1	1.7
Width of occipital ring	1.1	0.8	1.1

Horizon and Locality:—Manto-formation of Chêng-Shan, Chao-Kou-Chuang. Collected by University Excursion in 1923 (H. T. Yu 余新都 Coll.).

Genus **Crepicephalus** Owen.

Crepicephalus sp. indt.

Plate III, Fig. 6.

This is only represented by one pygidium.

Quadrilateral in outline, exclusive of lateral spines. Axial lobe very convex, cylindrical, with three transverse rings and one terminal ring which is again divided into one transverse ring and one terminal portion, far apart from the posterior margin. The

sides nearly parallel, contracting slightly at the middle, by incurving of the sides. Pleural lobe gently convex, also segmented by furrows. The postero-lateral and posterior margins flat and broad; lateral spines broad.

Width 5 mm. Length 4.4 mm.

HORIZON AND LOCALITY:—Middle Cambrian: from Changhia limestone of Chêng-shan, 8 li from Choa-Kou-Chuang, Chihli. Collected by University Excursion.

Genus **MANSUYIA** Sun (gen. nov.)

This genus differs from *Crepicephalus* in having very narrow fixed cheeks, in the absence of the palpebral ridge, in having very deep distinct dorsal furrows and in the short oblong form of the glabella.

The general form of the cranidium suggest *Anomocare* and *Anomocarella*, but the pygidium of this genus serves to distinguish it.

The associated pygidia of this genus are of the type of *Ceratopyge*, but the present genus differs greatly from that one in the cranidium.

Genotype: *Mansuyia orientalis* (Grabau) Sun.

This genus is characterized by its short oblong glabella, narrow fixed cheeks, and absence of the palpebral ridge. The pygidium has two inward-curving slender lateral spines which spring out from the second segment of the pleural lobe of the pygidium.

Mansuyia orientalis (Grabau) Sun

Plate III, Figs. 7 a–j.

1922 *Ceratopyge orientalis* Grabau (Mss.).

1923 *Ceratopyge orientalis* Sun. Upper Cambrian of Kaiping Basin. Bulletin of the Geological Society of China Vol. II, No. 1-2, p. 98. (listed).

This species is represented by many cranidia and the associated pygidia.

Glabella moderately convex, oblong in form, the front part slightly rounded; marked by three pairs of shallow broad short pits slightly impressed; occipital furrow rounded, and distinct; occipital ring uniform in width throughout, dorsal furrows and frontal furrow in the front of the glabella deep and clearly defined; frontal limb narrow slightly convex and elevated, separated from frontal rim by a shallow broad groove: frontal limb narrow in the middle, becoming wider toward each ends, and sloping

down anteriorly to the broad shallow groove in the front of the glabella; frontal rim moderately convex, broad in the middle, becoming narrower towards each sides.

Fixed cheeks very narrow; eye lobe of medium size, centrally placed.

The associated pygidium is of about the size of that of *Ceratopyge forficula*. It is broader than long with a well-defined convex median axis gently tapering backwards to within a short distance of the posterior margin of the pygidium where it is bluntly rounded. Median axis or axial lobe subconical and long with a very gentle rate of tapering, divided by seven transverse shallow distinct furrows into seven rings and one terminal portion which is again divided by shallow transverse furrows into two portions. The pleural lobes, in like manner, are also divided by five shallow slightly impressed furrows into six segments, the second being the broadest. Antero-lateral margins of limb rounded.

Lateral or side spines of pygidium slender long curved inward in the free part. The spine springs out from the broadest second segment of the pleural lobe which extends forward at an angle of about 45° with the median line, to about the position between the second and third ring of the axis.

In the majority of specimens from Chihli, this continuation of the spine and the segmentation of the axis and the pleuræ are not readily noted because of the worn or crushed character of the specimen.

Surface apparently smooth or slightly pustulated.

This species is characterized by its deep dorsal furrows and frontal furrow which separates the frontal limb and the glabella, short oblong glabella, narrow fixed cheeks, medium eye lobe and the strong lateral spines of the pygidium which spring out from the second segment. It is associated with *Kaolishania pustulosa*, etc.

Horizon and Locality:—Upper Cambrian: from Kaolishan limestone of Tai-An, Shantung (Y. C. Sun Coll.), also found in Fêngshan limestone of Luan-Hsien, Chihli by Mr. H. C. T'an of the Survey. More than thirty specimens examined.

Measurements:—

Cranidium	7 a	7 b	7 c	7 d	7 e
Length of cranidium	15.0 mm.	11.0 mm.	9.0 mm.	10.2 mm.	13.2 mm.
Width of cranidium at the palpebral lobe	13.5 mm.	10.5 mm.	8.1 mm.	10.0 mm.	—
Length of glabella	9.5 mm.	6.7 mm.	5.5 mm.	6.0 mm.	8.0 mm.
Width of glabella opposite the palpebral lobe	8.0 mm.	5.7 mm.	5.0 mm.	5.5 mm.	7.0 mm.
Width of frontal limb	2.3 mm.	1.8 mm.	1.5 mm.	1.8 mm.	2.5 mm.

Width of frontal rim	1.8 mm.	1.3 mm.	1.0 mm.	1.0 mm.	1.5 mm.
Width of occipital ring	2.0 mm.	1.7 mm.	1.4 mm.	1.5 mm.	2.0 mm.
Pygidium	7 f	7 g	7 h	7 i	7 j
Length	9.0 mm.	9.0 mm.	10.5 mm.	10.0 mm.	8.5 mm.
Width	14.5 mm.	14.2 mm.	15.5 mm.	12.5 mm.	13.0 mm.
Length of axial lobe	8.5 mm.	8.2 mm.	10.0 mm.	9.0 mm.	8.0 mm.
Average width of the transverse rings	1.1 mm.	1.1 mm.	1.2 mm.	—	—
Length of side spines (measured on curvature)	16.0 mm.	12.0 mm.	7.5 mm.	8.0 mm.	5.0 mm.

Genus **Kaolishania** Sun (gen. nov.)

General form subquadrangular, moderately convex; axial and pleural lobes strongly defined.

Cephalon wider than long, subsemicircular in outline; glabella truncato-conical, moderately convex and marked by three pairs of the lateral furrows, the posterior pair deep and broad, obliquely extending backward, the second pair deep and short, and slightly extending obliquely backward, and the anterior pair marked by a very slight trace; occipital furrows strong and distinct, occipital ring broad in the center, becoming narrow toward each side. A median longitudinal ridge extends from the front border of the glabella to the occipital furrow. The straight frontal part of the glabella and the fixed cheeks are separated from the frontal border by a strong and deep groove; frontal border narrow, slightly rounded in the front and turning up from the deep strong frontal groove to the frontal margin.

Fixed cheeks slightly convex and rising from the dorsal furrow, about one half the width of the glabella; palpebral ridge extending backward and outward from the dorsal furrow to the anterior part of the palpebral lobe; palpebral lobe of medium size.

Free cheeks moderately convex, elongate, broad at the anterior end where they join the fixed cheeks and the frontal border, and narrow at the posterior, ending in a slender rounded lateral spine; the cheek-body broad and moderately convex, separated from the slightly elevated narrow border by a distinct curving furrow.

The facial suture cuts the outer postero-lateral side of the genal angle, and passes almost directly inward to the base of the eye lobe, arching around the latter, it passes with a slight convex curve directly forward to the front margin.

Only one part of the fragmentary segment is known; the axial segment is moderately convex and marked by a strong groove; the pleural segment more or less flat and also marked by a broad distinct groove which gradually tapers to a point before the pleural segment reaches its end.

Pygidium large subquadrangular in outline; the axial lobe narrow and slender, divided by six distinct transverse furrows into five rings and one terminal section which is usually again divided by a shallow furrow into one ring and the terminal portion, and nearly reaches to the border; the pleural lobes broad, divided by five distinct furrows into six segments. The first two furrows descend with curving outline; while the other three extend obliquely backward to the border, usually short and slightly curved. The largest segment is the second segment from which the lateral spine springs out. The posterior border is narrow, separated from the pleural lobe by the posterior marginal groove, slightly convex and regularly rounded, and also slightly contracted at the posterior margin of the pygidium. Lateral spines about the same length as the pygidium, pointing directly backward but slightly outward.

Surface strongly marked by high pustules.

Genotype: *Kaolishania pustulosa* Sun.

This very remarkable trilobite resembles the genus *Blackwelderia* in the form of the glabella, but the strong side spines of the pygidium serve to distinguish it.

Kaolishania pustulosa Sun (sp. nov.)

Plate III, Figs. 8 a-h.

The description given of the genus *Kaolishania* includes what is known of the species.

This species is characterized by its truncato-conical glabella, narrow and concave frontal border, the distinct palpebral ridge, the short broad side-spine of the pygidium, the strongly pustulose character of the surface and the subquadrangular form of the pygidium.

This is the most common species in the collection from Tai-An. It is associated with *Mansuyia orientalis* (Grabau) Sun, *Chuangia batia* Walcott etc.

Measurements:—

Cranidium	8 a	8 b
Length of cranidium	11.0 mm.	12.5 mm.
Length of glabella	8.0 mm.	9.5 mm.

	8 a	8 b		
Width of cranidium at palpebral lobe	13.0	—		
Frontal width of glabella	4.5	5.0		
Basal width of glabella	7.5	8.5		
Width of frontal border	1.0	1.5		
Width of occipital ring	2.0	2.0		
Pygidium	8 e	8 f	8 g	8 h
Length	10.5	8.0	7.5	8.5
Width	17.0	14.0	12.5	14.0
Length of axial lobe	8.5	7.3	7.0	7.5
Anterior width of axial lobe	5.5	4.0	4.0	4.4

HORIZON AND LOCALITY:—Upper Cambrian: from massive gray limestone of Kaolishan from which the generic name is derived (Y. C. Sun Coll.).

Genus **LISANIA** Walcott

Lisania ? hsuchiachuangensis Sun (sp. nov.)

Plate IV, Fig. 1 a–b.

Cranidium subquadrilateral in outline, exclusive of the free cheeks. Glabella strongly convex subrectangular; antero-lateral angle rounded; apparently smooth; occipital furrow shallow but distinct; occipital ring narrow at both sides, becoming broader toward the center marked by a distinct central occipital node. Dorsal furrow narrow and clearly defined.

Fixed cheeks narrow, little more than one third the width of the glabella, sloping anteriorly to the frontal border and backward to the postero-lateral limbs; palpebral lobe about one-third the length of the cephalon; palpebral ridge distinct; frontal border slightly convex rounded in front very broad at the middle and separated from the glabella and the fixed cheeks by a narrow deep and distinct furrow. Postero-lateral limbs narrow about one half the width of the glabella and pronounced.

This species may be compared with *L. agonius* Walcott from the lower shale member of the Kiu-lung group of Yen-Chuang 顏 莊, Shantung, but differs from the latter in the more rectangular form, comparatively narrow occipital ring and in its shorter palpebral lobe.

HORIZON AND LOCALITY:—Middle Cambrian: from the Changhia limestone of Chêng-Shan, near Hsu-Chia-Chuang 徐家莊, Luan-Hsien, Chihli. (Coll. K.S. Hsu 徐光熙).

Measurements:—	1 a	1 b
Length of cranidium	6.5 mm.	4.0 mm.
Width of cranidium	6.0 mm.	4.0 mm.
Length of glabella	4.8 mm.	3.0 mm.
Width of frontal border	0.9 mm.	0.5 mm.
Width of occipital ring	1.0 mm.	0.5 mm.

Lisania rectangularis Sun (sp. nov.)

Plate IV, Fig. 2 a, b.

This species is represented by two broken central portions of the cephalon. Glabella moderately convex, subrectangular in outline; frontal margin rounded, apparently smooth; occipital furrow transverse and distinct; occipital ring broad at the center becoming narrow toward the sides.

Fixed cheeks narrow, less than one half the width of the glabella, the facial suture cut the frontal border slightly outward, backward to the anterior edge of the palpebral lobe; and thence curves around this lobe near to the occipital furrow; palpebral lobe large about one half the length of the cephalon, slightly convex.

Frontal border slightly convex with curving rounded margin, broad at the middle, becoming gradually narrow at the sides.

This species resemble *Lisania* cf *bura* (Walcott) from the Middle Cambrian of Changhia, Shantung, but differs in the subrectangular glabella, the large palpebral lobe and the course of the facial suture.

This species is characterized by its subrectangular glabella, narrow fixed cheeks, large palpebral lobe and the comparatively broader frontal border.

Horizon and Locality:—Middle Cambrian: from Changhia limestone of Chêng-Shan near Chao-Kou-Chuang, Chihli. Collected by Mr. K. S. Hsu 徐光熙, of Class 1925 of the Geological Institute of National University.

Measurements:—	2 a	2 b
Length of cranidium	3.5 mm.	3.3 mm.
Length of glabella	2.5 mm.	2.0 mm.
Width of glabella at palpebral lobe	1.7 mm.	1.5 mm.
Width of frontal limb	0.7 mm.	0.6 mm.
Width of occipital ring	0.5 mm.	0.6 mm.
Width of fixed cheek at the palpebral lobe	1.0 mm.	1.0 mm.

Genus **SOLENOPLEURA** Angelin

Solenopleura nodosa Sun (sp. nov.)

Plate IV, Figs. 3 a, b.

General form of cranidium transversely subrhomboidal, convex Glabella as long as the width at its base, the sides converging from the base towards the rounded front, so as to narrow the glabella about one fourth; anterior portion of the glabella very convex; three pairs of glabellar furrows, the posterior furrow distinct extending obliquely inward and backward and making an angle 45° with the dorsal furrow; the second and anterior pairs short and shallow in the form of pits; occipital furrow broad and well defined by the downward curvature of the posterior margin of the glabella and the rising of the surface of the occipital ring; occipital ring broad at the center, becoming gradually wider towards the sides, with a distinct median node at the posterior margin, dorsal furrow deep and well defined.

Fixed cheeks very convex at the center and sloping down toward the front groove and the postero-lateral groove, about one half the width of the glabella; palpebral lobe small and situated about in the middle of the glabella. Palpebral ridge moderately distinct, extending from the anterior part of the palpebral lobe, toward the dorsal furrow in front of the second furrow of the glabella. Postero-lateral limbs unknown; frontal limb very narrow and convex in front of the glabella and separated from the frontal rim by the broad and shallow frontal groove; frontal rim convex, rounded, about the width of the frontal limb and frontal groove combined, and of uniform width, with a straight frontal margin.

Surface marked by large pustules uniformly scattered.

This species is represented by two specimens of the cranidia.

This species is characterized by the presence of the small occipital node, palpebral ridge and also by the straight frontal margin of the frontal rim, and by the large uniformly scattered pustules.

HORIZON AND LOCALITY:—Middle Cambrian; from the massive cliff-making limestone of Chao-Kou-Chuang, Luan-Hsien, collected by National University Excursion under my direction in September 1923.

Measurements:—	3 a	3 b
Length of cranidium	12.5 mm.	6.6 mm.
Length of glabella	7.5 mm.	3.8 mm.
Width of glabella at base	7.2 mm.	3.5 mm.
Width of occipital ring at the center	2.0 mm.	1.1 mm.
Width of fixed cheeks at the palpebral lobe	4.0 mm.	2.0 mm.

Width of frontal limb	1.4 mm.	0.8 mm.
Width of frontal rim	1.4 mm.	0.9 mm.

In form this species resembles *Solenopleura bercæ* Walcott from Yen-Chuang, Shantung; but it differs in the presence of the distinct occipital ring and also of the palpebral ridge.

The presence of the palpebral ridge and the distinct occipital node suggest *Solenopleura holometopa* Angelin, but the position of the palpebral lobe and the proportionally shorter glabella serve to distinguish it. In this species the length of the glabella and its width at the base are subequal, while in the Swedish species the glabella is usually longer than wide.

Moreover, the palpebral ridge of our species extends from the anterior part of the palpebral lobe to the dorsal furrow, just a little in front of the second furrow of the glabella, while in *S. holometopa* it is distinctly marked and extends to the dorsal furrow one sixth the length of the glabella from the frontal margin of the glabella.

Genus **CHUANGIA** Walcott

1911 *Chuangia* Walcott, Smithsonian Miss. Coll., Vol. 57, No. 4, pp. 83-84.

1913 *Chuangia* Walcott, Research in China, Vol. 3, pp. 170-172.

Original description: "This genus is proposed for a group of Upper Cambrian trilobites in which the cephalon has a truncato-conical or sub-quadrangular glabella; a narrow, concave frontal limb and so far as known, a smooth test.

"The associated pygidium is large, with a strong axis, broad pleural lobes, and few indications of segments". (Walcott 1913 pp. 170-172).

Doctor Walcott compared the genus with *Anomocare* and *Ptychoparia* on account of the likeness of the general form of the cranidium. He also states under the description of the genus, that the characteristic frontal limb of *Chuangia* serves to distinguish it from the other two genera; and the genus *Chuangia* is characterized by the concave frontal limb which meets with the rim to form an angle and the rim does not rise above the dupwar sloping surface of the frontal limb.

In the Tai-An material collected by the college excursion, the outer shell of this genus was discovered and the shell or test is strongly marked by fine pustules; when the outer shell is exfoliated, the cranidium appears smooth.

Genotype--*Chuangia batia* Walcott.

CHUANGIA BATIA Walcott

Plate IV, Figs. 4 a–e.

1905 *Ptychoparia? batia* walcott, Proc. U. S. Nat. Mus., Vol. XXIX, p. 75.

1911 *Chuangia batia* walcott, Smithsonian Misc. Coll., Vol. 57, No. 4, p. 84, pl. 15, figs. 3, 3 a. (Referred and figured as genotype of new genus Chuangia).

1913 *Chuangia batia* walcott, Research in China, Vol. III pp. 170-171, plate 17, figs. 20, 20 a-d.

Cephalon, exclusive of the free cheek, subrhomboidal, moderately convex. Glabella truncato-conical; marked by three pairs of glabellar furrows very faintly shown; the posterior pair shallow, broad and slightly impressed extending from the dorsal furrow backward and inward; only faint traces of the broad second and anterior pairs of glabellar furrows are shown; occipital furrow nearly straight, rounded and very shallow; occipital ring strong, very slightly convex and slightly wider at the center than at the ends and marked by a minute node at the center near the occipital furrow; median longitudinal ridge distinct from the frontal margin of the glabella to the occipital furrow, dorsal furrow distinct but not strongly marked.

Fixed cheeks slightly convex, about one half the width of the glabella at the palpebral lobe, and curved downward in front to the frontal rim and backward in the furrow within the posterior margin; palpebral ridges distinct from the anterior part of the palpebral lobe to the dorsal furrow opposite the first pair or anterior glabellar furrows. Palpebral lobe small, and situated a little back of a transverse line drawn through the center of the cephalon; anterior lateral angle of the cranidium regularly rounded.

The facial suture converges on both sides from the anterior margin down to the anterior part of the eye, curves around the lobe and finally decends obliquely outward to the posterior corner.

The frontal margin of the cranidium forms a regular low arc, and is strongly bent up forming a high rim. Postero-lateral limb large, and marked by a strong and broad furrow within the elevated posterior margin. The front of the glabella and of the fixed cheeks curves down into a shallow furrow, from which the frontal rim rises before curving over to form a thick frontal margin.

An associated hypostoma, 9 mm. wide and 11 mm. long, is probably of this species.

Shell strongly marked by fine pustules.

Measurements:—

	4 a	4 b	4 c	4 d
Length of cranidium	10.7 mm.	8.5 mm.	8.7 mm.	13.5 mm.
Anterior width of cranidium	9.7 mm.	8.0 mm.	8.0 mm.	12.5 mm.
Posterior width of cranidium	15.0 mm.	—	12.6 mm.	—
Length of glabella	6.8 mm.	5.5 mm.	6.0 mm.	9.0 mm.
Basal width of glabella	5.8 mm.	4.5 mm.	4.5 mm.	7.0 mm.

Width of occipital ring	1.3 mm.	1.0 mm.	1 0 mm.	1.5 mm.
Width of frontal border	2.7 mm.	2.3 mm.	2.3 mm.	3.0 mm.

Horizon and Locality:—Upper Cambrian: from the lowest horizon of the Kaolishan limestone. Associated with this are *Mansuyia orientalis* (Grabau) Sun, *Kaolishania pustulosa* Sun, *Syntrophia orthia* Walcott etc. (Coll. Y. C. Sun).

This species is represented by many cranidia and associated pygidia; and is really one of the most common forms of Kao-Li-Shan.

The Kaolishan specimens differ from the type species in the presence of the median longitudinal ridge, in its distinct palpebral ridge and broader frontal border, longer glabella and comparatively narrow fixed cheeks. The course of the facial suture is also different from that in Walcott's specimens, converging slightly on both sides from the frontal margin to the eye, while in our material the facial suture converges rapidly on both sides from the frontal margin to the palpebral lobe.

This form is characterized by its concave frontal border, truncato-conical glabella, absence of the distinct glabellar furrows, distinct longitudinal median ridge, and palpebral ridge; and the finely pustulose character of the outer shell.

Genus **CHANGIA** Sun (Gen. nov.)

1923 *Changia* Sun, Bulletin of the Geological Society of China, Vol. II, No. 1-2 (listed).

General form elongate oval, moderately convex. Glabella of cylindrical form contracted in the middle by incurving of the sides opposite the palpebral lobe; marked by three pairs of short, slightly impressed furrows; occipital furrow distinct; occipital ring uniform in width throughout. Dorsal furrow deep broad and round; frontal furrow broad and deep.

Fixed cheeks very narrow; palpebral lobe of medium size and elevated; the facial suture cuts the frontal border with convex arc to the anterior part of the palpebra lobe, curves around the lobe and finally extends outward to the margin of the postero-lateral limb. Frontal border slightly convex, very broad, sloping down from the frontal groove in the front of the glabella to the rim of the border; antero-lateral angles rounded. The postero-lateral limb narrow, marked by a broad, shallow groove extending from the dorsal furrow to the extremities of the limb.

Free cheeks large ending into a strong genal spine which has about the same length as the cheek, body border narrow and depressed; cheek-body slightly convex, forming a triangular depressed area inside the posterior margin.

Thorax unknown.

Pygidium large with a strong central axis that terminates within a broad flattened border. Central axis divided by broad, deep and round furrows into six or more

transverse rings; pleural lobes also marked by broad furrows opposite the transverse rings of the central axis, but much flattened.

Surface apparently smooth under the lens.

The incurving sides of the glabella, the broad and flat frontal border and narrow fixed cheeks suggest the genus *Saukia*, but our genus differs from the latter in its longer glabella, three pairs of short slightly impressed glabellar furrows, and also in the position and the comparatively small size of the palpebral lobe.

This genus is the most common one in the upper zone of the Upper Cambrian of Chau-Mi-Tien and belongs to the family *Dikelocephalinæ*.

This genus is characterized by its broad, slightly convex frontal border, subrectangular glabella with both sides contracting in the middle, narrow fixed cheeks, large free cheeks, comparatively small palpebral lobe which is centrally placed, and the large pygidium with flattened border.

The generic name is given in honor of Dr. H. T. Chang 章鴻釗, former president of the Geological Society of China.

Genotype:—*Changia chinensis* Sun.

CHANGIA CHINENSIS Sun (sp. nov.)

Plate IV, Figs. 5 a–g.

General form large elongate and oval, moderately convex, cephalon transversely semicircular with genal angles extended into a strong spine. Glabella moderately convex, elongate, subcylindrical, contracting opposite the palpebral lobes by incurving of the sides of the glabella; marked by three pairs of short glabellar furrows, the posterior pair broad and short extending obliquely backward; the second pair of furrows parallel to the posterior one but short and also slightly impressed, the anterior pair very short and very slightly impressed; occipital furrow broad and shallow arching forward in the middle, occipital ring moderately convex broad in the middle and arching forward.

Frontal limb very broad, slightly convex, separated from the glabella by a strong distinct groove in the front of the glabella, the frontal margin slightly curved and the antero-lateral angles rounded. Dorsal furrows deep and distinct.

Fixed cheeks very narrow, slightly convex; the facial suture cuts the frontal border slightly outward and than inward toward the anterior part of the palpebral lobe, curves around the latter and finally extends outward and backward, outlining the postero-lateral limb. Palpebral lobe of medium size and elevated. Postero-lateral limb narrow,

triangular in outline; marked by a broad postero-lateral furrow extending outward but slightly backward to both extremities.

Free cheeks very large, subtriangular in outline, exclusive of genal spine, with a narrow depressed flat border; cheek-body slightly convex and broad, ending in a long genal spine.

Pygidium transverse, large and with a strong central axis that terminates within a broad flattened border. It is marked by clearly defined transverse rings that extend out in the pleural lobes to the border.

Surface smooth.

This species is characterized by the elongate cylindrical glabella, broad frontal border and also small palpebral lobe centrally placed. It is represented by several cranidia, free cheeks and pygidia.

Horizon and Locality:—Upper Cambrian: Upper zone of the Upper Cambrian of Chau-Mi-Tien region, Shantung. Collected by university expedition.

Measurements:—

Cephalon			
Cranidium (a-c)	5 a	5 b	5 c
Length of cranidium	25.0	10.0	10.0
Front width of cranidium	18.0	7.0	7.5
Length of glabella	15.5	6.5	6.0
Width of glabella opposite the palpebral lobe	8.0	4.0	4.0
Width of frontal border	6.5	2.3	2.6
Width of occipital ring	3.5	2.0	2.0
Free cheeks (d-f)	5 d	5 e	5 f
Length of cheek	37.0	35.0	12.5
Width of cheek	15.0	15.0	6.2
Length of genal spine (preserved)	10.0	32.0	6.5
Pygidium (g)	5 g		
Length	30.0		
Width	50.0		

Genus **QUADRATICEPHALUS** Sun (gen. nov.)

General form elongate oval; moderately convex. Cephalon transversely semi-ovate with genal angles extended backward in a strong spine.

Cranidium subrectangular in outline, exclusive of postero-lateral limb. Glabella moderately convex, sub-cylindrical with both sides parallel, slightly rounded in the front. It is marked by three pairs of glabellar furrows; the posterior pair shallow, distinct, extending obliquely inward and backward and connecting in the middle; the second pair short and shallow, being parallel to the posterior pair; the first or anterior pair very short about one fifth the width of the glabella; a median longitudinal ridge very pronounced, extending from the frontal furrow to the occipital furrow. Occipital furrow broad and rounded, slightly narrow in the center; dorsal furrow broad deep and rounded; frontal groove or furrow rounded and distinct; occipital ring transverse and of nearly uniform width.

Fixed cheeks very narrow, about one fourth the width of the glabella at the palpebral lobe; palpebral lobe very small and situated opposite the second furrow of the glabella and a little in front of the center of the glabella. The facial suture curve slightly outward from the frontal margin, thence curves inward to the anterior angle of the palpebral lobe and around it, and finally extends obliquely outward to outline the free cheeks from the postero-lateral limbs.

Frontal border slightly convex or flat with antero-lateral angle rounded, very broad, of uniform width throughout, about one fourth the length of the cranidium, the middle part of the border very slightly impressed.

An associated free cheek probably of this species, is large and broad with flat broad border and ending in a strong genal spine.

Surface strongly punctate.

This genus is entirely distinct from any other known in the Upper Cambrian of China and evidently belongs to the family *Dikelocephalinæ*. *Quadraticephalus* differs from *Saukia* in the longer subrectangular glabella with subparallel sides and straight frontal margin, small eye lobe and the punctate character of the surface.

Quadraticephalus differs from *Dikelocephalus* in the position of the palpebral lobe situated in the front of the middle of the glabella, longer glabella and also in the glabellar furrows. Other differences may be found in future when more complete specimens are obtained.

This genus is similar to the genus *Chuangia* in form, but the presence of the median longitudinal ridge, subrectangular glabella with subparallel sides and punctate character of the surface serves to distinquish it from that genus which is found in the Chau-Mi-Tien region of Shantung. The subrectangular glabella, pronounced median longitudinal ridge, small eye lobe opposite the second pair of furrows, narrow fixed cheeks and the punctate character of its surface are characteristics of this genus.

Genotype:—*Quadraticephalus walcotti* Sun.

Quadraticephalus walcotti Sun (sp. nov.)

Plate IV, Figs. 6 a-d.

This species is represented by several cranidia and separated free cheeks associated with it.

The generic description of *Quadraticephalus* is based on this species, and therefore nothing need be added here.

The species is characterized by the broad, slightly convex frontal border of the cephalon, small eyelobe placed opposite the second pair of the glabellar furrow, subrectangular glabella with a pronounced median longitudinal ridge, the presence of a depression dividing the frontal limb on the median line of the glabella and the free cheeks with their very broad strong genal spines.

The specific name is given in honor of Dr. C. D. Walcott in recognition of the great work done by him on the Cambrian Faunas of China.

Horizon and Locality—Upper Cambrian: from Kaolishan limestone of Tai-An, just below the foot of the Pagoda, i.e. the highest bed in that region (Coll. Y. C. Sun).

Measurements:—	6 a	6 b	6 c
Length of cranidium	15.5 mm.	14.8 mm.	10.0 mm.
Frontal width of cranidium	11.0 mm.	11.0 mm.	--
Length of glabella	9.6 mm.	9.8 mm.	6.5 mm.
Width of glabella opposite the palpebral lobe	6.2 mm.	6.5 mm.	4.0 mm.
Width of frontal border	4.0 mm.	3.4 mm.	2.0 mm.
Width of occipital ring	2.2 mm.	2.0 mm.	1.3 mm.

Quadraticephalus ? convexus Sun. (sp. nov.)

Plate IV, Fig. 7.

This species is represented by a broken central portion of the cephalon. Glabella quadrate in form very convex; it is distinctly marked by a longitudinal ridge extending from the furrow in the front of the glabella to the occipital furrow. It is also marked by two pairs of the glabellar furrows. The first or anterior pair faintly impressed and twisted;

the posterior pair shallow and slightly impressed extending from the dorsal furrow to the median ridge where they unite.

Occipital furrow shallow and broad, merging into the dorsal furrows on both sides.

Fixed cheek very narrow, about one fourth the width of the glabella. Frontal border convex and marked by the broad groove which separates the frontal border from the glabella.

Surface finely punctate.

I place this species under *Quadraticephalus* because of the quadratiform outline of the glabella, the presence of a distinct longitudinal median ridge, the narrow fixed cheek and the fine punctate character of the surface, although the frontal border is quite different. This species differs from *Q. walcotti* in the narrow frontal border, short and broad convex glabella and the glabellar furrows. When a perfect specimen is discovered, other differences may be found.

Measurements:—

	7
Length of cranidium	14.5 mm.
Length of glabella	10.0 mm.
Width of fixed cheeks opposite the palpebral lobe	2.0 mm.
Width of frontal border	2.6 mm.

HORIZON AND LOCALITY:—Upper Cambrian: from conglomerate limestone of of Kao-Li-Shan (Coll. Y. C. Sun).

Genus **PTYCHASPIS** Hall

Ptychaspis chinhsiensis Sun (sp. nov.)

Plate IV, Figs. 8 a–f.

1923 *Ptychaspis chinhsihsiensis* Sun, Upper Cambrian Fossils from Fêngtien. Bulletin of the Geological Society of China Vol. II, No. 1-2 p. 101 (listed).

This species is represented by several cranidia, separated fixed cheeks, and associated hypostoma and pygidia.

Dorsal shield elliptical in outline, moderately convex, with a large genal spine on each side.

Glabella moderately convex, the greatest convexity in the anterior lobe; it is divided by a broad distinct backwards arching transverse furrow into one long anterior lobe and one narrow transverse lobe. Anterior lobe very long, marked by two pairs of

furrows, the posterior pair very short and broad and the anterior pair slightly impressed, rarely distinct; the second lobe rather transverse, narrow at the center, becoming wider at the sides; occipital furrow distinct and broad arching forward at the center; occipital ring moderately convex, broad at the center and narrow at both sides.

Fixed cheeks very narrow, about one half the width of the glabella at the palpebral lobe; convex near the palpebral lobe, becoming more gentle both in the front and at the back of the palpebral lobe. Palpebral lobe distinctly elevated and separated from the fixed cheeks by an outward bending palpebral furrow, which extends from the posterior furrow of the anterior lobe to the front of the occipital furrow; dorsal furrows rounded and distinct in confluence with the postero-lateral furrow; postero-lateral limb narrow, the outer ends bending slightly backward; postero-lateral furrows distinctly marked, very broad near the dorsal furrow, becoming narrower toward the end.

The facial sutures first cut the front border, then extend inward and backward to the anterior part of the palpebral lobe, curve around this lobe and finally extend backward and outward to cut the posterior border of the cephalon.

Frontal border gently convex, broad at the middle and becoming gradually narrow on both sides, separated from the glabella and the fixed cheeks by a shallow furrow.

Free cheeks exclusive of the genal spine, subtriangular in outline; the border is well defined and extends to the facial suture; the body of the cheek moderately convex; genal spine about the same length as the cheek, pointing backward and slightly outward; the body as well as glabella separated from the border by a distinct groove; the border of uniform width, marked by several irregular striations.

The associated hypostoma is subrectangular in outline, with obtusely rounded posterior border; the central portion or body strongly convex, marked by a pair of the posterior furrows which extends obliquely inward and backward and are nearly parallel to the margin of the central body. Posterior rim very narrow and elevated, separated from the central portion by a broad posterior groove.

Fragmentary segments of the thorax are known with the axis gently arched and marked by a distinct groove; pleuræ about the same width as the axis, flat and marked by grooves narrowing toward the sides before reaching the end.

Pygidium subsemicircular in outline and transverse; the central axial lobe very convex and conical near to the posterior margin of the pygidium, divided by five distinct furrows into five transverse rings and one long terminal ring; the pleural lobes broad marked by nine or more furrows into ten or more segments which extend up to the flat planulate margin of the pygidium.

Cranidia, free cheeks, hypostoma and pygidia appear granulated under a strong lens.

This species is characterized by its finely granulated character, rather short second lobe, broad flat frontal border, absence of pustules and the conical axial lobe of the pygidium.

The form of the glabella and its size suggest *P. acamus* Walcott, but it differs from the latter in the comparatively narrow second lobe, in the absence of a marked pustulose and punctate character and in the broad frontal border. When the entire specimen of *P. acamus* is found, other differences will be found.

The largest specimen (c) 17 mm. in width has a length of 16 mm.

Measurements:—

Cephalon	8 a	8 b
Length of cranidium	—	11.0 mm.
Width of cranidium of palpebral lobe	—	11.5 mm.
Length of glabella	5.5 mm.	7.5 mm.
Width of glabella at palpebral lobe	4.0 mm.	5.5 mm.
Width of anterior lobe	4.5 mm.	6.0 mm.
Width of second lobe	1.0 mm.	1.3 mm.
Width of occipital ring	1.1 mm.	2.0 mm.
Hypostoma	8 d	
Length	6.5 mm.	
Width	6.0 mm.	
Free cheeks	8 e	
Width of cheek body at palpebral lobe	3.5 mm.	
Width of border of free cheeks	2.0 mm.	
Pygidium	8 f	
Length	5.0 mm.	
Width	—	
Length of axis	4.5 mm.	
Anterior width of axial lobe	2.0 mm.	

Horizon and Locality:—Upper Cambrian: from thin bedded argillaceous limestone of Sha-Kuo-Tun, Chin-Hsi-Hsien (錦西縣) from which this species is named. Collected by Dr. J. G. Andersson.

Ptychaspis angulata Mansuy var. **chinensis** Sun

Plate V, Figs. 1 a, b.

1915 *Ptychaspis angulata* Mansuy. Faunes Cambriennes du Haut-Tonkin, p. 25 pl. III, fig. 2 a-v. Mém. Serv. Géol. de l'Indochine. Vol. IV, fasc. II.

1916 *Ptychaspis angulata* Mansuy. Faunes Cambriennes de L'Extrême-Orient Méridional, pl. V, fig. 12 a-e. Pl. VI, fig. 1 a-d.

Mansuy described this species very fully, the translation of his description being as follows:

"The glabella is subrectangular, a little larger at the base than at the anterior extremity. The anterior lobe is roundly arched; the dorsal furrows, deep and narrow, are faintly sinuous. The first lateral furrows, well marked, very oblique behind, spread over two-thirds of the width of the glabella; they seem really to represent a second pair, the first pair of lateral furrows being frequently erased in species of this genus. The following furrows (transverse furrows) very deep, parallel to the preceding lateral ones, are continuous. Occipital furrow sinuous. The lower edge of the head, the occipital furrow, the lateral furrows and the anterior edge of the glabella are about equidistant in both varieties. In the middle of the occipital ring, a striking tubercle is noticeable in most samples; this tubercle, often broken at the top, gave rise to a spine more or less developed.

"Fixed cheeks very narrow, with a variable convexity, usually fairly well marked. Ocular lobes about semicircular, sinuous anteriorly, are contiguous to the glabella and join it in a very short ocular line. Frontal limb narrow, almost flat with a large arched tubercle in the middle; its width equal to that of the marginal rim, which is larger in the middle than laterally, and is separated from the limb by a large but not deep furrow. The anterior edge of the head is not curved but forms a very open obtuse angle. The sutures, very oblique in their posterior portion up to the ocular lobes, are sinuous; after having passed these occular lobes they become rectilinear and parallel to the axis of the glabella before reaching the anterior margin. The free cheeks though dissociated, are easily differentiable one from the other according to width. The surface is regularly convex, with the maximum convexity at the center. The marginal rim, large and elevated, with curved section, enlarges more and more until it reaches the genal angle. The posterior rim of the cheeks is much narrower. The genal spine, long, strong, acicular, with circular section, is nevertheless at its base much smaller than the peripheric rim. The lower edge of the free cheeks forms a concave arc with large radius near the genal angle.

"The dissociated thoracic segments show that the rachis was salient, with curved section. The pleuræ are large and are traversed by a well-marked, slightly oblique furrow; the pleural ends are inflected backwards. Some of the pygidia are arched, others

semicircular. It is probable that the longest belonged to the long variety and the shorter ones to the short variety. In all other characteristics they do not differ in any way. The axis is salient, truncato-conical, it is formed by seven segments; the terminals are obsolete. The lateral lobes have six furrowed segments, separated from the edge by an oblique and flattened limb."

Mansuy compared this species with *P. campe* Walcott from the Upper Cambrian of Chau-Mi-Tien of Shantung; and he also mentioned that this species differs from Walcott's species in the angular anterior edge of the frontal rim and also in the small eye lobe.

Two varieties were described by him. The width of the glabella equals 84 hundredths of the length in one variety, while in the other variety the width does not represent more than 60 hundredths of the length. He also mentioned that the short glabella is higher and more incurved longitudinally than the long glabella.

In the Kaolishan material four cranidia are represented.

This new variety differs from the type species in the anterior lobe enlarging forward in the presence of very broad rounded frontal groove separating the frontal rim from the glabella, and in the distinctly punctate character of the surface.

This variety is rather similar to *Ptychaspis acamus* var. *punctata* both in the form of the glabella and the surface character, but it differs from the latter greatly in the angular edge of the frontal rim which has a very obtuse angle.

Measurements:—

	1 a	1 b
Length of cranidium	9.4 mm.	—
Length of glabella	6.4 mm.	6.5 mm.
Frontal width of glabella	4.0 mm.	5.0 mm.
Width of anterior lobe	4.6 mm.	5.0 mm.
Width of second lobe	1.5 mm.	1.4 mm.
Width of frontal rim and groove combined	1.5 mm.	1.6 mm.
Anterior angle of frontal rim	135°	135°

Horizon and Locality:—Late Upper Cambrian: from the uppermost part of the Kaoli formation in the conglomerate limestone of Tai-An, Shantung. (Y. C. Sun Coll.)

Ptychaspis walcotti Mansuy

Plate V, Figs. 2 a.

1915 *Ptychaspis Walcotti* Mansuy. Faunes Cambriennes du Haut-Tonkin, p. 22, pl. 11, fig. 1 6a, b, pl. III, fig. 1 a-z. Mêm. du Serv. Géol. de L'Indochine. Vol. IV, fasc. II.

1916 *Ptychaspis Walcotti*: Faunes Cambriennes de L'Extrême-Orient Méridional, pp. 33-34, pl. V, fig. 10 a-j, fig. 11 a-b.

Dr. Mansuy Described this species very fully and the translation of the description is as follows:—

"The two species attributed to the genus *Ptychaspis* Hall found in the Cambrian of Upper Tonking, are very imperfectly known, being represented only by fragments of heads, by a few free cheeks and thoracic segments, and by pygidia which seem to be closely related to the forms of the same genus described by Mr. Walcott from the Cambrian of Shantung and of Shansi.

"The species herein described is represented by two varieties, well differentiated in their proportions, one with a longer glabella the other with a shorter glabella; the glabella of the first is somewhat contracted. These differences in the length and width of the glabella, separating these two forms, seem furthermore to represent only individual variations, for, as we will see later, very characteristic details of organization of specific order are common to both. *Ptychaspis angulata* nov. sp., described further on, found in another locality than *Pt. walcotti* nov. sp., is also represented by two varieties differentiated in the same degree and possessing common specific characteristics as strong as those observed in both varieties of the preceding species. In both *Pt. walcotti* and *Pt. angulata* the two varieties differ in certain parts but are similar in their fixed common characteristics. If we add that no intermediate variety has been observed, with one partial exception, in spite of the large number of specimen gathered, we are forced to the deduction (with due reservations) that the two varieties of our species are perhaps but the expression of sexual differences.

"We will describe in the first place the long variety of *Pt. walcotti* (nov. sp.). The glabella of the long variety of this species is subrectangular, the anterior side and the posterior side measuring in a large individual 11 mm. and 15 mm. The convexity is fairly well marked without reaching the high relief shown by certain species of the same genus. The longitudinal incurvation becomes progressively accentuated from the middle of the length and ends anteriorly in a rather abrupt curve. Dorsal furrows large and very deep, their depth being increased by the increased height of the fixed cheeks. The occipital furrow, equally well marked, deeper laterally and inflected backwards in the same parts, is slightly sinuous in the middle. Anterior lobe rectangular, the anterior edge of the glabella being almost straight, very gently convex. It is much wider than long and limited backwards by transverse marginal furrows, not very noticeable. The second lateral furrows, are still very oblique backwards, deeply furrowed, are separated one from the other by an interval equal to their length. The third lateral furrows are

still more marked than the preceding ones and with the same obliqueness at their ends, are continuous. The second and third lateral furrows as well as the occipital furrow, are separated by almost equal intervals. The occipital ring, in the same relief as the glabella, is large, with curved arc section, its width is greater in the middle than at the ends; on its posterior margin is inserted a strong occipital spine of which only the base, having the appearance of a large tubercle, is visible. The fixed cheeks, incomplete in all our specimens, are narrow and show a convexity almost as marked as that of the glabella; The rim which bounds them posteriorly is smaller than the occipital ring. Ocular lobes small, raised in the vertical plane and almost parallel to the dorsal furrows of the glabella. The width and the convexity of the frontal limb are almost equal to the width and convexity of the fixed cheeks; Its surface blends laterally and backwards in the surface of the fixed cheeks, in such a way that the glabella is surrounded by a perfect rectangular frame, which gives to the cranidium of our species a very individual appearance. The whole surface is covered by little tubercles, either subcircular or elliptical, drawn close together and sometimes mingling and scattered without symmetry.

"The free cheeks, the thoracic fragments and the separated pygidia which accompany the heads described above, are simply mentioned here, with all reservations as to their belonging to one or the other of the two varieties of *Pt. walcotti*. The free cheeks are large, one of the specimens is a little smaller than the others and this peculiarity allows us to suppose that it belongs to the long and narrow variety rather than to the short variety of *Pt. walcotti*, the glabella of this one being much larger than that of the long variety. The genal angles are not raised, they are situated in the prolongation of the posterior edge of the head. The genal spine is not very long but wide and robust, very diverging. It makes way without any deviation to the marginal rim. The thoracic fragments observed on the same fragments of shale, are much mutilated, with furrowed pleuræ and rounded arched axis. No other characteristic is noticeable.

"All the pygidia are of the same type and identical, one with the other. They are particularly remarkable because of their very transverse form and the strong inflection of the upper edge. The entire marginal region of these pygidia are thrown backwards and form a very obtuse angle sometimes even, in certain specimens, showing a rectilinear trace (perhaps as the result of a slight deformation). The rachis, with semicircular section, truncato-conical, is composed of five large segments, rounded and separated by deep furrows. The posterior segment, larger than the preceding ones, joins the posterior edge by an abrupt inflexion. On the lateral lobes can only be distinguished the proximal end of two upper segments, the following ones being entirely erased; the

whole surface of these lobes is covered by fine sinuous lines, drawn close together, resembling cracks, interrupted or joining, whose general direction is parallel to the edge.

"The glabella of the second variety of *Pt. walcotti*, of almost equal length and breadth, shows a subtrapezoidal contour; its longitudinal inflection becomes abruptly accentuated towards the anterior third of its length. The length and obliqueness of the anterior lateral furrows, the anterior concavity of the third lateral furrows, continuous, reproduce all the traits of the corresponding parts of the long variety. The marginal anterior rim is equally very wide, arched and contiguous to the glabella. This glabella of the short form, seem to represent the glabella of the long form but shortened, as if contracted with a stronger incurvation.

"SIMILARITIES AND DIFFERENCES. The 14 species of Upper Cambrian trilobites from Shantung and from Shansi, attributed to the genus *Ptychaspis* Hall, by Mr. Walcott, are all as poorly represented as are ours, by very mutilated heads, sometimes reduced to internal moulds of dorsal teguments from the glabella and from the fixed cheeks, by a few incomplete free cheeks and by three pygidia. From such insufficient material we may only venture on some limited comparisons, all conclusion being forbidden, particularly as we foresee that a revision of these forms based on the study of less fragmentary specimens, will modify in a large measure the interpretation which has heretofore been given, either by the reduction of the number of species already described, or by the reference of some of them to other genera.

"Among the Chinese species, *Pt. walcotti* (nov. sp.) represents closer affinities with *Ptychaspis acamus* Walc. from the Upper Cambrian limestone of the Chau-Mi-Tien, in Shantung. The glabella of *Pt. acamus* joins intermediate proportions to those of the two varieties of *Pt. walcotti;* its anterior edge is more convex. The occipital ring is smaller; finally in the Tonking species, the convexity of the long variety, in its anterior half, is much fainter, while it is more marked in the short variety. The granulations which cover the surface of our species, are bigger and closer and through the superficial structure of the integuments, *Pt. walcotti* draws closer to *Pt. cadmus* Walc. a species from the same locality as *Pt. acamus;* besides, *Pt. acamus*, *Pt. cadmus* and *Pt. campe* Walc. from Shantung, resemble each other closely. The differences in the proportions of the glabella, in the height and in the relative development of the frontal lobe and the lateral lobes, in these species, are faint, they vary in fact, very little from *Pt. walcotti*, and the comparison of the figures given by Mr. Walcott with those representing *Pt. walcotti* in the same work, will give a more exact notion of the similarity of these three Chinese species between them, and with the Tonking species, than the best description.

"*Ptychaspis walcotti* differs in both varieties from *Pt. angulata* characteristic of a little older horizon from the Cambrian of the region of Yen-minh, by the more clearly rectangular contour of the glabella and by its fainter convexity. The marginal anterior rim, in *Pt. walcotti* is large and continuous to the glabella, while a narrow limb separates it in *Pt. angulata*. These notable differences are also noticeable between the pygidia found with the fragments of heads of these two species. The pygidia associated with the cranidia of *Pt. angulata* are bounded by a smooth limb all over their circumferencial contour. The segments of pleural lobes are very apparent; it has been noted that on the pygidia found with *Pt. walcotti*, they are almost entirely erased."

One cranidium from Sha-Kuo-Tun probably belongs to the long variety of the Tonking species. It has a broad occipital ring, a straight anterior edge of the anterior lobe, moderately convex rectangular anterior lobe and large elliptical tubercles.

In these respects, as well as in size, our specimen agrees fairly well with Mansuy's species. This is the first example of this species found in China, although it occurs abundantly in the Upper Cambrian of Tonking. This suggests that the Shakuotun limestone of Fêngtien is equivalent to the zone of *Ptychaspis walcotti*, the uppermost zone of the Upper Cambrian of Tonking.

MEASUREMENTS:—

Length of cranidium	9.5 mm.
Length of glabella	6.5 mm.
Antero-posterior width of anterior lobe	5.2 mm.
Width of second lobe	1.5 mm.
Width of occipital ring	2.0 mm.
Width of frontal rim	1.2 mm.

HORIZON AND LOCALITY:— Upper Cambrian: from Shakuotun limestone, Sha-Kuo-Tun, Chin-Hsi-Hsien, Fêng-Tien. Collected by Dr. J. G. Andersson.

Ptychaspis subglobosa Grabau (Mss) (sp. nov.)

Plate V, Figs. 3 a-d

1923 *Ptychaspis subglobosa* (Grabau), Sun. Bulletin of the Geological Society of China Vol. II No. 1-2 (listed)

"This species is represented by four glabellas with parts of fixed cheeks attached (one of the specimen is shown from the under side and two are very imperfect).

Associated with these is a large number of free cheeks and genal spines which apparently belong to this species.

"Glabella large, almost parallel-sides except for the slightly wider subglobose anterior lobe, which is strongly convex and but slightly wider transversely, its antero-posterior dimension somewhat less than half the length of the entire glabella. Anterior glabellar furrow complete slightly less pronounced in the center and very gently arcuate; second furrow more strongly deflected backwards and faint in the center; occipital furrow similar to the anterior furrow but broader at the sides and somewhat fainter in the center; the convexity of the posterior segments somewhat less than that of the anterior lobe. Occipital segment slightly broader than second and third segments which are of equal width.

"Fixed cheeks flat or very gently convex; their width somewhat more than half the width of the glabella, broadly grooved posteriorly by the lateral extension of the occipital furrow.

"The associated free cheeks are large and extended into a long gently curved genal spine. The outer contour is gently and regularly convex, and the inner side contracts rapidly to the very gently tapering genal spine, which has a subcircular or broadly ovoid section with the narrow end on the inside. It is marked by subequally spaced, rather distint and more or less continuous longitudinal striæ. The length of the genal spine is considerable, being much greater than that of the glabella; its terminal end tapers rather more rapidly.

"Surface apparently smooth, though in one specimen there is a suggestion of faint discontinuous and concentrically placed wrinkles on the anterior lobe of the glabella.

"The specimens occur in a limestone conglomerate (intraformational) with large worn limestone pebbles. The slender genal spines are by far the most numerous, and they are mostly fragmentary, the anterior expansion of the free cheek being shown only in a few specimens. They are very like the genal spines of some species of *Paradoxides*, but more curved, and they are longer and more slender than those of any other species of *Ptychaspis* from the Cambrian of China. They are also much longer proportionately, more cylindrical and less rapidly tapering than are those of *P. minicaensis* Owen, the type species of the genus, from the St. Croix beds of Wisconsin.

"This species approaches *Ptychaspis calyce* Walcott, from the Upper Cambrian Ch'aumitien limestone of Shantung, in the form of the glabella but the anterior lobe is longer more nearly subglobose while the second furrow is more deflected backwards

medially and less continuous than in that species. The Fêngshan specimens are also uniformly larger. The free cheeks of our species are very distinct.

"*Measurements:* The length of the most perfect glabella is 25.5 mm., width of anterior lobe (longitudinal) 12.5 mm., width of central part of glabella 13.5 mm. The diameter of the median portion of the genal spines varies from 3.5 to 4 mm.

"*Horizon and Locality:* The specimens occur in a limestone conglomerate of Upper Cambrian collected by Dr. J. G. Andersson at Luan-Hsien, Chihli province." (Grabau Mss.)

Five more cranidia of this species were obtained from the Koal'i limestone. Two large ones occur in the same limestone conglomerate and are essentially of the same type as those of the Fêngshan limestone. Three other small specimens were found in the crystalline limestone full of *Obolus*, 2 or 3 meters below. The Shantung specimens are well preserved especially in the fixed cheeks, eye lobes and the surface while the Chihli specimens are nearly worn away and difficult for description.

Fixed cheeks flat, moderately convex near the palpebral lobe and sloping down the postero-lateral portion; triangular in outline, exclusive of the palpebral lobe, very broad in the posterior part about the width of the glabella and becoming narrow gradually toward the front; marked posteriorly by a broad and distinct groove, which extends outward from the furrow a little below the occipital furrow to the postero-lateral extremities and broadens slightly outward. It is also marked by distinct raised undulating ridges which are the characteristic feature of this species.

Palpebral lobe small, elongate, situated just opposite the first glabellar furrow and separated from the fixed cheeks by an incurved furrow and elevated. The occipital ring usually broader than the third lobe, slightly narrow in the center, becoming broad at both sides. It is distinctly marked by a median node.

The facial sutures cut the antero-lateral portion with a regular convexity to the anterior part of the palpebral lobe; and curving around this lobe, extend outward and backward to the postero-lateral extremities, forming angles of 45° with the posterior margin.

Surface strongly marked by elevated ridge, and wrinkles and also punctate.

The concentric wrinkles of the anterior lobe, and the general form of the cranidium suggest *P. ceto* Walcott from the Upper Cambrian Chaumitien limestone of Chau-Mi-Tien, Shantung, but our species differs in the longer subglobose form of the anterior lobe of the glabella, the punctate surface with distinct wrinkles and ridges, and also in the greater deflection of the transverse furrow of the glabella.

MEASUREMENTS:—

	a	b	c	d
Length of cranidium	25.5 mm.	19.0 mm.	.....	6.0 mm.
Width of cranidium at the palpebral lobe	.....	17.0 mm.	12.2 mm.	7.0 mm.
Length of glabella	21.8 mm.	16.0 mm.	9.0 mm.	5.0 mm.
Antero-posterior dimension of anterior lobe	12.5 mm.	10.0 mm.	5.0 mm.	3.0 mm.
Width of glabella	14.2 mm.	10.5 mm.	6.2 mm.	3.5 mm.
Width of the second lobe (antero-posterior)	4.8 mm.	3.5 mm.	2.0 mm.	1.3 mm.
Width of the third lobe ,, ,,	4.0 mm.	3.0 mm.	1.5 mm.	1.0 mm.
Width of occipital ring ,, ,,	.....	3.0 mm.	.....	1.0 mm.
Length of palpebral lobe	.....	.....	3.0 mm.	2.0 mm.

HORIZON AND LOCALITY:—Late Upper Cambrian: from the conglomerate limestone and crystalline limestone of Kaolishan formation of Tai-An, Shantung. (Y. C. Sun Coll.): also the upper Cambrian of Luan-Hsien, Chihli (J. G. Andersson Coll.).

PTYCHASPIS SUNI Grabau (mss.) (sp. nov.)

Plate V, Figs. 4a, b.

1923 *Ptychaspis suni* (Grabau) Sun, Bulletin of the Geological Society of China, Vol. II, No. 1-2 p. 98.

"Only the cephalon exclusive of the free cheeks is known but one free cheek, probably of this species is associated with this. Glabella with parallel sides, moderately convex, the greatest convexity apparently in the anterior lobe, though this is worn. Anterior and second lobe separated by a very faint furrow which is transverse; the width (longitudinal) of the two lobes combined being equal to the width of the glabella which in the specimens described is 5.75 mm. The second furrow is more pronounced, and more concave forward, the third or occipital furrow is strong and transverse. Length of entire glabella, 9 mm; width of occipital ring 1.7 mm.

"Fixed cheeks half the width of the glabella, subsemicircular in outline, with a pronounced narrow palpebral lobe defined by a well-marked furrow.

"Entire surface of cranidium strongly pustulose except where worn.

"The associated free cheek has about the width of this fixed cheek at the center of the occular lobe. Behind this it curves outward at first obliquely then abruptly ending in a narrow gently tapering genal spine of subcircular section and forming nearly half the length of the cheek. Anterior portion terminating in an angle of about 45°. Outer edge of free cheek gently but regularly curving from anterior end to the tip of the genal spine.

"This species resembles *Ptychaspis campe* Walcott from the Upper Cambrian Ch'aumitien limestone of Shantung in the form of the glabella, fixed cheeks and palpebral lobes, and in the pustulose character of the carapace. The occipital furrow of our species is however very much deeper than in that species, being moreover continuous, while it is interupted in the center in the Shantung species. Our species is more over nearly twice as large as *P. campe*.

"HORIZON AND LOCALITY: In the thin-bedded argillaceous limestone of Fêngshan formation of Yeh-Li, Luan-Hsien, Chihli, Collected by H. C. T'an. The species is named after Mr. Y. C. Sun, of the National Geological Survey."

PTYCHASPIS ACAMUS var. PUNCTATA Sun (var. nov.)

Plate V, Figs. 5a-d.

1905 *Ptychaspis acamus* Walcott, Proc. U. S. Nat. Mus., Vol. XXIX, p. 69.

1913 *Ptychaspis acamus* Walcott, Research in China Vol. III, p. 179, pl. 16, Fig. 18, 18 a.

1923 *Ptychaspis acamus* Walcott, Sun; Bulletin of the Geological Society of China. Vol. II, No. 1-2 p. 101 (listed).

This variety is represented by six cranidia, and associated free cheeks. Glabella strongly convex on the frontal lobe, but moderately convex at the back; Subrectangular in outline with two sides parallel to each other; frontal margin of the glabella very straight and separated from the uniformly narrow border by a straight pronounced groove. Anterior lobe quadrate in form, marked by two pairs of short slightly impressed glabellar furrows; the posterior pair little longer than the posterior ones, extending backward and inward for very short distance; second lobe very narrow antero-posteriorly about as wide as the occipital ring and separated from the large longer anterior lobe by a broad strong backward arching furrow.

Fixed cheeks very narrow about the same width as the frontal border. Dorsal furrow deep and distinct.

Frontal border narrow elevated and straight, of uniformly width throughout.

Occipital ring narrow of uniform width throughout.

Surface strongly marked by very large pustules and also finely punctated.

As only the glabella of the type species is known, the detail comparison is not possible.

This variety differs from type species in the distinctly punctate character of the surface, straighter frontal edge of the glabella, in the narrower anterior lobe and in the free cheeks.

The general form of the cranidium and the pustulose and distinctly punctate character of the surface suggest *Pt. angulata*, but it differs greatly in the straightened margin of the frontal border instead of the angular one.

This variety was obtained from the highest cambrian beds of Chau-Mi-Tien five meters above the *Orthoceras* horizon. It is associated with *Changia chinensis*.

Measurements:—

	a	b	c	d
Length of glabella	8.8 mm.	8.0 mm.	7.5 mm.	12.0 mm.
Width of glabella	6.0 mm.	6.0 mm.	6.0 mm.	8.5 mm.
Width of anterior lobe	7.0 mm.	6.0 mm.	7.0 mm.	9.5 mm.
Width of second lobe	1.5 mm.	1.57 mm.	1.5 mm.	2.0 mm.
Width of occipital ring	2.0 mm.	.....	.....	.....
Width of frontal border	.....	1.5 mm.	1.5 mm.	.....

Horizon and Locality: Uppermost Cambrian: from the upper limestone at Chau-Mi-Tien, Shantung. I tentatively put it in the Fêngshan horizon, separating these beds from the Chaumitien limestone. Collected by University Excursion of 1923. (Y. T. Chao, K. M. Wang, C. C. Yang and C. C. Tien Coll.)

Anderssonia Sun, subgenus of **Ptychaspis** (Subgenus nov.)

Cranidium gently convex, the width at the palpebral lobe and the length subequal. Glabella moderately convex, short, usually broad opposite the palpebral lobe by outcurving at the sides of the glabella, the front narrowly rounded. A very distinct backward-curving posterior furrow separates the anterior lobe and the narrow transverse lobe; the anterior lobe laterally extended at the base becoming less so toward the front, marked by one pair of very short and distinct furrows extending obliquely inward and backward; the second lobe slightly narrow in the middle, becoming wide at the sides, separated from the occipital ring by a transverse occipital furrow; occipital ring little wider than the second lobe and of uniform width; dorsal furrows rounded, distinct and subparallel.

Fixed cheeks very narrow, about one half the width of the glabella, slightly convex; the facial suture first cuts the posterior border and then bends inward to the base of the palpebral lobe, curving around it and finally extending outward and forward, and then inward again to cut the frontal border; frontal limb narrow slightly convex separated from the narrow elevated frontal rim by a very narrow distinct transverse furrow, frontal rim very narrow, extended transversely with a uniform width throughout. Palpebral lobe large and long extending from the very faint anterior furrow of the anterior lobe nearly to the occipital furrow, and separated from the fixed cheeks by an incurving furrow.

Associated free cheeks large with slender genal spine.

An associated segment of the thorax, probably of this subgenus is known. Axial lobe and pleural lobe subequal in length; axial lobe convex; pleural lobes of nearly uniform width throughout except the pleural end.

An associated pygidium transverse, with the narrow conical axis and flattened margins.

This new subgenus is included in the subfamily *Dikelocephalinæ* and is characterized by its slight, convex frontal limb, large and elongate palpebral lobes, narrow fixed cheeks and the narrow elevated frontal rim.

The narrow frontal limb, elongate palpebral lobe and the form of the glabella suggest the genus *Conokephalina*, but the strong lateral furrows, absence of the palpebral ridge and the broad form serve to distinquish it.

It differs also from *Ptychaspis* in the presence of the frontal limb and in the form of the glabella which is broad in the middle.

This new subgenus is named in honor of Dr. J. G. Andersson, who collected these specimens.

PTYCHASPIS (ANDERSSONIA) FENGTIENENSIS Sun (subgen. and sp. nov.)

Plate V, Fig. 7a-c

This species is represented by three fragmentary cranidia, and separated free cheeks, segment of thorax and pygidia associated with it.

The subgeneric description of *Anderssonia* is based on this species and the specific name is derived from Fêngtien where it was found.

HORIZON AND LOCALITY: This species is associated with *Pty. chinhsiensis*, *Pty. walcotti* and *Eoorthis shakuotunensis* etc. in the Shakuotun limestone of Fêngtien.

Measurements:—

	7a	7b
Cephalon		
Length of cranidium	6.5 mm.	4.5 mm.
Width of cranidium	6.5 mm.	5.5 mm.
Length of glabella	4.3 mm.	2.9 mm.
Width of glabella opposite the palpebral lobe	3.5 mm.	2.5 mm.
Width of anterior lobe (antero-posterior)	3.5 mm.	2.0 mm.
Width of second lobe	1.0 mm.	0.7 mm.
Width of occipital ring	1.1 mm.	0.9 mm.
Width of frontal limb	5.5 mm.	0.5 mm.
Width of frontal rim	0.6 mm.	0.5 mm.
Length of palpebral lobe	2.5 mm.	1.8 mm.

	7c
Pygidium (associated)	
Length	4.0 mm.
Anterior width	6.0 mm.

PTYCHASPIS (ANDERSSONIA) TANI Sun (sp. nov.)

Plate V, Fig. 6.

This species is represented by one broken portion of the cephalon.

Glabella moderately convex; divided by two backward arching transverse furrows into one large transverse lobe and two narrow transverse lobes; the combined width of the two narrow transverse lobes being nearly as great as that of the anterior lobe. Occipital furrow distinct.

Fixed cheeks narrow, about one half the width of the glabella at the palpebral lobe; palpebral lobe very large, extending from near the anterior part of the glabella to the occipital furrow, and separated from the fixed cheeks by an infra-curving furrow. Frontal rim elevated and of uniform width, separated from the glabella by a broad concave limb.

Surface strongly marked by pustules and irregularly curving ridges but not punctate.

This species resembles both *Pt. calyce* Walcott and *Pt. ceto* Walcott in the transverse form of the anterior lobe, but differs greatly from both in having a very large palpebral lobe, narrow fixed cheeks and also in the presence of the frontal limb.

The large palpebral lobe and the pustulose character of this species suggest *Pt. campe* from Chaumitien limestone of Chau-Mi-Tien, but the distinct, continuous arching transverse furrow and the concave frontal limb serve to distinguish it.

This species is characterized by the transverse form of the anterior lobe, large palpebral lobe, concave frontal limb and pustulose and ridged character of the surfaces. It is named after Mr. H. C. T'an, (譚錫疇) geologist of the Survey, in recognition of the geological work done by him in Shantung.

Measurements:—

Length of glabella	3.9 mm.
Width of Anterior lobe (longitudinal)	2.3 mm.
Width of second lobe	1.0 mm.
Width of third lobe	1.0 mm.
Width of frontal limb and rim combined	1.0 mm.

HORIZON AND LOCALITY:— Upper Cambrian: from the Upper Cambrian limestone of Chau-Mi-Tien. Collected by University Excursion.

Genus **ANOMOCARE** Angelin

ANOMOCARE FLAVA Walcott

Plate V, Figs. 8a–d.

1906 *Anomocare flava* Walcott, Proc. U. S. Nat. Mus., Vol. XXX, p. 583.

1913 *Anomocare flava* Walcott, Research in China. Vol. III, pp. 190-191, pl. 18; figs. 8; 8a-c.

This species was found by Willis and Blackwelder in the Kichou formation of Shansi and very fully described by Walcott. In the collection from the Kaiping Basin it is represented by more than 50 individuals and certainly is one of the most common species in the Changhia formation of North China. It is associated with *Dorypyge richthofeni*, *Solenopleura nodosa*, and two species of *Lisania*.

It is characterized by its quadrilateral cranidium, short and moderately convex glabella with slight indications of glabellar furrows, shallow occipital furrow, low and broad palpebral ridge, slightly convex, broad frontal rim, presence of the occipital node; and by a pygidium with a broad, planulate margin and with a narrow convex axis, slightly segmented.

Measurements:—

Cranidium	8a	8b
Length of cranidium	6.0 mm.	5.5 mm.
Width of cranidium at palpebral lobe	6.2 mm.	5.6 mm.
Length of glabella	3.5 mm.	3.4 mm.
Width of occipital ring	1.0 mm.	1.0 mm.
Width of frontal limb	0.4 mm.	0.4 mm.
Width of frontal rim	1.0 mm.	1.0 mm.
Pygidium	8c	8d
Length	5.0 mm.	6.0 mm.
Width	8.0 mm.	9.5 mm.

HORIZON AND LOCALITY:— Middle Cambrian: from the cliff limestone of Chêngshan, 8 li from Chao-Kou-Chuang, Chihli. Collected by University Excursion (K. S. Hsu 徐光熙 Coll.).

Genus **Dolichometopus** Angelin

Dolichometopus deois Walcott

Plate V, Fig. 9.

1905 *Dolichometopus deois* Walcott, Proc. u.s. Nat. Mus. Vol. XXIX, p. 94.

1906 *Bathyuricus asiaticus* Lorenz, Zeitschr. deutsch geol. Gesellsch., Vol. LVIII, pt. 2 p. 73, Pl. V, fig. 1-5. (species characterized and illustrated)

1900 *Amphoton steinmanni* Lorenz, idem., Vol., LVIII, pl. 2, p. 75, plate IV, figs. 15-17. (Species characterized and illustrated).

1913 *Dolichometopus deois* Walcott, Research in China, Vol. III, pl. 21, figs. 13, 13 a-d., Plate 22, figures 1, 1 a-h, 2, 2a-b.

Dr. Walcott gives a full description of this species.

This species is characterized by its prominent glabella diverging anteriorly with three pairs of rather short, very faintly impressed furrows; the presence of a small backward pointing occipital spine; narrow fixed cheeks; long palpebral lobe; and short and slightly convex frontal limb.

Dr. Walcott compared this species with *D. svecicus* Angelin and mentioned that this species differs from the latter in the greater convexity of the glabella, more convex frontal limb, and other minor details of the glabella and the fixed cheeks.

This species is represented by only one cranidium in the Luan-Chou (灤州) material. Our specimens agrees closely with the type of the species figured by Walcott both in form and size.

Horizon and Locality:— Middle Cambrian: from Changhia limestone of Kwan-Hsi-Ying (關西營), Luan-Chou. Collected by Dr. J. G. Andersson.

Measurements:—

Length of cranidium	11.0 mm.
Width of cranidium at palpebral lobe	9.8 mm.
Length of glabella	8.5 mm.
Basal width of glabella	5.0 mm.

Genus **ILLÆNURUS** Hall

Illænurus pagoda Sun (sp. nov.)

Plate V, Figs 10a–c.

Of this species only three pygidia are known.

Pygidium subtriangular in outline, usually broader than long, moderately convex.

Shell perfectly smooth without segmentation of the axis except at the frontal part where it is more strongly rounded. One specimen with a part broken away shows very slight axial segmentation in the cast of the interior. This may be one of Walcott's pecies. On account of the strong forward-projection, I refer it for the present, to a snew species—*Illænurus pagoda*.

Three specimens measure respectively: length 7.5 mm., 7.5 mm., 8.0 mm.; width 10 mm., 10 mm., 12.0 mm.

Horizon and Locality:— Upper Cambrian: from the conglomerate limestone of Kao-Li-Shan, Tai-An, Shantung (Y. C. Sun Coll.).

Several pygidia of this type have been obtained from the Fêngshan limestone of Chihli by Mr. H.C. T'an. They may belong to this species but on account of their weathered character precise identification is not possible. This species differs from the similar pygidia described by Walcott mainly in the absence of distinct demarkations of the axis.

Genus **TAIANOCEPHALUS** Sun (gen. nov.)

Cephalon semielliptical in outline, very transverse. The greatest convexity lies in the central posterior portion, sloping down both to the frontal margin, and to the antero-lateral angles.

Glabella truncato-conical, with broad base, the front about two-thirds of the basal width of the glabella; slightly contracted just opposite the palpebral lobes by a slight incurving of the sides. It is marked by two pairs of very broad shallow and short glabellar furrows in the form of shallow basin-like depressions, extending obliquely backward; A median longitudinal ridge extends from the frontal margin nearly to the occipital furrow. The occipital furrow is represented by one pair of broad lens-shaped depressions separated from each other by a broad space about equal in length to the depression.

Fixed cheeks narrow in the front and becoming very broad in the posterior parts. Dorsal furrows shallow and distinct; palpebral area at fixed cheek opposite the palpebral lobes moderately convex. Palpebral lobe small and situated nearly at the antero-lateral margin of the cephalon.

The facial suture cuts the frontal border and extends along the palpebral lobe and then backward and outward to the extremities of the postero-lateral limbs.

Postero-lateral limb triangular in outline and marked by a distinct shallow groove confluent with the dorsal furrow, and becoming gradually broader up to the postero-lateral margin.

Surface marked by pustules visible under a lens, outer test not known.

This genus is distinct from any known in China and characterized by its semielliptical cephalon, truncato-conical glabella, marked by two pairs of broad shallow depressions and the shallow occipital furrow separated by a broad central space, and the large triangular postero-lateral limb.

Probably it represents one form of the order *Proparia* with extended postero-lateral limbs.

This genus is represented by only one specimen, and associated with *Kaolishania pustulosa*, *Mansuyia orientalis*, etc.

Genotype: *Taianocephalus grabaui* Sun.

The specimen representing this genus was obtained from Kao-Li-Shan of the Tai-An region from which the generic name is given.

Taianocephalus grabaui Sun (gen. and sp. nov.)

Plate V, Fig. 11.

The generic description is based on this species.

This species is characterized by a large triangular postero-lateral limb, absence of the distinct frontal limb, the elevated palpebral area near the antero-lateral angle, and the truncato-conical glabella marked by a pair of glabellar depressions and the occipital furrow in the form of very broad, shallow pits.

Thorax and pygidium unknown.

Measurements:—

Length of cranidium	12.0 mm.
Width of cranidium at the palpebral lobe	12.0 mm.
Length of glabella	9.0 mm.
Anterior width of glabella	5.2 mm.
Posterior width of glabella	8.8 mm.
Width of postero-lateral limb	11.0 mm.

This species is named in honor of Prof. A. W. Grabau, Chief Palæontologist of the Survey.

Horizon and Locality:— Upper Cambrian: Kaolishan limestone of Tai-An region (Collected by Y. C. Sun).

Genus **Wongia** Sun (gen. nov.)

Cranidium subtriangular, exclusive of genal spine; glabella truncato-conical, moderately convex, not marked by glabellar furrows; occipital furrow very shallow and broad slightly arching backward. Occipital ring moderately convex, its transverse dimension about one half the length of the glabella and of about the same width throughout.

Fixed cheeks very broad, the greatest width of the fixed cheeks opposite the palpebral lobe is nearly equal to the frontal width of the glabella; they rise up moderately from the dorsal furrow to the palpebral lobe; dorsal furrow deep and distinct.

Frontal border with the same convexity as the fixed cheeks, with a regularly rounded frontal margin and separated from the glabella by a distinct frontal groove.

The course of the facial suture is rather remarkable, it curves first from the middle part of the frontal border with a regularly rounded arc to the anterior part of the palpebral lobe, and curving around this extends outward and backward so as to cut the free cheeks from the genal spine of the cranidium.

The postero-lateral limb becomes abruptly depressed, forming a subtriangular area. Genal spine pronounced, long and slender extending outward at about an angle of 45° with the longitudinal axis and forming a part of the fixed cheeks.

Thorax, free cheeks and pygidia are not known.

Cranidium faintly marked by pustules under a strong lens.

Because this form has the genal spines or genal angles on the fixed cheeks, it belongs to the order *Proparia*.

The members of this order are very common from the Ordovician onwards but are rarely found in the Cambrian strata.

Dr. C. D. Walcott mentioned that two Chinese Cambrian genera-*Damesella* and *Stephanocare*-have the characters of the order *Proparia*. But in the typical form of this order, the genal spines and the genal angles coincide and form one part of the fixed cheeks. Probably *Damesella* and *Stephanocare* may belong to a suborder of the *Proparia;* but the genus *Wongia* is quite distinct and certainly belongs to the typical form of the order *Proparia*.

I take extreme pleasure in naming this new genus *Wongia* in honor of Prof. W. H. Wong, President of the Geological Society of China and Director of the national Geological Survey.

Genotype-*Wongia triangulata* Sun.

Wongia triangulata Sun (gen. sp. nov.)

Plate V, Figs. 12a–b.

This species is represented by four individuals in one fossil band; only cranidia are known.

The description of the genus is based on this species and therefore nothing needs be added except the measurements of the type specimen.

Length of cranidium	2.8 mm.
Width of cranidium at the palpebral lobe	3.0 mm.
Length of glabella	1.5 mm.
Width of glabella at the base	1.4 mm.
Width of frontal border	0.8 mm.
Width of fixed cheeks at palpebral lobe	0.95 mm.

This species is characterized by its triangular cranidium, the long curved lateral spines and the course of the facial suture.

HORIZON AND LOCALITY:— Late Middle Cambrian: from the thin platey limestone in Kushan shale of Lincheng, Chihli.

Collected by Y. T. Chao and C .C. Tien.

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List of Localities referred to, arranged Alphabetically under Provinces.

(see map, fig. 1.)

Chihli 直隸省

*	1.	Chang-Shan	長山	* 2. Chao-Kou-Chuang	趙各莊
*	3.	Chêng-Shan	稱山	* 4. Fêng-Shan	鳳山
*	5.	Jên-Chuang	任莊	* 6. Kwang-Hsi-Ying	關西營
*	7.	Lei-Chuang	雷莊	* 8. Lin-Cheng	臨城
*	9.	Lin-yu	臨楡		

Shantung 山東省

	10.	Chang-Hia	張夏	* 11 Chau-Mi-Tien	炒米店
	12.	Kao-Kia-Pu	高家坡	* 13. Kao-Li-Shan	高里山
*	14	Ku-Shan	崮山	15. Lien-Hua-Shan	蓮花山
	16.	Sin-Tai	新泰	17. Ta-Wen-Kou	大汶口
	18.	Tsing-Chou-Fu	青州府	19. Tsing-Lung-Shan	青龍山
	20.	Wang-Chuang	王莊	21. Yen-Chuang	顏莊
	22.	Yen-Tsy-Yai	燕子崖		

Shensi 陝西省

23.	Ch'ou-P'ing-Hsien	鎮平縣	

Shansi 山西省

	24.	Fang-Lan-Chen	芳蘭鎮	25. Ting-Hsiang-Hsien	定襄縣
	26.	Tung Yü	東寓(嶼)	27. Yau-To'	岩頭

Fêngtien 奉天省

	28.	Fu-Chou	復州	* 29. Sha-Kuo-Tun	沙鍋屯
	30.	Sai-Ma-Ki	寨馬集	31. Ta-Ling	大嶺
	32.	Tschang-Hsing-Tao	長興島	33. Wa-Fang-Tien	瓦房店
	34.	Wu-Lo-Pu	五路坡		

* Localities which have furnished material described in this memoir.

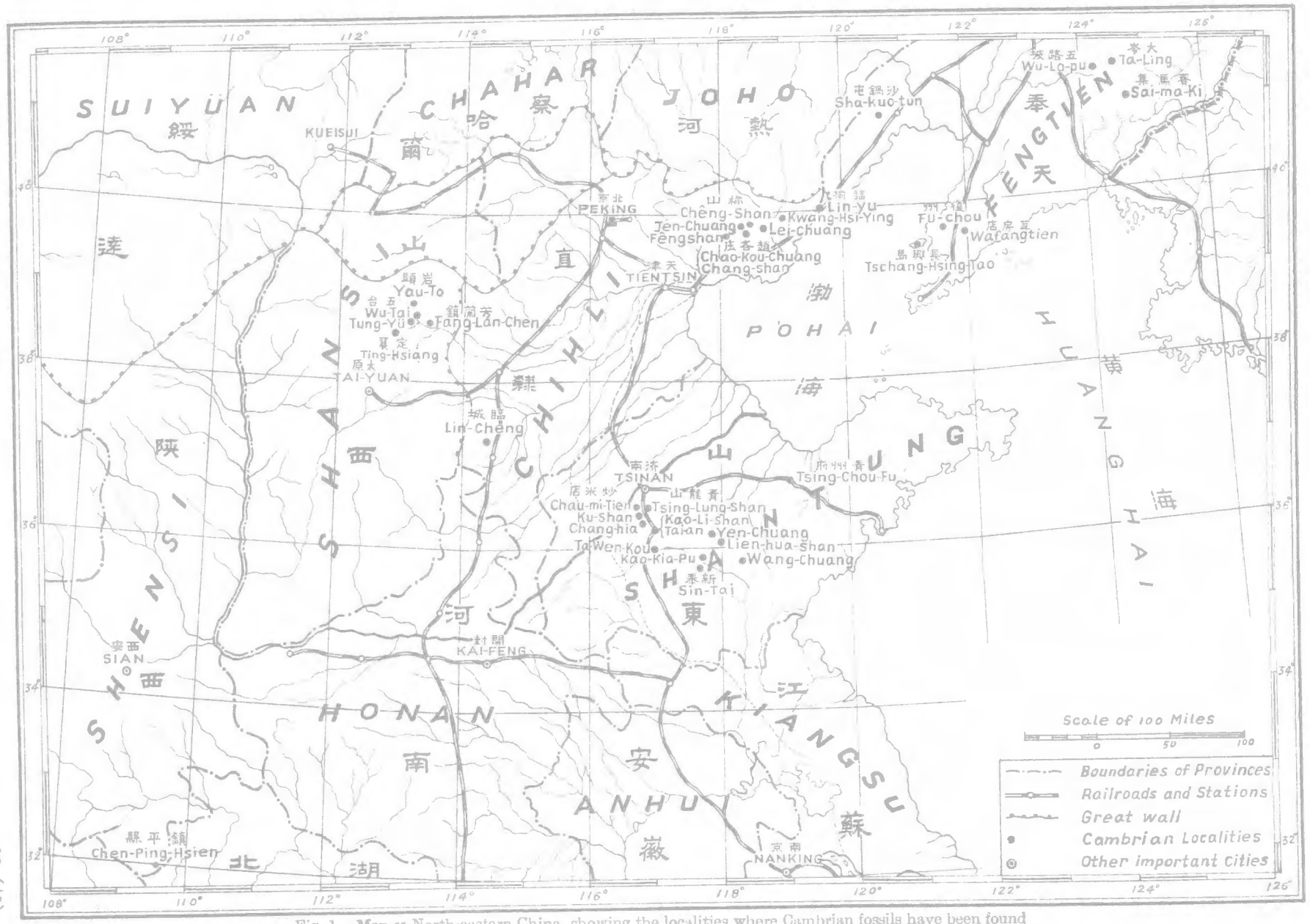

Fig. 1. Map of North-eastern China, showing the localities where Cambrian fossils have been found
(see the list on the preceding page)

EXPLANATION OF

PLATE I

PLATE I.

Cambrian Brachiopoda etc. from North China. Drawings by K. C. Liu (劉光誠)

Fig. 1. *Clonograptus? cambria* Sun.....p. 15

1 one stripe × 3

Upper Cambrian, Kaolishan limestone, Kao-Li-Shan, Tai-An, Shantung (Coll. K. W. Hsu. Holotype, G. S. Ch. Cat. No. 629).

Fig. 2. *Climactichnites mathieui* Sun.....p. 16

2 an impression of the trails on the under side of the rock, showing the character in relief.

Lower Cambrian, Manto shale, Luan-Chou, Chihli (Coll. F. F. Mathieu. Holotype, G. S. Ch. Cat. No. 630).

Fig. 3. *Obolus* (*Westonia*) *leei* Sun.....p. 17

3a exterior of the ventral valve × 3

3b counter-part of the same × 3

3c portion of the surface character 8 times enlarged.

Cambrian, from purple shale of Luan-Chou, Chihli (Coll. F. F. Mathieu. Holotype, G. S. Ch. Cat. No. 631).

Fig. 4. *Obolus mollisonensis* Walcott (?).....p. 17

4a crushed valve × 4 4b crushed valve of another individual × 4

Early Upper Cambrian, Changshan Shale, Jen-Chuang, Luan-Hsien, Chihli (Coll. A. W. Grabau, F. F. Mathieu, G. S. Ch. Cat. No. 632 a, b).

Fig. 5. *Obolus linyuensis* Sun.....p. 18

5 exterior of ventral valve × 6

Lower Cambrian, Manto Shale, Hung-Shan-T'ou, Lin-Yu-Hsien, Chihli (Coll. University Expedition. Holotype, G. S. Ch. Cat. No. 633).

Fig. 6. *Obolus taianensis* Sun.....p. 19

6a one portion of limestone with several individuals of this species, natural size (Paratypes and Holotype).

6b one valve enlarged × 5. (Holotype).

Upper Cambrian, Kaolishan limestone, Kao-Li-Shan, Tai-An, Shantung (Coll. Y. C. Sun. Cotype, G. S. Ch. Cat. No. 634).

Fig. 7. *Obolus luanhsiensis* Grabau.....p. 19

7a exterior of a ventral valve × 3

7b exterior of another valve × 3

7c exterior of the crushed ventral valve × 3

Upper Cambrian, Fengshan limestone, Yeh-Li, Luan-Hsien, Chihli (Coll. H. C. Tan. Cotypes, G. S. Ch. Cat. Nos. 635, 636, 637).

中國北部寒武紀動物化石　孫雲鑄

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EXPLANATION OF

PLATE V

PLATE V.

Cambrian Trilobites from North China. Drawings by K. C. Liu (劉光誠)

Fig. 1. *Ptychaspis angulata* var. *chinensis* Sun.....p. 67

1a cranidium × 3 1b cranidium × 3

Uppermost Cambrian, Kaolishan formation, Kao-Li-Shan, Tai-An, Shantung (Coll. Y. C. Sun. Cotypes, G. S. Ch. Cat. Nos. 602, 603.).

Fig. 2. *Ptychaspis walcotti* Mansuy.....p. 68

2 weathered cranidium × 2

Upper Cambrian, Shakuotun limestone, Sha-Kuo-Tun Chin-Hsi-Hsien, Fêngtien (G. S. Ch. Cat. No. 604. Collected by Dr. J. G. Andersson).

Fig. 3. *Ptychaspis subglobosa* Grabau.....p. 72

3a weathered cranidium, natural size (Holotype).

Upper Cambrian from Fêngshan limestone, Yeh-Li, Chihli (Coll. H. C. T'an, G. S. Ch. Cat. No. 605.).

3b cranidium × $1\frac{1}{2}$ 3c cranidium × 3 3d cranidium × 3

Upper Cambrian, Kaolishan formation, Kao-Li-Shan, Tai-An, Chihli (Coll. Y. C. Sun, Plesiotypes G. S. Ch. Cat. Nos. 606, 607, 608.).

Fig. 4. *Ptychaspis suni* Grabau.....p. 75

4a crushed cranidium × 2 4b associated free cheek × 3

Uper Cambrian, Fêngshan formation, Fêng-Shan, Yeh-Li, Chihli (Coll. H. C. T'an, Holotype G. S. Ch. Cat. Nos. 609.).

Fig. 5. *Ptychaspis acamus* var. *puncatata* Sun.....p. 76

5a crushed cranidium × 2 5b crushed cranidium × 2

5c crushed cranidium × 2 5d crushed cranidium × 2

Upper Cambrian, from the Upper limestone of Chau-Mi-Tien, Shantung (Coll. National University Excursion. Cotypes, G. S. Ch. Cat. Nos. 610, 611, 612, 613, 614.).

Fig. 6. *Ptychaspis (Anderssonia) tani* Sun.....p. 79

6 cranidium × 5

Upper Cambrian, from the highest zone of Chau-Mi-Tien. (Collected by National University Excursion. Holotype, G. S. Ch. Cat. No. 615.).

Fig. 7. *Ptychaspis* (*Anderssonia*) *fêngtienensis* Sun.....p. 78

7a cranidium × 4 7b cranidium × 3 7c associated pygidium × 6

Upper Cambrian, Shakuotun limestone, Sha-Kuo-Tun, Chin-Hsi-Hsien, Fêngtien (Coll. J. G. Andersson. Cotypes, G. S. Ch. Cat. Nos. 616, 617, 618.).

Fig. 8. *Anomocare flava* Walcott.....p. 80

8a cranidium × 4 8b cranidium × 4
8c pygidium × 4 8d pygidium × 4
Middle Cambrian, Changhia limestone, Chêng-Shan, Chao-Kuo-Chuang, Chihli (Coll. K. S. Hsu. G. S. Ch. Cat. Nos. 619, 620, 621, 622.).

Fig. 9. *Dolichometopus deois* Walcott.....p. 81

9. cranidium × 2
Middle Cambrian, Changhia limestone, Kwang-Hsi-Ying 關西營 Luan-Chou, Chihli (Coll. J. G. Andersson, G. S.Ch. Cat. No. 623.).

Fig. 10. *Illænurus pagoda* Sun.....p. 82

10a pygidium × 3 10b pygidium × 3 10c pygidium × 3
Upper Cambrian, Kaolishan formation, Kao-Li-Shan, Tai-An, Shantung (Coll. Y. C. Sun. Cotypes G. S. Ch. Cat. Nos. 624, 525, 626.).

Fig. 11. *Taianocephalus grabui* Sun.....p. 84

11 cranidium × $1\frac{1}{2}$
Upper Cambrian, Kaolishan limestone, Kao-Li-Shan, Tai-An, Shantung (Coll. Y. C. Sun. Holotype, G. S. Ch. Cat. No. 627.).

Fig. 12. *Wongia triangulata* Sun.....p. 85

12a cranidium × 7 (Holotype, G. S. Ch. Cat. No. 628a).
12b associated cranidium × 8 (Paratype, G. S. Ch. Cat. No. 628b).
Late middle Cambrian, Kushan formation, Lin-Cheng, Chihli (Coll. Y. T. Chao and C. C. Tien.).