

會協學地京東

No.

支那地理學調查

自明治四十四年至大正五年

報告書

全三卷

GEOGRAPHICAL RESEARCH IN CHINA

1911—1916

REPORTS

Three Volumes

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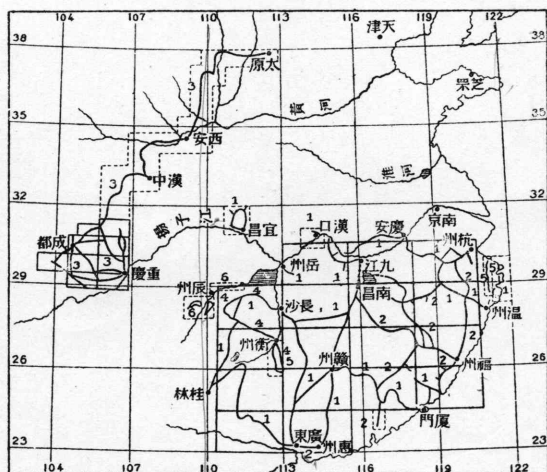
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東京地理學協會

大正九年

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1920 TŌKYŌ

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第三卷

Palaentology of Southern China.

南支那產古生物調查報告摘要

支那地學調查報告 第三

支那調査報告第三卷ヲ刊行スルニ當リテ原稿ノ整理及印刷ニ尠ナカラサル日
子ヲ要シ加之矢部氏病氣ノ爲出版期日大ニ遅延スルニ至リタルハ事情止ムヲ
得サルニ出ツト雖モ深ク遺憾トスル所ナリ特ニ採集標本ノ關係上第七章以下
ハ之ヲ省略シテ今後ノ調査研究ニ讓ルニ至レルハ更ニ遺憾トスル所ニシテ會
員諸君ニ對シ慚愧ニ堪ヘス然レ共別ニ化石圖譜二十八版ニ其學名及地質年代
ヲ附シテ刊行スルヲ得タルハ頗ル欣快トスル所ニシテ右ニ舉ケタル缺陷ヲ補
ヒテ尙餘リアリト謂フヘシ茲ニ矢部氏及早坂氏ニ對シ深ク其勞ヲ謝ス

東京地學協會

大正九年三月

主幹

井上禧之助

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南支那產古生物調查報告摘要

南支那產古生物調查報告摘要

理學博士 矢部長克

本報告ニ錄スル所ノ古生物材料ハ大正二年ヨリ同四年ニ互リ東京地學協會ヨリ南支那各地ニ派遣セラレタル理學士野田勢次郎、理學士小林儀一郎、理學士山根新次三氏ノ採集セラレタルモノヲ主トシ、尙過ル十數年間予ノ手許ニ蒐集セラレタル數多ノ標品ヲ含ム、後者ノ中特ニ重要ナルモノハ前京都帝國大學理工科大學教授工學博士山田邦彥氏及ビ臼井勝三氏ノ採品ナリ、而シテ此兩採品ノ一部ハ予ガ曾テ滯歐中「ブレスラウ」大學教授「フリッツ・フレッヒ」氏ノ研究スル所トナリ、其古生物學及ビ地質學上ノ結果ハ「リヒト・ホーフ・エン」氏「支那」第五卷ニ登載セラル。又山田博士採品中植物化石ハ既ニ東京帝國大學教授理學博士橫山又次郎氏ノ調査ヲ經其著「支那產中生代化石」ニ記述セラレタリ、此植物化石ハ本編ニ於テハ再記セザルモ「フレッヒ」氏ノ記述セルモノハ再ビ本編中ニ收ムルコトトセリ。

本編中ニ記載セル古生物ハ生物學上ヨリ分類スレバ植物ニハ石灰藻類、羊齒類、石松類、木賊類、蘇鐵類等ニシテ、動物ニハ有孔蟲類、珊瑚類、腕足類、苔蘚蟲類、辨鰓類、腹足類、翼足類及頭足類並ニ甲殼類等アリ。就中珊瑚類及腕足類ハ最モ異種ニ富メリ。

右化石中珊瑚類化石ハ北支那、朝鮮及本邦產ノモノト共ニ既ニ數年前ヨリ理學士早坂一郎氏ノ補助ヲ得テ調査シタル所ナリ、又腕足類ハ同氏ニ調査ヲ委託セルヲ以テ本編中殘餘部類ノ化石記事ト並ニ今回調査ノ全材料ヨリ新タニ得タル結果ヲ既知ノ事實ニ照合シ試ミタル考察トハ予ノ單獨執筆セル所ナリ。

地質學上ヨリ見ル時ハ今回調査ノ材料中ニハ寒武利亞紀ヨリ侏羅紀ニ互ル各地質時代ヲ代表スルノ化石アリ、就中最多數ヲ占ムルモノハ二疊紀ノモノナリトス。

此等化石ノ記事及ビ之ニ關スル考察ノ詳細ハ英文ニ讓リ、茲ニハ研究ノ結果ヲ基トシ南支那地質ノ大要ヲ記述スルニ止メン、而シテ此目的ニハ之ヲ本邦ノ地史系統及ビ北支那、南滿洲、北朝鮮ノモノト比較スルコト最モ趣味アリ。

本邦ニ發達スル古生層ハ秩父古生層ニヨリテ代表セラレ、在來ノ學者ハ之ヲ上中下ニ分チ其下部ニハ御荷鉢層ト稱スル主ニ綠色片狀岩即チ輝岩ヨリ成ル累層ヲ置キタレドモ、予ノ考フル所ニヨレバ此累層ハ之ヲ秩父古生層ヨリ除クヲ至當トシ、秩父古生層ナル名ノ下ニ在來其上中部ト知ラレタルモノ、ミヲ置クベキモノナリ、即チ此定義ニヨレバ秩父古生層ハ御荷鉢層ノ上ニ位スル厚キ硅岩層ヲ以テ始マリ、粘板岩、砂岩、硅質砂岩、放散蟲硅岩、輝綠凝灰岩、硅岩及石灰岩ヨリ成ル厚キ累層ナリ、此中放散蟲硅岩ハ極微粒ノ硅質泥土中ニ夥多ノ放散蟲殻ヲ含ムモノニシテ些ノ砂粒ヲ混ゼズ、並ニ石灰質ナラザル點ニ於テ深海堆積土ノ性質アリ。之ニ反シテ石灰岩ハ瀕海堆積物ナリ、而シテ下部秩父古生層ノ上部ニ位スルモノハ時ニ海百合

類ノ莖ノ破片ヲ含有スル以外今日マデ時代決定ニ適當ナル化石ヲ見出サズ、其上部秩父古生層ノ上部ヲ占ムルモノニ至リテハ Schwager 氏ノ研究以來著名ナル紡錘蟲石灰岩ニシテ、其ノ美濃國不破郡赤坂ニ發達スルモノハ最上部石炭紀即チ露西亞地質學者ノ所謂 Schwagerina stage ニ相當スルモノヨリ始マリ、二疊紀前部ヲ代表スルモノナリ、從テ其以下ニ位スル秩父古生層ノ大部ハ上部石炭紀及ビ恐ラク其以前ノ或ル地質時代ヲ代表スルモノナリ。斯ノ如クシテ下部石炭紀ヨリ以下泥盆、ゴトランヂヤン、オルドヴィシヤン及寒武利亞紀ノ化石ヲ未ダ見出ス能ハザルヲ以テ是等時紀ノ地層ガ本邦ニ發達スルヤ否ヤ未詳ナリ。

層位上御荷鉾層ハ秩父古生層ヨリ古ク三波川層即チ結晶片岩系ハ猶之ヨリ古ク尙雲母片岩、片麻岩中ニ更ニ是ヨリ古キ時期ノ堆積物ヲ含ムアルハ疑フベカラザル所ナリ。

然レドモ是等ノ變質結晶岩類ヲ以テ直ニ寒武利亞紀以前ノモノト看做スニハ寒武利亞層ノ發達セザル本邦ニ於テ積極的ノ證明ヲ得ルコト能ハズ。

之ニ反シ北朝鮮、南滿洲及ビ北支那ニ於テハ古生層ハ厚キ寒武利亞層ヲ以テ始マル、其最モ標式的ナルモノハ山東省ニアリテ「カーネギー」研究隊ノ Willis 及ビ Blackwelder 兩氏ノ研究ニヨレバ、最下部ハ饅頭板岩 (150-170m) ト稱スル赤色岩類アリ、特有ナル三葉蟲 Redlichia ヲ含ミ下部寒武利亞紀ノモノナリ。其上ニ位スル九龍累層ハ石灰岩ヲ主トシ板岩ヲ夾ム (240-380)、之ヲ分チテ最下ヲ張夏石灰岩、次ヲ崗山板岩、更ニ其上ヲ炒米店石灰岩トシ、中部寒武利亞紀ニ特有ナル夥多ノ三葉蟲及ビ腕足類化石ヲ含ム、炒米店石灰岩ノ上部ハ上部寒武利亞ニ相當ス。北

朝鮮及ビ南滿洲ニハ管ニ山東省ノモノト全ク同一ナル夥シキ化石ヲ含メル中部寒武利亞板岩及ビ石灰岩ノ發達スルノミナラズ最近ニハ下部寒武利亞紀ノ赤色岩類 *Redlichia shale* ノ發達セルヲ知ルニ至レリ。山西省ニ於テモ亦山東省ト同一ナル發達ヲ見、北支那一帶總テ同様ナルモノノ如シ。

今眼ヲ轉ジテ南支那揚子江中流ニ發達スル Willis 及 Blackwelder 氏ノ鷄心嶺石灰岩ハ野田氏ノ今回得タル材料ニヨリ少クモ其中部ガ寒武利亞紀ノモノナルコトヲ確ムルヲ得タリ。此鷄心嶺石灰岩ハ此地方ニ頗ル廣ク分布スルモノナルガ故ニ今日上記以外ニ尙ホ化石發見ナキニ拘ラズ北支那ニ於ケルガ如ク南支那ノ北部ニ於テ寒武利亞層ノ廣ク分布スルハ疑フベカラザル處ナリ。更ニ南シテ雲南ノ地方ニ至ラバ又寒武利亞層ハ好ク發達シ北支那ニ見ルト同一ナル *Redlichia* ヲ含ム地層アリ、砂岩、板岩及ビ泥灰岩ノ互層ヨリ成ル、其外夫ヨリモ若キ寒武利亞層ノ存在モ化石ニヨリテ證明セラレタリ。

北支那、南滿洲及ビ北朝鮮一帯ノ地ニ於テハ寒武利亞地層ノ上ニ厚キ石灰岩ノ累層アリ、特有ナル化石 *Acanthoceras*, *Maclurea*, *Raphistoma* 等ヨリ「オールドヴィシヤ」紀ノモノナルヲ知ル。南支那ニ於テモ之ニ相當スル地層好ク發達シ揚子江中流ノ鷄心嶺石灰岩ノ最上部及ビ其ノ上位スル Willis 及 Blackwelder 氏ノ新灘板岩ノ一部ハ即チ之ヲ代表スルコト化石上明カナリ。又雲南省ニ於テモ亦同様ニ「オールドヴィシヤ」層ノ大發育ヲ見ル、予ノ今回調査セル材料ニヨレバ貴州省及ビ四川省ノ境界地方ニ又「オールドヴィシヤ」紀ノ疑アル化石ヲ有スル地層アリ。

「リヒトホーフエン」氏踏査以來既ニヨク知ラレタル秦嶺以北ノ地ニアリテハ「オルドヴィシヤ」石灰岩ノ上ニ位スルモノハ常ニ最上部石炭紀層ニシテ、「ゴトランヂヤン」ヨリ泥盆、下部石炭紀及ビ上部石炭紀ノ大部ヲ代表スル地層ヲ缺ク、之ニ反シ秦嶺以南ノ地即チ南支那ニ於テハ「オルドヴィシヤ」紀ヲ終リ「ゴトランヂヤン」紀ニ入ルモ尙引續キタル海ノ狀態ニアルヲ以テ或ハ石灰岩或ハ粘板岩ノ堆積ヲ見ル、四川省ノ北部朝天地方ニ於テ「リヒトホーフエン」氏ハ「オルドヴィシヤン」、「ゴトランヂヤン」、泥盆、石炭紀ニ特有ナル化石ヲ含メル地層ガ順次相重ナルヲ目撃シタルコトアルガ、尙ホ此以外江蘇省鎮江ノ地方ニ於テ「オルドヴィシヤ」石灰岩ノ上ニ下部「ゴトランヂヤン」ニ特有ナル筆石ヲ含メル粘板岩ヲ發見セルコトアリ。此種ノ粘板岩ハ雲南省西部ニヨク發達シ「オルドヴィシヤ」層ノ上ニ整合ニ位ス、雲南省東部ニ於テモ亦兩紀層ハ整合ノ關係ヲ示ス、曾テ臼井勝三氏ガ武昌ニ赴任中採集セラレタル材料ニヨレバ湖北省宜昌府ノ稍北ニ發達スル石灰岩層ハ其一部ニ「オルドヴィシヤン」ノ特有ナル化石ヲ含ミ、其上ニ整合ニ位スル地層ヨリ最下部「ゴトランヂヤン」ニ特有ナル化石ヲ出ス、是レ既ニ「ブレスラウ」大學Frech 教授ノ説ケル所ナリ。

現在ノ知識ニ於テ南支那ニ發達スル「ゴトランヂヤン」ハ其下部ヲ主トシ上部ノ存否ハ大ニ疑アリ、之ニ次グ泥盆紀ノ地層ハ古來支那ニ於テ藥用ニ供セラレタル石燕ノ母岩ニシテ南支那一帶ニ其分布スルヲ見ル。然モ下部泥盆紀層ハ化石ニヨリテ證明セラレタルモノ只雲南ニアルノミ、蓋シ其以北ニハ餘リ多ク發達スルナカルベキカ、只湖南省永州府道州ニ發達スル

Tentaculites ヲ含ム石灰岩ハ或ハ此時期ノモノナラズヤトノ疑アリ。中部泥盆紀ハ主ニ珊瑚石灰岩、上部泥盆紀ハ腕足類石灰岩ナルコト最普通ニシテ、今日マデ知ラレタル主要ナル產地ハ四川省北部、甘肅省南部、陝西省南部、湖南省、雲南省等ナリ。但シ此以外ニ未ダ化石ノ發見セラレタルコトナクシテ層位上泥盆紀ト思ハル、モノ其分布甚ダ廣シ、予ガ今回調査セル材料中ニモ泥盆紀化石ハ比較的の多クシテ殊ニ多クハ在來記錄セラレタルコトナキ新產地ナリ、即チ湖南省南部ニ於テ Frech 氏ガ最近ニ記錄セル泥盆層ノ存在ハ同省永州府江華縣桂陽ノ南ナル諸產地ヨリ來レル化石ニヨリ新ニ證明セラレ此ノ地域ヨリ更ニ南廣西省内ニ連續ス、即チ興安縣桂林府附近ニ發達スル石灰岩ハ其一部確ニ此時代ノモノナリ、其外前京都帝國大學教授山田博士ノ材料ニヨレバ貴州省ノ西部、四川省ノ西部ニ上中泥盆層ハ善ク發達ス、此泥盆紀海産生物群ノ特性ハ其中部ナルト上部ナルトヲ問ハズ歐洲ノ同時代ノ地層中ニ出ヅルモノト全ク同一ナルコト既ニヨク知ラレタル所ナリ。

次ニ支那ニ發達スル石炭紀層ニ就テ揚子江中流所謂三峽地方ノ地層々序ニ就テ述ブルヲ便トス、此地方ハ古クハ「リヒトホーフエン」氏ノ調査アリ近クハ「カーネギー」探檢隊ノ調査並ニ Abendenon 氏及ビ山田博士ノ調査アリ、又最近ニハ野田氏ノ調査モアリテ大ニ其事情ヲ明カニスルヲ得タリ、然レドモ尙重大ナル地質學上ノ疑問ノ伏在スルアリ、宜昌ヨリ揚子江ヲ溯リ夔州ニ至ル間ニ一大向斜層ノ存在スルアリ、其最下底ト想ハル、モノハ種々ノ片麻岩、結晶片岩並ニ花崗岩ニシテ其上ニ不整合ニ位スル左記ノ諸累層ヲ見ル、今茲ニ野田氏ノ地層分類ガ最

近ニシテ最モ古生物調査ノ結果ト一致セルヲ以テ之ニヨルコト、セン。

南沱層

牛肝石灰岩層 (Niu-kan Limestone)

下部粘板岩層

平善壩石灰岩層 (Ping-shar-pa Limestone)

上部粘板岩層

米倉石灰岩 (Mi-tsan Limestone)

洩灘雜色頁岩層 (Yeh-tan Shale)

中生層

右ノ中南沱層ハ主ニ砂岩ヨリナリ Willis 及ビ Blackwelder 氏ノ所謂 Zhan-tou Tillite ト稱セル古キ氷河ノ堆積物トシテ地質學者ニ其名ヲ轟カセルモノナリ。兩氏ハ之ヲ寒武利亞初期ノモノト考ヘタリ。又其上ナル牛肝石灰岩、下部粘板岩及平善壩石灰岩ハ其大要 Willis 及ビ Blackwelder ノ鷄心嶺石灰岩ニ相當スベク、其上ナル上部粘板岩層ハ向斜層ノ西翼ヲナセル部分新灘ニ善ク發達スルヲ以テ新灘板岩ノ名アリ。

前ニ述ベタル如ク野田氏ノ採集品ニヨレバ平善壩石灰岩ノ最下部ヨリ寒武利亞ニ特有ナル化石ヲ發見セラレタルガ、即チ層位上南沱層ノ界ヨリ上約四百五十米ヲ距ツルノ位置ニシテ、其地層ガ寒武利亞殊ニ下部寒武利亞ラシキコトハ著シ、從テ南沱層ノ氷河堆積物が果シテ

寒武利亞初期ノモノナルヤ疑ヲ夾ムノ餘地ヲ生ゼリ、乃チ南沱層ハ寒武利亞初期ヨリモ寧ロ寒武利亞以前ノモノニ非ザルナキヤノ疑アリ、今日マデ全世界中寒武利亞氷河ノ遺物トシテ唱導セラレタルモノハ只僅ニ此南沱層ト南濠洲「アデレイド」ノ地方ニアルモノトニ限ラレ、濠洲ノモノハ Moeting 氏ノ詳ナル調査ニヨレバ寒武利亞ノモノナルヤ或ハ寒武利亞以前ノモノナルヤ決定シ難キ事情アリ。南沱層ノ地質時代ガ果シテ如何ナルモノナルヤハ斯ノ如クシテ地質學上之ヲ詳査スルノ價值アル大問題ナリ、加之牛肝石灰岩ガ今日マデ知ラレタル下部寒武利亞化石層ノ位置ヨリモ更ニ下位ナル化石帶ヲ夾ムアルヲ期待シ得ルガ故ニ古生物學上其探究ハ今後ノ重要ナル一事業ナリ。

Abendanon 及ビ野田氏ハ平善礫石灰岩ノ最上部並ニ新灘板岩即チ上部粘板岩層ノ下底ニ當ル處ヨリ「オルドヴィシヤ」紀ノ化石ヲ採集セラレタリ、即チ此ノ新灘板岩ノ大部分ハ或ハ「オルドヴィシヤ」紀ニ屬スルカ或ハ最モ若クシテ「ゴトランヂヤン」又ハ泥盆紀ノモノナラザルベカラズ、其上ナル米倉石灰岩ノ下部ニ相當スル部分ヨリハ Willis 氏 Blackwelder 氏並ビニ野田氏ニヨレバ共ニ石炭紀最上部或ハ二疊紀ノ海産古生物ヲ埋藏ス、依テ米倉石灰岩下底ノ下何處ニカ層位學上ノ缺位ノアルベキ理ナレドモ何人モ此ノ如キヲ認メタルコトナシ、然レドモ諸學者ノ記事ヲ綜合スル時ハ新灘板岩ノ中或ハ其下ニ其缺位ヲ求ムル能ハザルガ故ニ必然其疑ヲ新灘板岩及ビ米倉石灰岩ノ間ニ置クモノナリ、換言スレバ新灘板岩ハ層位上石炭紀ノモノトスルヨリモ前述ノ如ク一層古キ地層ノモノトスルヲ適當トス。

Willis 及 Blackwelder 氏ノ記スル處ニヨレバ新灘板岩ノ最上部或ハ兩氏ノ所謂巫山石灰岩乃チ野田氏ノ米倉石灰岩ノ下底ニ相當スルモノヨリ數種ノ腕足類及ビ苔蘚蟲ノ化石ヲ得タリ、之ヲ調査セル Girty 氏ハ腕足類ヲ以テ恐ラク泥盆若シクハ「ゴトランヂヤン」ヲ指示スルモノトシ、Ulrich 及 Bassler 氏ハ下部石炭紀ヲ指示セルモノトセリ、野田氏ノ採集品中最モ重要ナルモノ、一ハ新灘ニ近キ一小溪流中ニ砂利トシテ採集セルモノニシテ此石灰岩ニハ二疊紀ニ特有ナル化石ヲ含ム、野田氏ハ此石灰岩ハ恐ラク米倉石灰岩ノ最下部ヨリ來レルモノナラント云ヘリ。

茲ニ最不思議ナルハ「リヒトホーヘン」氏ノ層位上ノ記事「フレッヒ」氏ノ化石上ノ結果ナリ、兩氏ニヨレバ新灘板岩ノ下ニ横ハル珊瑚石灰岩アリ、上ニハ腕足類石灰岩アリ珊瑚石灰岩ハ其含ム珊瑚化石歐洲ノ下部石炭紀ノモノト同一ニシテ從テ此石灰岩ハ下部石炭紀ナリ、而シテ腕足類石灰岩ハ其含ム腕足類化石ヨリ二疊紀ニ相當スルコト疑フベクモ非ズ、今此兩氏ノ説ク處ト前記 Willis, Blackwelder, Abendenon 及ビ野田氏ノ記事ニハ其間ニ著シキ相違アリ、一方ノ下部石炭紀珊瑚ヲ含ムト云フ石灰岩ノ位置ハ他方ニ於テハ恰モ「オールドヴィシヤ」ノ化石ヲ含ム位置ニ相當スルヲ見ル、總テノ事實ヲ綜合スルニ米倉石灰岩層即チ巫山石灰岩層ハ其下部ヨリ既ニ二疊紀ニ算入スベキモノナルコトハ疑ナキニ似タリ、只最モ疑問ナルハ下部石炭紀ト知ラレタル珊瑚石灰岩ノ位置ナリトス。

「リヒトホーヘン」ハ其大著支那ノ中ニ於テ下部石炭紀石灰岩ノ北支那及ビ南滿洲ニ大ニ發

達スルヲ記セリ、此石灰岩ハ其後化石ノ發見ニヨリ「オルドヴィシヤ」紀ノモノナルコトヲ確定スルニ至レリ。其石灰岩ノ上ニハ外觀上殆ド整合ニ位スル最上部石炭紀層及ビ二疊紀ノ夾炭層アリ、下部石炭紀層及ビ上部石炭紀ノ大部ヲ代表スルノ地層全ク缺ケタルコトハ前ニ述ベタルガ如シ、只山東省ニ下部石炭紀石灰岩ノ發達シ並ニ其間ニ炭層ノ介在スルコトヲ「フレッヒ」氏ハ主張セリ、此レ恐ラク誤謬ナルコトハ予ガ曾テ地質學雜誌上ニ示摘セル處ニシテ「フレッヒ」氏ノ所謂下部石灰岩ハ最上部石炭紀ノモノニシテ、同省ノ古生代石炭層ハ南滿洲及ビ北朝鮮ニ於ケルモノト全ク同一ニシテ、主ニ下部二疊紀ノモノナルコトヲ證明スルノ化石アリ、直隸省及ビ山西省ノ炭田モ全ク同一時期ノ炭層ナルコトヲ信ズベキナリ、北支那ニハ全然下部石炭紀石炭層ハ勿論石灰岩ノ發達スルモノナキヲ信ズ。

南支那ニアリテモ下部石炭紀層石灰岩並ニ炭層ノ發達スルコト「フレッヒ」氏ノ同ジク主張スル所ナリ、前記揚子江中流ノ珊瑚石灰岩ノ外之ト同様ナルハ江蘇省南京ノ近クニ發達シ同様ニ歐洲ノ下部石炭紀ノ珊瑚ト同一ナルモノヲ含ム。又四川省ノ南部重慶府ノ南ナル炭田ノ炭層ニ互層スル石灰岩及ビ砂岩ヨリ下部石炭紀ノ腕足類化石ノ存在ヲ記錄セリ、山田博士ハ之ニ近キ綦江ノ地方ヲ旅行セラレタルガ下部石炭紀ノ化石ヲ得ズシテ反ツテ二疊紀特有ノ化石ヲ採集セラレタルコトアリ。

雲南省ニ於テモ下部石炭紀層ハ之ヲ上部石炭紀及ビ二疊紀ノモノニ比スルニ其發達不充分ナリ。

予ノ今回調査セル材料中ニモ南支那ニ下部石炭紀層ノ發達セルヲ確ムルノ十分ナル化石ナシ、只貴州省威寧ノ東ヨリ山田博士ガ曾テ採集セラレタル腕足類一種及ビ湖南省黃家坡ヨリ石井八萬次郎氏が曾テ採ラレタル數種ノ腕足類ノミハ下部石炭紀ナルベキ疑アリ。

新灘ニ産スル珊瑚石灰岩ノ珊瑚ガ歐洲ノ下部石炭紀ノモノニ酷似スルハ事實トシテ認ムベキモノナリ、山田博士ガ曾テ威寧ノ南東ヨリ得ラレタル珊瑚化石中又之ト同一ナル性狀ノモノアリ、予ガ長ク下部石炭紀ノモノト想像シ來リタルガ現今ニ於テハ反ツテ最上部石炭紀乃至ハ二疊紀ノモノナルベキヲ信ズルニ至レリ、總テ日本、朝鮮、支那ノ最上部石炭紀及ビ二疊紀珊瑚化石ハ著シク歐洲ノ下部石炭紀ノモノニ類似スルヲ知ルニ至レリ、如此シテ層位上並ニ上陳ノ事實ヨリシテ新灘ニ於ケル下部石炭紀ノ發達ハ目今暫ク之ヲ否定スルヲ安全ナリトス。江蘇省石炭紀モ亦然リ。

雲南省ニ於テハ上部石炭紀及ビ二疊紀ノ海成層非常ニヨク發達シ、其以外ノ南支那ノ諸省ニアリテハ確實ニ上部石炭紀ノ主部ヲ代表スルノ地層ヲ見ズ、或ハ少クモ化石ニヨリテ今日マデ知ラレタル此時期ノ地層甚ダ尠シ、之ニ反シ最上部石炭紀ヨリ二疊紀ハ石灰岩或ハ炭層ニヨリテ代表セラル、乃チ此時期ノ地層ハ前述ノ如ク北支那、南滿洲及ビ北朝鮮ニモヨク發達シ加之本邦ニ於テモ秩父古生層上部ニヨリ能ク代表セラル、是等ノ地方ニ發達スル此ノ時期ノ岩層ヲ綜覽スルニ

第一、北支那、南滿洲及ビ北朝鮮ニ發達スルモノハ最上部石炭紀海成層ヲ以テ始マリ、直ニ

厚キ下部二疊紀ノ夾炭層トナル

第二、本邦秩父古成層上部ニ發達スル如キ厚キ紡錘蟲石灰岩ハ南支那諸處ニ殊ニ雲南ニ於テ殆ド他ニ類例ナキ好發育ヲナス。

第三、此紡錘蟲石灰岩ノ間ニ互層シ腕足類化石ニ富メル地層ヲ夾ムコトアリ、此ノ地層ハ印度ソルトレンヂニ最モ標式的ニ發達セリ。

南支那(雲南省ヲ除キ)ニ發達スル最上部石炭紀及ビ二疊紀ノ地層ハ此ノ三式ノ混合ト稱スル、或ル場所ニハ有孔蟲石灰岩ヨリ發達シ他ノ場所ニ於テハ石炭層ヲ交ヘ又腕足類化石ニ富メル地層ナルコトアリ。

南支那ニ發達スル石炭層ニハ二疊紀ノモノアルノミナラズ又中生代ノモノアルコト北支那、南滿洲、北朝鮮ト同一ナリ。二疊紀ノモノト認ムベキモノニハ江西省樂平ノモノ及ビ湖南省耒河ノモノアリ是等ハ「リヒトホーフエン」氏ノ踏査以來既ニ知ラレタルモノナルガ、其後江西省豐城、同雲都縣、鷄栖、湖北省南東部ノモノ、湖南省安化縣、同新化縣ノモノハ何レモ同時期ノモノナルヲ知ルヲ得タリ、尙ホ同時期ノ炭層ハ貴州省ニモ發達スルモノ、如シ。

本邦ニ於テハ秩父古生層堆積ノ最後ガ二疊紀ノ終リナルヤ或ハ又三疊紀ノ始メナルヤ未ダ之ヲ知ルニ由ナキモ、中部三疊紀ノ含化石層ノ下ニハ秩父古生層ノ上部ヲナセル石灰岩等ノ礫ヨリ成レル礫岩ノ發達スルヲ見レバ、少クトモ二疊紀ノ終ヨリ中部三疊紀ノ始メニ至ル間ノ時期ニ於テ日本群島今日ノ位置ニ陸地ノ存在セルコトハ疑フベカラズ。而シテ中部三

疊紀ノ海水ニヨリ再ビ覆ハル、ニ至レルガ、北支那、南滿洲及ビ朝鮮等ニ於テ少シモ二疊紀以後ノ海成層ノ發達スルモノナキヲ以テ見レバ、三疊紀ノ海ノ分布ハ日本浦鹽斯德附近等ヲ以テ限リトシ其以西ニ及バザリシモノナラン。南支那ニ於テハ之ニ反シ廣ク海成三疊紀層ノ發達スルアリ、最モヨク發達セルハ雲南省ニシテ二疊紀層ノ最上部ニ玄武岩及ビ安山岩ノ岩床ヲ伴フ累層アリ、其上ニ位スル板岩及ビ砂岩ノ累層ハ間々炭層及ビ植物化石層ヲ含ミ最下部三疊紀ヲ代表ス、其上ニ二枚貝化石ヲ含ム淺海ノ堆積アリテ下部三疊紀ヨリ中部三疊紀ニ亘ル地層アリ、其後「アンモン介」ニ富メル「アルプス」式ノ堆積物ヲ作り中部三疊紀ノ上部ヨリ上部三疊紀ヲ代表ス、而シテ其最後ニハ更ニ夾炭層發達シ以後再ビ海水ノ覆フ所トナラズ、其以外ノ諸省ニアリテハ此ノ如キ十分ナル層序ヲ尙ホ未ダ知ル能ハザルモ著シキコトハ湖南省湘潭地方ニ發達スル「アンモン介」層ト江西省信豐縣鐵石口ノ「ブソイド」モノチス「層ナリ、湘潭ノ「アンモン介」ハ全ク新層新種ナルモ其性質ヨリ二疊紀ノ最上部或ハ寧ロ三疊紀初期ヲ指示スルモノ、如クニシテ殊ニ「アルプス」式ノ堆積ヲ想ハシムルモノナリ。鐵石口ノ地方ニ於テハ板岩ノ間ニ石灰ヲ夾ミ石灰岩中ニハ石灰藻ノ一種「スフィロコデウム」ノミヲ見出サレタルモ板岩中ニ西藏及ビ印度支那東京ノ下部三疊紀層中ニ出ヅル *Pseudomonotis* ノ一種ヲ產スルニヨリ此地ニモ同代ノ海成層ガ發達セルヲ推知スルヲ得タリ。此兩地層ノ地理上分布ハ如何ナルヤ今日全ク不明ナレドモ南支那ニ於ケル三疊紀層分布ヲ論ズルニ貴重ナル資料ナリ、貴州省ニ於テハ之ニ反シ山田博士ハ *Benackia* ト稱スル珍ラシキ下部三疊紀ノ「アンモン介」ヲ發

見セラレタルコトアルガ此化石並ニ同地方ノ中部三疊紀層ニ出ヅル化石ハ何レモ獨逸式ノ海成地層ノ其地ニ發達スルヲ示ス、揚子江ノ中流ヨリ四川ノ盆地ニ互リ廣ク發達スル赭色岩層ノ下部ハ主ニ石灰岩ヨリ成リ其三疊紀ノ堆積物ナルコトハ其上ニ位スル累層ガ侏羅紀ノモノナルヨリ推定シ得ル所ナリ、但シ今日マデ之ヲ確證スルノ化石ヲ出ササルガ故ニ或ハ其下部ハ二疊紀ノモノナラズヤトノ說アリ、此種ノ地層ハ單ニ四川ノ盆地ノミナラズ南支那ノ諸地方ニ發達スル赭色岩層ノ下ニ横ハルモノナラン。

雲南省ニ於テ三疊紀ノ最上部ハ石炭及ビ植物化石ヲ出ス陸成層ヨリ成ルコトヲ述ベタルガ、其以外ノ南支那ノ諸省ニ於テモ同様ニ「レチック」以後ハ最早乾陸トナリ海水ニ覆ハレタルコトナシ、即チ赭色岩層ヨク發達シ其間ニ炭層ヲ夾ミ或ハ三疊紀最上部或ハ侏羅紀下部或ハ侏羅紀中部ヲ證スル植物化石ヲ伴フ、而シテ其夾炭層ノ最モヨク發達スルハ四川省、江西省等ナリ「フレック」教授ノ淡水産二枚介化石ノ調査及ビ横山博士ノ植物化石ノ調査ニヨレバ赭色岩層ノ一部ハ又下部白堊紀ノモノナリ。

以上ノ外福建省内ニ於テ野田、山根兩氏ノ調査セル所ニヨレバ紡錘蟲石灰岩ヲ含メル二疊紀ノ板岩砂岩ノ累層ノ上ニ外觀上整合ニ横ル殆ド同性質ノ板岩ヲ含ムモノアリテ其植物化石ハ雲南省ノモノト同一ナル下部三疊紀ノモノナルヲ知ルニ至レリ。

斯ノ如ク南支那一帶ノ地ハ二疊紀ノ終リニ於テ一旦陸地トナレル證跡アルモ直ニ三疊紀海水ノ覆フ處トナリ、其終リニ於テ再ビ海水面上ニ擡頭シ、自後殆ド今日ノ狀態ニ在リ、北支那

南滿洲及ビ朝鮮等ニアリテハ前述ノ如ク二疊紀及ビ其以後ノ海成層ヲ全ク缺キ之ニ代リテ二疊紀ノ夾炭層三疊紀最上部及ビ侏羅紀ノ夾炭層アリ、又南滿洲ニ於テハ撫順炭田ノ如キ中部第三紀ノ夾炭層アリ其含有スル植物化石ニヨレバ一方ニ於テハ上記南支那ノモノ他方ニ於テハ本邦内若干ノ地域ニ海成地層ノ間ニ夾マル植物化石層ノモノト全ク同性質ニシテ、即チ當時ニアリテ是等諸地方ハ連續セル一塊ノ陸地ナリシ事明カナリ、只本邦ニ於テハ此大陸ノ邊緣ヲ形作リシヲ以テ陸成層ト海成層ト相交互スルヲ見ルナリ。

今回調査セル南支那化石ノ材料ニハ侏羅紀以後ノモノ全ク存在セズ、此地方ニハ第三紀以後今日マデノ氣候風土動物分布ノ變遷ニ徵スルニ重要ナル哺乳動物化石ノ產出アリテ是等ノ問題ニ就キテ既ニ知ラレタル所モ多ケレドモ新資料全ク缺クルヲ以テ只ニ在來ノ報告ヲ繰リ返スニ過ギザルニヨリ之ヲ省略ス。(終)

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ERRATA

Page 43, *Batostomella antiqua* Yabe sp. nov.

“Pl. XXVIII. figs. 2 a—b.” should read

“Pl. XXVIII. figs. 3 a—b.”

Page 85, *Favosites gotlandicus* Lam.

“Pl. VII. fig. 3 a—b.” should read

“Pl. IX. fig. 6.”

支那地理學調查

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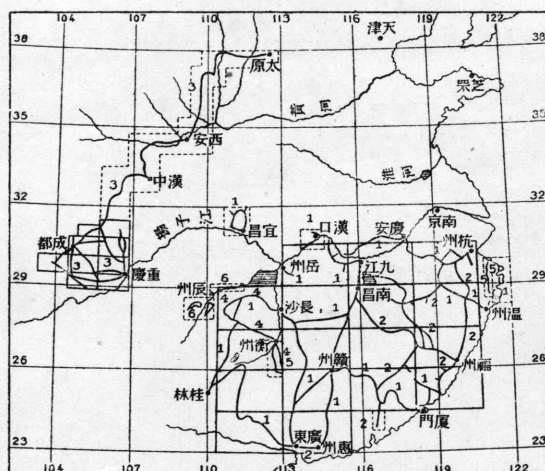
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Palæontology of Southern China.

Serious illness prevented me for the past one year from continuing the present study. It is to my great regret that this report including the fossils from Cambrian to Lower Carboniferous is now published, leaving the rest for a future time. The report has already been finished in December, 1918.

The atlas shows the fossils, ranging from Cambrian to Lower Carboniferous and all here described, besides those belonging to still Upper Palæozoic as well as Mesozoic.

March 15th, 1920.

H. Yabe.

Palaeontology of Southern China.

By H. Yabe and I. Hatasaka.

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Brief Summary of the Palaeontological Study of Southern
China (in Japanese). By H. Yabe.

Palæontology of Southern China.

By

H. Yabe and I. Hayasaka.

Introduction and Summary.

In the present paper are considered fossils from Southern China collected by the geologists sent out by the Tōkyō Geographical Society during the five years, 1911-1915, and also those which have gradually accumulated in my possession through the courtesy of many contributors during the past fifteen years. The geologists who took part in the research work undertaken by the Geographical Society were Messers S. Noda, Y. Ishii, S. Yamane, N. Fukuchi, G. Kobayashi, and I. Sugimoto; while the identification and description of the fossils collected by them was deputed to me by Mr. K. Inouye, Director of the Imperial Geological Survey and Secretary and Councillor of the Tōkyō Geographical Society. Among the fossils from the other sources, there is one lot comprising a considerable number of well-preserved specimens collected by Mr. K. Yamada, formerly Professor of the Engineering College of the Imperial University of Kyōto, and the small but very notable collection of Mr. S. Usui; parts of these two collections were taken with me some years ago to Europe, where they were worked out by late Prof. Dr. F. Frech of Breslau University, who is one of the most learned in the geology and palæontology of China. The geological and palæontological results obtained from this material were published by him in the fifth volume of Ferdinand von Richthofen's monumental work "China." Further the Mesozoic plant fossils in the collection of Prof. Yamada have already been described by Prof. M. Yokoyama in his "Mesozoic Plants of China."¹⁾ While the fossils treated by Prof. Yokoyama are not included in the present study, those described by Prof. Frech form a part of it.

1) Journ. Coll. Sci., Imp. Univ. Tōkyō, vol. XXI, art. 9, 1906.

Biologically the material now at hand comprises fossils belonging to very varied groups: it includes calcareous algae, fern-like plants, sphenophyllales, equisetals and cycads among the plants; and foraminiferas, corals, brachiopods, bryozoans, molluscs and trilobites among the animals. Of these fossils, Palæozoic corals—together with those from Northern China, Japan and Korea—have been studied by myself since 1912, in collaboration with Mr. I. Hayasaka; the full accounts of these fossils will be given in a paper entitled “Palæozoic Corals from Japan, Corea and China” which will appear in the near future in the Science Reports of the Tōhoku Imperial University, Second Series Geology. To this collaborator was also offered the study of the brachiopods which form an essential part of the present material, these brachiopods—all of the Palæozoic age—have been worked out in connection with his study in a wider scope, comprising all the Palæozoic brachiopods from Southern and Northern China, Japan and Corea; and his results, as a whole, will be published also in the near future in the same Science Reports.¹⁾ The descriptions of all other fossils in the present report together with some geological statements of general interest and a summary of our previous knowledge concerning the palæontology and geology of China are my contributions.

Geologically the present material comprises fossils ranging in ages from Cambrian to Jurassic, those of the Permian age being most numerous among them. From Southern China, some Lower Cretaceous plants and fresh water shells have lately been described by M. Yokoyama²⁾ and Frech,³⁾ numerous

1) It is here expressly stated that by mutual understanding between Mr. Inouye and myself, all these parts also will soon or later and in modified or unmodified form be published in the said Science Reports.

2) Yamada collected some plant fossils from Shi-kuan-tsu in Chao-hua-hsien and Sha-chi-miao in Ho-chou, both in Prov. Sse-ch'uan: these Yokoyama assigned to the Lower Cretaceous age; they are:—

	Shi-kuan-tsu.	Sha-chi-miao.
Glossozamites hoheneggeri Schenk	+	+
G. acuminatus Yok.	—	+
Podozamites lanceolatus L. et H.	+	—
Coniopteris nitidula Yok.	+	—
Cladophlebis sp.	—	+

Yokoyama: Mesozoic Plants from China. Jour. Coll. Sci., Tōkyō, vol. XXI., art. 9. 1906.

3) Cremer found some fresh water bivalves in a coal bearing formation developed at Li-tschong-yuan along the Yang-tse-kiang, 5 li above Fu-tscho, Tshung-king-fu, Prov. Sse-ch'uan; Frech who described these fossils under the name *Unio cremeri* Frech, U. j. böhmii Frech and *Cyrena* (Miodon) cf. *kilianii* believed the age of the formation to be the lower Cretaceous. Frech: in Richthofen's China, vol. V. 1911.

interesting Later Tertiary and Pleistocene mammalian remains described by Owen, Koken, Schlosser¹⁾ and Matsumoto,²⁾ and a Younger Tertiary plant

1) The important localities of Later Tertiary and Pleistocene mammalian fossils in Southern China are, according to M. Schlosser, as follows:

Pleistocene: Tshung-king-fu, Prov. Sse-ch'uan; I-chang, Prov. Hu-peh (loess); Prov. Yun-nan (loess); Wu-ting-tshou, Prov. Yun-nan (cave); Schi-tsian-fu, Prov. Kuei-tchou (cave); King-jen-fu, Prov. Kuang-si (cave).

Upper Pliocene: Stegodon beds of Western Kan-su (?), Yun-nan (?) and Fuh-kien (?).

Lower Pliocene: Red clay with Hipparion of Tschuug-tu-fu, Tsching-king-fu and Tshing-tchou in Prov. Sze-chuan; of Si-ning-fu, Prov. Kan-su; of Tsching-kiang, Prov. Kuan-tung; or Prov. Tsche-kiang. Reddish sand and greyish green marl with Hipparion of Wai-king-fu and Ju-tschou-wei in Prov. Ho-nan; of I-chang and Jun-jang-fu along the river Han, both in Prov. Hu-nan.

According to Schlosser, the Pleistocene mammalian fossils from China constitute two different faunas, one a loess fauna of the Upper Pleistocene age and the other a cave fauna of the Lower Pleistocene: characteristic to the former are

Elephas primigenius Blum.
Equus sp.
Bison priscus Boj.
Cervus cf. *aristotelis* Cuv.
Hyæna sinensis Ow.

Rhinoceros tichorinus
Bos primigenius Blum.
Cervus mongoliae Gaud.
Cervus sp.

and to the latter

Ursus aff. *japonicus*
a *Canidae* of wolf-size
Hyæna sinensis Ow.
Tapirus sinensis Ow.
Equus sp.
Cervus orientalis
Elephas namadicus Falc.

Hyænactos? sp.
Felis sp.
Hyæna plicidens
Chalicotherium sinense Ow.
Sus sp.
Cervus leptodus Kok.

The Upper Pliocene fauna, less manifold in China than in Java, includes

Stegodon insignis Falc.
Aceratherium sp.
Gazella aff. *subgutturosa*

Pantholopus hundsienensis
Equus sivalensis Falc.
Hyæna macrostoma Lyd.

On the other hand, the Lower Pliocene mammalian fossils are distinguished by him into two different groups, a steppe and a forest fauna; to the former belong the remains found in the red clay of Prov. Sze-chuan and others, and to the latter those from the reddish sandstone and variegated marl of the Provinces of Ho-nan, Hu-nan, Hu-pei, etc.

Characteristic to the steppe fauna are

Mastodon pandionis
Aceratherium blanfordi
Camelopardalis aff. *sivalensis* Falc.
Urimatherium sp.
Palæoreas sinensis
Plesiaddax
Paraboselaphus

Rhinoceros habereri
Anchitherium zitteli
Alcicephalus sinensis
Gazella dorcadoidea
G. altidens
Tragocerus
Strepsiceros
Pseudobos

and to the forest fauna

Vupes sinensis Schlosser
Meles taxipater Schlosser
Dipoides majori Schlosser
Cervus pl. sp.
Rhinoceros branchoi Schlosser
Equus cf. *sivalensis* Falc.
Tragocerus sylvatica Schlosser

Lutra brachygnatus Schlosser
Mavhairodus horribilis Schlosser
Cervavus pl. sp.
Mastodon lydekeri
Ceratotherium sp.
Gazella palæosinensis Schlosser

Numerous species described by Schlosser are, however, common to the two faunas, though each of them is certainly more prominent in one of the faunas than in the other; thus most of the remains of *Hyæna*, *Palhyæna hipparionum* Grev., *Mastodon* aff. *latidens*, *Camelopardalis microdon* and *Hipparion* belong to the Steppe fauna: while the greater part of all forms of *Suidæ* and of *Proto-traceros* and all the remains of *Cervavus* belong to the forest fauna.

2) Very recently, H. Matsumoto described

described by Schenk;¹⁾ none of the fossils of these ages are represented in the present material.

Hyæna ultima Matsumoto
Stegodon orientalis Owen (= *S. insignis* of Schlosser)
S. sinensis Owen (= *S. clifti* of Schlosser)
Aceratherium banfordi Lydekker var. *hipparionum* Koken
Rhinoceros sinensis Owen
R. plicidens Koken
Proboselaphus watasei Matsumoto
P. liodon Matsumoto
Buffelus two sp.
Bibos geron Matsumoto

from Prov. Sze-chuan (H. Matsumoto: On some fossil mammals from Sze-chuan, China. Science Reports of the Tōhoku Imp. University, II. ser. Geology, vol. III., No. 1, 1915), and

Elephas aff. *primigenius* Blum.
Equus leptostylus Matsumoto
Sus aff. *scrofa* Linne
Cervus (*Pseudaxis*) *hortulorum* Swinhoe
Elaphurus davidianus M. Edw.
Bos primigenius Boj.
Bison exguus Matsumoto
 A human sacrum

from Prov. Ho-nan (Matsumoto: On some fossil mammals from Ho-nan, China. Sci. Rep. vol. III., No. 1, 1915). Of the fossils from Sze-chuan, enumerated above, he distinguished two faunas, one comprising those forms marked with an asterisk, and the other including all the remaining ones. While the latter represents the *Stegodon* fauna of the Upper Pliocene age, the former are believed by him to have been derived from a cave deposit of the Lower Pleistocene. Decidedly younger than this is the Ho-nan fauna, which he assigned to the Upper Pleistocene, though there is considerable doubt about the integrity of the fauna as regards the geological age. K. Hasebe has already expressed a different view concerning the human sacrum (Hasebe: On Mr. Matsumoto's "A fossil human sacrum from Ho-nan" (in Japanese). Jour. Anthropolog. Soc. Tokyō, vol. XXX., No. 344, 1915).

1) A. Schenk described *Rhus stavus* Schenk from San-shui-hsien, 24 geographical miles W. of Canton Schenk: Pflanzenreste aus dem Tertiär des Südlichen China. In Richthofen's China, vol. IV.)

List of Fossils from Southern China described and illustrated in the present paper.

CAMBRIAN :

Coscinocyathus cf. *cancellatus* Bornemann.

Between Hou-ping and Mon-chia-ho, hsing-shan-hsien, Prov. Hu-peh.

Orthotheca glabra Walcott.

Ta-hsi-tau, Hui-tso-hsien, Prov. Yun-nan.

Helcionella rugosa (Hall) *paupera* Billings.

Ta-hsi-tau, Hui-tso-hsien.

? An indeterminable Trilobite.

Lan-hsi, Chen-chou-fu, Prov. Hu-nan.

ORDOVICIAN :

Girvanella sinensis Yabe.

San-yu-tung, Tung-hu-hsien and Liu-chia-ho, Hsin-shan-hsien, both
in Prov. Hu-peh.

Polylopho (?) *dubia* Yabe, nov. sp.

No-lu-ping, Tung-hu-hsien, Prov. Hu-peh.

Batostomella antiqua Yabe, nov. sp.

Huan-chia-chang, Tung-hu-hsien, Prov. Hu-peh.

Maclurea neritoides Eichwald. No-lu-ping.

Raphistoma sinense Frech. No-lu-ping.

Eccylopterus abendanoni Frech. No-lu-ping.

Orthoceras chinense Foord.

Hu-peh.

Between Yang-ko-la, Chi-chiang-hsien, Prov. Sse-ch'uan and Chu-
tien-ya, Prov. Kuei-chou.

Orthoceras (?) sp. indet. No-lu-ping.

Orthoceras sp. indet. No-lu-ping.

? An indeterminable Nautiloid.

Liu-chia-ho, between Tung-shan-hsien and Wei-ning-hsien, Prov.
Hu-peh.

Cyrtoceras (*Meloceras*) *asiaticum* Yabe, nov. sp.

Hsing-shan-hsien, Prov. Hu-peh.

Actinoceras (*Ormoceras*) sp. indet.

Pan-tse-ya, Hu-hsi, Hsin-shan-hsien, Prov. Hu-peh.

Discoceras *eurasiaticum* Frech. No-lu-ping.

Discoceras sp. indet. No-lu-ping.

Lituites (*Ancistroceras*) *angelini* Boll. No-lu-ping.

Isotelus *usuui* Yabe, nov. sp. No-lu-ping.

Illæus *sinensis* Yabe, nov. sp. No-lu-ping.

(*Asaphus* sp. No-lu-ping.)¹⁾

Triplecia *poloi* Martelli. No-lu-ping.

Kao-huang-ling, Hsing-shan-hsien, I-chang-fu, Prov. Hu-peh.

Plectambonites cf. *sericeus* Sowerby. Kao-huang-ling.

Orthosina cf. *hemipronites* (v. Buch) Frech. No-lu-ping.

GOTLANDIAN :

Halysites *pycnoblastoides* Etheridge. Lo-ling-po, north of No-lu-ping,
I-chang-fu, Prov. Hu-peh.

Favosites *gotlandicus* Lam. Lo-ling-po.

Trochoceras sp. indet. Huang-kuo-chi, Ta-kuan-ting, Prov. Yun-nan.

Orthoceras sp. indet. Hui-lung-chi, Ta-kuan-ting.

Pentamerus *borealis* Eichwald. Lo-ling-po.

Dalmanella *æquivalvis* Davidson. Lo-ling-po.

DEVONIAN :

Solenopora ? sp. Near Hung-kuo-chi, Ta-kuan-ting, Prov. Yun-nan.

Nodosaria- and *Lingulina*-like Foraminifera.

Kwei-ling, Prov. Kuang-si.

Amphipora *ramosa* Phill.

Kwei-ling, Prov. Kuang-si.

Chin-tou-shan, Ho-lu-kou, Kiang-hua-hsien, Prov. Hu-nan.

1) Only a picture of this is given in the atlas.

- Stromatoporella eifeliensis* Nicholson. West of Men-kan-shan, Tien-chuen-chou, Prov. Ssu-ch'uan.
- Chaetetes tenuissimus* Frech. Lao-tsa-tei, Hsing-an-hsien, Kwei-lin-fu, Prov. Kuang-hsi.
- Alveolites ramosus* Roemer. Lao-tsa-tei.
- Alveolites suborbicularis* Lam. var. *minor* Frech.
Near Hung-kuo-chi, Ta-kuan-ting, Prov. Yun-nan.
- Favosites asteriscus* Frech. Yang-liu-shu, Ta-kuan-ting.
- Favosites goldfussi* M.-Edw. et Haime. South of Pen-chao-tse, Chachua-hsien, Prov. Ssu-ch'uan.
- Favosites goldfussi* M.-Edw. et H. var. *major* Frech.
Sing-lung-pu, Ta-chien-lu-ting, Prov. Ssu-ch'uan.
- Favosites* aff. *forbesi* M.-Edw. et H. South of Ping-yi-pu, Ping-wu-hsien, Prov. Kiang-si.
- Favosites sinensis* Yabe et Hayasaka. Pei-shi-pu, Ping-wu-hsien.
- Striatopora cristata* Gürich.
Lao-tsa-tei, Hsing-an-hsien, Prov. Kuang-si.
- Plagiopora* cf. *denticulata* M.-Edw. et H.
West of Men-kan-shan, Tien-chuen-chou, Prov. Sse-ch'uan.
- Aulopora subcampanula* Cowper Reed.
Ling-ling, Yung-chou-fu, Prov. Ssu-ch'uan.
- Cylindrophyllum simplex* Yabe et Hayasaka.
Near Hung-kuo-chi, Ta-kuan-ting, Prov. Yun-nan.
- Cyathophyllum* (s. s.) *heterophylloides* Frech.
South of Ping-yi-pu, Ping-wu-hsien, Prov. Ssu-ch'uan.
Lao-tsa-tei, Hsing-an-hsien, Prov. Kuang-si.
- Cyathophyllum douvillei* Frech var. *sinensis* Yabe et Hayasaka.
Yang-liu-shu, Ta-kuan-ting, Prov. Yun-nan.
- Cyathophyllum* (*Fascicularia*) *cæspitosum* Goldf. var. *breviseptatum* Frech.
South of Ping-yi-pu, Ping-wu-hsien, Prov. Sse-ch'uan.
- Monotrypa parasitica* Kayser.
Near Ling-ling, Yung-chou-fu, Prov. Hu-nan.

Tentaculites sp. pl.

Shuang-chin-tang, Tao-chou, Yung-chou-fu, Prov. Hu-nan.

Spirifer disjunctus Sow. var. *sub-archiaci* Martelli.

Neighbourhood of Ling-ling, Yung-chou-fu, Prov. Hu-nan.

Spirifer disjunctus Sow. var. *verneuili* Murchison.

Between Tou-tang and Wei-ning, Ta-ting-fu, Prov. Kuei-chou.

Spirifer disjunctus Sow. var. *vicari* Pellizari, Locality unknown.

Spirifer disjunctus Sow. cf. var. *gortani* Pellizari. „

Spirifer disjunctus Sow. var. *lonsdalei* (Murchison) Martelli.

Locality unknown.

Spirifer ziczac Rømer var. *undecimplicata* Rømer em. Scupin.

Between Mien-tien and Shan-shui-tang, Nan-ning-hsien, Prov.

Kuang-si.

Atrypa reticularis L. var. *richthofeni* Kayser em. Frech.

Ning-chiang, Han-chung-fu, Prov. Shen-si.

San-toi-pa, Chao-hua-hsien, Prov. Ssu-ch'uan.

Atrypa reticularis L. var. *desquamata* Sow. Ning-chiang.

Atrypa reticularis L. var. *auriculata* Hayasaka, nov. var.

Between Mien-tien and Shan-shui-tang, Prov. Kuang-si.

Athyrisina squamosa Hayasaka, nov. gen. et. sp.

Pen-chao-tse, Chao-hua-hsien, Prov. Ssu-ch'uan.

Athyrisina squamosa Hayasaka var. *rhomboidalis* Hayasaka, nov. var.

Pen-chao-tse.

Athyrisina minor Hayasaka, nov. sp.

Between Shang-shui-tang and Mien-tien.

Rhynchonella parallelepipedata Bronn. Ning-chiang, Prov. Shen-si.

Dalmanella atriatula Schlotheim.

Between Mien-tien and Shang-shui-tang, Prov. Kuang-si.

Between Wei-ning and Tou-tang, Prov. Kuei-chou.

South of San-toi-pa, Prov. Ssu-ch'uan.

LOWER CARBONIFEROUS:

Orthotetes crenistria (Phill.) Frech.

East of Tou-tang, Ta-ting-fu, Prov. Kuei-chou.
Spirifer bisulcatus Sowerby.

Huang-tu-pu, Prov. Hu-nan.

Athyris royssii L'Éveillé. Huang-tu-pu.

Rhynchonella pleurodon Phillips. Huang-tu-pu.

UPPER CARBONIFEROUS AND PERMIAN¹⁾:

Makroporella sinica Yabe, nov. sp. (Permian.)

Fu-shan and Chin-tsai-tang coal mines, Lung-chiang-chen, Prov. Hu-peh.

Wang-wu and Kwang-feng, Kwang-feng-hsien, Prov. Kiang-si.

U-chai, Ta-kuan-ting, Chao-tung-fu, and north of Cjang-ti.

Lu-ting-ting, Prov. Yun-nan.

Makroporella tenuis Yabe, nov. sp. (Permian.)

U-chai, Ta-kuan-ting, Chao-tung-fu, Prov. Yun-nan.

Makroporella crass Yabe, nov. sp. (Permian.)

Wang-wu, Kwang-feng-hsien, Prov. Kiang-si.

North of Chang-ti, Lu-ting-ting, Prov. Yun-nan.

Che-hai, Hui-tso-hsien, Prov. Yun-nan.

Tieh-shi-kou, Lung-nan-hsien, Prov. Kiang-si.

Margaritina schwageri Zittel. (Permian.)

Shin-tan, Kuei-chou-hsien, Prov. Hu-peh.

Lingulina cf. *szechenyii* Lörenthy. (Permian and upper Carboniferous.)

Fu-shan coal mines, Lung-chang-chen, Prov. Hu-peh.

North of Chang-ti, Lu-ting-ting, Prov. Yun-nan.

Bigenerina yamadai Yabe, nov. sp. (Upper Carboniferous.)

East of Yang-chao-shan, Wei-ning-chou, Prov. Kuei-chou.

Tetrataxis conica Ehrenberg.

Shin-tan, Prov. Hu-peh.

Archæodiscus cf. *karreri* Brady.

Fu-shan coal mines, Lung-chang-chen, Prov. Hu-peh.

North of Chang-ti, Lu-ting-ting, Prov. Yun-nan.

1) The fossils of these and the later geological ages are only illustrated in the atlas.

- Schwagerina princeps* Ehrenberg. (Upper Carboniferous.)
 East of Yang-chao-shan, Wei-ning-chou, Prov. Kuei-chou.
- Schwagerina* (*Verbeekina*) *verbeeki* Geinitz. (Lower Permian.)
 Hsiau-liau-shan, Hsing-kuo-hsien, Wu-chang-fu, Prov. Hu-peh.
- Doliolina gigantea* Yabe, nov. sp. (Uralian or Permian.)
 U-chai, Ta-kuan-ting, Caho-tung-fu, Prov. Yun-nan.
- Dolioloina lepida* Schwager. (Lower Permian.)
 Ho-chang, between Ho-tung and Tsu-chung, Wei-ning-chou, Prov. Kuei-chou.
- Fusulina sino-indica* Yabe, nov. sp. (Permian.)
 Sa-mu-keng, Fen-i-hsien, Yuan-chou-fu, Prov. Kiang-si.
- Fusulina* sp. indet. pl.
 Ho-chang, Wei-ning-hsien, Prov. Kuei-chou.
 Che-hai, Hui-tso-hsien, Prov. Yun-nan.
 Between Ho-chang and Hsia-ma-kuan, Prov. Kuei-chou.
- Fusulinella deprati* Yabe, nov. sp. (Permian.)
 Fu-shan coal mines, Prov. Hu-peh.
- Fusulinella sphærica* Abich. (Lower Permian.)
 Ho-chang, between Ho-tung and Tsu-chung, Prov. Kuei-chou.
- Disjectopora milleporiformis* Waagen and Wentzel. (Permian.)
 Lian-shan coal mines, Tung-lu-hsien, Yen-chou-fu, Prov. Cheh-kiang.
- Irregularitopora undulata* Waagen and Wentzel. (Permian.)
 Lian-shan coal mines.
- An indeterminate Hydrozoa (?)
 Hua-shih-tang, Kan-hsien, Kan-chou-fu, Prov. Kiang-si.
- Myriopora* (?) *pyriformis* Yabe et Hayasaka. (Upper Carboniferous.)
 Su-pu, Wei-ning-chou, Prov. Kuei-chou.
- Michelinia* (*Protomichelinia*) *microtoma* Yabe et Hayasaka. (Upper Carboniferous.)
 Mei-tsa-kou, north of Wu-chang, Prov. Hu-peh.
- Syringopora ramulosa* Goldfuss. (Carboniferous.)¹⁾

1) Among the corals enumerated here, there may be several forms of the Lower Carboniferous age, and this *Syringopora* is one of those that are Lower Carboniferous in Europe.

Hsia-lo-shih-chao, Shao-yang-hsien, Pao-king-fu, Prov. Hu-nan.

Syringopora sp. α .

Between Pai-shui and San-toi-pa, Pen-chao-tse, Chang-hua-hsien,
Prov. Ssu-ch'uan.

Syringopora sp. β .

Syringopora sp. γ .

Kwei-yang-chou, Prov. Hu-nan.

Syringopora sp. δ .

Kwei-yang-chou, Prov. Hu-nan.

Tetrapora elegantula Yabe et Hayasaka. (Carboniferous?)

Prov. Fuh-kien.

Kung-shan, Hui-tso-hsien,

Hung-hua-yuen, Tung-tse-hsien,

Chung-kiang-hsien.

Lonsdaleia (s. s.) *volzi* Yabe et Hayasaka. (Carboniferous.)

Ho-chang, Wei-ning-chou, Prov. Kuei-chou.

Lonsdaleia (s. s.) sp. indet. (Carboniferous.)

North of Pan-chiao, Kun-ming-hsien, Prov. Yun-nan.

Lonsdaleia (*Waagenella*) *hupeiensis* Yabe et Hayasaka. (Carboniferous.)

Ho-chang, Wei-ning-chou, Prov. Kuei-chou.

Lithostrotion irregulare Phill. var. *asiatica* Yabe et Hayasaka. (Carboni-
ferous.)

Hsin-hua-hsien, Pao-king-fu, Prov. Hu-nan.

Lithostrotion ramosum Romanowsky. (Upper Carboniferous.)

Kwei-yang-chou, Prov. Hu-nan.

Lithostrotion (*Lithostrotionella*) *unicum* Yabe et Hayasaka. (Carboni-
ferous?)

Kung-shan, Hui-tso-hsien, Prov. Yun-nan.

Diphyphyllum simplex Yabe et Hayasaka. (Lower Carboniferous.)

Hsia-lo-shih-chao, Siao-yang-hsien, Pao-king-fu, Prov. Hu-nan.

Thysanophyllum longiseptatum Yabe et Hayasaka. (Carboniferous.)

Yang-chia-yu, Ngan-hua-hsien, Chang-sha-fu, Prov. Hu-nan.

Polythecalis confluens Yabe et Hayasaka. (Carboniferous.)

- Kung-shan, Hui-tso-hsien, Prov. Yun-nan.
- Synocladia* (?) sp. indet. (Permian or Uppermost Carboniferous.)
- Chiu-tsai-tang, Lung-chiang-chen, Wu-chang-fu, Prov. Hu-peh.
- Polypora* cf. *megastoma* Koninck. (Permian.)
- Wa-kiang, I-chun-hsien, Prov. Kiang-si.
- Polypora*? sp. indet. (Permian.)
- Wa-kiang, I-chun-hsien, Prov. Kiang-si.
- Orthotetes srmeniacus* Arthaber. (Permian or Upper Carboniferous.)
- Mei-tse-kou, south of Wu-chang-fu, Prov. Hu-peh.
- Orthotetes ruber* Frech. (Permian.)
- Sung-shou-kuan, Chang-yi-chou, Chu-ching-fu, Prov. Yun-nan.
- Schuchertella* sp. indet. (probably Permian.)
- South of Tung-kung-su, Tsung-yi-hsien, Tung-yi-fu, Prov. Kuei-chou.
- Dalmanella indica* Waagen. (Permian or Upper Carboniferous.)
- Mei-tse-kou, Prov. Hu-peh.
- Spirifer* (*Reticularia*) *inequilateralis* Gemmellaro. (Permian.)
- Tung-tse-hsien, Tsung-yi-fu, Prov. Kuei-chou.
- Athyris protea* Abich var. *armeniaca* Arthaber em. Frech. (Permian.)
- South of Tung-kung-su, Prov. Kuei-chou.
- Productus punctatus* Martin. (Permian or Upper Carboniferous.)
- Mei-tse-kou, Prov. Hu-peh.
- Productus sumatrensis* Roemer var. *palliat*a Kayser em. Fliegel.
- (Permo-Carboniferous, or Permian.)
- North of Pai-yen, Pi-chieh-hsien, Tsung-yi-fu, Prov. Kuei-chou.
- Lo-ling-po, Tung-hu-hsien, Prov. Hu-peh.
- Mei-tse-kou, Prov. Hu-peh.
- Productus* cf. *sino-indicus* Frech. (Permian.)
- Chiu-tsai-tang, Lung-chiang-chen, Wu-chang-fu, Prov. Hu-peh.
- Productus yabei* Frech. (Permian.)
- South of Tung-kung-su, Tsung-yi-hsien, Prov. Kuei-chou.
- Productus cora* (d'Orbigny) Diener.

Neighbourhood of Ho-chang, Wei-ning-chou, Ta-ting-fu, Prov. Kuei-chou.

Productus sp. aff. *yunnanensis* v. Loczy. (Permian?)

Gai-sha-ping, Wei-ning-chou, Ta-ting-fu.

Productus *vishnu* Waagen var. *radiata* Hayasaka, nov. var. (Permian or Upper Carboniferous.)

Mei-tse-kou, Prov. Hu-peh.

Productus *paviei* Mansuy var. *hsianhuænsis* Hayasaka, nov. var. (Permian).

Hsin-hua-hsien, Pao-ching-fu, Prov. Hu-nan.

Productus (*Marginifera*) *spinulo-costatus* Abich. (Permian or Upper Carboniferous.)

Lo-ling-po, Prov. Hu-peh.

Chonetes *barusiensis* Davidson. (Permian.)

Tung-tse-hsien, Tsung-yi-fu, Prov. Kuei-chou.

Lyttonia *richthofeni* Kayser em. Hayasaka. (Permian.)

Kuan-yin-chao, Chi-chang-hsien, Chung-ching-fu, Prov. Ssu-ch'uan.

Tung-tse-hsien, Tsung-yi-fu, Prov. Kuei-chou.

Coal field of Feng-cheng-hsien, Prov. Kiang-si.

TRIASSIC :—Marine :

Beneckeisa *sinensis* Frech. (Lower Triassic.)

Gai-chou, Prov. Kuei-chou.

Dinarites sp. indet. (Lower Triassic.)

Between Gai-chou and Lung-chang, Prov. Kuei-chou.

Pseudohalorites *subglobosus* Yabe nov. gen. et. sp. (Triassic or Permian.)

Pseudohalorites *celestis* Yabe nov. sp.

Hsian-tan-hsien, Prov. Hu-nan.

Myophoria? sp. indet. (Lower Triassic.)

Gai-chou, Prov. Kuei-chou.

Myophoria *radiata* v. Loczy. (Lower and Middle Triassic.)

Between Pei-gai-chang and Shin-mao-chang, Shu-wen-hsien, Prov. Kuei-chou.

- Pseudomonotis* (*Clararia*) *griesebachii* Bittner var. *concentrica* Yabe, nov.
var. (Triassic or Permian.)
Tieh-shi-kou, Prov. Kiang-si.
- Sphærocodium sinicum* Yabe, nov. sp. (Permian or Triassic.)
Tieh-shi-kou, Prov. Kiang-si.

TRIASSIC AND JURASSIC FLORA :

- Sphenophyllum sinocoranicum* Yabe, nov. sp. (Lower Triassic)
Tai-shu-tou, Chen-ti, An-chi-hsien, Prov. Fuh-kien.
- Equisetum sarrani* Zeiller. (Lower Triassic.)
Tai-shu-tou.
- Neocalamites carreri* Zeiller. (Rhætic.)
Lung-wan-tung, Kiang-pei-hsien, Prov. Ssu-ch'uan.
- Lacopteris polypodioides* Brongniart. (Jurassic.)
Chia-ch'uan-tien, Hon-ch'i-shui, I-chang-fu, Prov. Hu-pei.
- Pecopteris* sp. indet. (Lower Triassic.)
Tai-shu-tou, Prov. Fuh-kien.
- Neuropteridium* (?) sp. indet. (Lower Triassic.)
Tai-shu-tou.
- Sphenopteris* sp. indet.
- Tæniopteris spatulata* Mc Clelland. (Rhæt-Jurassic.)
Hu-chia-fang, Ping-hsiang-hsien, Prov. Kiang-si.
- Pterophyllum contiguum* Schenk. (Rhæt-Jurassic.)
Chang-chia-ling, Chung-jen-hsien, Prov. Kiang-si.
- Pterophyllum* (*Anomozamites*) *inconstans* F. Braun. (Rhæt-Liassic.)
Hu-chia-fang, Ping-shang-hsien, Prov. Kiang-si.
- Pterophyllum æquale* Brongniart. (Rhæt-Liassic.)
Hu-chia-fang.
- Tsang-yuan, Chun-jen-hsien, Prov. Kiang-si.
- Pterophyllum* (*Anomozamites*) sp. indet. (Rhæt-Liassic.)
Tsang-yuan.
- Pterophyllum nathorsti* Seward. (Jurassic.)
Chia-ch'uan-tien, Hon-ch'i-shui, I-chang-fu, Prov. Hu-peh.

- Podozamites distans* Presl.—*P. lanceolatus* L. et H. (Rhæt-Jurassic.)
 Hu-chia-fang.
 Tsang-yuan.
 Ching-shan-wan, Ta-yeh-hsien, Prov. Hu-peh.
- Czekanowskia rigida* Heer. (Rhæt-Liassic.)
 Hu-chia-fang.
- Clathropteris meniscoides* Brongniart. (Rhæt-Liassic.)
 Pin-Hsiang coal-field, Prov. Kiang-si.
 Tai-hu, Prov. Kiang-su.
- Cladophrebis denticulata* Brong. var. *densifolia* Yabe, nov. var. (Jurassic.)
 Ping-Hsiang.
 Chang-kia-ling, Chung-jen-hsien, Prov. Kiang-si.
 Ta-lu-kou, Hsing-an-hsien, Prov. Kiang-si.
- Cladophrebis raciborski* Zeiller. (Jurassic.)
 Chin-kang-hsien, Pen-hsien, and Ta-shih-ku, Pa-hsien, both in Prov.
 Ssu-ch'uan.
 I-chang-fu, Prov. Hu-peh.
- Cladophrebis rœsserti* Presl. (Rhætic.)
 Su-lu-pu, Hsing-an-hsien, Prov. Kiang-si.

All these fossils now at my disposal were collected either by those whose circumstances permitted them to make only a very hurried and superficial collection, or by those who were not expert in this line of work; it is deeply to be regretted that the geologists sent out by the Tōkyō Geographical Society were likewise obliged to make their trip under similar conditions. Thus the present material comprises numerous species, which are very varied both in biological nature and also in geological age, as will be seen from the above list. But it is seldom that we find a species from a locality or a horizon represented by a number of specimens, and often the identification of a species must rest on only one or two fragmentary specimens; the sole exception to this is the case of the Devonian brachiopods which are already known to be very common in Southern China. Under such circumstances it was a matter of course that considerable difficulty accompanied the study of the present material, and due allowance must be

asked for errors in the specific or even generic determination of certain fossils described in this paper. It may well be said that these fossils might better have been excluded from the present study; but often on such imperfect specimens depends the fate of a formation of considerable extent and considerable thickness at least so far its geological age is concerned, and it is the duty of one who studies fossils to attempt as close an approximation to the truth as is possible in order to help other geologists to study the stratigraphical sequence in the field.

As stated already above, a part of the present paper is devoted to a brief statement of previous knowledge concerning the stratigraphy and palaeontology of China, and the presentation of certain geological problems requiring further research. Some of the geological results obtained by the present study deserve special mention here, though they will be treated at length in the following chapters.

First of all, the discovery of a *Coscinocyathus* in the Ki-sin-ling limestone of Willis and Blackwelder developed along the middle course of the Yang-tse-kiang, in a horizon some 200-500 m. above its very base, is convincing testimony as to the Cambrian age of the most part of the limestone complex and suggests the possibility of its lower part being older than any Cambrian rocks known elsewhere. At the same time the Lower Cambrian age of the Nan-tou tillite underlying the Ki-sin-ling limestone at Nan-tou seems by no means sure.

The Ordovician age of the uppermost part of the Ki-sin-ling limestone and the lower part of the underlying Sin-tan shale finds confirmation in the discovery by Noda of many Ordovician fossils from two new localities in the same district. Also Usui found there Ordovician fossiliferous beds conformably overlaid by basal-Gotlandian fossiliferous beds which themselves underly Lower Permian limestones. The occurrence of basal-Gotlandian beds in close association with Ordovician rocks seems to be the general rule in Southern China.

The limestones exposed along the I-chang gorge represent the upper part of the Ki-sin-ling limestone of Willis and Blackwelder, and are not the

equivalent of their Wu-shan limestone; this correlation proposed by Noda has received confirmation from the palæontological side.

The Lower Carboniferous age of the coralline limestone collected by Richthofen at Shin-tan, along the middle course of the Yang-tse-kiang, is doubtful; the Sin-tan shale is considered here never to be so young as Carboniferous; the coralline limestone was perhaps derived from the basal part of the overlying Wu-shan limestone which is surely Permian in age. The alleged Lower Carboniferous age of the coralline limestone from Hsi-hsia-shan near Nan-king can likewise not escape similar criticism.

It has for a long time been well known that Devonian rocks are extensively distributed in southern China, whereas these are never met with in northern China, southern Manchuria or Korea; the fossils now at my disposal not only confirm the development of these rocks also in the southern part of the province of Hu-nan, as very lately reported by Frech, but also indicate the extension of the Devonian area southwestward into the northern part of the province of Kwang-si, and especially to the district surrounding Kwei-lin.

In northern China, southern Manchuria and Korea, there is no convincing tract of Lower Carboniferous rocks; if any rocks of this age are developed in southern China, their distribution, I believe, is very limited, for there are very few fossils at all in the present material which remind one of the Lower Carboniferous age. To this category belong a brachiopoda from a little east of Wei-ning, Prov. Kwei-chou, and a few brachiopods from Hwan-tu-pu, Prov. Hu-nan; the latter fossils, however, give one the impression that they represent more likely a stage transitional between the Upper Devonian and the Lower Carboniferous.

Nor is there any true trustworthy evidence in the present material which indicates the development of deposits representing the main part of the Upper Carboniferous age in southern China, excluding those belonging to its uppermost division, an equivalent of the Schwagerina stage of Russia; a very thick complex mostly of marine origin and of the Uppermost Carboniferous and Permian ages is extensively developed in southern China, and in part also comprises coal-bearing series. Only in the province of Yun-nan,

have we the marine sediments of the Upper Carboniferous age in complete development ; it is also there that the Lower Carboniferous sediments appear to be developed to a notable extent.

The most interesting fossils in the present collection are those of the Permian age, namely *Pseudohalorites subglobosus* Yabe and *P. celestris* Yabe from Hsiang-tan hsien, Prov. Hu-nan, and *Pseudomonotis griesbachi* Bittner var. *concentrica* Yabe from Tieh-shi-kou, Prov. Kiang-si ; these occurrences show the extension of the Himalayan Permian sea to the interior of southern China.

Perhaps already in latest Permian and surely in early Triassic, terrestrial conditions prevailed in a part of the present provinces of Yun-nan and Fuh-kien ; in these places we now find coal bearing deposits covering Permian *Fusulina* limestones and containing *Gigantopteris dentata* flora. The distribution of this flora is not confined to these provinces, but extends to northern Korea. On the other hand, there are also developed over an extensive area of southern China the Lower and Middle Triassic marine deposits in the so-called German facies, with *Beneckeia* and many forms of *Myophoria*. Since the Rhætic age, southern China has never been overflowed by marine water, but has remained in a terrestrial condition to the present time, accordingly there are developed coal-bearing formations in the Rhætic-Liassic, Upper Jurassic and Lower Cretaceous ages, sometimes occupying the same basin with the coal-bearing formation of the Permian age. Only in the province of Yun-nan, does the Upper Triassic formation comprise marine deposits with ammonites in open sea facies.

Volumes I and II of this report, just published, contain detailed accounts, in Japanese, of the geology and geography of the districts traversed by each of the geologists despatched ; and in the last chapter of the first volume, Mr. Noda gives a short, but concrete summary of all of the facts obtained by them, taking into consideration also those previously known. In this most valuable chapter, he distinguishes the following divisions in the geological formations developed in southern China :

A. Metamorphosed Rocks :

I. Gneiss formation.

2. Phyllite formation.

B. Sedimentaries :

- | | |
|--|---|
| 1. Lower Palæozoic formation. | Cambrian. |
| 2. Middle Palæozoic formation. | Ordovician to Devonian. |
| 3. Older Upper Palæozoic formation. | Dinantian and Moscovian. |
| 4. Younger Upper Palæozoic formation. | Permocarboniferous. |
| 5. Lower Mesozoic formation. | Triassic (Rhætic excluded and the Upper Thuringian included). |
| 6. Upper Mesozoic formation. | Rhætic-Jurassic, including a part of Cretaceous. |
| 7. Quartz trachyte tuff and red sandstone formation. | Post-Cretaceous and Pre-Pliocene. |
| 8. Red formation (=Red basin formation of Richthofen and Loczy), loess and alluvium. | Pliocene and later. |

This undertaking must have been accompanied with considerable difficulties, because there is a veritable lack of harmony among the authors of each chapter concerning the geological divisions and other points, from which it is difficult to escape in such a work as this. My first plan was to work out all the stratigraphical details given by them, in order to bring these into combination with the results obtained by our palæontological studies of the collected materials; but unfortunately this plan had to be soon abandoned, as it became evident that such an effort demanded much more time than could now be devoted to it, and I am obliged to satisfy myself with presenting in this volume what can directly be deduced from the palæontological data. The divergence of opinions between the geologists concerned in this geological research on one side and me on the other was inevitable, in spite of constant efforts to carry on necessary correspondence. This was

partly owing to the fact that the geological reports were completed before the palæontological one, and partly because there are certain radical differences in many points between the view expressed previously by various authorities in the same field and my owns which have gradually developed during the palæontological study outlined above.

February 11, 1918.

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CHAPTER I.

Cambrian.

The extensive investigation of Cambrian fossils by CH. D. WALCOTT is one of the foremost palaeontological works that has yet appeared. The Cambrian fossils of China have also of late been studied by him and in consequence our knowledge in this respect has made great progress.

His "The Cambrian Faunas of China" (Research in China, vol. III. 1913) contains an excellent summary of the works of previous authors in the same field. From it we quote the following :—

"The presence of Cambrian fossils in China was first announced by Baron v. RICHTHOFEN in 1883¹⁾. The material gathered by him was studied by E. KAYSER to whom the brachiopods²⁾ were entrusted, and by W. DAMES, who described the trilobites³⁾.

"KAYSER described and named the following brachiopods : *Orthis lin-narsoni*⁴⁾; *Lingulella* sp.; *L.* sp."

"DAMES described and named the following trilobites :

<i>Agnostus chinensis</i>	<i>Anomocare minus</i>
<i>Dorypyge richthofeni</i>	<i>A. nanum</i>
<i>Conocephalites frequens</i>	<i>A. planum</i>
<i>C. quadriceps</i>	<i>A. subcostatum</i>
<i>C. subquadratus</i> ⁵⁾	<i>Liostracus megalurus</i> ⁷⁾
<i>C. typus</i> ⁶⁾	<i>L. talingensis</i>
<i>Anomocare latclimbatum</i>	? <i>Liostracus</i> , 2 sp.
<i>A. majus</i>	2 <i>pygidia</i> , gen. and sp. undt."

1) RICHTHOFEN: China, vols. I. and IV.

2) E. KAYSER: Cambrische Brachiopoden von Liautung.

3) W. DAMES: Cambrische Trilobiten von Liautung.

4) This belongs to *Eoorthis*, according to WALCOTT.

5) This belongs to *Anomocare*, according to WALCOTT.

6) This belongs to *Ptychoparia*, according to WALCOTT.

7) This belongs to *Anomocare*, according to WALCOTT.

"The material described by DAMES came from three localities in Liau-tung¹⁾, as follows :

Sai-ma-ki²⁾ (in situ) :

<i>Lingulella</i>	<i>Anomocare latelimbatus</i>
<i>Agnostus chinensis</i>	<i>A. majus</i>
<i>Conocephalites frequens</i>	<i>A. nanum</i>
<i>C. quadriceps</i>	<i>A. subcostatum</i>

Ta-ling³⁾ (loose rock in wall) :

<i>Dorypyge richthofeni</i>	<i>Anomocare minus</i>
<i>Conocephalites frequens</i>	<i>A. nanum</i>
<i>C. subquadratus</i>	<i>Liostracus talingensis</i>
<i>C. typus</i>	<i>L. ? sp.</i>

Wu-lu-pu⁴⁾ (débris slope) :

<i>Dorypyge richthofeni</i>	<i>Liostracus megalurus</i> "
<i>Anomocare planum</i>	

"DAMES compared the Cambrian trilobites with those of Europe, America and India, and concluded that the trilobite fauna of Sai-ma-ki and Ta-ling was of about the age of the Scandinavian Andrarum limestone and the Potsdam group of North America. He did not find any Chinese species that could be identified with those of Scandinavia and America, but the general appearance of the fauna as a whole was so similar that he considered their equal age proven. He further states that the age of the rocks containing *Dorypyge richthofeni*, from Wu-lo-pu, is probably the same as that of the *Quebec group*, basing this upon comparisons with species from Utah, which he referred to *Dorypyge*."

"C. GOTTSCHÉ⁵⁾ in 1886, called attention to the presence of Cambrian rocks and fossils in northeastern Korea, south of Wi-wön⁶⁾. He published a geological section and identified *Anomocare planum*, *Anomocare majus*,

1) Liau-tung = 遼東

2) Sai-maki = 賽馬集

3) Ta-ling = 大岑

4) Wu-lu-pu = 臥龍舖

5) C. GOTTSCHÉ: Geologische Skizze von Korea. Sitzungsberichte d. k. preusch. Akad. d. Wiss. Berlin, vol. XXXVI. 1886. pp. 9-11.

6) Wi-wön = 渭原

Dorypyge richthofeni and *Lingulella* cfr. *nathorsti*. He also mentions the genera *Theca*, *Orthis*, *Lingulella* (two species), *Agnostus*, *Conocephalites*, *Crepicephalus*, and ? *Remnopleurides*, and correlates the formation with that of the Andrarum limestone of Scandinavia."

"In 1899 M. BERGERON¹⁾ described the following Cambrian fossils from shaly limestones collected in the Province of Shan-tung²⁾, China :

<i>Agnoitus douvilléi</i>	<i>Arthricocephalus chauveaui</i>
<i>Olenoides leblanci</i>	<i>Dicellosephalus</i> ? <i>sinensis</i> ³⁾
<i>Drepanura premesnili</i>	<i>Calymene</i> ? <i>sinensis</i> ⁴⁾

"In 1903, H. Monke⁵⁾ published a paper on the Geology of Shan-tung and described certain "Upper Cambrian" trilobites, as follows :

<i>Agnostus koerferi</i>	<i>Drepanura ketteleri</i>
<i>Liostracina krausei</i>	<i>Stephanocare richthofeni</i>
<i>Teinistion lanci</i>	<i>S. sinense</i>
<i>T. sodeni</i>	<i>S. sp. ?</i> "
<i>Drepanura premesnili</i>	

"In 1904, TH. LORENZ described some problematical fossils as Algae under the new family Ascosomeaceae of the Siphoneae⁶⁾. The genus *Ascosoma* was proposed to include one species, *Ascosoma phaneroporata*, and a second species was placed under a new genus as *Mitscherlichia chinensis*."

"In 1905, some of the results of the CARNEGIE Institution of Washington's Expedition to China were published by the writer⁷⁾, and a second paper appeared in 1906⁸⁾. These two papers included descriptions and certain introductory notes on the Cambrian fossils collected by Messrs B. WILLIS and E. BLACKWELDER."

- 1) M. BERGERON: Etude de quelques trilobites de Chine. Bull. soc. géol. France, 3rd ser., vol. XXVII. 1899.
- 2) Shan-tung = 山東
- 3) This belongs, according to WALCOTT, to *Stephanocare*.
- 4) This belongs, according to WALCOTT, to *Blackwelderia*.
- 5) H. MONKE: Beiträge zur Geologie von Schantung. I. Obercambrische Trilobiten von Yen-tsy-yai. Jahrb. d. k. preuss. geol. Landesanstalt u. Bergakademie, Berlin, vol. XXIII. 1903.
- 6) TH. LORENZ: *Ascosomeaceae*, eine Neue Familie der Siphoneen aus dem Cambrium von Schantung. Centralb. f. M. G. u. P. 1904.
- 7) C. D. WALCOTT: Cambrian Faunas of China, Proc. U. S. Nat. Mus. vol. XXIX. 1905.
- 8) C. D. WALCOTT: Cambrian Faunas of China, paper No. 2. Proc. U. S. Nat. Mus. vol. XXX. 1906.

"H. WOODWARD¹⁾ reviewed, in 1905, the work of H. MONKE and discussed some of the species occurring in a collection of fossils obtained from "West Shantung, and south of Tsing-tschou-fu²⁾, 36° 40' N. lat., 118° 40' E. long."

"Late in 1906 a short memoir by LORENZ³⁾ appeared in which he described a number of new genera and species of Cambrian fossils collected by him in the province of Shan-tung and assigned stratigraphic horizons to them."

"The fauna from Lai-wu⁴⁾ was worked out of single block found loose in the bed of a brook about 9 km. west of Lai-wu. LORENZ concludes that the fauna represents the time of the base of the Swedish *Andrarum limestone*, within the limits of the zone of *Paradoxides davidus* and *P. forschhammeri*¹²⁾. The list of the species given by him is as follows :

<i>Olenoides (Dorypyge) richthofeni</i>	<i>Amphoton steinmanni</i> ⁹⁾
<i>Agnostus fallax</i> var. <i>laiwuensis</i> ⁵⁾	<i>Ptychoparia (Solenopleura)</i> sp.
<i>A. parvifrons</i> ⁶⁾	<i>Hyalolithes</i> sp.
<i>Anomocare commune</i> ⁷⁾	<i>Raphistoma bröggeri</i> ¹⁰⁾
<i>A. ovatum</i> ⁸⁾	<i>Acrothele bohémica</i> ¹¹⁾
<i>Alokistocare</i> sp.	

"The fauna from Wang-ts Chuang¹³⁾ occurs at three horizons. It is listed by Lorenz as follows :

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- 1) H. WOODWARD: On a Collection of Trilobites from the Upper Cambrian of Shantung, North China. Geol. Magazine of London, new series, dec. V, vol. 2, 1905.
 - 2) Tsing-tschou-fu = 青州府
 - 3) TH. LORENZ: Beiträge zur Geologie und Palaeontologie von Ostasien. II. Palaeontologischer Teil. Zeitsch. d. deutsch geol. Gesellschaft, Bd. LVIII, 1906.
 - 4) Lai-wu = 萊蕪
 - 5) = *A. chinensis* DAMES, according to WALCOTT.
 - 6) = *A. cfr. parvifrons* LINNARSON, according to WALCOTT.
 - 7) = *Anomocare chinensis* WALCOTT, according to WALCOTT.
 - 8) = *Anomocare tenuis* WALCOTT, according to WALCOTT.
 - 9) = *Dolichometopus deoisi* WALCOTT, according to WALCOTT.
 - 10) = *Platyceras willisi* WALCOTT, according to WALCOTT.
 - 11) = *Acrochele mathewsi eryx* WALCOTT, according to WALCOTT.
 - 12) The horizon of the *Dorypyge richthofeni* fauna is in the Middle Cambrian below the central part of the Kiu-lung group in Shantung, as pointed out by WALCOTT. WALCOTT: l.c. p. 6.
 - 13) Wang-ts Chuang = 王莊

A lower layer with (a)¹⁾:

*Anomocare speciosum*²⁾

*Agnostus parvifrons latelimbatus*³⁾

*Bathyriscus asiaticus*³⁾

*Acrothele granulata*⁶⁾

*Agnostus fallax*⁴⁾

Eighty meters higher up, a layer with (b).⁷⁾:

Teiniostion (?) sp.⁸⁾

Drepanura (?) sp.⁹⁾

At 80 meters above, an upper layer has (c)¹⁰⁾

*Shantungia buchrukeri*¹¹⁾

*Liostracus latus*¹²⁾

"At the locality of Tai-shan¹²⁾ south of Tsi-nan¹³⁾ Lorenz found fragments of a trilobite that he named *Lioparia blautocides*,¹⁴⁾"

"At the locality of Tsing-tschou-fu he reports the following:

*Lioparia latelimbata*¹⁵⁾

*Obollea nitida*¹⁷⁾

*Shantungia crassa*¹⁶⁾

Orthis sp.

A not closely definable brachiopod *Acrothele* sp."

The great illustrated monograph by WALCOTT on Cambrian fossils from China, appeared in Research in China, vol. III, 1913; the paper contains descriptions of

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- 1) This is located in the lower portion of the Kiu-lung group, as pointed out by WALCOTT. WALCOTT: l.c. p. 7.
 - 2) = *Anomocarella speciosa* (LORENZ), according to WALCOTT.
 - 3) = *Dolichometopus deois* WALCOTT, according to WALCOTT.
 - 4) = *A. chinensis* DAMES, according to WALCOTT.
 - 5) = *A. latelimbatus* (LORENZ), according to WALCOTT.
 - 6) = *A. matthewi eryx* WALCOTT, according to WALCOTT.
 - 7) This represents, according to WALCOTT, the zone of *Damesella blackwelderi* which occupies the central part of the Kiu-lung group. WALCOTT: l.c. p. 7.
 - 8) = *Damesella* cfr. *blackwelderi* WALCOTT, according to WALCOTT.
 - 9) = *Damesella* cfr. *blackwelderi* WALCOTT, according to WALCOTT.
 - 10) This may be assigned, according to WALCOTT, to the upper limestone of the Kiu-lung group, where the Upper Cambrian fauna is well developed. WALCOTT l.c. p. 7.
 - 11) = *Chuangia nitida* WALCOTT.
 - 12) Tai-shan = 泰山
 - 13) Tsi-nan = 濟南
 - 14) = *Anomocarella baucis* WALCOTT, according to WALCOTT.
 - 15) = *Anomocare latelimbatus* DAVES, according to WALCOTT.
 - 16) *Shantungia crassa* LORENZ of p. 109 = *Sh. monkei* LORENZ of p. 95; this = *Pagodia monkei* (LORENZ), according to WALCOTT.
 - 17) *Obollea nitida* LORENZ of p. 109 = *O. gracilis* LORENZ of p. 95; this = cf. *Obolus obscurus* WALCOTT, according to WALCOTT.
-

	Genera	Subgenera	Species	Varieties
<i>Foraminifera</i>	1		1	
<i>Porifera</i>	2		2	
<i>Anthozoa</i>	1		1	
<i>Annelida</i>	1		1	
<i>Brachiopoda</i>	13	4	36	4
<i>Gastropoda</i>	5		11	2
<i>Pteropoda</i>	2		11	1
<i>Cephalopoda</i>	1		1	
<i>Trilobita</i>	36	1	175	4
<i>Ostracoda</i>	1		6	

from various localities and horizons of Liao-tung, Shan-tung, Shan-si and Shen-si. The annexed list shows the geographical and geological distribution of these fossils :

	Lower Cambrian	Middle Cambrian	Upper Cambrian	Shan-tung	Shan-si	Shen-si	Liao-tung
Foraminifera							
<i>Globigerina ? mantoensis</i>		×		×			
Porifera							
<i>Protospongia chloris</i>		×		×			
<i>P. sp. undt.</i>		×					×
Anthozoa							
<i>Coscinocyathus elvira</i>		×			×		
Annelida							
<i>Planolites sp. undt.</i>		×					×
Brachiopoda							
<i>Micromitra sculptilis</i>		×					×
<i>M. (Paterina) labradorica orientalis</i>		×		×			
<i>M. (P.) lucina</i>		×					×
<i>M. (Iphidella) pannula maladensis</i>		×					×
<i>M. (I.) pannula ophirensis</i>		×		×			×
<i>Obolus chinensis</i>		×		×			×
<i>O. damesi.</i>		×		×			×

	Lower Cambrian	Middle Cambrian	Upper Cambrian	Shan-tung	Shan-si	Shen-si	Liau-tung
<i>Obolus matinalis</i> ?			×	×			
<i>O. minimus</i>		×		×			
<i>Obolus obscurus</i>		×		×	×		
<i>O. shansiensis</i>		×			×	×	×
<i>O. (Westonia) blackwelderi</i>		×		×			
<i>O. (W.)</i> sp. undt.			×	×			
<i>Lingulella manchuriensis</i>		×					×
<i>L. marcia</i>		×					×
<i>L. (Lingulepis) eros</i>		×		×			
<i>L. (L. ?)</i> sp. undt.		×			×		
<i>Dicellonius parvus</i>		×		×		×	
<i>Obolella asiatica</i>	×			×		×	
<i>Yorkia ? orientalis</i>		×			×		
<i>Acrothele matthewi eryx</i>		×		×			×
<i>A. ? minuta</i>		×		×			
<i>A. rara</i>		×		×			
<i>A. lisani</i>		×		×			
<i>Acrotreta pacifica</i>		×		×			×
<i>Ac. shantungensis</i>		×		×	×	×	×
<i>Ac. venia</i>		×					×
<i>Discinopsis sulcatus</i>			×	×			
<i>Fillingsella pumpellyi</i>			×	×			
<i>B. richthofeni</i>	×			×			
<i>Eoorthis agreste</i>		×		×			
<i>E. doris</i>			×	×			
<i>E. kayseri</i>			×	×	×		
<i>E. kichouensis</i>		×			×		
<i>E. linmarsoni</i>			×	×			
<i>E. pagoda</i>			×	×			
<i>E. sp. undt. (a)</i>		×		×			

	Lower Cambrian	Middle Cambrian	Upper Cambrian	Shan-tung	Shan-si	Shen-si	Liau-tung
<i>Eoorthis</i> sp. undt. (b)		×			×		
<i>Huenella orientalis</i>			×	×			
<i>Syntrophia orthina</i>			×	×			
Gastropoda							
<i>Scenella clotho</i>		×		×			
<i>S. ? dilatatus</i>		×			×		
<i>S.</i> sp. undt.			×	×			
<i>Matherella circe</i>			×	×			
<i>Straparollina</i> sp. undt.		×		×			
<i>Pelagiella chromus</i>		×		×			
<i>P. clytia</i>			×	×			
<i>P. pagoda</i>			×	×			
<i>P. willisi</i>		×			×		
<i>Helcionella ? churius</i>		×		×			
<i>H. rugosa chinensis</i>	×			×			
<i>H. rugosa orientalis</i>		×		×			
<i>H. ? ? simplex</i>		×			×		
Pteropoda.							
<i>Hyolithes cybele</i>		×		×			×
<i>H. daphnis</i>			×	×			
<i>H. delia</i>	×			×			
<i>H.</i> sp. undt.	×			×		×	
<i>Orthotheca cyrene</i>		×	×	×			×
<i>O. cyrene dryas</i>		×		×			
<i>O. dauris</i>		×		×			
<i>O. delphus</i>		×		×			×
<i>O. cfr. delphus</i>		×					×
<i>O. doris</i>		×				×	
<i>O. glabra</i>		×			×		×
<i>O.</i> sp. undt.			×	×			

	Lower Cambrian	Middle Cambrian	Upper Cambrian	Shan-tung	Shan-si	Shen-si	Liau-tung
Cephalopoda							
<i>Cyrtoceras cambria</i>			×	×			
Trilobita							
<i>Agnostus chinensis</i>		×		×	×		×
<i>A. douvillei</i>		×		×			×
<i>A. kushanensis</i>		×		×			
<i>A. parvifrons latelimbatus</i>		×		×			
<i>Microdiscus orientalis</i>		×				×	
<i>Shumardia</i> sp. undt.		×		×			
<i>Redlichia chinensis</i>	×			×			
<i>R. ? finalis</i>		×		×			
<i>R. nobilis</i>	×			×			
<i>R.</i> sp. undt. (a)		×		×			
<i>R.</i> sp. undt. (b)	×			×			
<i>R.</i> sp. undt. (c)	×			×			
<i>Albertella pacifica</i>		×					×
<i>Dorypyge bispinosa</i>		×		×			
<i>D. richthofeni</i>		×		×			×
<i>D. richthofeni laevis</i>		×			×		
<i>Teimistion alcon</i>		×		×			
<i>T. lansi</i>				×			
<i>T. typicalis</i>		×		×			×
<i>Stephanocare ? monkei</i>		×		×			
<i>S. richthofeni</i>		×		×			
<i>S. ? sinensis</i>		×		×			×
<i>S. ?</i> sp. undt.		×		×			
<i>Blackwelderia alastor</i>		×		×			
<i>B. cilix</i>		×		×	×		
<i>B. sinensis</i>		×		×			×
<i>Damesella bellagranulata</i>		×		×			

	Lower Cambrian	Middle Cambrian	Upper Cambrian	Shan-tung	Shan-si	Shen-si	Liau-tung
<i>Damesella blackwelderi</i>		×		×			×
<i>D. brevicaudata</i>		×		×			
<i>D. sp. undt.</i>		×		×			×
<i>Drepanura ketteleri</i>		×		×			
<i>D. premesnili</i>		×		×			×
<i>Ptychoparia acilis</i>	×			×			
<i>P. granosa</i>	×			×			
<i>P. impar</i>	×			×			
<i>P. impar var. ?</i>		×		×			
<i>P. kochibei</i>		×					×
<i>P. ligea</i>	×			×			
<i>P. lilia</i>		×			×		
<i>P. ? tolus</i>		×		×			
<i>P. typus</i>		×					×
<i>P. spp. undt.</i>		×		×			
<i>P. (Emmrichella) bromus</i>		×		×			
<i>P. (E.) constricta</i>	×			×			
<i>P. (E.) eriopia</i>		×		×			
<i>P. (E.) mantoensis</i>	×			×			
<i>P. (E.) theano</i>		×		×			
<i>Conocephalina belus</i>			×	×			
<i>C. dryope</i>			×	×			
<i>C. maia</i>		×			×		
<i>C. vesta</i>		×			×		
<i>C. sp. undt.</i>		×			×		
<i>Crepicephalus convexus</i>		×					×
<i>C. damia</i>		×		×	×		
<i>C. magnus</i>		×		×			
<i>Lonchocephalus tellus</i>		×		×			
<i>Liostracina krausei</i>		×		×			×

	Lower Cambrian	Middle Cambrian	Upper Cambrian	Shan-tung	Shan-si	Shen-si	Liau-tung
<i>Proampyx burea</i>			×	×			
<i>Pterocephalus asiaticus</i>		×		×			
<i>P. busiris</i>			×	×			
<i>P. ? liches</i>		×					×
<i>Shantungia spinifera</i>		×		×			×
<i>Inouyia abaris</i>		×		×			
<i>I. ? acalle</i>		×		×			
<i>I. armata</i>		×			×		
<i>I. capax</i>		×			×		
<i>I. divi</i>		×		×			
<i>I. ? inflata</i>		×			×		
<i>I. melie</i>		×			×		
<i>I. ? regularis</i>		×			×		
<i>I. thisbe</i>		×		×			
<i>I. titiana</i>		×		×			
<i>Agraulos abrota</i>		×		×			
<i>A. dirce</i>		×		×			
<i>A. dolon</i>		×		×			
<i>A. dryas</i>		×		×			
<i>A. nitida</i>		×			×		
<i>A. obscura</i>		×			×		
<i>A. sorge</i>		×					×
<i>A. ula</i>		×			×		
<i>A. vicina</i>		×			×		
<i>Pagodia bia</i>			×	×			
<i>P. dolon</i>			×	×			
<i>P. lotos</i>			×	×			
<i>P. macedo</i>			×	×			
<i>Lisania agonius</i>		×		×			
<i>L. ajax</i>		×		×			

	Lower Cambrian	Middle Cambrian	Upper Cambrian	Shan-tung	Shan-si	Shen-si	Liau-tung
<i>Lisania alala</i>		x		x			
<i>L. ? belemus</i>		x		x			
<i>L. bura</i>		x		x			
<i>L. cfr. bura</i>		x			x		
<i>L. sp. undt.</i>		x	x	x			
<i>Solenopleura agno</i>		x		x			x
<i>Solenopleura beroe</i>		x	x	x			x
<i>S. chalcon</i>		x					x
<i>S. intermediu</i>		x		x			
<i>S. pauperata</i>		x			x		
<i>S. sp. undt.</i>		x		x			x
<i>Chuangia batia</i>			x	x			
<i>C. fragmenta</i>			x	x			
<i>C. nais</i>			x	x			
<i>C. nitida</i>			x	x			
<i>Menocephalus abderus</i>		x		x			
<i>M. acanthus</i>		x		x			
<i>M. acerius</i>		x		x			
<i>M. acis</i>		x		x			
<i>M. admeta</i>		x		x			
<i>M. agave</i>		x		x			
<i>M. ? depressus</i>			x	x			
<i>M. ? sp. undt.</i>		x		x			
<i>Levisia adrastia</i>		x		x			
<i>L. agenor</i>		x		x			
<i>Ptychaspis acamus</i>			x	x			
<i>P. baubo</i>			x	x			
<i>P. bella</i>			x		x		
<i>P. brizo</i>			x	x			
<i>P. cactus</i>			x	x			

	Lower Cambrian	Middle Cambrian	Upper Cambrian	Shan-tung	Shan-si	Shen-si	Liau-tung
<i>Ptychaspis cadmus</i>			×	×			
<i>P. calchas</i>			×	×			
<i>P. callisto</i>			×	×			
<i>P. calyce</i>			×	×			
<i>P. campe</i>			×	×			
<i>P. ceto</i>			×	×			
<i>P. spp. undt.</i>			×	×			
<i>Anomocare alcinoe</i>		×		×			
<i>A. daulis</i>		×		×			
<i>A. ephori</i>		×					×
<i>A. flava</i>		×			×		
<i>A. latelimbatum</i>		×		×			×
<i>A. lisani</i>		×					×
<i>A. megalurus</i>		×			×		×
<i>A. minus</i>		×			×		×
<i>A. minus var.</i>		×					×
<i>A. ? nereis</i>		×			×		
<i>A. subquadratum</i>		×		×			×
<i>A. sp. undt.</i>		×			×		
<i>A. spp. undt.</i>		×	×	×			
<i>Anomocarella albion</i>		×		×			
<i>A. baucis</i>			×	×			
<i>A. bergioni</i>			×	×			
<i>A. bigsbyi</i>		×			×		
<i>A. biston</i>		×		×			
<i>A. butes</i>		×		×			
<i>A. chinensis</i>		×					×
<i>A. comus</i>		×			×		
<i>A. hermias</i>		×					×
<i>A. irma</i>		×			×		

	Lower Cambrian	Middle Cambrian	Upper Cambrian	Shan-tung	Shan-si	Shen-si	Liau-tung
<i>Anomocarella macar</i>		×					
<i>A. subrugosa</i>		×		×			
<i>A. tatian</i>		×		×			
<i>A. temenus</i>		×		×			×
<i>A. tenes</i>		×		×			
<i>A. thraso</i>		×		×			
<i>A. toxeus</i>		×		×			
<i>A. trogus</i>		×		×			
<i>A. tutia</i>		×		×			
<i>A. undata</i>		×			×		
<i>Coosia ? bianos</i>			×	×			
<i>C. carme</i>			×	×			
<i>C. ? daumus</i>		×		×			
<i>C. decelus</i>		×		×			
<i>Dolichometopus alceste</i>		×		×			
<i>D. deois</i>		×		×			×
<i>D. derceto</i>		×		×			
<i>D. dirce</i>		×		×			
<i>D. hyrie</i>		×			×		
<i>D. ? sp.</i>		×		×			
<i>Hysterolenus ? spp. undt.</i>			×	×			
<i>Bathyriscus manchuriensis</i>		×					×
<i>Asaphiscus iddingsi</i>		×					×
<i>Iliaemurus canens</i>			×	×			
<i>I. ceres</i>			×	×			
<i>I. dictys</i>			×	×			
Ostracoda							
<i>Aluta bergeroni</i>			×			×	
<i>A. enyo</i>			×			×	
<i>A. eris</i>			×			×	

	Lower Cambrian	Middle Cambrian	Upper Cambrian	Shan-tung	Shan-si	Shen-si	Liau-tung
<i>Aluta fragilis</i>			×			×	
<i>A. sterope</i>			×			×	
<i>A. woodi</i>			×			×	
Schizophyta							
<i>Girvanella</i> (?) ¹⁾	×			×			

The sequence of the Cambrian rocks in the Chang-hsia district in prov. Shan-tung will be here cited as the type of the Cambrian formation prevailing in the land lying north of the Tsin-ling-shan; according to E. BLACKWELDER,²⁾ it is as follows:

Tsi-nan dolomite—*Ordovician*.

Kiu-lung³⁾ Group { Chau-mi-tien⁴⁾ limestone; a complex, 180 m. thick and composed of blue gray limestone with intraformational conglomerate at various horizons.
 Ku-shan⁵⁾ shale; a 15 m. thick complex of green shale and slabby limestone.
 Chang-hia limestone; a complex 150 m. thick and composed of gray limestone mottled with ocher in its upper, dark gray oolitic limestone in the middle and olive gray oolitic limestone in the lower part.

Man-to⁶⁾ shale; a complex 150 m. thick and composed of (upper) brown shale with thin gray limestones and (lower) buff and gray shales with gray and buff earthy limestone and black slabby limestone.

Tai-shan complex—*Archean*.

1) BLACKWELDER; Petrography in Research in China, Vol. II., p. 379. 1907.

2) BLACKWELDER in Research in China, Vol. I., 1, p. 24 et seq.

3) Kiu-lung = 九龍

4) Chau-mi-tien = 炒米店

5) Ku-shan = 崗山

6) Man-to = 饅頭

After detailed study of the Cambrian fauna from China, WALCOTT came to the following important conclusion :

I. The *Redlichia* fauna of Shan-tung (Man-to shale), Shan-si, Yun-nan, northern India (Spiti), West Australia (Kimberley district) and South Australia, is very distinctive and confined to the Asiatic continent and Australia. It is of Lower Cambrian age, and *Obolella asiatica*, *Helcionella rugosa chinensis* and *Redlichia chinensis* are the characteristic forms of the Man-to shale. The climatic condition during the Man-to shale he considered, was arid and severely cold.

II. The overlying Kiu-lung group of Shan-tung is a succession of limestones and shales ; this indicates a relatively shallow-sea condition and favourable environment for the life of the sea. The Middle Cambrian fauna of the Kiu-lung group, the *Dorypyge* fauna, is marked by the absence of the genus *Paradoxides* ; and has in common with the Atlantic *Paradoxides* fauna *Dorypyge*, *Solenopleura*, *Anomocare* and some other genera.

The Middle Cambrian fauna of China is divisible into three subfaunas : a. in the lower subfauna, the species belonging to the genera *Ptychoparia*, *Inonyia* and *Agraulus* predominate and a species of *Redlichia* is found ; b. to the middle, *Dorypyge richthofeni* subfauna, *Dorypyge*, *Dolichometopus* and *Solenopleura* are peculiar ; all these named genera drop out in the succeeding c. upper subfauna, in which the genera *Damesella*, *Blackwelderia* and *Teinistion* are found. In Shan-tung the upper part of the Kiu-lung group and the next higher Ku-shan shales contain the said upper subfauna.

The Upper Cambrian fauna, which is found in Chau-mi-tien limestone of Shan-tung, is characterised by the various species of *Eoorthis*, a Cephalopoda, and the trilobite genera *Pagodia*, *Chuangia*, *Ptychaspis*, *Illaeurus*. Thus it contains many genera well represented in North America, as *Ptychaspis*, *Illaeurus*, etc. The absence of a true *Dicelocephalus* in the Chinese fauna is considered by WALCOTT to be very noteworthy, as the genus is found in association with *Ptychaspis* and *Illaeurus* in the Upper Cambrian fauna of the interior portions of North America.

Wide apart from the extensive Cambrian region of Manchuria, Shan-tung and Shan-si, there is another Cambrian tract in southern China and especially in eastern Yun-nan, where J. DEPRAT and H. MANSUY¹⁾ recognized the following rock successions and fossils:

Aca dian—green and rosy shale and sandstones, sandstones with

- Discina* sp.
- Acrothele mathezi eryx* WALCOTT
- Obolus damesi* WALCOTT
- Lingulella* sp.
- Palacolenus deprati* MANSUY
- Ptychoparia yunnanensis* MANSUY
- Bradoria douvillei* MANSUY
- Amiella prisca* MANSUY
- Hyolites* sp.

Georgien—

- | | | |
|--------------|---|---|
| Upper series | { | Upper division—Marl and sandstone with |
| | | <i>Obolus chinensis</i> WALCOTT |
| | | <i>O. detritus</i> MANSUY |
| | | <i>Palacolenus douvillei</i> MANSUY |
| | | <i>P. lantenoisi</i> MANSUY |
| | | <i>Redlichia nobilis</i> WALCOTT |
| | | <i>Aluta</i> sp. |
| | | <i>Nothozoe</i> sp. |
| | | Middle division—Marl and sandstone in alternation, with |
| | | <i>Obolus detritus</i> MANSUY |
| | | <i>Redlichia chinensis</i> WALCOTT |
| | | <i>R. carinata</i> MANSUY |
| | | <i>R. walcotti</i> MANSUY |
| | | Lower division—Variegated marly shale with |
| | | <i>Acrothele orbicularis</i> MANSUY |
| | | <i>Lingula yunnannensis</i> MANSUY |
| | | <i>Obolus</i> sp. |
| | | <i>Lingulella</i> sp. |

1) J. DEPRAT: Les séries stratigraphiques en Indochine et au Yunnan. Mém. serv. géol. de l'Indochine Vol. II., fasc. 2. 1913. J. DEPRAT et H. MANSUY: Étude géologique du Yunnan oriental, Part 1. Géologie Générale par DEPRAT. Mém. Vol. I., fasc. 1. 1912. Part 2. Paléontologie par MANSUY. Mém. Vol. I., fasc. 2. 1912.

Lower series { Compact arcose sandstone intercalating a few limestones and containing
Planolites sp.
Redlichia chinensis WALCOTT

In late years, the Cambrian fields in northern Korea and southern Manchuria were frequented by many Japanese geologists; in 1905, T. OGAWA¹⁾ gave a brief account of the Cambrian stratigraphy and palaeontology of the region in the Tokyo Journal of Geography, Vol. XVII., based on materials obtained by himself and by N. FUKUCHI, N. KANEHARA, Y. OTSUKI and S. KAWASAKI. In this paper, written in Japanese, he set forth:

1. The succession of the Cambrian rocks in the vicinity of Liau-yang²⁾;
2. The succession of the Cambrian rocks on the island of Tschang-hsing-tau,³⁾ off Niang-niang-kung⁴⁾ 25 km SWW of Fu-chou.⁵⁾ He found there many fossils which he then believed to be new species; most of these are surely referable to the new species described by WALCOTT.
3. The occurrence of *Coscinocyathus* cfr. *billingsi* WALCOTT, and *C.* sp. (probably new) in a limestone exposed near Sai-ma-ki.
4. The succession of the Cambrian rocks developed along the Hun-kiang,⁶⁾ a right tributary of the Am-nok-gang (Oryoku-kô),⁷⁾ where *Salterella* sp. was found in a limestone lense intercalated in purple shale and lying a little below a greenish limestone with *Dorypyge richthofeni* and other trilobites.

At present, our knowledge of the geology of Korea and southern Manchuria is much extended owing to the gradual progress of the geological survey work undertaken by the geologists of the Mining Bureau of the Government General of Korea on one side and by those of the Geological Office of the South Manchurian Railway Company on the other.

A very condensed account of our latest knowledge of Korean stratigraphy was given in an official bulletin⁸⁾ edited by the Government General

1) T. OGAWA: The Cambrian Formation of North China. (北支那ノカムブリア層)

2) Liau-yang = 遼陽

3) Tschang-hsing-tau = 長興嶋

4) Niang-niang-kung = 娘々宮

5) Fu-chou = 復州

6) Hun-kiang = 渾江

7) Am-nok-gang = 鴨綠江

8) Explanatory Catalogue of Articles exhibited by the Mining Bureau. 1915. (始政五年記念朝鮮物産共進會農商工部鑛務課出品目錄及解説書)

of Korea in connection of the National Exhibition of 1915. According to this paper, the Palaeozoic rocks of Korea are divisible into two main divisions, the lower of which comprises those of the Cambrian and Ordovician ages. This lower division is again subdivided in the following way :

Upper group, Great Limestone Formation :

Upper part containing gastropods, cephalopods etc., characteristic of Ordovician.

Middle part intercalating oolitic limestone beds and intraformational limestone conglomerate (Wurmalk).

Lower part containing Middle Cambrian trilobites and brachiopods.

Lower group, Yôtoku¹⁾ series :

Composed of quartzites and clay slates, with some intercalation of sandstone and limestone. Lower Cambrian.

In 1916, H. MURAKAMI²⁾ of the Geological Office of the South Manchurian Railway Company made an important contribution to the geology of the southern part of Liau-tung peninsula, and proposed the following succession of the Cambrian rocks there developed :

Carboniferous.

(Unconformity)

Middle Cambrian : total thickness 1,200 m.

Upper division D: Siliceous sandstone and siliceous slate in alternation.

Middle division :

C : Upper part comprising platy limestone, with the intercalation of nodular limestone.

Lower part composed of reddish, purplish and greenish slates, with *Cryptozoon* limestone.

B : Thin foliated slates, intercalating lenses or layers of oolitic limestone ; trilobites and brachiopods are common. At the top of this group lies a zone of reddish micaceous sandstone.

Lower division A : A thick complex of platy, marly limestone,

1) Yôtoku=陽德

2) M. MURAKAMI: Report on the Geology of Kwantōshu, Manchuria (in Japanese) (滿州關東州地質調査報告). 1916.

with red slate and fossiliferous oolitic limestone at its top and intercalating phyllitic slate near its base.

(Unconformity)

Lower Cambrian : total thickness 1500 m.

3. Red slate with *Redlichia*.
2. Siliceous sandstone.
1. Very thick complex of marly limestone.

(Unconformity)

Precambrian.

The Cambrian fossils now at hand are very numerous, but almost all of them are derived from Manchuria, Shan-tung and Korea, and hence are not taken into consideration in the present paper. Thus we have only four forms to be treated at this place which are derived from three different localities ; of these fossils, three are surely Cambrian, while one is referred to Cambrian with a query.

1. Dark grey earthy limestone from Ta-shi-tou, Hui-tso-hsien, prov. Yun-nan¹⁾ (YAMADA Coll. No. 76), with
Helcionella rugosa paupera BILLINGS.
Orthotheca glabra WALCOTT.
2. Light grey compact limestone collected between Hou-ping and Monchia-ho, Hsing-shan-hsien, prov. Hu-peï²⁾ (NODA Coll. No. 110.) with
Coscinocyathus cfr. *cancellatus* BORNEMANN.
3. Dark grey compact calcareous argillite from Lan-hsi, Chen-chou-fu, prov. Hu-nan (coll. by K. KOBAYASHI), with a trilobite, gn. et sp. indet.

The Cambrian age of the last is very doubtful ; although the single fragmental thorax reminds one somewhat of *Ptychoparia*, yet there is no other convincing evidence, palaeontological or stratigraphical, in support of this assumption. The second specimen has specially an important bearing on the geology of the middle course of the Yan-tze-kiang ; this will be explained in Chapter III.

1) 雲南省會澤縣大石頭 2) 湖北省興山縣后坪, 門家河ノ間 3) 湖南省辰州府蘭溪

Incertae Sedis.

Coscinocyathus, BORNEMANN.

Coscinocyathus cfr. *cancellatus* BORNEMANN.

Pl. XVI., Fig. 8 a-b ; Pl. XIX., Fig. 3.

Cfr. 1887. *Coscinocyathus cancellatus* BORNEMANN : Versteinerungen des sardinischen Cambrischen Schichtensystems, p. 69, pl. XI., fig. 4 c, 5 c ; pl. XIX., figs. 3, 4, 5 c ; pl. XX., figs. 1, 4, 5,—8 ; pl. XXXI., fig. 15.

1899. *Coscinocyathus* cfr. *cancellatus* v. TOLL : Beiträge zur Kenntniss des Sibirischen Cambrium I., p. 45, pl. V, f, e ; pl. VII., figs. 2 a 5 a.

Coscinocyathus of moderate size ; external shape not exactly known, but probably in the form of a warped bowl. Lamina hardly 4 mm. broad, very narrow in proportion to the internal cavity. Radial septa very numerous, hardly 1 mm. apart, complete. Tabulae almost as approximate as the septa and complete, slightly convex upward (?). Intervalum partitioned by the septa and tabulae into numerous loculi with a quadrate vertical section. Outer wall, septa and tabulae very thin and finely poriferous ; pores uniform in size, numbering 5 for each millimeter.

The specimen being firmly embedded in limestone, its true shape is at present unknown ; but as one side of the limestone block enclosing it shows a re-entrant angle of its lamina, it seems probable that it when complete, possessed the form of a warped bowl. The inner wall of the lamina is almost wholly worn away so that its nature is not clearly ascertainable, though certainly it is very thin and poriferous.

The irregularly folded wall and wide intervalum of the present specimen makes it comparable with *C. cancellatus*, first described by BORNEMANN from the Lower (Middle ?) Cambrian of Sardinia ; the same or a closely allied form was recorded also by v. TOLL from the Cambrian limestone of Torgoschino along the Jenissei, Siberia.

Loc. :—Between Hou-ping and Mon-chia-ho, Hsing-shan-hsien, prov. Hupei.

Geological Age :—Cambrian, probably Lower Cambrian.

Pteropoda ?

Hyolithidæ.

Orthotheca, NOVAK.

Orthotheca grabra WALCOTT.

Pl. XIX., Fig. 1.

1911. *Orthotheca grabra* WALCOTT: Cambrian Faunas of China, p. 75, pl. XIV., figs. 5, 5a.
 1913. *Orthotheca grabra* WALCOTT: The Cambrian Faunas of China, p. 97, pl. V., figs 23, 23a; pl. VI., fig. 7.

Slender tube elliptical in cross section, but little flattened on the dorsal surface; slightly attenuating below and almost straight, though some specimens show a very slight curvature. Surface smooth.

Dimensions:—The broadest specimen at hand measures 4 mm in length; this being fragmentary, it must certainly have exceeded 5 mm. when complete. The longer diameter of the tube measures 1.8 mm.

Localities:—The specimen examined is from Ta-hsi-tau, Hui-tso-hsin, prov. Yun-nan; found together with *Helcionella rugosa paupera* in dark grey earthy limestone.

The original specimens of this species described by WALCOTT are from the Middle Cambrian of Shan-si and Manchuria.

Geological Age:—Cambrian, most probably Middle Cambrian.

Gastropoda.

Palæoacmæidæ.

Helcionella, GRABAU AND SHIMER.

Helcionella rugosa (HALL) paupera BILLINGS.

Pl. XIX., Fig. 2.

1847. *Metoptoma? rugosa* HALL: Palæontology of New York, vol. I., p. 306, pl. LXXXIII., figs. 6 a—c.
 1872. *Stenotheca pauper* BILLINGS: Canadian Naturalist, New Ser., vol. VI., p. 479.

1886. *Stenotheca rugosa* WALCOTT; Second Contribution to the Studies on the Cambrian Faunas of North America. P. 128, pl. XII., figs. 1 a—e.
1890. *Stenotheca ? rugosa* WALCOTT: The Fauna of the Lower Cambrian or *Olenellus* Zone. P. 617, pl. LXXIV., figs. 1a-i, 2—7.
1909. *Helcionella rugosa* A. W. GRABAU and H. W. SHIMER: North American Index Fossils, Invertebrates. Vol. I., p. 607, figs. 810.
1905. *Stenotheca rugosa chinensis* and *orientalis* WALCOTT: Cambrian Fauna of China. p. 16.
1913. *Helcionella rugosa chinensis* and *orientalis* WALCOTT: The Cambrian Fauna of China. P. 91, pl. V., figs. 8, 15, 15a.

Shell capuliform, depressed conical, aperture elliptical, apex produced and acute, submarginal and incurved. Concentric folds broad, becoming gradually obsolete toward the aperture.

Dimensions :—The largest specimen has a height of 2.8 mm. and an aperture of 3 mm. in longitudinal diameter.

This species, *H. rugosa*, is very variable in form and sculpture; the present form much resembles *H. rugosa paupera* BILLINGS.¹⁾ Of the two forms of this species described by WALCOTT from China, *H. rugosa chinensis* has a less incurved shell with more numerous and narrower folds; *H. rugosa orientalis*, on the other hand, differs considerably from the present form by having a strikingly prolonged shell with acute folds. *H. rugosa paupera* is known from the Lower Cambrian of Newfoundland and eastern Massachusetts.

Loc. :—Ta-shi-tou, Hui-tso-hsien, prov. Yun-nan; found together with *Orthotheca glabra* WALCOTT in dark grey earthy limestone.

H. rugosa chinensis is found in the lower part of the Man-to shale formation (Lower Cambrian) of Shan-tung, while *H. rugosa orientalis* is known from the middle part of the Chang-hsi formation (Middle Cambrian) of Shan-tung.

Geological Age :—Cambrian, in all probability Middle Cambrian.

1) WALCOTT: Second Contribution, p. 129. "On examining the type of *Stenotheca paupera* in the collection of the Geological Survey, I found it to be a coarsely ribbed variety of *S. rugosa*."

Trilobita.

GN. et SP. INDET.

Pl. XVI., Fig. 11.

Thorax with 7 or more transverse segments; axial lobe moderately convex, slightly broader than half the breadth of the pleural lobe, and gradually narrowing posteriorly. Pleuræ nearly flat, horizontal and at right angles to the axial lobe, out to the geniculation, where they bend downward and backward, terminating in a falcate extremity; pleural furrow long and broad, starting at the dorsal furrow near the front and extending out on the falcate end. The free pleural extremity of the last segment is considerably larger than those anterior to it.

The cephalon and the greater part of the pygidium are missing; the small part of the latter found attached to the thorax indicates that the pygidium, when complete, attained a considerable size. On the specimen, it shows two rings, with the cylindrical axial lobe and a flattened lateral lobe preserved; with two curved interpleural furrows; each rib of the lateral lobe is distinctly marked by a narrow pleural groove; the character of the margin is unknown.

Dimensions:—The fragmental specimen, figured, is some 30 mm. long; the axial lobe of the thorax, after restoration, measures 10 mm. in maximum breadth, and the pleural lobe 16 mm.

The preservation of the pygidium is so incomplete that the segments considered above as belonging to the pygidium may with equal right be assigned to the thorax; if this be not the case, the resemblance of the present specimen to *Ptychoparia* is considerable. No other fossils being found in association with it, and the stratigraphical order of the rock from which it was collected being unknown, I have at present no other means of determining the geological age of the present fossil, though it certainly belongs to the Older Paleozoic and most likely to the Cambrian.

Locality:—Lan-hsi, Chen-chou-fu, prov. Hu-nan; in a dark grey compact calcareous argillite.

CHAPTER II.

Ordovician.

The most important geological features peculiar to Chinese land north of Tsin-ling-shan are 1. an extensive development of Ordovician limestone, and 2. a total absence of the marine sediments ranging from Gotlandian up to Lower carboniferous. These relations are at least quite true of southern Manchuria and northern Korea to which my personal observations extend, and appear also to hold good in Shan-tung, according to the recent studies of I. HAYASAKA.¹⁾

The Ordovician limestone, with rare intercalations of clastic sediments, appears almost always to pass insensibly downward to Upper Cambrian limestone.²⁾ Formerly this Ordovician limestone was included by RICHTHOFEN in his "Kohlenkalkstein";³⁾ lately in Shan-tung, it was called Tsi-nan limestone by WILLIS and BLACKWELDER.⁴⁾ The geologists of the Mining Bureau of the Korean Government General included it in the "Great Limestone Formation."⁵⁾

In spite of its very extensive and thick development, the Ordovician limestone is never richly fossiliferous; when present, the fossils are usually found scattered in certain layers.

The first convincing evidence of the Ordovician age of the said limestone was brought forth by G. C. CRICK⁶⁾ of the British Museum on material from south of Tsin-tchou-fu⁷⁾ in Shan-tung, which according to him contains

Actinoceras (*Ormoceras*) aff. *tenuifilum* Hall

Gonioceras sp.

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- 1) H. YABE: Is Lower Carboniferous really developed in Shantung? Journ. Geol. Soc. Tokyo, vol. XXIII, No. 274. 1916. pp. 129—137.
 - 2) TH. LORENZ: Beiträge zur Geologie und Palaeontologie von Ostasien, I. Geologischer Teil. 1905. p. 14; F. FRECH: in RICHTHOFEN'S China, vol. V., p. 14. 1911.
 - 3) Richthofen: China, vol. II., p.
 - 4) Researches in China, vol. I., p. 110 etc.
 - 5) Explanatory Catalogue of the Articles exhibited by the Mining Bureau, Korea. 1915. P. 3.
 - 6) G. C. CRICK: Straight shelled Nautiloidea from North China. Geol. Mag. London. N.S., dec. IV., vol. X., pp. 481—485. 1903.
 - 7) 青州府

A form strongly suggesting *Dalmanella testudinaria*

According to FRECH,¹⁾ the British Museum further possesses some specimens of other Upper Ordovician fossils,

Trochoceras sp. and

Actinoceras sp.,

derived from a locality in Shan-tung which is not exactly known.

The same author²⁾ also described

Actinoceras richthofeni FRECH, and

Raphistoma cfr. *aequilaterum* KOKEN

which were collected by RICHTHOFEN at Hsiau-sörr along the Ta-tse-ho³⁾ in Manchuria; they likewise represent the Upper Ordovician. Nautiloids with the same features as those mentioned above are rather common in the Ordovician limestone of southern Manchuria and northern Korea.

Further discoveries of Ordovician fossils in Shan-tung are as follows:

1. Ho-shan⁴⁾ along the highway leading from Poshan to Tsi-nan⁵⁾ (LORENZ).⁶⁾

Asaphus boehmi LORENZ

Maclurea logani Salter

Hyolithes sp.

Middle Ordovician in age.⁷⁾

2. Santefan, south of Ho-shan (LORENZ).⁸⁾

Plectambonites sericea (Sow.)

Upper Ordovician in age.⁹⁾

3. Chau-mi-tien; about 400 ft. above the base of the Tsi-nan limestone (WILLIS and BLACKWELDER; ident. by S. WELLER).¹⁰⁾

1) F. FRECH: l.c. p. 14.

2) FRECH: l.c. pp. 8, 12.

3) Hsiau-sörr = 小布?; Ta-tse-ho = 太子河

4) 胡山

5) 濟南

6) TH. LORENZ: Beiträge zur Geologie und Palaeontologie von Ostasien II. Palaeontologischer Teil. 1906. p. 109.

7) F. FRECH in RICHTHOFEN'S China, vol. V., p. 14.

8) TH. LORENZ: l.c. p. 110.

9) F. FRECH: l.c. p. 14.

10) S. WELLER: A Report on Ordovician Fossils collected in Eastern Asia in 1903-4. In Research in China, vol. III., p. 179.

Orthoceras sp.

4. Seven and a half miles SSE of Sin-tai-hsien¹⁾; a few hundred feet below the top of the Tsi-nan limestone (WILLIS and BLACKWELDER; ident. by S. WELLER)²⁾

Orthoceras sp. and a gastropod.

5. NE of Tsai-kia-chuang³⁾; Tsi-nan limestone (WILLIS and BLACKWELDER; ident. by S. WELLER)⁴⁾

Orthis? or *Dalmanella?* sp.

Maclurea? or *Helicostoma?* sp.

Lophospira sp.

Orthoceras sp.

Asaphus? sp.

6. Two and seven-tenths miles SW of Yen-chuang⁵⁾; upper part of the Chau-mi-tien limestone (WILLIS and BLACKWELDER; ident. by S. WELLER)⁶⁾

Orthoceras sp.

7. Five and a half miles SW of Tsi-nan; Tsi-nan limestone (WILLIS and BLACKWELDER; ident. by S. WELLER)⁷⁾

Strophomena sp.

Orthoceras sp.

8. A gravel in the valley of a dry stream 4.8 miles WSW of Tsi-nan (WILLIS and BLACKWELDER; ident. by S. WELLER)⁸⁾

Orthoceras sp.

From these fossils, GIRTY concludes that the Tsi-nan limestone may belong somewhere in the middle division of the Ordovician.⁹⁾

WILLIS and BLACKWELDER proposed to define the "Sinian formation" more accurately than RICHTHOFEN, and marked the Tsi-nan limestone as the Upper

1) 新泰縣

2) S. WELLER: l.c. p. 279.

3) 耿家庄

4) S. WELLER: l.c. p. 279.

5) 顏庄

6) S. WELLER: l.c. p. 280.

7) S. WELLER: l.c. p. 280.

8) S. WELLER: l.c. p. 280.

9) S. WELLER: l.c. p. 279.

Sinian.¹⁾ According to them the Tsi-nan limestone comprises two divisions in Shan-tung: a lower 75 m. thick complex of shale and coarse crystalline dolomite, and an upper 750 m. thick dolomitic limestone. In northern Shan-si they encountered also the Sinian well exposed in its characteristic development, with massive limestones at its top, which are the equivalent of the Chau-mi-tien and Tsi-nan divisions of Shan-tung. The complex in Chili and Shan-si, which corresponds to the Tsi-nan limestone as well as the underlying Kiu-lung group of Shan-tung, was called by them the Ki-chou²⁾ limestone.

In southern China, the Ki-sin-ling limestone of WILLIS and BLACKWELDER is equivalent of the Ki-chou limestone and is represented by limestones 1350-1500 m thick on the middle Yan-tse-kiang, in Hu-pei and eastern Sze-chuan. The *Sinian* strata definitely known by fossils, however, are seldom to occur in south-eastern China to the south of the Yang-tse-kiang³⁾; only from Lun-shan, E. of Nanking, some Ordovician fossils have been recorded as mentioned below. In the province of Yun-nan, on the other hand, the Ordovician rocks are again well developed.

1) The Sinian formation in the sense of RICHTHOFEN is very indefinite; sometimes he understood his Lung-mönn beds (now accepted to be of the Middle Cambrian age) by Upper Sinian (China, vol. II., p. 226); see also the following note by E. TIESSEN on pp. 738-9 of China, vol. III.

“Das Sinicum im SO lichen China gliedert sich in drei Haupt-Stufen, die in weiter Ausdehnung haben nachweisen lassen. Grundlegend für ihre Erkennung waren die Beobachtungen in Ta-hau-shan, am Po-yang-See und im Querschnitt der Gebirgsszüge zwischen dem Tsien-tang-kiang und dem Yang-tse-kiang. Diese drei Stufen sind vom Liegenden zum Hangenden: 1. der Ta-hau-Sandstein, 2. die Lu-shan Schiefer, 3. der Matsu-Kalkstein. Eine Parallelisierung mit dem übrigen System der Formationen ist, wegen des Mangels an palaeontologischen Material, noch nicht möglich. Es muss festgehalten werden, dass Verf. als Sinische Formation einen Complex definiert hat, der nicht etwa mit dem Cambrium gleich zu setzen ist, sondern sowohl nach unten wie nach oben hin einen grösseren Umfang besitzt. Nach oben hin gehört wenigstens das Untersilur noch zu diesem Begriff. Innerhalb dieser Grenzen schwankt die Altersangabe jener Gruppen, da sogar das tiefste Glied, der Ta-hau-Sandstein, als cambrisch oder silurisch bezeichnet wird. Dagegen waren früher sogar die darüber folgenden Lu-shan-Schiefer als wahrscheinlich untercambrisch angenommen; die höchste Stufe, der Matsu-Kalkstein, wiederum, wie der Ta-hau Sandstein, bald als cambrisch, bald als silurisch gedeutet worden. Da aber die drei Stufen, wenigstens am Po-yang-See und von dort abwärts am Yang-tse-kiang, in engerem Verband in der genannten Folge erscheinen, so ist ihre Zusammenfassung unter den Begriff der Sinischen Formation so lang geboten, bis sich eine genauere Bestimmung auf palaeontologischer Grundlage durchführen lassen wird. Die Gleichstellung mit dem Sinicum Nordchina's ist hier ausdrücklich betont worden.”

2) Ki-chou = 蕪州

3) See above quotation from China, vol. III.

In nearly all of the Ordovician districts in southern China the strata seem to be developed in intimate relation with Gotlandian rocks. This and the very extensive development of Devonian rocks are two geological features characteristic of southern China.

One of the Chinese fossils familiar to geologists from early times is *Orthoceras chinense* FOORD, the polished slab of reddish mottled earthy limestone with this fossil being a favourite ornament for alcoves in Chinese houses (Pagoda stone). This was formerly regarded as a Devonian fossil; but lately FRECH has assigned it with right to Ordovician.¹⁾ The localities of the slabs with *O. chinense*, first described, are recorded as being (1) near I-chang²⁾ in Prov. Hu-pei³⁾ and (2) north of Kwan-tung.⁴⁾ The apparently inexhaustible supply of this material for ornamental purpose indicates that these places are to be counted among localities prolific in Ordovician fossils.

Through the contributions of KAYSER,⁵⁾ FRECH,⁶⁾ MARTELLI,⁷⁾ MANSUY,⁸⁾ WELLER,¹⁴⁾ BROWN⁹⁾ etc., the development of Ordovician rocks in the following districts are confirmed on the evidence of fossils.

1. Lun-shan,¹⁰⁾ WSW of Tshönn-kiang,¹¹⁾ prov. Kiang-su;¹²⁾ Upper Ordovician; ident. by FRECH.¹³⁾

Asaphus sp. of the group of *A. expansus*.

Endoceras duplex WAHLENBERG

Orthosina squamata v. PAHLEN.

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- 1) FRECH: RICHTHOFEN'S China, vol. V., p. 10.
 - 2) I-chang = 宜昌
 - 3) Hu-pei = 湖北
 - 4) Kwan-tung = 廣東
 - 5) KAYSER: Mittel-und Obersilurische Versteinerungen aus dem Gebirgsland von Tschau-tien. RICHTHOFEN'S China, vol. IV.
 - 6) FRECH: l.c.
 - 7) MARTELLI: Fossili del Siluriano inferiore dello Schensi. 1901.
 - 8) MANSUY: Étude géologique du Yun-nan oriental. Paléontologie. 1902.
 - 9) BROWN: Contributions to the Geology of the Province of Yun-nan in western China. III. Notes on the Stratigraphy of the Ordovician and Silurian Beds of western Yun-nan. Records Geol. Surv. India. Vol. XLIII. 1913.
 - 10) Lun-shan = 崑山
 - 11) Tshönn-kiang = 鎮江
 - 12) Kiang-su = 江蘇
 - 13) FRECH: Ueber Palaeozoische Faunen aus Asien und Nordafrika. N. Jahrb. M. G. P. 1895. Bd. II. FRECH in RICHTHOFEN'S China, vol. V., pp. 2. 3.
 - 14) S. WELLER: l.c.

Orthis cfr. *calligramma* DALM.

Raphistoma sinense FRECH.

2. and 3. Between the second and third gorges of the Yang-tse-kiang¹⁾ above I-chang (2), and Tung-hu-hsien,²⁾ north of I-chang (3); upper Ordovician; ident. by FRECH.³⁾

Orthoceras chinense FOORD (2)

Cyrtoceras (*Meloceras*) cfr. *ellipticum* LOSSEN (2)

Lituities (*Ancistroceras*) *angelini* BOLL. (3)

Discoceras verbeeki FRECH (2)

D. eurasiaticum FRECH (3)

Maclurea neritoides EICHW. (3)

Raphistoma sinense FRECH (3)

R. (Eccyliopterus) abandannoni FRECH (2)

To this the following three forms, which are mentioned by FRECH as from "I-tschou-fu, Prov. Hupei,"⁴⁾ are to be added, for they are derived from that locality (3):

Illaenus sp. (3)

Isotelus sp. (3)

Orthisina cfr. *hemipronites* (3)

From this district I have still many other species characteristic of Ordovician, which will be enumerated later on.

4 and 5. Lean-shan⁵⁾ in the Tsin-ling⁶⁾ mountains (4), and a locality not exactly known (5) in prov. Shen-si⁷⁾; (4) ident. by MARTELLI⁸⁾ and (5) ident. by G. PELLIZZALI.⁹⁾

Calymene paronai PELLIZZARI (5)

Orthis calligramma DALM. var. *serica* MARTELLI (4)

1) Yang-tse-kiang = 揚子江

2) Tung-hu-hsien = 東湖縣

3) FRECH in RICHTHOFEN'S China, vol. V., pp. 4-13.

4) FRECH: l.c. p. 3.

5) Lean-shan - Chinese character unknown.

6) Tsin-ling = 秦嶺

7) Shen-si = 陝西

8) MARTELLI; l.c.

9) PELLIZZARI: Fossili Palaeozoici antichi dello Scensi (Cina). Rivista Italiana di Paleontologia, vol. XIX. 1913.

- O. calligramma* var. *davidsoni* DE VERN. (4)
Triplecia poloi MARTELLI (4), 5)
Orthisina giraldi MARTELLI (4)
Fenestella ambigua HALL (4)
Spirorbis inornatus HALL (4)
6. Kiau-tschang-pa,¹⁾ Prov. Sze-chuan ;²⁾ ident. by KAYSER.³⁾
- a. Dark trilobite limestone.
- Asaphus* sp.
Calymene sp.
Trinucleus richthofeni KAYSER
Orthis kiautschangpensis KAYSER
- b. Light grey brachiopoda limestone.
- Orthis calligramma* DALM.
Plectambonites sericea SOW.
Strophomena corrugatella DAVIDSON
Spirifer radiatus SOW.
7. Sü-kia-pa,⁴⁾ along the Ta-ning,⁵⁾ prov. Sze-chuan ; found in Ki-sin-ling⁶⁾ limestone ; ident. by S. WELLER.⁷⁾
- Lingula* sp. undt.
Strophomena sp. undt.
Triplecia poloi MARTELLI.
Orthis calligramma DALM.
Plectorthis willisi WELLER
Dalmanella testudinaria DALM.
D. subæquata CONRAD
Clitambonites chinensis WELLER
Hemipronites tenuistriata WELLER
Cornulites sp. undt.

1) Kiau-tschang-pa = 校場壩

1) Sze-chuan = 四川

3) KAYSER: l.c.

4) Sü-kia-pa = 徐家壩

5) Ta-ning = 大甯

6) Ki-sin-ling = 雞心嶺

7) WELLER: l.c.

Gastropod gen. and sp. undt.

Cryptodonta ? sp. undt.

Vaginoceras sp. undt.

Ampyx chinensis WELLER

A. sp. cfr. *costatus* BOECK.

Asaphus blackwelderi WELLER

A. tainingensis WELLER

A. sp. cfr. *expansus* DALM.

A. asiaticus WELLER

A. laevis WELLER

A. chinensis WELLER

A. sp. undt.

A. sp. undt.

A. ? sp. undt.

Isotelus ? sp. undt.

I. sp. undt.

Megalaspis minor WELLER

Illæmus ? *bronteoides* WELLER

Proetus ? sp. undt.

Calymene sp. undt.

Pterygomotopus ? sp. undt.

WELLER considered this fauna to be contemporaneous with that of the *Vaginatenkalk* of the Baltic region in Europe and of the Black River formation of the United States of America.

8. Si-yang-tang,¹⁾ N. of Eul-long-si-chou,²⁾ and Siau-tou-kau,³⁾ NE of the former, in eastern Yun-nan ; ident. by MANSUY.⁴⁾

a. Fissile marly slate of Si-yang-tang.

Lingula cfr. *striata* SOW.

L. deprati MANSUY

Discina (*Orbiculoidea*) *sinensis* MANSUY

1) Si-yang-tang—

2) Eul-long-si-chou—

3) Siau-tou-kau—

4) MANSUY: l.c.

} Chinese characters unknown.

Strophomena sp. undt.

Spirifer bourgeoisi MANSUY

Leda circumflexa MANSUY

Pteronites sp. undt.

Goniophora contraria MANSUY

Sinocaria asiatica MANSUY

Ceratiocaris pierloti MANSUY

- b. Black micaceous *Calcschist*, some 13 m higher than (a).

Dionide formosa BARRANDE

- c. Dark slate of Siau-tou-kau.

Bothriolepis sp.

9. Pupiao,¹⁾ Lameng,²⁾ and Shih-tien³⁾ in western Yun-nan ; ident. by C. REED.⁴⁾ The first is the very locality from which Lóczy⁵⁾ early recorded the occurrence of cystidian remains, which were referred by him with doubt to *Hemicosmites* and are now assigned by REED to *Caryocrinus*, and of some fragments of a trilobite. J. C. BROWN lately found rich Ordovician faunas in this and adjacent districts.

- a. Pupiao.

Cheirurus cfr. *mitis* SALT.

Ogygites yunnanensis REED

Illenus cfr. *linnarssoni* HOLM

I. cfr. *atavus* EICHW.

Remnopleurides cfr. *sexlineatus* ANG.

Calymene unicornis REED

C. sp.

Lichas aff. *verrucosa* EICHW.

Cyphaspis cfr. *megalapis* M^cCOY.

Pliomera sp.

Asaphus sp.

1) Pupiao=蒲缥

2) La-meng— } Chinese characters unknown.

3) Shih-tien— }

4) BROWN: l.c.

5) Loczy: in Wiss. Ergeb. d. Reised. Grafen B. Széchenyi, vol. III., p. 21.

Leperditia sp.

Primitia sp.

Raphistoma cfr. *qualternatus* SCHLOTH.

Cyrtolites sp. ?

Conocardium sp. ?

Ctenodonta sp.

Pachydictya ? sp.

Orthis aff. *actoniæ* SOW.

O. sp.

O. aff. *bocki* LAMANSKY

O. cfr. *calligramma* DALM.

Hyolithes 2 sp. undt.

H. cfr. *asteroidens* REED

Cheirocrinus sp. pl.

Caryocrinus sp.

Heliocrinus aff. *araneus* SCHLOTH.

H. sp.

Protocrinus ? sp.

Didymograptus bifidus HALL

D. murchisoni BECK

Diplograptus sp.

The age of the fossiliferous beds is, according to REED, Lower Ordovician and approximately equivalent to the Upper Arenig and Lower Llandeilo ; the single exception being the bed with *Caryocrinus*, the exact position of which is still not certain.

b. La-meng.

Harpes sp.

Ogygites sp.

Orthis aff. *balclatchiensis* DAV.

Plectambonites aff. *llandeiloensis* DAV.

Heliocrinus sp.

The beds with these fossils belong to the same horizon as those from Pupiao.

c. Shih-tien. The number of beds cited below are those originally given by BROWN.

<i>Illaenus</i> cfr. <i>linnarssoni</i> HOLM.	Bed No. 3
<i>I.</i> aff. <i>schmidti</i> NIESZK.	6
<i>Lichas</i> cfr. <i>celorhin</i> ANG. var. <i>coniceps</i> EICHW.	6
<i>Asaphus</i> aff. <i>broggeri</i> SCHMIDT	6
<i>Orthoceras</i> cfr. <i>tortum</i> ANG.	3
<i>O.</i> cfr. <i>commune</i> WAHLENB.	3
<i>O.</i> cfr. <i>scrabridum</i> ANG.	3
<i>O.</i> sp.	3
<i>O.</i> cfr. <i>actuum</i> ANG.	6
<i>O.</i> sp.	6
<i>Clitambonites</i> cfr. <i>ascendens</i> PANDER	6
<i>Orthis</i> aff. <i>bocki</i> LAMANSKY	6
<i>Philhedra</i> sp.	6

REED is of the opinion that the above mentioned fossils suggest the contemporaneity of the beds Nos. 3 and 6 with the Vaginatenskalk of the Baltic province.

<i>Illænus</i> <i>cæcoides</i> REED	5
<i>I.</i> cfr. <i>linnarssoni</i> HOLM.	5
<i>Calymene</i> sp.	5
<i>Endoceras</i> cfr. <i>wahlenbergi</i> FOORD	5
<i>E.</i> aff. <i>cancellatum</i> EICHW.	5
<i>Orthoceras</i> sp. pl.	5
<i>O.</i> cfr. <i>scrabridum</i> ANG.	5
<i>O.</i> cfr. <i>regulare</i> SCHLOTH.	5
<i>Lituites</i> ? sp.	5
<i>Trocholites</i> sp.	5
<i>Trochoceras</i> <i>yunnanensis</i> REED	5
<i>Bellerophon</i> (<i>Simiites</i>) cfr. <i>regulosus</i> KOKEN	5
<i>Holopea</i> sp.	5
<i>Clitambonites</i> sp.	5
<i>Caryocystis</i> <i>bicompressa</i> REED	5
<i>Heliocrinus</i> <i>fiscellata</i> BATHER	5

<i>H. subovalis</i> REED	5
<i>H. qualus</i> BATHER	5
<i>Sphaeronis shihtienensis</i> REED	5
<i>Ovocystis mansuyi</i> REED	5
<i>Echinosphaera sinensis</i> REED	5
<i>Sinocystis loczyi</i> REED	5
<i>S. yunnanensis</i> REED	5
<i>S. piroides</i> REED	5
<i>Camarocrinus asiaticus</i> REED	5

The abundance of cystideans in this fauna of the bed No. 5, after REED, suggests its correlation with the Echinosphaeritenkalk of Scandinavia and of the Baltic province of Russia.

The Ordovician materials of the present study comprise :

1. Exact locality unknown ; only noted as derived from the vicinity of I-chang,¹⁾ prov Hu-pei (YAMADA Coll. No. 4). Very fine, isolated specimens of

Triplecia poloi MARTELLI

2. Pan-tse-ya,²⁾ Hu-hsi,³⁾ Hsing-shan-hsien,⁴⁾ prov. Hu-pei (NODA Coll. No. 102) ; found in a brownish marly limestone :

Asaphus sp.

Actinoceras (*Ormoceras*) sp. undt.

Orthoceras chinense FOORD

Cyrtoceras (*Meloceras*) *asiaticum* YABE

3. Kao-huang-ling,⁵⁾ Hsing-shan-hsien,⁴⁾ prov. Hu-pei (NODA Coll. No. 103) ; found in a dark grey marly limestone and a semicrystalline limestone :

Triplecia poloi MARTELLI

Plectambonites cf. *sericea* SOW.

A much deformed *Orthis*-like shell.

4. Liu-chia-ho,⁶⁾ Hsing-shan-hsien, prov. Hu-pei (NODA Coll. No. 100) ;

1) I-chang = 宜昌

2) Pan-tse-ya = 播子埡

3) Hu-hsi = 戶溪

4) Hsing-shan-hsien = 興山縣

5) Kao-huang-ling = 高荒峯

6) Liu-chia-ho = 劉家河

a platy, marly limestone contains pseudo-oolites composed of fine filaments of

Girvanella sinensis YABE

5. Huang-chia-chang,¹⁾ Tung-hu-hsien,²⁾ prov. Hupei (NODA Coll. No. 122); a grey limestone with abundant fragments of

Batostomella antiqua YABE

6. San-yu-tung,³⁾ near I-chang, Tung-hu-hsien, prov. Hu-pei (YAMADA and FUKUCHI); a dark grey, sapropelic limestone with numerous pseudo-oolites which are composed of filaments of

Girvanella sinensis YABE

On a former occasion, I took this limestone to be of Carboniferous age, following WILLIS and BLACKWELDER; the locality is, however, included in an Ordovician area by NODA. Since the same form of *Girvanella* is found in an Ordovician limestone from Liu-chia-ho, mentioned above, the present specimen is also assigned to Ordovician.

7. No-lu-ping,⁴⁾ Tung-hu-hsien, prov. Hu-pei (S. USUI Coll.); found in limestones, which are mostly grey in colour and earthy in texture, being rarely crystalline:

Polyrophe (?) *dubia* YABE

Orthis ? sp.

Orthisina cfr. *hemipronis*

Raphistoma sinense FRECH

Maclurea neritoides EICHW.

Raphistoma (*Eccyliopterus*) *abendanoni* FRECH

Lituites (*Ancistroceras*) *angelini* BOLL var.

Discoceras eurasiaticum FRECH

Discoceras sp. undt.

Orthoceras sp. undt.

Orthoceras sp. undt.

Isotelus usuii YABE

Iliaenus sinensis YABE

1) Huang-chia-chang = 黃家場

2) Tung-hu-hsien = 東湖縣

3) San-yu-tung = 三遊洞

4) No-lu-ping — Chinese character unknown.

According to USUI, the fossiliferous horizon of No-lu-ping is followed higher up by another which is well exposed on Mt. Lo-ling-po¹⁾ near No-lu-ping: the latter contains certain fossils indicating its lowest Gotlandian age, as will be mentioned later on. All these older Palaeozoic rocks are then overlaid by a complex of Permian age.

8. Liu-cha-chao,²⁾ between Tung-shan-hsien³⁾ and Han-ning-hsien,⁴⁾ prov. Hu-pei (Y. ISHII Coll.); in a reddish mottled crinoidal limestone:

An *orthoceratid*, gen. et sp. undt.

With no other fossils at hand, it is quite arbitrary to assign this limestone to Ordovician; but such an assignment seems highly probable.

9. Between Yang-ko-la,⁵⁾ Chi-chiang-hsien,⁶⁾ prov. Sze-chuan, and Chu-tien-ya,⁷⁾ prov. Kwei-chou⁸⁾ (YAMADA Coll.).

Orthoceras chinensis FOORD

O. sp.

Schizophyta.

Schizophyceæ.

Girvanella, NICHOLSON and ETHERIDGE.

Girvanella sinensis YABE.

Pl. XVI., Fig. 1-2.

1912. *Girvanella sinensis* YABE: Ueber einige Gesteinbildende Kalk-algen. Sci. Rep. Tôhoku Imp. Univ., ser. II., vol. I., p. 1, pl. I., fig. 1; text-fig. 1.

5) Lo-ling-po—Chinese character unknown.

6) Liu-chia-chao=劉家橋

3) Tung-shan-hsien=通山縣

4) Han-ning-hsien=咸寧縣

5) Yang-ko-la=楊哥老

6) Chi-chiang-hsien=荃江縣

7) Chu-tien-ya=酒店埡

8) Kwei-chou=貴州

“Die wurmförmigen Zellfäden sind gleichmässig etwa 0.01 mm. dick, rund im Querschnitt, teilen sich dichotom, schlingen sich ganz dicht und fast regellos, und bilden undeutlich concentrische Lagen um den central gelegenen Fremdekörper. Weder Schlauche noch Querwände sind in den Zellfäden beobachtet.

“Unverkennbar ist die Aehnlichkeit zwischen diesen Algenfäden und denen der untersilurischen *Girvanella problematica* NICHOLSON und ETHERIDGE von Airyshire, Schottland, in ihrem gesammten Habitus. Als Unterscheidungsmerkmal beider anzugeben ist aber die Knollenbildung der schottischen Art durch ihre ganz regellos geordneten Zellfäden und die Pseudoolitbildung der chinesischen Art durch mehr oder weniger concentrischen Anhäufung der Zellfädenmasse. Die letztere Art kann aber nicht der Gattung *Sphaerocodium* angehören, da nicht nur die Zellfäden keine Schläuche bilden, sondern sie sich nicht concentrisch geordnet sind wie bei *Sphaerocodium bornemanni* ROTHPLETZ; trotz der concentrischen Lagerbildung der Zellfädenmassen, sind die Zellfäden selbst nicht bei unserer Form concentrisch geordnet; im Gegenteil erkennt man oft leicht, manche Zellfäden mehr oder weniger vertical laufen in den von meist wirr verschlungenen Fäden entstandenen Massen.”

“Die Pseudooliten von *Girvanella sinensis* erscheinen oval oder ellipsoidisch im Dünnschliff und erreichen 4—7 mm in Grösse. Sie sind tief brown gefärbt. Das Gestein ist dolomitisierter mergelige Kalk und enthält einige Bruchstücke von Molluskenschalen und Echinodermenkalkgebilde, welche als Nucleus in den Pseudooliten sich befinden.”

“Da alle von NICHOLSON, ETHERIDGE und ROTHPLETZ untersuchten Exemplare von *Girvanella problematica* die Knolle der regellosen verwirrten Zellfäden sind, finde ich zweckmässig die chinesische Form von oben genannter spezifisch zu trennen, aber nicht generisch, obwohl das geologische Alter dieser nicht genau bekannt ist und wahrscheinlich einer Formation bedeutend junger (Carbon) als jener anzugehören scheint.”

The geological and geographical distribution of the genus *Girvanella* and its history was very fully summarized by E. J. GARWOOD in his recent publication “On the Important Part played by Calcareous Algae at certain Geological Horizons, with special Reference to the Palaeozoic

Rocks¹⁾; the following is essentially an abstract of this paper, with a slight modification.

Girvanella was originally described in 1878 by NICHOLSON and ETHERIDGE jun., from the Ordovician rocks of the Girvan district, Scotland.²⁾ The genus was established to include certain small nodular structures composed of a felted mass on interlacing tubes, having a width of 10 and 18 μ , the cells being typically simple, imperforate tubes without visible internal partitions. The genotype *G. problematica* was at that time referred to the arenaceous foraminifera. In 1887, BORNEMANN,³⁾ in describing his new genus *Siphonema* (= *Girvanella*) found in the Cambrian rocks of Sardinia, suggested that this organism might belong to the calcareous algae. In 1891, ROTHPLETZ⁴⁾ noticed that some of the specimens of *Girvanella* which he examined were characterised by dichotomous branching of the tubes; on this account he removed the genus from the *Rhizopods* to the calcareous algae placing it provisionally among the *Codiaceae*. Three years later A. BROWN⁵⁾ expressed the opinion that *Girvanella* might ultimately come to be regarded as referable to the *Siphonaceae Verticillatae*. In 1898, however, A. C. SEWARD⁶⁾ remarked that its exact position in the organic world was quite uncertain, but that it might be more fittingly discussed among the *Schizophyta* than elsewhere. Lastly in 1908, ROTHPLETZ⁷⁾ reaffirmed his opinion that *Girvanella* must be referred to the *Codiaceae*.

Siphonema described by BORNEMANN from the *Archacocyathus* limestone of Sardinia was shown by HINDE⁸⁾ to be congeneric with *Girvanella*. BLACK-

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- 1) Geological Magazine, London. Dec. V., vol. X. 1913. p. 440 et seq.
 - 2) NICHOLSON and ETHERIDGE: A Monograph on the Silurian Fossils of the Girvan District in Airyshire. Vol. I. 1880. p. 23, pl. IX., fig. 24.
 - 3) BORNEMANN: Die Versteinerungen des Cambrischen Schichtensystems der Insel Sardinien. Abt. I. Nova Acta d. k. Leop.-Carol. deutsch. Akad. d. Naturforscher. Bd. LI., No. 1. 1886.
 - 4) ROTHPLETZ: Fossile Kalkalgen aus der Familie der Codiaceen und der Corallinen. Z. d. deutsch. geol. Gesell., 1891, p. 301.
 - 5) A. BROWN: On the Structure and Affinities of the Genus *Solenopora*. Geol. Mag., London. Dec. IV., vol. I., p. 203. 1894.
 - 6) SEWARD: Fossil Plants. Vol. I., p. 124. 1898.
 - 7) ROTHPLETZ: Ueber Algen und Hydrozoen im Silur von Gotland und Oesel. K. Svenska Vetenskapsakademiens Handlingar, vol. XLIII., No. 5.
 - 8) Review of BORNEMANN's paper, cited above, by HINDE. Geol. Mag., London. Dec. III., vol. IV., p. 228. 1887.

WELDER¹⁾ found *Girvanella* (?) in a red oolite from the Man-to formation of Chang-hia district,²⁾ Shan-tung; in this case, *Girvanella* tubes are said to have no direct relation to the formation of the oolitic grains, sometimes being found in their core, and sometimes forming a crust upon them. The reference of the filaments to the genus seems to me somewhat doubtful. CHAPMAN³⁾ reported the occurrence of *Girvanella problematica* in a lower Cambrian limestone of Androssan, and others in South Australia.

It has been stated above that *G. problematica* was first described from the Ordovician rocks of Girvan district in Scotland, where it occurs very abundantly in association with *Solenopora*; from the Chazy limestone of North America H. M. SEELY⁴⁾ has described *Strophocetus ocellatus*, which is now usually considered to be identical with *Girvanella*, and in my former paper, a reference to this species was made based on the figure of it given by J. D. DANA in his Manual of Geology⁵⁾; further *G. sp.* and *G. richmondensis* MILLER have been reported from the Ordovician rocks of West Ontario.¹¹⁾ SCHUCHERT⁶⁾ also reported *Girvanella* from the Ordovician rocks on the east coast of Behring Strait.

Girvanella tubes were also found in Wenlock limestone at Malvern⁷⁾ and elsewhere in England; the *Girvanella* limestone is also extensively developed in the Gotlandian of Gotland, as pointed out by ROTHPLETZ.⁸⁾ Further, G. W. CARD⁹⁾ and F. CHAPMAN¹⁰⁾ reported its occurrence in the limestone, of the same age, of Victoria and Queensland.

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- 1) BLACKWELDER: Petrography in Research in China, vol. II. 1907. P. 379, pl. LV., fig. A.
 - 2) Chang-hia = 張夏
 - 3) CHAPMAN: Australian Fossils. 1914. p. 82.
 - 4) SEELY: A New Genus of Chazy Sponges. Amer. Journ. Sci., vol. XXX., p. 355. 1885.
 - 5) Fourth edition, p. 501, figs. 625, 626.
 - 6) Cited after Haug: Traité de Géologie, vol. II., pt. 1, p. 643.
 - 7) WETHERED: On the Microscopic Structure of the Wenlock Limestone. Q. J. GEOL. Soc. London. Vol. XLIX., p. 236. 1893.
 - 8) ROTHPLETZ: Ueber Algen und Hydrozoen im Silur von Gotland und Oesel. K. SVENSKA Vetenskapsakademiens Handlingar Vol. XLII., No. 5, p. 6. 1908.
 - 9) CARD: Limestones from Lion Oolitic Creek, Stanwell, near Rockhampton. Geol. Surv. Queensland, Bull., No. 12. 1900.
 - 10) CHAPMAN: On the Relationship of the Genus *Girvanella* and its Occurrence in the Silurian Limestone of Victoria. Rep. Ass. Adv. Sci. Adelaide Meeting 1907. 1908.
 - 11) WETHERED: On the Occurrence of the Genus *Girvanella* in Oolitic Rocks and Remarks on Oolitic Structure. Q. J. GEOL. Soc. London, vol. XLVI., p. 270, pl. XI., figs. 1, 2. 1890.

Girvanella also finds an extensive distribution in the lower Carboniferous of Britain; E. WETHERED¹⁾ described *G. incrustans*, with tubes having a diameter of 0.01 mm. and *G. ducii*, with a diameter of 0.02 mm. from the limestone of this age of the Avon gorge and Tortworth, England. GARWOOD²⁾ remarked that these organisms must have flourished at this period over an area of at least 3,000 sq. miles in the north of England alone. The *Girvanella* nodular bed occurs at the base of VAUGHAN's upper *Dibunophyllum* zone.

According to Deprat,⁴⁾ the Moscovian limestone of Tha-tchong in Yun-nan contains *Girvanella* sp.

The youngest geological horizon in which the occurrence of *Girvanella* has been confirmed is the British Oolites; according to WETHERED,³⁾ *Girvanella* tubes are fairly abundant in the Leckhampton pisolites (*G. pisolitica*), and coralline oolite of Weymouth (*G. minuta* and *G. intermedia*).

Locality:—San-yu-tung, Tung-hu-hsien, and Liu-chia-ho, Hsing-shan-hsien, both in the province of Hu-pei.

Tetracoralla.

Zaphrentidæ.

Polyrophe, LINDSTRÖM.

Polyrophe (?) dubia YABE, sp. nov.

Pl. XV., Fig. 5a.-d.

Corallum simple, short horn shaped; circular in cross section; surface

- 1) A. F. FOERSTE: Upper Ordovician Formations in Ontario and Quebec. Mem. Geol. Surv. Canada, LXXXIII., p. 178. 1916.
- 2) GARWOOD: l.c. p. 498.
- 3) WETHERED: The Inferior Oolite of the Cotteswold Hills with special Reference to its Microscopic Structure. Q. J. GEOL. Soc. London. vol. XLVII. 1891. p. 550 et seq., pl. XX. WETHERED: On the Microscopic Structure of the Jurassic Pisolite.. Geol. Mag. Dec. III., vol. VI., p. 200.
- 4) DEPRAT: Étude Géol. du Yun-nan oriental; Géologie generals, p. 107.

smooth, except numerous distinct costal striae in pinnate arrangement; wall thin. *Calyx* deep and abrupt, with flat bottom. Septal spines very minute, numerous; tabulae thin, numerous, about 8 in a space of 5 mm., mostly horizontal, often coalescing and giving rise to horizontal series of coarse vesicles of unequal size; not seldom spiniferous.

The internal structure of the coral is very simple, with no other endothecal elements than the tabulae and minute spiniferous processes. It represents a new species probably allied to *P. glabra* LINDSTRÖM from the Gotlandian of Gotland. The named species is a compound corallum, though also often found simple; its corallites are provided with thecal expansions outside and horizontal tabulae and numerous spiniferous processes inside; the spines are very numerous and arranged in regular lines in position corresponding to septa, over the whole inner surface of *calyx*. The Chinese form also much resembles certain species of *Amplexus*²⁾ with the septa very diminutive in size. As I now believe, though with some slight doubt, that there is no lamellar septa developed in the present coral, it is assigned to the genus *Polyrophe*, and not to *Amplexus*.

Locality:—No-lu-ping, Tung-hu-hsien, prov. Hu-pei (Usui Coll.)

Bryozoa.

Trepostomata.

Batostomellidæ.

Batostomella, ULRICH.

Batostomella antiqua YABE sp. nov.

Pl. XIX., Fig. 4; Pl. XXVIII., Figs. 2a-b.

Zoarium consisting of solid slender ramose branches, 1.5–4 mm broad; slightly flexuous and circular in cross section. *Zooecial* tubes amalgamated per-

1) G. LINDSTRÖM: Beschreibung einiger Obersilurischer Korallen. Bihang till K. Svenska Vet. Handlingar. Vol. XXIV, 1896. p. 43, pl. VIII, figs. 99–100.

2) For instance, *A. exilis* BILINGS; L. M. LAMBE: A Revision of the Genera and Species of Canadian Palaeozoic Corals. Pt. II, p. 131, pl. IX, figs. 5, 5 a, 5 b.

fectly ; thin-walled in the axial part, but much thickened in the peripheral zone where the interspaces are provided with numerous strong acanthopores and occasionally with small mesopores ; almost circular in cross section, having some blunt projections from the wall. *Zoecial* apertures always oblique to the surface, and arranged in oblique rows. Tabulae rare, especially in the axial part.

The genus *Batostomella* is common in Upper Palaeozoic rocks, and its oldest representative is hitherto known from the Gotlandian ; as the present species was found by NODA in the upper part of his Ping-shan limestone, which is surely of the Ordovician age it is the oldest known form of this genus ; hence the specific name *antiqua* is proposed for it.

Locality :—Huan-chia-chang, Tung-hu-hsien, prov. Hu-pei.

Gastropoda.

Raphistomidæ.

Maclurea, LESEUR.

Maclurea neritoides EICHWALD.

Pl. XVI., Fig. 12a.-b.

1860. *Maclurea neritoides* EICHWARD : Lethaea Rossica, p. 1140, pl. XLIII., fig. 14.
 1897. *M. neritoides* KOKEN : Die Gastropoden des baltischen Untersilurs, p. 147.
 1911. *M. neritoides* FRECH : in RICHTHOFEN'S China vol. v, p. 10, pl. IV., figs. 1a-2b.

Sinistral shell with flat spire and somewhat convex and widely umbilicated base ; whorls 3 or 4, rapidly enlarging ; outer edge of the whorls obtusely angular ; outer side slightly convex ; umbilicus wide and abrupt, exposing about half of the inner whorls.

Dimensions :—The largest diameter of the upper surface attains 27 mm., the corresponding width of the aperture being 11 mm, and that of the next adjoining whorl 4 mm. ; the height of the shell is a little more than 10 mm.

The single specimen from China was figured by FRECH in China vol. V. ; he compared it with numerous specimens of *M. neritoides* from Holmstrand near Christiania, Norway, and found them specifically identical. The latter specimens were identified by F. ROEMER with *M. logani* Salter¹⁾ from the Ordovician of Canada. KOKEN pointed out the great likeness existing between the European *M. neritoides* and the Canadian *M. logani*.²⁾ The latter, however, seems to me to be provided with a narrower umbilicus.

The original description of *M. neritoides* given by EICHWALD³⁾ is as follows :

“ Testa magna, anfractus 2—3 ve latitudine subito incrementes, superne plani, utroque margine externo et interno declives inque marginem inferiorum obtusum excurrentes, apertura triangulari ; umbilico profundo magno.”

“ La surface du test est finement striée, a stries d'accroissement transversale très-rapprochées.”

LORENZ⁴⁾ described an apparently very imperfect specimen from Ho-shan in Shan-tung under the name *M. logani* ; he identified it with the specimens of *M. logani* from Porsgrund, which may belong to *M. neritoides*.⁵⁾ So far as I can judge from his figures of the Shan-tung specimen, it differs from *M. neritoides* as well as from *M. logani* in having less rapidly enlarging whorls.

Loc. :—No-lu-ping, Tung-hu-hsien, prov. Hu-pei ; “ lower bed ” (USUI Coll.)

M. neritoides is known from the Lyckholm bed of Estland and the uppermost *Chasmops* limestone of Norway.

1) SALTER: Ordovician Fossils from eastern Canada. Canada Geol. Surv., Can. Org. Rem., Dec. I. 1859. FERD. ROEMER: Lethaea Palaeozoica, pl. V., fig. 6. GRABAU and SHIMER: North American Index Fossils. Invertebrates Vol. I., p. 664. fig. 920.

2) KOKEN: l.c. p. 174.

3) EICHWALD, l.c.

4) LORENZ: Beitr. z. Geologie und Palaeontologie von Ostasien. II. Palaeontologischer Teil. P. 104.

5) KOKEN: l.c. p. 174.

Raphistoma, HALL.**Raphistoma sinense FRECH.**

Pl. XVI., Fig. 7 ; Pl. XXVII., Fig. 11.

1895. *Raphistoma sinense* FRECH : Ueber Palaeozoische Faunen aus Asien und Nordafrika. P. 3, fig. 1 a-b.

1911. *R. sinense* FRECH : RICHTHOFEN's China vol. V., p. 11, pl. III., figs. 4 a-b.

This species FRECH describes as follows :

“ Die vorliegende Form gehört zur Reihe des *Raphistoma qualteriatum*. *R. schmidtii* KOKEN¹⁾ aus dem nordischen Orthocerenkalk steht der chinesischen Form ausserordentlich nahe. Die flache Form des Gewindes und die Art der Einrollung ist bei beiden Arten vollkommen übereinstimmend. Doch ist *R. schmidtii* doppelt so hoch als die flache chinesische Form.”

“ Auch *R. damesi* KOKEN²⁾ ist, wie der Vergleich von Originalexemplaren erkennen lässt nahe mit *R. sinense* verwandt und nur durch das treppenförmig in der Mitte etwas erhöhte Gewinde zu unterscheiden.”

The figured specimen from Tun-hu-hsien was referred by FRECH to *R. sinense*, a species which was first described on two specimens from Lung-shan, prov. Kiang-su ; the former is a stone-nucleus of a shell composed of 4 or 5 volutions, with depressed spires and wide, open umbilicus. The upper surface of the whorls is slightly concave, separated from the slightly convex peripheral surface by an obtusely angular border. The umbilical border is distinctly angular.

Dimensions :—Diameter of the upper surface 2.6 mm ; height 1.4 mm.

Loc. :—No-lu-ping, Tung-hu-hsien, prov. Hu-pei (USUI Coll.) The other known locality of this species is Lung-shan, 80 km. E. of Nan-king, prov. Kiang-su.

Raphistoma schmidtii KOKEN and *R. damesi* KOKEN are found in *Orthoceras* limestone of northern Europe.

1) KOKEN: Entwicklung der Gastropoden vom Cambrium bis zur Trias, Pl. XI., fig. 8. KOKEN: Die Gastropoden des baltischen Untersilurs, p. 166.

2) KOKEN: Entwicklung der Gastropoden, pl. XI., figs. 4, 4a. KOKEN: Gastropoden des baltischen Untersilurs, p. 165, text-fig. 21.

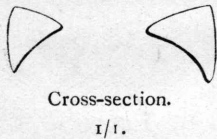
Eccyliopterus, REMELE.**Eccyliopterus abendanoni FRECH.**

Pl. XIX., Fig. 7a-b.

1911. *Raphistoma (Eccyliopterus) abendanoni* FRECH: RICHTHOFEN'S China vol. V., p. 12, pl. III., figs. 1 a-d.

FRECH founded this species on two specimens which are figured in "China," vol. V. The smaller specimen (fig. 1 b.), 37 mm. in diameter "shows an evolute shell composed of few volutions; the whorles are trigonal in cross section, with the outer side slightly convex and the upper and lower sides slightly concave. As the latter two meet in an acute inner border, the shell would probably appear like the annexed figure in cross section.

Among the fossils from Tung-hu-hsien, there is a specimen, which, though much damaged in extraction from the hard matrix, is hardly distinguishable from the smaller specimen of FRECH cited above; the present specimen, however, shows not a little difference from the larger one of FRECH in the course of the sharp striae on the surface of the test. In the former, the fine, but very distinct striae run almost vertically on the outer side of the shell, being never so conspicuously flexuous as those shown in FRECH's fig. 1 d. It is, therefore, only provisional that the present specimen is now called *E. abendanoni*.



Further, there is also some doubt about its generic position; according to KOKEN, *Eccyliopterus* of REMELE comprises the shells showing the following features:

"Gehäuse rechts gewunden, evolut, eine offene Spirale bildend. Windungen dreiseitig, die Winkel zwischen Apical-und Extern-Seite zu einem kragenförmigen Gebilde ausgezogen.

Die Sculptur besteht in fadenförmigen, ungleichen Rippen, welche scharf nach rückwärts geschwungen, auf dem Kragen aber wieder steil aufgerichtet sind.

Der Kragen besteht aus einer Doppellamelle der äusseren Schalen-

schicht mit ihren Rippen ; zwischen diesen Lamellen werden stark nach vorn gerichtete Septa der inneren Schalenschicht abgelagert, welche die äusseren Rippen schräg kreuzen. Der Kragen besitzt also eine dem Schlitzbande der Pleurotomarien vergleichbare Structur, ohne aber direct als solches aufgefasst werden zu können, denn die Lunulae des Pleurotomarienbandes gehören der äusseren Schalenschicht an."

It is yet to be proven that the present specimen has this peculiar feature of marginal carina.

Locality :—No-lu-ping, Tung-hu-hsien, prov. Hu-pei (USUI Coll.). The type specimens of this species are from a locality lying between the second and third gorges of the Yang-tse-kiang above I-chang.

Cephalospoda.

Nautiloidea.

Orthoceratidæ.

Orthoceras, BREYN.

Orthoceras chinense FOORD.

Pl. XXVII., Figs. 3 a-b.

1856. *Orthoceras* sp. S. P. WOODWARD :

Quart. Journ. Geol. Soc. London. Vol. XII., p. 378, pl. VI., fig. 1.

1887. *O. chinense* FOORD : Catalogue of Fossil Cephalopoda. British Museum. I. P. 100.

1911. *O. chinense* FRECH : RICHTHOFEN'S China, vol. V., p. 8, pl. II., figs. 2 a-c.

"Shell straight, cylindrical, rate of increase 1 in 9. Length of body chamber unknown. *Septa* distant about $1\frac{1}{2}$ the diameter or more, but becoming more crowded as they approach the chamber of habitation ; direct, strongly arched ; the necks very long, so as to reach nearly half way across the space between two septa. *Siphuncle* central, cylindrical, very slightly contracted between the necks. Test unknown." This is the original diagnosis of *O. chinense* given by FOORD.

According to FRECH, the largest specimen of this species in the British Museum attains almost 1 m. in length; I have also seen many polished slabs of limestone with this fossil, of which four measurements of the shells are given below:

	Length	Diameter of the larger end.	Diameter of the smaller end.
1.	1000 mm.	70 mm.	—
2.	370 "	55 "	17 mm.
3.	330 "	40 "	6 mm.
4.	220 "	35 "	25 mm.

No. 1 and 4 are from Yang-ko-la, and No. 2 and 3 from unknown localities.

The specimens now at hand are much smaller in size, but isolated from the matrix, as shown on Plate XXVII. The septa are further apart than half the diameter of the tube, and are provided with a long septal neck.

Locality:—The figured specimens are from prov. Hu-pei (NODA Coll. No. 102). Found in association with *Cyrtoceras* (*Meloceras*) *ellipticum* LASSEN, and *Asaphus* sp. ABENDANON obtained it, together with *Discoceras verbeeki* FRECH, at a place between the second and third gorges of the Yan-tse-kiang above I-chang. The two specimens measured above, No. 1 and No. 4 are from a locality on the road between Yang-ko-la, Chi-chiang-Hsien, prov. Sze-chuan and Chu-tien-ya, prov. Kwei-chow (YAMADA Coll.)

Orthoceras (?) sp. indet.

Pl. XVIII., Fig. 3; Pl. XXVII., Figs. 2a-e.

This represents a very remarkable type of orthoceracone Nautilids, and it is only provisional that I refer the specimen to the genus *Orthoceras*. The specimen is a fragment of a cylindrical shell, in state of internal cast, and 50 mm. long; it is oblong in cross section, measuring 29 mm and 24 mm in larger and smaller diameter respectively. The surface of the stone nucleus is smooth, except for 6 sharply impressed annular lines which are 5—7 mm. apart; the impressions are somewhat wavy, probably owing to the secondary deformation of the entire shell. The lines at first sight appear to be the suture

lines of the septa, but in reality coincide with them only partially. On examining the surface of the stone nucleus with magnifier in detail, we see that the suture lines deviate downwards considerably (that is apically) from the lines in question on the two sides normal to the shorter axis of the shell. The shell in longitudinal section shows there are only two moderately concave septa at the base, the remaining upper portion representing the body chamber. The septa are traversed at the center by a broad (12 mm. in diameter) empty tubular space, which is completely shut off from the interior of the camerae by means of the septal necks, these being very long and extending beyond the preceding septum. There is absolutely no organic deposit in the interior of the shell.

At present the real nature of the impressed lines on the surface is quite obscure to me; there are two possible explanations:—

1. If the specimen represents an internal cast of an *Orthoceras*-like shell the interior of the test must have been provided with sharp annular thickenings, and therefore the broad tube is the siphuncle. So far, I am aware of no instance of such annular thickening of the test, on its internal surface, in any known species of orthoceracone Nautilids.

2. It is also conceivable that the present specimen may represent the siphuncular infilling only of an *Orthoceras*-like shell, and not the stone nucleus of the shell as a whole; then the impressed lines on the surface of the specimen would be the suture lines of the septa marked on the siphuncle and not on the inside of the shell, and the siphuncle would be divided by septa, as in *Diphragmoceras* HYATT, which, however are not complete like those of the genus named, but traversed by a broad central endosiphonal tube.

The future discovery of test-bearing specimens may reveal the real nature of this striking form.

Locality :—No-lu-ping, Tung-hu-hsien, prov. Hu-peh (USUI Coll.)

***Orthoceras* sp. indet.**

Pl. XXVII., Fig. 5.

Shell straight, very elongate conical, with an apical angle of about 8°; oblong? in cross section; surface smooth. Septa moderately concave, about

$1\frac{1}{3}$ diameter or a little more apart. Siphuncle narrow, central, and surrounded by very short septal neck.

Dimensions :—Length 136 mm., diameter of the larger end 16 mm. and that of the smaller end 8 mm.

Two specimens have been examined, of which the larger one has the dimensions given above ; both are partly rubbed, and the real outline of the shell in cross section is not exactly known, though in most probability it is oblong.

Distinguished easily from *O. chinense* by somewhat more crowded septa and very short septal neck.

Locality :—Between Yang-ko-la, Chi-chian-hsien, prov. Sze-chuan and Chu-tien-ya, prov. Kwei-chou (YAMADA Coll.); found together with *O. chinense* FOORD.

Orthoceras sp. indet.

Pl. XIX., Figs. 10 a-b.

A cast of two contiguous septated chambers ; almost circular or slightly oblong in cross section (owing to deformation ?) ; the lower chamber, 25×23 mm. in cross section, is about 8 mm. deep. The siphuncle is central and only 3 mm. broad.

Too imperfect for specific identification ; but apparently distinguished from *O. chinense* by the possession of more numerous septa. It is possible that this is specifically identical with the preceding form.

Locality :—No-lu-ping, Tung-hu-hsien, prov. Hu-pei (USUI Coll).

Gen. et. sp. indet.

Pl. XXVII., Fig. 1.

This is a fragment of a straight cone Nautilid, with very crowded septa near the body chamber ; no further features being exhibited on the specimen, its generic and specific determination is quite out of the bounds of possibility.

Loc.:—Liu-chia-chao, between Tung-shan-hsien and Han-ning-hsien, Wu-chang-fu, prov. Hu-pei (ISHII coll.); in a reddish mottled crinoidal limestone. Simply from the nature of its matrix, I provisionally assign it to Ordovician.

Cyrtoceratidæ.

Cyrtoceras, GOLDFUSS.

Cyrtoceras (Meloceras) asiaticum YABE sp. nov.

Pl. XVIII., Fig. 14; Pl. XXVII., Figs. 7a-b.

1911. *Cyrtoceras (Meloceras)* cfr. *ellipticum* FRECH: RICHTHOFEN'S China vol. V., p. 6, pl. II., figs. 3 a-c.

Shell very slender: septated part rather strongly and uniformly arcuate, gently enlarging from the posterior to the anterior; elongate oval in cross section, being somewhat narrower along the external side than along the internal. Siphuncle very narrow, and situated very close to the external side. Septa rather closely set, 2-3 mm. apart. According to FRECH, the shell is rather thick and its surface shows only fine striae; the siphonal wall is very thin and not surrounded by siphonal collar of the septa. Of the body chamber, only a small portion is known; it is less arcuate than the septated part.

Dimensions:—The figured specimen measures 115 mm. along the convex side of the shell (of which the last 26 mm. represents the basal portion of the body chamber), and 80 mm. along the chord. Cross section of the whorl, taken from the middle portion of the shell, 16 mm. long and 13 mm. broad.

The present specimen, I think, is quite similar to that described by FRECH¹⁾ under the name *C. (M.)* cf. *ellipticum* LOSSEN; as the former is almost entirely deprived of the test, it appears to be more slender than the latter. As already pointed out by him, the Chinese form has the septated

1) C. LOSSEN: Ueber einige Lituiten. Zeitsch. d. deutsch. geol. Gesell. Bd. XII. 1860. p. 27, pl. I., figs. 3 a-b.

portion of the shell more strongly arcuate than *C. ellipticum* LOSSEN from the Ordovician limestone near Sorau; I consider the difference is considerable enough for the specific separation of the two forms. Further, the former is more slender than the latter.

C. plebeium BARRANDE¹⁾ from E1-E2 of Bohemia resembles the present species more closely, being distinguishable only by its but slightly broader shell.

Locality:—Hing-shan-hsien, prov. Hu-pei (NODA Coll.). FRECH's specimen is from the locality between the second and third gorges of the Yang-tse-kiang above I-chang.

Actinoceratidæ.

Actinoceras, BRONN.

Subg. *Ormoceras*, STOKES.

Actinoceras (*Ormoceras*) sp. indet.

Pl. XVIII., Fig. 12; Pl. XIX., Fig. 9.

1911. *Actinoceras* (*Ormoceras*) aff. *tenuifilum* CRICK: Notes on Some Specimens of Straight-shelled Nautiloidea collected by the Rev. S. COULING. Geol. Mag. Dec. IV., vol. X., p. 481, pl. XXII., fig. C.

Shell straight, large, cylindrical; circular? or oblong? in cross section; 34 mm. in diameter. Septa numerous, moderately concave; 6 mm. apart. Siphuncle submarginal, 10 mm. in diameter, swelling moderately between septa; internal deposit very thick (3-4 mm.), leaving a space at most 2.5 mm. wide for somewhat irregularly annulated endosiphuncle and with extremely narrow tubuli radiating from the annuli.

This species is represented by a very fragmental specimen, the surface of which is also much eroded; however, judging from the small portion of the

1) BARRANDE: Système silurian. Vol. II., p. 525, pl. CIX., figs. 11-16; pl. CCVII., figs. 1-5; pl. CCVIII., figs. 10-16.

surface of the test preserved, it certainly had neither annular nor longitudinal sculpture of any kind, except at most fine lines of growth. On account of its peculiar nummuloidal siphuncle, it is referred to the genus *Actinoceras* (*Ormoceras*).

G. C. CRICK reported the occurrence of an *Actinoceras* nearly allied to *Ormoceras tenuifilum* HALL¹⁾ in Shan-tung; the latter is a species common in the Ordovician Black River limestone of New York State. The Chinese specimens, the present one as well as that figured by CRICK, are apparently provided with a narrower siphuncle than the American form, whereas the former two resemble each other very closely not only in this feature, but in all other features. It is very probable that the present specimen is specifically identical with the one from Shan-tung.

A. richthofeni FRECH²⁾ from Liau-tung and Korea is a more conical shell, rapidly enlarging anteriorly; its nummuloidal siphuncle is broader than that of the present species.

Locality :—Pan-tse-ya, Hu-hsi, Hsing-shan-hsien, prov. Hu-pei (NODA Coll. No. 102).

Trocholitidæ.

Discoceras, BARRANDE.

Discoceras eurasiaticum FRECH.

Pl. XVIII., Figs. 2a-b.

1911. *Discoceras eurasiaticum* FRECH : in RICHTHOFEN's China vol. V., p. 5, pl. I., figs. 1a-2b.

- 1) J. HALL: Palaeontology of New York, vol. I., p. 55, pl. XV., fig. 1; pl. XVI., fig. 1; pl. XVII., fig. 1. Grabau and Shimer: North American Index Fossils, Invertebrata. Vol. II., p. XVII., 115, fig. 1351.
- 2) FRECH: in RICHTHOFEN's China vol. V., p. 8, pl. II., fig. 4. This species was first established by FRECH on the specimens from Hsiau-örrh, Liau-tung. The G. I. S. Collection contains many specimens of this species, which were collected by myself from Kwa-sen-do, Ko-to-gun, Hei-an-nan-dô, Korea (江東郡貨泉洞).

Shell flat, discoidal, composed of very slowly growing whorls in contact and slightly impressed; whorls subquadrate in cross section, broader than high and external side slightly longer than the internal. Siphuncle internal. Surface costated; costae very numerous, sharp, almost twice as far as their own breadth, bending obliquely backward on the side and forming a deep and broad hyponomic sinus on the external side.

Dimensions :

Diameter of shell	...	...	...	...	...	...	80 mm.
Diameter of shell (the last 1/4 volution being omitted; this applies also to the following measurement)	...	...	...	...	...	...	70
Breadth of whorl	...	...	...	...	...	...	22
Height of whorl	...	...	...	...	...	...	17
Width of umbilicus...	...	...	...	...	...	...	37

Concerning this species FRECH makes the following remark :

“Die Art ist zunächst mit *Discoceras antiquissimum* F. ROEMER sp. non auct. verwandt und unterscheidet sich von ihr :

1. Durch evolutere Form und geringere Breite der Umgänge
2. Durch sehr viel kräftigere und regelmässigere Anwachsstreifen.

Die Zwischenräume zwischen den Anwachsstreifen sind bei *D. eurasiaticum* mehr als doppelt so breit als bei *D. antiquissimum*.

Die starke Zurückbiegung der Anwachsstreifen, die Lage des Siphos auf der Innenkante der Windungen, die lange fast einen Umgang einnehmende Wohnkammer sind übereinstimmend. Die kräftig ausgebildete Sculpture beginnt auf dem zweiten Umgang (von innen gerechnet); der erste Umgang ist bei beiden Arten mit sehr feinen Anwachsstreifen versehen.

In der Windungsform ist *D. teres* EICHWALD der neuen Art ähnlich, jedoch liegt der Siphos subcentral und ist nur der Innenseite etwas genähert.”

The second Chinese species, *D. verbecki* FRECH, is easily distinguished from the present species by the whorls, which are oblong in cross section.

Locality :—No-lu-ping, Tung-hu-hsien, prov. Hu-pei (USUI Coll.).

Discoeceras sp. indet.

Pl. XIX., Fig. 5 ; Pl. XXVII., Fig. 6.

The figure shows another species of the same genus which is distinguished from *D. curasiaticum* by its relatively wider umbilicus, oblong whorls, and considerably weaker surface sculpture ; the first and third features distinguish it also from *D. verbeeki*. Too imperfect for further specific identification.

Locality :—No-lu-ping, Tung-hu-hsien, prov. Hu-pei (USUI Coll.)

Lituitidæ.

Lituities, BREYN.

Lituities (Ancistroceras) angelini BOLL.

Pl. XXVII., Figs. 4a-b.

1911. *Lituities (Ancistroceras) angelini* FRECH : in RICHTHOFEN'S China, vol. V., p. 5.

Shell cylindro-conical, measuring 76 mm. in length, 21 mm. and 10 mm. in the diameter of the larger and smaller ends ; circular in cross section. Septa concave, about 5 mm. apart ; siphuncle very narrow, subcentral. Septal neck well developed, about as long as half the septal distance. Surface with numerous very fine striae showing the undulation characteristic of the shell of *Lituities*.

I was not able to obtain from any library in Japan BELL'S and REMELE'S papers with the description of this species : hence, in the specific identification of this specimen, I simply follow FRECH who gives the following account of it.

“ Ein Bruchstück von I-chang, das man auf den ersten Blick für ein *Orthoceras* halten würde, zeigt auf der Aussenseite die bezeichnende Skulptur

und bei dem Längsschnitt durch den centralen Siphon gut ausgeprägten Siphonaldüten.

REMELE hat in der genannten Arbeit zwei Varietäten von *Lituites angelini* var. *virgata* und var. *lineata* unterschieden. Bei dem chinesischen Exemplar konnte nur die Zugehörigkeit zu der bezeichnenden Hauptart festgestellt werden."

Locality :—No-lu-ping, Tung-hu-hsien, prov. Hu-pei (USUI Coll.).

Trilobita.

Asaphidæ.

Isotelus, DEKAY.

Isotelus usui YABE sp. nov.

Pl. XVIII., Fig. 9; Pl. XIX., Fig. 8.

1911. *Isotelus* sp. FRECH : in RICHTHOFEN's China, vol. v., p. 3.

Cephalon parabolic, about $\frac{2}{3}$ as long as wide, pointed in front, and prolonged behind in genal spine; convex. Glabella hardly defined from the remaining part of the cranidium, with very faint trace of almost parallel dorsal furrows at base, as wide apart as $\frac{1}{4}$ the width of the cephalon. Facial sutures unite at a blunt angle in front, curve first strongly outwards and then inwards to eyes, behind which they bend again sharply outwards to cut posterior margin in a very acute angle at little more than half the distance between glabella and genal angles. Free cheek trigonal; genal spine slender, slightly curved and directed backward; as long as 4 thoracic segments. Eye lobe moderate in size.

Thorax with 8 segments preserved; axial lobe cylindrical, as wide as the pleurae. Pleurae consist of inner horizontal straight portion and outer curved portion which bends downward and slightly backward; rounded at the extremity; and provided with a broad strong furrow.

Dimensions :—Cephalon (measured along the chord) 23 mm. wide and 15 mm. long; thorax 32 mm. wide and 14 mm. long.

The single specimen at hand somewhat resembles *I. maximus* LOCKE from the Ordovician of the United States of America. As the latter is now considered to represent only a stage in the development of *Isotelus gigas* DEKAY without genal spine,¹⁾ it is only provisional that I establish a new species on the present specimen.

Locality :—No-lu-ping, Tung-hu-hsien, prov. Hu-pei (USUI Coll.).

Illænidæ.

Illaenus, DALMAN.

Illaenus sinensis YABE sp. nov.

Pl. XVIII., Fig. 10.

1911. *Illaenus* sp. FRECH : in RICHTHOFEN'S China, vol. V., p. 3.

Cephalon semielliptical, nearly twice as broad as long; smooth all around convex, with the anterior portion strongly bent down almost to the right angle, and the lateral sides more gently sloping to the margin. Posterior margin of the cephalon slightly concave in outline. Glabella with independent convexity, and well vaulted at the basal portion; occupies nearly the middle third of the cephalon and extends less than half its length. Axial furrows well marked, subparallel, first slightly converging toward the anterior end where they curve outward. Fixed cheek with the base nearly as wide as the glabella, palpebral lobe but slightly elevated, rather large in size and relatively close to the posterior margin of the cephalon. Eyes rather large in size. Posterior branch of the facial suture very oblique; anterior branch? Free cheeks considerably broader than the fixed cheek and genal angle well rounded; posterior and interior borders of the cephalon meeting at the genal angle in an angle of about 65°. Inferior border of the cephalon lies almost in a plane. Surface bears numerous fine terrace-lines.

1) GRABAU and SHIMER: North American Index Fossils, Invertebrates. Vol. II. 1910. p. 94.

2) G. HOLM: Illaeniden. In FR. SCHMIDT'S Revision der ostbaltischen Silurischen Triobiten. Mém. l'Acad. Imp. Sci. St.-Petersbourg, VII. Ser., Tome XXXIII. 1886. p. 87, pl. II., figs.

Thorax, with 10 segments preserved, little longer than the cephalon. Axial lobe about $\frac{2}{3}$ of the whole breadth near the anterior border, gradually becoming narrower toward the pygidium; pleurae, convex with inner portion straight, and the outer portion bent downward. Inner portion of the pleurae almost half as long as the outer in the first segment, and nearly equal in the last.

Pygidium unknown.

Dimensions :—

Cephalon 29 mm. broad, measured along the chord.

15 mm. long in projection.

Glabella 11 mm. broad at the base measured along the chord.

Eyes 19 mm. apart, measured along the chord.

4.5 mm. distant from the dorsal furrow in projection.

2 mm. distant from the posterior border of the cephalon, in projection.

Thorax 16 mm. long in projection.

30 mm. broad measured along the chord.

Axial lobe of the first segment 11 mm. broad, in projection.

Axial lobe of the last segment 8 mm. broad, in projection.

This species resembles *I. revaliensis* HOLM. from the *Vaginoceras* limestone of the Baltic province; the latter is characterised by having a semicircular cephalon, of which the free cheeks are more prolonged to the genal angle than in the present species,

Locality :—No-lu-ping, Tung-hu-hsien, prov. Hu-pei (USUI Coll.)

Brachiopoda.

(By I. HAYASAKA.)

Strophomenidæ.

Triplecia, HALL.

Triplecia poloi MARTELLI sp.

Pl. XXII., Figs. 1-5.

1901. *Schizophoria poloi*, MARTELLI :—Fossili del Siluriano Inferiore dello schensi (Cina). Boll. della Soc. Geol. Ital., p. 302, pl. IV., figs. 17-22.

1901. *Porambonites intercedens*, MARTELLI (non PANDER):—Ditto, p. 304. pl. IV., figs. 13-16.

1913. *Spirifer (Martinia) poloi*, PELLIZZARI:—Fossili Paleozoici Antichi dello Scensi (Cina). Rivista Ital. di Paleontologia, vol. XIX., p. 45. pl. I., figs. 8-10.

1913. *Triplecia poloi*, WELLER:—A Report on Ordovician Fossils collected in Eastern Asia in 1903-04. Research in China, vol. III., p. 281. pl. 25, figs. 7-9.

This species was first recorded by MARTELLI in 1901, from Lean-shan in the Tsin-ling mountains. The second material was also collected at the same locality, and was examined by PELLIZZARI. In the province of Sze-chuan the same species was gathered by the CARNEGIE expedition two or three years later, a description of it having appeared quite recently. Almost at the same time as this third discovery, Prof. K. YAMADA of the Kyoto Imperial University obtained several exceedingly well preserved examples of the species in the neighbourhood of I-chang-fu, in the province of Hu-pei. It is this material from Hu-pei that the writer is about to describe.

The species was first introduced by MARTELLI as belonging to the genus *Schizophoria*. According to PELLIZZARI, however, this species is by no means a *Schizophoria*, because there are hardly any smooth form in the genus *Orthis*, and besides, he believes he has found the characteristics of a *Spirifer* in the dental apparatus. Thus, he says, "e ciò tanto per le robuste lamine dentarie della grande valva, quanto per l'apparato di sostegno del lofoforo nella valva dorsale." In his plate is figured a specimen that has its dorsal valve polished away at its visceral portion (pl. I., fig. 9). The present writer is not certain whether the section of the spirals is represented on the cut end of the shell. Neither is anything said about this by PELLIZZARI. One of the Hu-pei specimens was prepared by the writer for the purpose. Its dorsal valve was transversely polished so as to reveal the interior of the visceral portion (fig. 4). On the polished surface nothing but two short, somewhat divergent dental plates are shown, and there is no trace of spirals recognizable. Besides, the mesial fold of the shell is so very conspicuous that no *Martinia* seems to be comparable with it.

The present writer does not, however, agree with MARTELLI in placing it in the genus *Schizophoria*. In the genus *Orthis* "la rarità di forme lisce, prive di ornamentazione radiale," as PELLIZZALI observes, is really the case. Or rather, no smooth form can be regarded as an *Orthis*. Thus it seems most reasonable to regard the fossil as a *Triplecia*, as was done by WELLER in his report above mentioned. Of course a *Triplecia* may possess fine radial striae: for HALL says, "Surface with obscure concentric growth-lines, and fine radiating striae on the inner laminae; in rare instances there are radiating lines on the exterior."¹⁾ Yet it is certain that the fossil is neither an *Orthis* nor a *Schizophoria*.

Then *Triplecia poloi* from Hu-pei may be described somewhat in the following manner.

The shell is composed of two valves of unequal convexity, and is remarkably wider than long. In the anterior portion it is somewhat trilobate, the mesial fold being very conspicuous there. The hinge-line is quite straight, but rather short, being about one half of the greatest width of the shell in the majority of the specimens. It is, however, by no means constant, and in some of the examples it occupies about $\frac{2}{3}$ of the maximum breadth of the shell. The ventral valve is shallow, convex about the beak, but very strongly depressed by the development of a wide and deep mesial sinus in the anterior margin. The width of the sinus along the front margin is about $\frac{1}{3}$ of the entire antero-lateral margin of the shell. The area is low but very distinctly realized, with a delthyrium in the middle, which is covered by a slightly convex deltidial plate probably with a foramen. The beak is somewhat attenuated and slightly overhangs the cardinal area. The dorsal valve is by far the more convex and especially the median part of the visceral portion is almost hemispherically gibbous, the gibbosity extending to the anterior margin, so as to correspond to the sinus on the opposite valve. The beak is less pointed than in the ventral valve and is less overhanging too. The area also is consequently lower. Interiorly there are dental lamellae or plates that are rather short and somewhat diverging. On the surface of both the valves hardly any trace of radial striae is visible, although a number of concentric growth lines are developed, except in the marginal portion of the shell.

1) HALL:—Nat. Hist. New York. Palaeontology, vol. VIII., pt. I., p. 270, 1892.

Dimensions :—

Length.	Width.	Thickness or Depth.	Hinge-line.
19 mm.	26 mm.	14 mm.	17 mm.
20 mm.	27 mm.	17 mm.	13 mm.
21 mm.	27 mm.	15 mm.	13 mm.
22 mm.	27 mm.	14 mm.	12 mm.
23 mm.	28 mm.	17 mm.	13 mm.
23 mm. +	32 mm.	18 mm.	15 mm.

Remarks :—There seems to be a somewhat wide range of variation in the relative length of the hinge-line, but in all other points the shells possess relative dimensions quite similar to those of specimens from the other localities. However, the forms reported by WELLER do not seem sufficiently well preserved to be taken into comparison.

There is a species of the genus made known to science from the Central Himalaya by COWPER REED, namely *Triplecia uncata* SALTER sp. It was originally described from the Northern Himalaya as *Orthis uncata* by the latter author, but is now referred to HALL's genus by REED on reasonable grounds. From this Hu-pei form is distinguished by several remarkable differences. The former is much less transverse in outline, or rather circular, with a median sinual depression on the ventral valve which is traceable very close to the beak region. REED observes, "The fine radial striæ described by SALTER are not usually visible on the outer surface, but are in some cases traceable on the inner laminæ.¹⁾" The reason why radial striæ, though faint, are drawn in the figures given by him is thus made clear.

WELLER includes in the species now under consideration another form from Lean-shan, *Porambonites intercedens* MARTELLI (non PANDER). An examination of some figures of the latter species, as for instance, those given by DAVIDSON,²⁾ inclines the present writer also to agree with the American paleontologist. The difference in form of the two fossils, one of MARTELLI and the other of PANDER, is too conspicuous to be disregarded. The fine

1) C. REED:—Ordovic. and Silur. Fossils from the Central Himalayas. Palaeontologia Indica, XV., vol. VII., 2. p. 30. 1912.

2) T. DAVIDSON:—Monogr. Brit. Fossil Brach., III., p. 195. pl. XXV., etc. 1864—71.

radial striæ on the surface of the valves of *Porambonites intercedens* MARTELLI may make one hesitate to identify it with the same author's *Triplecia poloi*. Yet these radial striæ may be ascribed to the state of preservation, because the shell possesses radial striæ on the inner laminæ as explained above. The rare cases in which fine radial striæ occur, as remarked by HALL, also may be made clear by the method of speculation suggested by REED.

Localities :—1) Lo-ling-po near No-lu-ping, Tung-hu-hsien, I-chang-fu, prov. Hupei ; 2) Kao-huang-ling, Hsing-shan-hsien, I-chang-fu, prov. Hu-pei.

Geological Age :—Ordovician. This species ought to be regarded as an indicative of the Ordovician Formation in Eastern Asia.

Plectambonites, PANDER.

Plectambonites cf. sericeus Sow.

Pl. XXII., Figs. 6 and 7.

- 1839. *Leptaena sericea*, MURCHISON :—The Silurian System, pt. II., p. 636. pl. 19, fig. 1.
- 1839. *Leptaena sericea* var. MURCHISON :—ditto, fig. 2.
- 1847. *Leptaena sericea*, HALL :—Nat. Hist. New York, Palaeontology, vol. I., p. 110. pl. XXXI., fig. 2 ; p. 287. pl. LXXIX., fig. 3.
- 1851. *Leptaena sericea*, HALL :—ditto, vol. II., p. 59. pl. XXI., fig. 1.
- 1864. *Leptaena sericea*, DAVIDSON :—Monogr. Brit. Sil. Brach., p. 323. pl. XIVIII., figs. 10-19.
- 1883. *Leptaena sericea*, KAYSER :—Von Richthohen's China, vol. IV., p. 41. pl. III., fig. 8.
- 1892. *Plectambonites sericea*, HALL :—Nat. Hist. New York, Palaeontology, vol. VIII., pt. I., pl. XV., fig. 26.
- 1906. *Plectambonites sericea*, LORENZ :—Beitr. z. Geol. u. Palaeont, v. Ostasien unter besoder. Berücksicht. d. Prov. Schantung. Z. d. d. g. G., LVIII., p. 96. pl. VI., figs. 9, 10.
- 1909. *Plectambonites seriseus*, GRABAU and SHIMER :—N. American Index Fossils, vol. I., p. 227, fig. 274.

This is a species rather widely distributed in the northern hemisphere ; the record of its occurrence in the other half of the globe is not at present accessible to the writer. According to DAVIDSON " It has been found in Russia, Estonia, Bohemia, Norway, Spain, the island of Anticosti, Canada West, the United States, etc." It has also been described from Canada East¹⁾ and Sweden.¹⁾ Its first discovery in Eastern Asia took place only very recently, when LORENZ was making a research in the province of Shan-tung. Although he does not give any verbal explication of the species from Shan-tung, his identification is acceptable. He, instead of describing it, gave pictures of the specimens from Europe and America with which the Chinese examples was compared.

The writer is now to make known the second locality of the species in China, where it was collected together with several other fossils by Mr. S. NODA of the Imperial Geological Survey of our country. There are several examples of the species at hand that are all very firmly imbedded in a piece of brownish crystalline limestone. It is impossible to take a specimen out of the mother rock, and consequently the detection of the minute characteristics of the specimens is not very easy. Moreover, the fine surface sculpture is only recognizable with the aid of a magnifier of somewhat strong power ; for the limestone, being rather coarsely crystalline, is traversed by many small fractures due to the aggregation of small grains.

The specimens from the province of Hu-pei that are to be described now are characterized by a convexity of the ventral valve along the median lines, so that they are best compared with such figures as those of *Leptaena sericea* var. of MURCHISON, and figure 10 of DAVISON. If, therefore, the outline of the shell were much less transverse, or rather longer than wide, this fossil might have been named *Leptaena alternata* or *deltoides*; only the size is too small.

The shell is small and transversely semicircular in outline, the hinge-line representing the greatest breadth of the shell, and extending a little beyond the sides of the latter. Cardinal extremities, angular or pointed, but sometimes also slightly rounded. Ventral valve, convex, especially so in the

1) BIGSBY:—Thesaurus siluricus, p 96. 1868.

center ; along the median line the shell is somewhat more remarkably folded. This median fold ends in a beak, small and pointed, but projecting only a very little beyond the hinge-line. Dorsal valve lacking. The surface of the shell is decorated with very fine radial striae that look like bundles of silk. At regular intervals there are much coarser striae among them ; these are also visible to the naked eye. The striae, both fine and coarse, increase in number anteriorly. There are several stages intermediate between the stronger striae observable without the aid of a magnifying glass ; for they come into existence at various distances from the beak, in accordance with the growth of the shell. The silky striae or radii are granulate and intercrossed by equally minute concentric lines which may be called growth lines.

Dimensions :—

Length.	Width.	Thickness.
9 mm.	14 mm.	3 mm.
11 mm.	15 mm.	?

Remarks :—In the present fossils the beak is very small, only very slightly projecting, and the punctures on the surface of the shell are extremely minute. The form also is more transverse than *Plec. transversalis*, for DAVIDSON gives, for instance, as the proportion of the length, width and depth 9, 11, 1. The shell is rather more flattened than in the latter species. According to DAVIDSON the chief distinction between these two very resemblant species lies in the difference of the shape of the muscular impressions. He says that they are expanded and flattened in *Plec. sericea* while they are convex in the other. This difference, however, has not been detected in the Chinese examples. As far, however, as the specimens accessible are concerned, the present fossil most resembles the species *Plec. sericea*, although there are several allied forms of the genus known. Even among a number of species of the group illustrated by BARRANDE¹⁾ the most resemblant is nothing but his *Leptaena transversalis*, which, however, is less allied to the Chinese fossil than *Plec. sericea* is.

Locality :—Kao-huang-ling, Hsing-shan-hsien, I-chang-fu, prov. Hu-peí. In association with *Triplecia poloi* and several other brachiopods of which the determination is not possible.

Geological Age :—This species has been discovered in both the Ordovician and the Gotlandian formations. According to BIGSBY's catalogue, however, it seems to have been found most abundantly in the "Lower stage" of the Silurian formation; it is rarest in the "Upper stage." From the associate fossil the Chinese example cannot but represent the Ordovician Age.

Clitambonitidæ.

Orthisina, D'ORBIGNY.

Orthisina cfr. *hemipronites* (v. BUCH) FRECH.

Pl. XXII., Fig. 8.

1911. *Orthisina* cf. *hemipronites*, FRECH:—VON RICHTHOFEN'S China, vol. V., p. 3.

The material of the fossil here examined is a specimen which has already been mentioned though rather casually by FRECH in his work above quoted, by the way of an addendum to the description of *Orthisina squamata* v. PAHLEN. All that he says about this fossil is, "Eine andere *Orthisina* (*O.* cf. *hemipronites*) lag mir von I-chou-fu,¹⁾ Provinz Hupei, vor, wo sie mit *Iliaenus* und *Isotelus* sp. zusammen vorkommen."

The writer, not being able to refer to any of the pictures of the species by VON BUCH, cannot but follow FRECH in calling the fossil by the name assigned to it by him. But it may be described here in the following way, so that anybody who is able to compare this and the Russian form may find what are the real relations between them.

The shell is subequally biconvex, the ventral valve being shallower than the dorsal. The former is rather evenly convex, though somewhat flattened in the middle of the anterior margin. Consequently the ventral view of the shell is somewhat quadrate, partly owing of course to its having lost the umbonal prolongation of the valve. On the contrary, the dorsal valve is much more strongly gibbous rising quite abruptly above the auricular portion, so that the shell does not look so quadrate in the dorsal, as in the ventral view.

1) I-chou-fu (宜昌府) FRECH's mispronunciation of I-chang-fu.

The hinge-line is straight and the beaks of neither of the valves overhang it. There seems to have been a pretty large area under the beak of the ventral valve, although it is not clear now, because of its having had the beak broken away. The beak of the dorsal valve is far less prominent, and consequently has a very low area. The anterior margin of the shell fluctuates slightly in correspondence with the very slight sinual depression of the ventral valve. The whole surface of the two valves is ornamented with fine radial striae that increase in number anteriorly by means of division or dichotomy. They are separated from each other by spaces of about the same width as the striae themselves. About four of the striae occupy a space of 2 mm. along the anterior border. Beside these radial thread-like striae there are concentric larger ones that are especially eminent in the marginal portion of the shell. They look like concentric but somewhat irregular ridges.

Dimensions :—

Length.	Width.	Thickness.	Hinge-line.
ca. 32 mm.	35 mm.	20 mm.	26 mm.

Remarks :—In general outline this fossil resembles the Gotlandian form *Orthis rustica* Sow.¹⁾ But the latter possesses coarse concentric ribs on the surface of the shell instead of fine striae. Besides, its gibbosity is also inferior to that of the present fossil. The median sinual flattening, too, is much better developed in *Orthis rustica* than in the Chinese species.

By having two convex valves, the Chinese brachiopod is easily distinguished from *Orthisina ascendens* PANDER,²⁾ which has features resembling the former, but with a slightly concave dorsal valve.

Locality :—Lo-ling-po near No-lu-ping, Tung-hu-hsien, I-chang-fu, prov. Hu-pei.

Geological Age :—If this is really an *Orthisina hemipronites* v. BUCH, then it represents the Ordovician age. The specimen was collected by Prof. K. YAMADA in association with *Triplecia poloi* and *Plectambonites* cfr. *sericeus*.

1) DAVIDSON:—Monogr. Brit. Foss. Brach., III., pl. XXXIV., figs. 13-22.

2) DAVIDSON:—Monogr. Brit. Foss. Brach., V., pl. XVI., figs. 16-18.

CHAPTER III.

Geology of the District along the Middle Course of the Yang-tse-kiang.

The district lying along the middle course (I-chang to Kui-chou) of the Yang-tse-kiang has invited attention of many geologists of different nationalities; the stratigraphy of the rocks exposed there is variously interpreted by them, and there prevails a great diversity of opinion on certain important points.

According to WILLIS and BLACKWELDER, the Ki-sin-ling limestone, already referred to above, is the representative of the Cambro-Ordovician Sinian formation in the said district.¹⁾ They found no fossils in the limestone in situ; but based on the fossils (*Obolus asiatica*) found in the pebbles picked up on a river bar of the Nan-kiang,²⁾ near Chön-ping-hsien,³⁾ prov. Shen-si, they believed the lower part of the limestone to be almost equivalent to the basal part of the Kiu-lung group of Shan-tung. The upper part of the Ki-sin-ling limestone shows, on the other hand, a transition to overlying Sin-tan shale, the transitional beds being composed of interbedded shale, and limestone, and yielding the Middle Ordovician fossils at Su-kia-pu, as stated above.

“In the transition with the underlying Ki-sin-ling (Sinian) limestone, the shale (Sin-tan shale) lies directly upon an even and unweathered surface of the limestone as if in conformable relation. Where the limestone lies overturned upon the Sin-tan,⁴⁾ on the south side of the Ki-sin-ling, the transition between the formations was noted particularly, the layers of shale including seams of limestone which become more abundant and pass quickly into massive dark limestone with local shaly partings. Wherever observed, the contact with the overlying Wu-shan⁵⁾ (Carboniferous) limestone presented

1) Research in China, p. 269. I., 1.

2) Nan-kiang = 南江

3) Chön-ping-hsien = 鎮平縣

4) Sin-tan = 新灘

5) Wu-shan = 巫山

an appearance of conformable bedding. Both the upper and lower limits of the Sin-tan are, therefore, regarded as conformable contacts."

The green and variegated shales of the Sin-tan have as yet yielded no fossils, but a small collection was obtained from the gray limestone which might be considered as occurring in the top of the Sin-tan or at the base of the Wu-shan, in an exposure at the upper end of the chasm, immediately north of Tung-kuan-kou¹⁾ and south of Ta-miau-ssi.²⁾

"From this material DR. GIRTY has identified the following:

<i>Fistulipora willisiana</i> GIRTY	<i>Schuchertella</i> (?) sp.
<i>F.</i> sp.	<i>Spirifer</i> (?) sp.
<i>Leioclema</i> sp.	<i>Rhynchonella</i> (?) sp.
<i>Taeniodictya</i> (?) sp.	<i>Proetus</i> (?) sp.
<i>Fenestella</i> (?) sp.	Fish plate (?)
<i>Dalmanella</i> (?) sp.	Crinoidal fragments.

"The evidence furnished by this fauna is not conclusive. The bryozoans are considered by ULRICH and BASSLER as of Lower Carboniferous (Mississippian) age. The associated forms, however, are not entirely consonant and suggest to GIRTY an earlier period—Devonian or possibly Silurian. . . . In the Wu-shan limestone at Tung-kuan-kou, 360 m. above this horizon and in the immediate vicinity, Upper Carboniferous (Pennsylvanian) forms were collected. Furthermore, fossils obtained on the Ta-ning-ho, from the basal layers of the Wu-shan, are also of Upper Carboniferous age, and it is therefore probable that no part of the great limestone can be assigned to the Lower Carboniferous. We thus have no more than a few feet of shale between a definite Upper Carboniferous horizon and a doubtful one, which is either Lower Carboniferous or earlier. We do not think it can be much earlier and therefore assign it, and with it the passage from Sin-tan shale to Wu-shan limestone, to the Lower Carboniferous. As the Middle Ordovician fauna collected at Sü-kia-pa is close to the transition zone from the Ki-sin-ling limestone to the Sin-tan shale, that is, near the base of the shale, it is evident

1) Tung-kuan-kou } Chinese characters unknown.
2) Ta-miau ssi }

that the Sin-tan formation, 540 m. thick, represents Silurian and Devonian time in this region.¹⁾”

The generalized section of formations in eastern Sze-chuan and middle Yang-tse gorges given by WILLIS and BLACKWELDER is as follows²⁾ :—

Permo-mesozoic	Kui-cho ³⁾ series	300 + m.	Sandstone, shales and sandy shales, with thin limestones and coal seams.
		45 m.	Gray fossiliferous limestone.
		120 m.	Massive red shale.
(Unconformity—inferred)			
Upper Carboniferous	Wu-shan limestone	900 m.	Massive, thick bedded limestone of gray, brown, or black colour, locally flinty.
		60 m.	Local green shale and thin limestone.
		165 ± m.	Dark bituminous limestone locally rich in flint nodules.
		15 ± m.	Local quartzitic sandstone.
		60 ± m.	Dark limestone.
(Local unconformity ?)			
Middle Palaeozoic	Sin-tan shale	350 m.	Massive green shale with thin local quartzite and crystalline limestone; shales often brown or black in upper horizons.
Sinian (Cambro-Ordovician.)	Transition		Sü-kia-pa transition member; green shale and thin limestone.
	Ki-sin-ling limestone	1200 ? m.	Dense gray limestone without flint nodules; massive, thick bedded. Basal layers locally cherty.
		75 m.	Dense slaty limestone and shale and thin basal conglomerate.

1) Research in China, vol. I, 1, p. 273.

2) Research in China, vol. I, 1, p. 264.

3) Kui-cho=歸州

Sinian Cambro- ordovician.	(Unconformity)		
	Nan-tou ¹⁾ tillite	65 m.	Glacial till; lower 30 m. not ob- served.
		45 m.	Conglomerate, arkose sadstone.
Algonkian ?	(Unconformity)		
	Huang-ling ²⁾ gneiss		Gneissoid quartz diorite. Gneiss and diorite.

S. NODA³⁾ recognised, on the other hand, the following order of rock-succession, in the same district, which is essentially similar to but not quite identical with that proposed by WILLIS and BLACKWELDER :

Mesozoic :

Hsing-shan ⁴⁾ red sandstone series		} = Kui-cho series.
Hsiang-chi ⁵⁾ coal bearing sandstone series	500 m.	
(Jurassic).		
Yeh-tan ⁶⁾ variegated slate series	100 m.	} = Kui-cho series.
(Triassic).		

Palaeozoic :

Mi-tsang ⁷⁾ limestone series	1150 m.	} = Wu-shan limestone.
(Permocarboniferous).		
Upper Clayslate series	300 m.	} = Sin-tan shale + transition beds.
a. Thin slate		
b. Thin marl layer (Ordovician)		
c. Thick shale.		
Ping-shan ⁸⁾ limestone series	400 m.	} = Ki-sin-ling limestone.
Lower Clayslate series	150 m.	
Niu-kan ⁹⁾ limestone series	300 m.	

1) Nan-tou = 南沱

2) Huang-ling = 皇陵

3) NODA: Geology of the Northwestern Part of Hu-peh-sheng (Japanese, with English Résumé). Bull. Imp. Geol. Surv. Japan, vol. XXV., No. 1, 1915. Also this reports, vol. II. p. 462 et seq.

4) Hsing-shan = 興山

5) Hsiang-chi = 香溪

6) Yeh-tan = 淺灘

7) Mi-tsang = 米倉

8) Ping-shan = 平善

9) Niu-kan = 牛肝

Nan-tou sandstone series 200 m. = Nantou-tillite.
Precambrian.

Gneiss and crystalline schists } = Huang-ling gneiss.

It is almost certain that the Ping-shan limestone series of NODA, together with the underlying Lower Clayslate and Niu-kan limestone series, corresponds to the Ki-sin-ling limestone of WILLIS and BLACKWELDER; as NODA found *Coscinocyathus* cf. *cancellatus* BORNEMANN in the Ping-shan limestone series¹⁾ (in a horizon but little above the Lower Clayslate series, and hence some 450 m. above the very base of the Ki-sin-ling limestone), the Cambrian age of the greater part of the Ki-sin-ling limestone became confirmed on fossil evidence. It is a question, however, whether the Nan-tou tillite—that ancient boulder clay deposit of glacial origin—is really of the Lower Cambrian age, as assumed by WILLIS and BLACKWELDER.

BLACKWELDER and WILLIS believed the early Cambrian age of the Nan-tou tillite on account of 1) “that it lies at the base of the Cambro Ordovician limestone,²⁾” and 2) that “the tillite passes into a greenish shale, consisting of the same materials, including characteristic pebbles, all rearranged by water, and this shale conglomerate grades into the overlying limestone.³⁾”

WILLIS, further, sought a support of his view of Cambrian glaciation in the Lower Cambrian Man-to shale of Shan-tung; this red formation, according to him, is composed of the end product of mechanical and chemical rock decay under special climatic condition favourable to oxidation, the persistence of the red colour in the formation showing that organic substances were not present in quantity, and the absence or poorness of organism in the shore of the Man-to sea indicating the low temperature of that time.⁴⁾

It must not be forgotten that there is another possibility in this connection; namely, the Nan-tou tillite may be older than Lower Cambrian. I get this impression, first because the Cambrian (if not surely Lower Cambrian) fossil was found in a very high horizon of the Ki-sin-ling limestone, as pointed out

1) See this paper p. 20.

2) Research in China, vol. I., 1, p. 269.

3) Research in China, vol. II., p. 39.

4) Research in China, vol. II., pp. 38-40.

above and second, on the following stratigraphical account given by BLACKWELDER :

“Nan-tou formation is limited above by an uneven surface, upon which lies a thin sheet of conglomerate. The matrix of the conglomerate is a greenish argillaceous limestone and the pebbles are like those in the underlying tillite. The two formations are therefore related by a basal conglomerate, which the till was well calcured to furnish.¹⁾”

The true nature of a red formation such as Manto shale is a subject to be variously interpreted; at least, it is to me not quite sure, that the Man-to sea was inhabited by a limited number of shore organisms owing to the cold temperature, for the equivalent red shale (with *Redlichia chinensis*) in Manchuria and Korea is found sometimes full of the tests of trilobites and brachiopods in its particular zone, which is in itself red shale and non-calcareous.

At present, we know two reported cases of Cambrian glacial deposits, one of which is Nan-tou tillite now we concern and the other the extensive tillite developed in the Adelaide district of South Australia. As to the latter, it was sometimes interpreted as of Pre-*Olenclius* age; according to NOETLING,²⁾ however, it is not quite excluded that the boundary between the tillite and the overlying Cambrian quartzite is simply deceptive, the present condition being brought to existence by a subsequent tectonic disturbance. As the Cambrian glaciation is thus yet established nowhere in the world, I feel warranted to express on behalf of safety that it is premature to assign Lower Cambrian age to the Nan-tou tillite.

The b. marl layer in the Upper Clayslate series of NODA contains the fossils described above at Pan-tse-ya (Hu-hsi) and Kao-huang-ling, which indicate without doubt the Upper Ordovician age of the marl layer. The same bed exposed along the Yang-tse-kiang near Sin-tan did not afford any fossils to NODA; but E. C. ABENDANON³⁾ succeeded in collecting a fine lot of fossils in a limestone bed quite near the spot. This collection was studied by FRECH

1) Research in China, vol. I., 1, p. 269.

2) F. NOETLING: Ueber Glazialschichten angeblich cambrischen Alters in Süd-Australien. Geol. u. Pal. Abh., N.F., Bd. XI., 1912.

3) ABENDANON: Structural Geology of the Middle Yang-tse-kiang Gorges. Journal Geol., vol. XVI., 1908.

who found them characteristic of Upper Ordovician. About the locality, ABENDANON wrote the following lines :

“ Between the Mi-tan and Niu-kan-ma-fei or Ox-liver gorges, we find the Sin-tan area. In about the middle of this area, which is bordered on the W., S. and E. by the high gorge limestone (Wu-shan limestone) mountains, occurs the low and sharp fold of Lung-tchoe. . . . This fold which has a 45° W.-dipping and a 10° E.-dipping limb, itself dips steeply south. It exposes a reddish brown limestone, in which I found lower Silurian Nautili, and many fine and very large Orthoceratite casts. I therefore believe that this must be the same limestone as the Ki-sin-ling limestone of BLACKWELDER and WILLIS. On this limestone rests the green shale formation (Sin-tan shale) and above that the gorge limestone formation.¹⁾ ”

Although the fossiliferous rock exposed along the Yang-tse-kiang (reddish brown limestone) and that of Pan-tse-ya and Kao-huang-ling (brownish marl and dark grey marly limestone) are not lithologically identical, yet it is very probable that they are of the same stratigraphical horizon, for among a few fossils found from these places there are two important forms common to them, *Orthoceras chinense* FOORD and *Cyrtoceras (Meloceras) asiaticum* YABE. If this be true, then the fossil bed of ABENDANON does not correspond to the Ki-sin-ling limestone of WILLIS and BLACKWELDER, as suspected by ABENDANON, but is at most equivalent to the transition beds between the Ki-sin-ling limestone and the Sin-tan shale. In this connection it may be mentioned that the fossil fauna of Sü-kia-pa found in the transition beds contains *Triplecia poloi* MARTELLI, which is also known from Kao-huang-ling.

Thus at present there is no convincing evidence to show that any of the Ordovician faunas mentioned in the preceding chapter were found in the thick Ki-sin-ling limestone itself; most likely they were derived from the transition beds of WILLIS and BLACKWELDER, that is the lower part of the Upper Clayslate series of NODA. The Sin-tan shale then may be not much younger than Ordovician.

1) ABENDANON: l.c. p. 602.

It is, indeed, striking that v. RICHTHOFEN found a coral limestone just beneath the Sin-tan shale at Sin-tan, with a coral fauna which according to FRECH is decidedly of Lower Carboniferous age.¹⁾ The stratigraphical relation of this limestone to the other rocks was given by v. RICHTHOFEN in details as follows; namely going up-stream from San-to-ping²⁾ along the Yang-tse-kiang he found³⁾:

- | | | |
|---|----------|---|
| 1. Granite of San-to-ping. | | |
| 2. Dark granitic rock. | | |
| 3. Crystalline schists. | | |
| 4. Thick bedded dark sandstone. | | { (= Nan-tou sandstone series of NODA.) |
| 5. Platy limestone | 1200 ft. | { (= Niu-kan limestone of NODA). |
| 6. Thick bedded limestone of gray, yellow and black colour | 1100 ft. | |
| 7. Greenish sandstone | 30 ft. | { (?= Lower Clayslate series of NODA). |
| 8. Platy limestone, yellowish and greynish in colour. Coral limestone. | 400 ft. | { (= Ping-shan limestone series of NODA). |
| 9. Lustrous green slate, interbedded with dark reddish brown siliceous and calcareous slate | 800 ft. | { (= Upper Clayslate series of NODA). |
| 10. Thick bedded limestone | 150 ft. | { (= Mi-tsang limestone of NODA). |
| 11. Platy nodulous limestone | 1500 ft. | |
| 12. Bluish white, thin bedded limestone | 1500 ft. | |
| 13. Thick bedded limestone | | |

FRECH⁴⁾ described from a limestones (with chert), near Sin-tan,

Productus lineatus WAAG.

P. spinulo-costatus ABICH.

P. intermedius ABICH var. *sinensis* FRECH.

The limestone, according to FRECH, has the following stratigraphical relation with the other rocks:

1) FRECH: in RICHTHOFEN's China, vol. V., p. 61.

2) San-to-ping = 三斗坪

3) RICHTHOFEN: China, vol. III., pp. 106-7.

4) FRECH: in RICHTHOFEN's China, vol. V., pp. 175-177.

1. Lower Carboniferous coral limestone.
2. Sin-tan shale, probably corresponding to the Upper Carboniferous.
3. Limestone; the upper part containing chert and the above mentioned organic remains.
4. Bluff-limestone.

From this, we see :

RICHTHOFEN No. 8	=	FRECH No. 1.
9	=	2.
10	=	3.
11	=	4.

Comparing RICHTHOFEN's division with that of NODA, it is almost beyond doubt that Nos. 5-8 of the former cover the whole of the Niu-kan limestone, Lower Clayslate and Ping-shan limestone series of the latter, although it is not sure whether No. 7 of RICHTHOFEN actually coincides with the Lower Clayslate series of NODA. Likewise, that No. 9 of RICHTHOFEN exactly corresponds to the Upper Clayslate series of NODA is a matter of conjecture though it is quite unlikely that No. 8 also represents the lower part of the latter. More convincing is, then, the identity of RICHTHOFEN's No. 9 and the basal part of NODA's Mi-tsang limestone series (=WILLIS and BLACKWELDER's Wu-shan limestone), for this correlation is supported by the brachiopods studied by FRECH and cited above, and

Margaritina schwageri ZITTEL

found in a limestone picked up by NODA in a gully at Sin-tan, which he believes to have been derived from the basal part of his Mi-tsang-limestone. As the last named fossil is previously known only from the *Productus* limestones of the Salt Range and the equivalent deposits of prov. Yun-nan, the basal part of the Mi-tsang limestone can not be older than the Uppermost Carboniferous. The brachiopoda described by FRECH from RICHTHOFEN's No. 10 beds indicating the Lower Permian age, this complex is surely identical with the basal part of NODA's Mi-tsang limestone.

FRECH who simply followed to RICHTHOFEN's stratigraphical statement and found the identity of the coral fauna of Sin-tan and that of the European Lower Carboniferous was forced to attribute the Upper Carboniferous age to

the Sin-tan shale ; however, I have already brought forth the evidence for the much older age of the latter group. Where is then the position of the No. 8 coral limestone ? This is one question concerning the coral limestone which must be left for future researches in field.

Another question in connection with the coral limestone relates to its geological age. FRECH distinguished the following forms in the material collected by v. RICHTHOFEN in the said limestone along the Yang-tse-kiang immediately below Sin-tan :—

Zaphrentis delanoui M.-EDWARDS et HAIME.

Z. guerangeri M.-EDWARDS et HAIME ?

Michelinia favosa GOLDFUSS.

Battersbyia, a new species.

If these corals are correctly identified, there is no escape from the conclusion that the limestones belong to the Lower Carboniferous. As none of these fossils, however, are illustrated, we are unable to form an idea of what the corals actually are, or of the geological age of the limestones. But arguing from the fact that the Permian and Upper Carboniferous corals from Japan, Korea and China, studied by HAYASAKA and myself, are often hardly distinguishable on cursory observation from the Lower Carboniferous forms of Europe, we must constantly guard against early conclusions based on material too scanty for such palaeontological study.

The development of the Lower Carboniferous limestone with a rich brachiopoda fauna in Shan-tung was maintained by FRECH ; but I have up to the present found no evidence in support of his assertion. This I have explained in detail in another paper.¹⁾

After all, the most probable one of various conjectures formed as to the coral fauna of Sin-tan and the stratigraphical position of the coral limestone is that 1) the block of limestone with corals is perhaps derived somewhere from the upper part of the cliff and belongs to the Mi-tsang limestone, and 2) that the coral fauna is similar to, but not quite identical with that of the European

1) YABE: Is Lower Carboniferous really developed in Shan-tung, China ? Jour. Geol. Soc. Tokyo, vol. XXIII., No. 274. 1916.

Lower Carboniferous, just as in the case of the Japanese Permian coral fauna.

WILLIS-BLACKWELDER and ABENDANON agree with RICHTHOFEN in considering the limestone of the I-chang gorge to be the equivalent of that of the Mi-tsang gorge, both belonging to the Wu-shan limestone of WILLIS-BLACKWELDER (=the gorge limestone of ABENDANON). NODA, on the other hand, maintains that the limestone of the I-chang gorge is lower than that of the Mi-tsang, and corresponds to the upper part of the Ki-sin-ling limestone (=his Ping-shan limestone); this is confirmed, he insists, by the fact that his Upper Clayslate series with a fossiliferous zone is found at Huang-chia-chang, some 18 km. NE of I-chang. ABENDANON likewise rejects the view of WILLIS and BLACKWELDER that the Sin-tan shale is developed along the I-chang gorge, and assigns the limestone of the gorge to the Wu-shan limestone, but not to Ki-sing-ling limestone, as NODA does.

YAMADA first and later FUKUCHI obtained at San-yu-tung, a village near by, a very bituminous black limestone with numerous pseudo-oolites formed of *Girvanella* filaments; it was certainly derived from one of the black limestones in RICHTHOFEN's profile cited above. On a former occasion I assigned with doubt the *Girvanella* limestone to Upper Carboniferous, following WILLIS and BLACKWELDER; but we now find that the limestone must be at least as old as Ordovician, if we accept the view held by NODA. Since an apparently identical form of *Girvanella* was found forming pseudo-oolites in a limestone from Liu-chia-ho, Hsing-shan-hsien, which was collected by NODA in his Upper Clayslate, the *Girvanella* limestone from San-yu-tung, is also here referred to Ordovician, and the fossil is treated in Chapter II. of this paper.

CHAPTER IV.

Gotlandian.

We have already seen above that marine sedimentation took place uninterruptedly from the Ordovician to the Gotlandian at the south of Tsin-ling-shan, and thus the Gotlandian fossiliferous rocks are found in association with those of the Ordovician in most cases.

FRECH¹⁾ who studied the USUI Collection of fossils from Tung-hu-hsien, found in it a *Pentamerus borealis* EICHW. This species points to the Lower Gotlandian, and thus the development of the Lower Gotlandian, in intimate stratigraphical relation with the Upper Ordovician—with the characteristic fossils mentioned in the preceding chapter—becomes palaeontologically confirmed in this district.

From the district of Kiau-tschang-pa, prov, Sze-chuan, RICHTHOFEN²⁾ reported fossiliferous Ordovician-Carboniferous rocks in the following stratigraphical succession :

- f. Black and brown, very bituminous limestone—Carboniferous.
- g. Grey limestone and fragile grey marl, with *Atrypa reticularis*—Devon.
- h. Green shale, with intercalation of coralliferous limestone nodules with many brachiopods and corals.
- i. Limestone bands ; very impure, being argillaceous. Many corals.
- k. A thick complex of green shale, with a few interbedded thin limestone layers ; the limestone contains brachiopods.
- l. Limestone, intercalated with sandstone, shale, and siliceous limestone ; red limestone is characteristic. Many triobites and brachiopods.³⁾

1) FRECH: in RICHTHOFEN'S China, vol. V., pp. 14-15.

2) RICHTHOFEN: China, vol. II., Chapt. XII., pp. 596-598.

3) RICHTHOFEN found these fossiliferous deposits ranging between Ordovician and Carboniferous in age to be in a very regular succession in the Chao-tien mountains; I am, however, not quite sure whether this is really the case. It is hardly credible that there is no stratigraphical break in this section.

In the chapter on the Ordovician, I have already referred to two small faunas described by KAYSER from Kiau-tschang-pa; these are derived from horizon 1. The upper part of 1, however, being characterised by the following fossils

Orthoceras sp.

Spirifer elevatus DALM.

S. interlineatus SOW.

Rhynchonella borealis SCHL. var. *sinensis* KAYSER.

R. sp.

R. ? sp.

was believed to represent the Gotlandian age.¹⁾ G. LINDSTRÖM²⁾ who studied the Palaeozoic corals in RICHTHOFEN'S collection, found in this horizon two new species,

Ceriaster calamites LINDST.

Amplexus viduus LINDST.

The younger i and h also contain many brachiopods and corals of the Middle Gotlandian age, the former being rich in brachiopods and the latter in corals; the fossils found in these two beds are, according to KAYSER and LINDSTRÖM:

Atrypa reticularis LINN.

Meristella tumida DALM.

Strophomena shönsüenensis KAYSER

Spirifer elevatus DALM.

Orthis bouchardi DAVIDS.

Euomphalus ? sp.

Orthoceras sp.

Encrinurus sp.

Alveolites suborbicularis GOLDF.

Favosites forbesi E. H.

F. fibrosus GOLDF.

Heliolites interstinctus L.

H. decipiens MACCOY.

Plasmopora tubulata LONSD.

1) KAYSER: Mittel-und Obersilurische Versteinerungen aus dem Gebirgsland von Tschau-tien. RICHTHOFEN'S China, vol. IV., p. 37.

2) G. LINDSTRÖM: Obersilurische Korallen von Tschau-tien. Ibid. p. 50.

Halysites catenularius L.

Amplexus distans LINDST.

A. appendiculatus LINDST.

Cyathophyllum angustum LONSD.

C. ? pachyphylloides LINDST.

C. densum LINDSTR.

Ptychophyllum richthofeni LINDST.

P. cyathiforme LINDST.

Platyphyllum sinense LINDST.

Cystiphyllum cylindricum LONSD.

Further KAYSER¹⁾ found the following fossils in light coloured crystalline and oolitic limestones from Chao-tien,²⁾ also of the Middle Gotlandian age :

Spirifer elevatus DALM.

Nucleospira pisiformis HALL

Atrypa ? tshautienensis KAYSER.

Rhynchonella sp.

The Ordovician limestone of Lun-shan, near Tsin-kiang, prov. Kiang-su, is overlaid by a graptolite slate,³⁾ which according to FRECH,⁴⁾ contains

Climacograptus scalaris L.

Linograptus nilssonii BARR.

Diplograptus sp.

Retiolites ? sp.,

and represents the Lowest Gotlandian.

In western Yun-nan, Gotlandian fossiliferous strata are also found in succession to the Ordovician rocks already referred to above. According to the contribution of BROWN and REED, there are developed black fissile slates, 70 ft. thick, in Shih-tien, which contain characteristic Llandvery graptolite fauna, composed of

Monograptus lobiferus M'COY

1) RICHTHOFEN: China vol. III., p. 718.

2) Chao-tien = 朝天

3) RICHTHOFEN: China, vol. III., p. 718.

4) FRECH: Lethaea Palaeozoica, I. 1897. p. 679. FRECH in RICHTHOFEN'S China, vol. V., p. 17.

Monograptus spinigerus ?

M. becki ? BARR.

M. tenuis ? PORTL.

Retiolites perlatus NICH.

Climacograptus scalaris ? HIS.

Mesograptus modestus LAPW.

Another yellowish white, soft, sandy shale of the same locality afforded them

Monograptus sp.

Diplograptus sp. ;

these fossils also indicate the same age.¹⁾

According to DEPRAT²⁾ and MANSUY,³⁾ Gotlandian strata are developed in eastern Yun-nan and especially in the region lying between the Ki-sha-kiang and Yun-nan-fu, where they recognised the following succession of the rocks (in ascending order) :

- 5) Variegated slaty sandstone of Hoang-li-tsuen with *Orthis bourchardii* DAVIDS.
- 4) Grey sandstone without fossils.
- 3) Grey limestone without fossils.
- 2) Slaty sandstone of Ma-la-ly, with

Lingula loulanensis MANSUY

Modiomorpha lavalii MANSUY

Palaeoncolo triangularis MANSUY

Cythere sp.

Sphenophyllum indet.

- 1) The upper part of the sandstone with *Bothriolepis* ; its lower part is considered to belong to the Upper Ordovician.

Thus here we have again a case of gradual transition from the uppermost Ordovician to the Gotlandian.

1) J. C. BROWN: Contributions to the Geology of the Province of Yun-nan in western China. (I) The Bhamo-Teng-yueh Area. Rec. Geol. Surv. India, Vol. XLIII. 1913.

2) DEPRAT: Étude géologique du Yun-nan oriental. Géologie générale. 1912. pp. 65, 65. DEPRAT: Les séries stratigraphiques de l'Indochine et au Yun-nan. 1913. p. 69.

3) MANSUY: Étude géologique du Yun-nan oriental. Paléontologie. 1912. pp. 38-40.

The annexed list shows the Gotlandian fossils now at my disposal which will be treated below :

	A	B	C
1. <i>Halysites pycnoblastoides</i> ETHERIDGE	+	—	—
2. <i>Favosites gotlandicus</i> LAM.	+	—	—
3. <i>Pentamerus borealis</i> EICHW.	+	—	—
4. <i>Dalmanella aequivalvis</i> DAVIDSON	+	—	—
5. <i>Trochoceras</i> sp. undt.	—	+	—
6. <i>Orthoceras</i> sp. undt.	—	—	+
A. Lo-ling-po, near No-lu-ping, Tung-hu-hsien, prov. Hu-pei (USUI Coll.); in marly limestone of greyish colour.			
B. Huang-kuo-tsao, ¹⁾ Ta-kuan-ting, ²⁾ prov. Yun-nan (YAMADA Coll.); in a dark grey shale.			
C. Hui-lung-chi, ³⁾ Ta-kuan-ting, prov. Yun-nan (YAMADA Coll.); in a dark grey shale.			

Coelenterata.

Tabulata.

*Halysites*⁴⁾ FISCHER.

Halysites pycnoblastoides ETHERIDGE.

Pl. VII., Figs. 3a-b.

1) Huan-kuo-tsao = 黃葛槽

2) Ta-kuan-ting = 大關廳

3) Hui-lung-chi = 回龍溪

4) On the former occasion, the paper of C. REED with the important contribution on the Ordovician and Gotlandian fossils of central Himalayas (Palaeontologia Indica, Ser. XV., vol. VII., No. 2. 1912) escaped my attention to my great regret. That paper includes his descriptions of two new forms of *Halysites* from the Gotlandian rocks Hor. 6. from Kanaur, Bashahr and Spiti, which are:

Halysites catenularia var. *kanaurensis* REED

H. waltichi REED.

The former shows a corallum composed of stout flexuous laminae, markedly constricted between the successive corallites; the corallites are subcircular or subelliptical, and occasionally intercalated with interstitial tubes. Spines are not present in this form.

The second species, on the other hand, is characterized by its slender corallum, the chain of which forms a loose and open network; the corallites are subquadrate in cross section, broadly united end to end; there are neither interstitial tubes nor septal spines. This new species is, in my opinion, hardly distinguishable from *H. parallelus* from Gotland.

1904. *Halysites pycnoblastoides* R. ETHERIDGE: A Monograph of the Silurian and Devonian Corals of New South Wales. Pt. I, The Genus *Halysites*. Mem. Geol. Survey, New South Wales. Palaeontology No. 13, p. 30, pl. IV., Figs. 1, 2; pl. VIII., figs. 5, 6.
1915. *Halysites pycnoblastoides* YABE: Bemerkungen über einige Halysites-Arten p., 36 (12), pl. IX (V), figs. 3, 4.
1915. *H. pycnoblastoides* YABE and HAYASAKA: Palaeozoic Corals from Japan, Korea and China, Journ. Geol. Soc. Tokyo, vol. XXII., p. 79.

Corallum pyriform, small, 30 mm. high and 15 mm. wide: fenestrules somewhat irregularly polygonal and unequal in size; one side of the fenestrules composed of 1-11 corallites together with the corresponding number of the interstitial tubes; the average width of the fenestrules is 15 mm. Corallites oval in cross section, 1.8 × 1.5 mm. large, traversed by numerous tabulae which are complete and concave upwards; there are 8-9 tabulae in a space of 5 mm. Septal spines well developed in the corallites, always 12 in number, directed obliquely upwards; rather long, but not so long as to form a pseudocolumella at the center of the corallites. Interstitial tubes well developed, regularly intercalated between the corallites; those at the junction of three corallites are especially large, unequally six-sided, while the others are smaller, (0.5 × 0.3 mm.), rectangular and elongate at right angle to the chain of the corallites. Tabulae in the interstitial tubes horizontal, slightly less than twice as many as those in the corallites.

Obs.—The single specimen of this species at hand being a young stock, it must be expected that its fenestrules will somewhat be smaller than those of the older stocks; nevertheless the present specimen shows already very characteristic features of the fenestrules in their irregular polygonal outline and by being very variable in size.

The interstitial tubes of the specimen show a kind of small spinous processes, which are no doubt of different origin from those in the corallites.

Now comparing this specimen with those forms previously described from

the Baltic province and the British Isles in Europe, Canada and Australia, its nearest ally is found in *H. pycnoblastoides* ETHERIDGE from New South Wales, but in none of the forms from the northern Hemisphere. In fact there are certain differences between the Chinese specimen and the original of the named Australian species; thus, for instance, the corallites of the former are more rounded than those of the latter. Further, ETHERIDGE did not make mention of the obliquity of the spines in the corallites of his species; moreover, there are no traces of such spinous processes in its interstitial tubes as are seen in those of the Chinese form. Irrespective of these differences—some of which are decidedly insignificant for the specific identification and the others are those not to be taken as actual differences without further confirmation—the Chinese form is believed to be identical with the Australian species, both coinciding in all the essential points of structure.

To the same type of *Halysites* with *H. pycnoblastoides* belong *H. catenularia* var. *nitida* LAMBE and *H. catenularia* LAMBE from Canada, the latter two however, differ, from the former, among many others, in having their interstitial tubes of somewhat different outline.

Locality :—Lo-ling-po, north of No-lu-ping, I-chang-fu, prov. Hu-peï.
Found in association with *Favosites gotlandicus* LAM.

Geological Age :—Gotlandian.

Favosites, LAM.

Favosites gotlandicus LAM.

Pl. VII., Fig. 3 a-b.

- 1854. *Favosites gotlandicus* M.-EDWARDS and HAIME : Brit. Fossil Corals, p. 256, pl. XL., figs. 1, 1a.
- 1879. *F. gotlandicus* NICHOLSON : Palaeozoic Tabulate Corals, p. 46, pl. I., figs. 1-6.
- 1902. *F. gotlandicus* POČTA : Système Sil. du centre de la Bohême. vol. VIII., 2, p. 230, pl. LXXVI.
- 1915, *F. gotlandicus* YABE and HAYASAKA : Palaeozoic Corals from Japan, Korea and China, p. 66.

Corallum discoidal; corallites prismatic, rather variable in diameter, but usually slender, measuring hardly over 1.8 mm.; diverging radially from the base upwards. Wall thin, sometimes wrinkled transversely. Mural pores arranged mostly in two alternate rows and occasionally in a single row; relatively large, $\frac{1}{3}$ mm. in diameter and circular, being surrounded by an elevated rim. Tabulae very thin, complete, usually horizontal but sometimes slightly concave or convex. Septa very rarely recognizable as delicate spinules in some of the large corallites.

Obs.—This species is represented by a single, young stock, corallites of which are therefore relatively slender, as a whole, in comparison with those of a larger stock; the corallites vary considerably in diameter in the present specimen, no doubt owing to their rapid multiplication. Nevertheless the general likeness in the internal structure of this specimen to the typical examples of *F. gotlandicus* from Europe is considerable, and we are quite convinced as to their specific identity. It is only necessary here to mention that this young specimen from China strikingly resembles in its external aspect *Michelinia microstoma* YABE and HAYASAKA¹⁾ of similar dimension, though the internal structure is naturally quite different in these two types of the tabulate corals.

Locality :—Lo-ling-po, north of No-lu-ping, prov. Hu-pei.

Geological Age :—Gotlandian.

Cephalopoda.

Trochoceratidæ.

Trochoceras, BARRANDE.

Trochoceras sp. indet.

Pl. XVIII., Fig. 7.

The figure shows a nautiloid fossil with an evolute shell; it is here provisionally referred to the genus *Trochoceras* simply on account of its

1) YABE and HAYASAKA: Palaeozoic Corals from Japan, Korea and China, p. 61.

resemblance to *Trochoceras optatum* BARR.¹⁾ and the allies in its general outline and surface sculpture. Its ill preservation, however, prevents further detailed comparison for specific identification.

The shell consists of a few evolute (depressed trochoid?), rapidly enlarging whorls, with its last portion free; the shell surface bears rather distant acute costae curving backwards on the side; the costae die out gradually toward the aperture, being replaced by crowded finer striae on the free portion of the whorls.

Dimension :—

Diameter of closely coiled portion.	42 mm.
Diameter of umbilicus, corresponding to the former.	17 mm.
Height of whorl, corresponding to the former.	13 mm. ?
Diameter of shell, free portion of whorls included.	50 + mm.
Length of free portion of whorls.	23 mm.
Height of aperture.	19 mm.

Owing to the great deformation the specimen had suffered, the above measurements of course lack sufficient exactness.

Locality :—Huang-kuo-chi, Ta-kuan-ting, prov. Yun-nan (YAMADA Coll.); in a dark grey shale.

Geological Age :—Probably Gotlandian.

The presence of *Trochoceras* in Chinese Gotlandian fauna is interesting, for the group is especially well represented in Bohemian rocks, and seems to give some hint as to the faunal affinity between the southern Chinese and the Bohemian Gotlandian.

Orthoceratidæ.

Orthoceras BREYN.

Orthoceras sp. indet.

Pl. XVIII., Fig. 8.

This is also too ill preserved and does not allow specific identification; it represents a long conical tube with an apical angle of 13° ; the total length

1) BARRADE: Système silurien du centre de la Bohême. Vol. II., p. 111, pl. XXIII, figs. 5-10.

of the shell measures 55 mm., of which 25 mm. is occupied by the body chamber; probably it is not complete in its apical portion. The septa 1-1.5 mm. apart. Neither the position and nature of the siphon and siphonal collar, nor the sculpture of the surface are shown by the single specimen.

Locality:—Hui-lung-chi, Ta-kuan-ting, prov. Yun-nan (YAMADA Coll.); in a dark grey shale. The rock is quite similar to that with *Trochoceras* sp. mentioned above. They are probably of the same geological age.

Brachiopoda.

(By I. HAYASAKA).

Pentameridæ.

Pentamerus, Sow.

Pentamerus borealis EICHWALD.

Pl. XII., Fig. 9.

1860. *Pentamerus borealis*, EICHWALD:—*Lethaea rossica*, vol. I., p. 787.
 ? 1894. *P. oblonga*, HALL (pars):—*Nat. Hist. New York*, vol. VIII., p. 59, pl. LXX., fig. 4, etc.
 1908. *P. borealis*, GÜRICH:—*Leitfossilien*, vol. I., p. 59. p. 1. 21, fig. 1.
 1911. *P. borealis*, FRECH:—*VON RICHTHOFEN'S China*, vol. V., p. 15, pl. IV., fig. 3.

A specimen already mentioned and illustrated by Prof. FRECH in his work above cited is now to be described somewhat more in detail. The specimen belongs to Prof. YABE, who while abroad had showed it to the former. The only figures accessible to the writer for comparison are those of the named species from the Baltic Region of Russia given by Dr. GÜRICH in his "*Leitfossilien*." The writer therefore greatly regrets that he is unable to study the real affinities between the Chinese and the Baltic forms as he could wish though FRECH's authority may no doubt be followed as conclusive.

The valves of the fossils are markedly different both in size and shape. The former is extraordinarily elongate, and, as it is also quite deep, looks something like a cylinder. The beak is very strongly incurved, and overhangs a high but narrow cardinal area. The smaller or dorsal valve is rather flat and longitudinally oval in outline, with a pointed beak and an inconspicuous median sinual depression corresponding to a median fold on the opposite valve. The dorsal valve is, so to speak, a lid that closes the obliquely cut end of a cylinder or rather a cone of the ventral valve. The area of the ventral valve is rather narrow and high.

From the beak the dorsal valve gradually increases in width throughout the posterior $2/3$ of its length, and then somewhat suddenly narrows again anteriorly. Thus the greatest width of the dorsal valve is at $2/3$ of the length of the valve from its beak. There are two inconspicuous but distinct ridges on the ventral valve running from the tip of the beak to the two points on the lateral margin that are the two extremities of the greatest width: the ridges run quite parallel to the general longitudinal curvature of the ventral shell along its median line. The portions of the ventral shell lying between the lateral margins of the area and the ridges just mentioned are quite flat transversely, while the middle part of the valve between the two ridges, having the median fold, is very strongly curved transversely. There is a median septum in the ventral valve exhibited by a straight groove along the top of the median fold extending for nearly half of the length of the valve. The dorsal valve is provided with two, nearly parallel septa that begin at the beak and extend half of its length.

Remarks:—The species is such a characteristic form that one can at one glance distinguish it from almost all of the other species of the genus. According to GÜRICH, there is an essential difference between this and *P. oblongus* SOWERBY. Therefore, it would seem superfluous here to dwell upon the relation of the two species, were there no American forms mentioned by HALL as *P. oblongus*. But according to HALL there seems to be a number of form variations in *P. oblongus* of his circumscription. The writer, however, can not help doubting whether there is really any specimen of *P. borealis* in HALL'S material. He figures many oval forms representing

P. oblongus of the ordinary shape, but there are also some that have the umbonal portion quite elongate. Especially worthy of mention is the one represented by fig. 4 of plate LXX. Must it not be regarded as a form much more appropriate to *P. borealis* than to *P. oblongus*?

Locality.—Lo-ling-po near No-lu-ping, Tung-hu-hsien, I-chang-fu, prov. Hu-pei.

Geological Age:—The lower division of the upper Silurian (Gotlandian). *Dalmanella aequivalvis* which will be described next was found in association.

Orthidæ.

Dalmanella, HALL and CLARKE.

Dalmanella aequivalvis DAVIDSON sp.

Pl. XXII., Fig. 10.

1864-1871. *Orthis aequivalvis*, DAVIDSON:—Monogr. Brit. Dev. Brachiopods, p. 263. pl. XXX., figs. 9 and 10.

In the original description of this species, DAVIDSON called it an *Orthis*. According, however, to the more recent palaeontologists, the genus is subdivided into several different groups each of which denoting an independent genus. On examining the fossil, as well as the definitions of these genera by various authors, the writer is led to place it in the genus *Dalmanella*. It has a remarkably rounded contour and the surface of the shell is ornamented with very fine radial striae. Besides, in both the valves the area is not very conspicuous, as is usually the case with *Dalmanella*. The valves are almost equally convex too.

This species is represented by only one example, which, however, has comparatively well retained its outward characteristics. It has also the peculiar shape that is characteristic of the species. The diagnosis given by DAVIDSON long ago, though brief, holds excellently good with the Chinese fossil under examination. It is as follows:—"Shell almost circular, broadly rounded anteriorly, as well as at the cardinal extremities. Valves almost

equally and moderately convex, without folds or sinus; hinge-line shorter than the breadth of the shell; areas narrow, than in the ventral valve slightly the larger. External surface marked by numerous thread-like radiating striae, which increase in number by the interporation of a finer rib between each pair of the larger ones. The whole surface is likewise traversed by concentric lines."

This definition, the writer is sure, will be found necessary and sufficient for explicating the Chinese form. The following measurements may supplement it to some extent.

Length.	Width.	Thickness.	Hinge-line.
19 mm.	21 mm.	11 mm.	12 mm.

DAVIDSON's measurements are ;

10 lines.	11 lines.	5 lines.
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Thus the size and the proportion too are almost coincident in the two forms. The thread-like striae number 3 or 4 in a distance of 1 mm. along the margin.

Locality :—Lo-ling-po near No-lu-ping, Tung-hu-hsien, I-chang-fu, prov. Hu-pei.

Accompanied by *Pentamerus borealis* described above.

Geological Age :—In Britain it was found in the Wenlock Formation of two different localities. Thus the formation which yielded this fossil must be of the Gotlandian Age.

CHAPTER V.

Devonian.

Marine Devonian sediments have certainly a very considerable extension in southern China; the fossiliferous deposits of this age are developed not only in the tracts of the folded rocks—the Tsin-ling mountains and the Indo-Chinese mountain range (i.e. in the provinces of Yun-nan, Sze-chuan, Shen-si and Kan-su), but also in other districts in the provinces of Kwang-si, Kwei-chou and Hu-nan. Beyond the boundary of China proper, their occurrence is reported from Tong-king, Birma, Central Asia, Kweun-lun and Altai. Throughout these regions, the Devonian formation is represented only by its upper and middle divisions, but not by the lower; and hence it has been suggested that the marine transgression began in central and eastern Asia with the earlier part of the Middle Devonian (Kweun-lun transgression). It is now also well known that the Upper and Middle Devonian fauna of Asia are hardly distinguishable from those of Europe, as typified by the Eifelian faunas.

The first record of Chinese Devonian fossils was probably that given by M. DE KONINCK, who found in a lot of fossils from a locality in the province of Yun-nan, 100 leagues west of Kwan-tung,

Spirifer chechiel KONINCK,

Terebratula yunnanensis KONINCK,

Serpula omphalodes GOLDFUSS,

and noted at the same time the occurrence of a common form of *Strophalosia* in China. T. DAVIDSON obtained similar material, which was said to have been derived from the province of Kwan-si, and distinguished the following forms:

Spirifer disjunctus SOW.

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- 1) KONINCK: Notice sur deux espèces de brachiopodes du terrain paléozoïque de la Chine. Bull. Acad. de Belgique, vol. XIII., pt. 2, p. 415.
 - 2) DAVIDSON: On Some Fossil Brachiopods of the Devonian Age from China. Quart. Journ. Geol. Soc. London, vol. IX., 1853, p. 353.

Cyrtia murchisoniana KONINCK

Rhynchonella hanburii DAVIDS.

Productus subaculeatus MURCHISON

Crania obsoleta GOLDF.

Spirorbis omphalodes GOLDF.

Cornulites epithonia GOLDF. ?

Aulopora tubaeformis GOLDF. = *A. subcampanulata* COWPER REED, according to COWPER REED.

GUYERDET¹⁾ also recorded from Ku-tshu, situated between the Yang-tse-kiang and the Lang-tsang-kiang,²⁾

Rhynchonella cuboides SOW.

R. pugnus MARTIN

Atrypa reticularis L.

and R. I. MURCHISON³⁾ from the province of Sze-chuan.

Spirifer verneuili MURCH.

S. archiaci MURCH.

Atrypa reticulris L.

Productus subaculeatus MURCH.

Numerous Devonian fossils are also in RICHTHOFEN'S collection; these were described by E. KAYSER⁴⁾ in the fourth volume of RICHTHOFEN'S China, and a number of them were subsequently revised by F. FRECH.⁵⁾ The collection comprises three sets of material, the first set (1) having been collected in situ near Tchou-tien in the northeastern part of the province of Sze-chuan, and the second (2) bought at Lung-tung-pei,⁶⁾ near Tchou-tien, and considered to be derived from that place, while the third (3) was bought in various towns from Chinese merchants who sell fossils as medicaments under the name Shi-yen.⁷⁾ KAYSER distinguished the following forms in the collection :

1) GUYERDET: in Comptes Rendus Acad. Sc. Paris, vol. LIII., No. 19, 1864. Cited after KAYSER.

2) Lang-tsang-kiang = 瀾滄江

3) MURCHISON: Siluria, 1st 72 edition, p. 400.

4) KAYSER: Devonische Versteinerungen aus dem Südwestlichen China, and KAYSER: Devonische und Carbonische Versteinerungen von Tschau-tien. Both, in RICHTHOFEN'S China vol. IV.

5) FRECH: in RICHTHOFEN'S China vol. V.

6) Lung-tung-pei—Chinese character unknown.

7) 石燕

1	2	3	
—	—	+	<i>Rhynchonella parallelpipeda</i> BRONN.
—	+	—	<i>R. procuboides</i> KAYSER var. <i>lungtunpeicnsis</i> KAYSER
—	—	+	<i>R. hamburii</i> DAVIDS.
—	—	+	<i>Pentamerus galeatus</i> DALM = <i>P. biplicatus</i> SCHNUR, according to FRECH
+	—	—	<i>Atrypa reticularis</i> L.
—	—	+	<i>A. desquamata</i> SOW.
—	—	+	<i>A. aspera</i> Schloth. var. <i>sinensis</i> KAYSER
—	—	+	<i>Merista plebeya</i> SOW. ?
—	—	+	<i>Nucleospira takwanensis</i> KAYSER = <i>Spirifer</i> (<i>Martinia</i>) <i>inflatus</i> SCHNUR.
—	—	+	<i>Spirifer officinalis</i> KAYSER = <i>Sp. verneuili</i> MURCH., according to FRECH.
—	—	+	<i>S. undiferus</i> ROEMER var. <i>takwanensis</i> KAYSER.
—	—	+	<i>S. chechiel</i> KON. = (<i>S. speciosus</i>).
—	—	+	<i>S. verneuili</i> MURCH.
—	—	+	<i>Cyrtia murchisoniana</i> KON.
—	—	+	<i>Orthis striatula</i> SCHLOTH.
+	—	+	<i>O. Mcfarlanei</i> MEEK.
+	—	—	<i>O. richthofeni</i> KAYSER = <i>Atrypa reticularis</i> L. var. <i>richthofeni</i> , according to FRECH.
+	—	—	<i>Productus subaculeatus</i> MURCH.
—	—	+	<i>Strophalosia productoides</i> MURCH.
+	—	—	<i>Crania obsoleta</i> GOLDF.
—	—	+	<i>C. cimaensis</i> DE RYCKHOLD
—	—	+	<i>Spirorbis omphalodes</i> GOLDF.
—	—	+	<i>Chaetetes parasiticus</i> KAYSER
—	—	+	<i>Aulopora tubaeformis</i> GOLDF.
—	—	+	<i>A. repens</i> KNORR = <i>A. serpens</i> GOLDF., according to COWPER REED.

The SZÉCHENYI-LÓCZY expedition in China also succeeded in finding Devonian fossils in situ at several places; the fossils underwent the study of

LÓCZY and FRECH and were identified as follows :—

Loc. Paj-sui-kiang¹⁾ in southern Kan-su. Along the gorge is exposed a limonitic sandstone in association with clay shale; above the sandstone occur thin-bedded limestone layers, and above these thick beds of the bituminous limestone. Marly strata in alternation with the dark blue limestone layers contain numerous fossil corals, crinoids, brachiopods, bivalves etc. among which the following forms have been distinguished.

Cypricardinia scalaris PHILLIPS

Megalodus ? sp. indet.

Spirifer aperturatus SCHLOTH. cfr. var. *latistriata* FRECH

Waldheimia whidborni DAVIDS

Stromatopora concentrica GOLDF.

Favosites reticulatus BLAINV.

This small fauna was assigned by LÓCZY to Middle Devonian.²⁾

Loc. Hoa-ling-pu, in western Sze-chuan. In western and south-western Sze-chuan and in the adjacent districts of Yun-nan, Devonian rocks seem to have an extended distribution; according to LÓCZY, in the first region, there are developed some Palaeozoic rocks, which overly granitic and diabasic rocks on one side and underly a Rhaetic and Jurassic coal bearing formation on the other; the lower part of the Palaeozoic complex, composed mostly of limestone, has no fossil, and assigned by him to Silurian simply on account of the Middle Devonian age of the overlying part. The latter, composed of shale and earthy limestone, contains a rich fauna of the said age at Hoa-ling-pu³⁾; according to FRECH⁵⁾ it is equivalent to the middle portion of the *Stringocephalus* limestone. The fossils are :

Actinopteria ? *densiradiata* LÓCZY.

Chonetes orientalis LÓCZY,

Orthis or *Atrypa* sp.

1) Paj-sui-kiang = 白水江

2) LÓCZY: Beschreibung der Fossilen Reste von Wirbelthieren und von Mollusken und die Palaeontologisch-stratigraphischen Ergebnisse. In Wissenschaftliche Ergebnisse der Reise des Grafen BÉLA SZÉCHENYI in Ostasien, vol. III, 1899, pp. 21-26; p. 168.

3) Hoa-ling-pu = 黃林鋪

4) LÓCZY: l.c. pp. 27-40; pp. 169-171.

5) FRECH: in RICHTHOFEN'S China, vol. V., pp. 45-49.

Spirifer undiferus F. ROEM.

S. elegans STEIN.

S. cfr. thetidis BARR.

S. sp. indet. aff. apperturatus SCHLOTH.

Merista aff. M. tumida DALM.

Atrypa sp. indet. aff. interstitialis EICHW.

Rhynchonella elliptica SCHNUR

Camarophoria sü-tschuanensis LOCZY

C. sp. indet. aff. ascendens KING

Pentamerus galeatus DALM.

Waldheimia sp. indet. aff. widbornei DAV.

Cyathophyllum loczy FRECH

Haplothechia ? chinensis FRECH

Favosites goldfussi M. E. & H.

F. asteriscus FRECH

F. reticulatus BLAINV.

Alveolites reticulatus STEIN.

Striatopora clathrata STEIN.

Localities in Prov. Yun-nan. The Devonian formation attains an enormous development in the province of Yun-nan; the greater part of the Devonian fossils bought by RICHTHOFEN from Chinese apothecaries and described by KAYSER were said to have been derived from Ta-kwan-tin¹⁾ in this province.²⁾ LÖRENTHEY³⁾ who microscopically examined limestones in the SZÉCHENYI-LÓCZY collection found *Favosites* and *Stenopora* in a limestone from Suj-tschai, in the valley of the Lang-tsang-kiang, and Lóczy⁴⁾ believed in the Devonian age of the limestone. But as to our present knowledge of Devonian palaeontology and stratigraphy of this province we are mostly indebted to French authorities, H. DOUVILLÉ,⁵⁾ LECLÈRE,⁶⁾ LANTENOIS,⁷⁾ DEPRAT and MAN-

1) Ta-kwan-tin = 大關廳

2) KAYSER: Devonische Versteinerungen, in RICHTHOFEN's China vol. IV., p. 79.

3) LÖRENTHEY: Mikroskopische Untersuchungen der Palaeozoischen Gesteine. In Wissenschaftliche Ergebnisse der Reise des Grafen Bele Szechenyi, vol. III., p. 244.

4) LOCZY: l.c. p. 167.

5) H. DOUVILLÉ: Examen des fossiles rapportés de Chine par la mission LECLERE. Comptes Rendus, 1900.

6) LECLÈRE: Etude géologique et minière des provinces chinoises etc.

7) LANTENOIS: Résultats de la Mission géologique et minière. Ann. des mines. 1907.

suy¹⁾; according to the two authors last named all three divisions of Devonian formation are well represented there. The fossiliferous zones already recognised were put together by DEPRAT²⁾ in the following list:

- Famennian.
- 17. Marly limestone with *Spirifer tenticulum* of Ta-hi-ti³⁾
 - Spirifer tenticulum* DE VERNUIL
 - S. curvatus* v. BUCH.
 - Atrypa douvillei* MANSUY
 - A. arimaspus* EICHW.
 - A. desquamata* SOW.
 - Rhynchonella huoti* DE VERN. et KAYS.
 - R. letiensis* GOSSELET
 - R. gigantea* MANSUY
 - Cyathophyllum douvilléi* FRECH
 - 16. Grey limestone with *Spirifer verneuili* of Ta-hi-ti.
 - Spirifer verneuili* MURCH. var. *yunnanensis* MANSUY
 - S. curvatus* v. BUCH
 - Atrypa bodini* MANSUY
 - Productella bourguignoni* MANSUY
 - Rhynchonella (Pugnax) pugnax* MART.
 - R. (Camarotechia) convexa* MANSUY
 - Anastrophia proxima* MANSUY
 - 15. White limestone with crinoids of Mo-chien-tsin.⁴⁾
 - Spirifer curvatus* v. BUCH.
 - Atrypa reticularis* L.
 - A. asper* DALM.
 - Orthis richthofeni* KAYS.
 - Athyris concentrica* v. BUCH
 - Rhynchonella (Pugnax) pugnax* MART.
 - 14. Rosy limestone of La-li-he.⁵⁾

1) J. DEPRAT et H. MANSUY: Étude géologique du Yun-nan oriental. 1912. etc.

2) J. DEPRAT: Les séries stratigraphiques en Indochine et au Yun-nan. Mém. du serv. géolog. de l'Indochine, vol. II., fasc. 2. 1913.

3) Ta-hi-ti =

4) Mo-chien-tsin = } Chinese characters unknown.

5) La-li-he =

- Paradoceras globosum* MÜNSTER
Atrypa asper DALM.
Styliola sp.
13. Laminated marl of Lou-tchai-tchong.¹
Spirifer undiferus ROEM.
Sigillaria sp.
Lepidodendron sp.
Rhynchonella omaliusi GOSSELET
Athyris concentrica v. BUCH.
Productella subaculeata v. MURCH.
Orthoceras sp.
Favistella columnaris MANSUY
12. Marl of Ta-ping-pou.²
Leiorhynchus deprati MANSUY
Strophalosia productoides MURCH.
Productella subaculeata MURCH.
11. Black limestone with *Rhynchonella procuboides* of Po-shi.³
Rhynchonella procuboides KAYS. var. *lungtungpeensis* KAYS.
Orthis striatula D'ORB.
Streptorhynchus umbraculum SCHL.
Orthothetes crenistria PHILL.
Atrypa reticularis L.
A. asper DALM.
Strophalosia productoides MURCH.
Productella subaculeatus MURCH.
Cyathophyllum douvillei FRECH
C. hexagonum MICH.
Alveolites suborbicularis LMK.
A. subaequalis M.-E. & H.
10. Marly limestone with *Stringocephalus* of Si-tche-yi, Pa-mao-tsen, Ta-hi-ti, etc.

1) Lou-tchai-tchong } Chinese characters unknown.
 2) Ta-ping-pou }
 3) Po-shi = 婆兮 }

- Stringocephalus burtini* DEFR.
Uncites gryphus SCHLOTH.
Cyrtina heteroclyta DEFR.
Spirifer undiferus ROEM.
S. thetidis KAYS.
Spiriferina cristata SCHL. var. *octoplicata* SOW.
Strophalosia productoides MURCH.
Productella subaculeata MURCH.
Chonetes orientalis LÓCZY.
Waldheimia whidbornei DAV.
Camarophoria sseutchoanensis LÓCZY
Athyris concentrica M'COY.
Orthis striatula SCHL.
Atrypa desquamata SOW.
A. reticularis L.
Orthoceras tenuilineatum SANDB.
Cyrtoceras (Kophinoceras) ornatum GOLDF.
Cardiola migrans BARR.
Megalodon cucullatus SOW.
Modiomorpha duponti MANSUY
Delabra cf. *unilateralis* SOW.
D. sp.
Macrochilina acculata SCHLOTH.
Natica (Naticopsis) antiqua GOLDF.
Murchisonia margarita WHIDB.
M. loxonemoides WHIDB.
M. angulata PHILL.
M. angulata PHILL. var. *conoidea* MANSUY
M. bigranulosa VERN.
M. bilineata VERN.
Pleurotomaria delphimuloides SCHL.
Bellerophon striatus DE FÉRUSS et D'ARCH.
Pleurotomaria subimbricata M'COY

- Aulopora repens* KNORR.
A. tubaeformis GOLDF.
Cyathophyllum caespitosum GOLDF.
C. ceratites GOLDF.
Clathrodictyon yunnanense MANSUY
9. Rosy grey limestone of Si-tché-yi.¹⁾
- Atrypa aspera* DALM.
A. reticularis L.
Conchidium (Sieberella) galeatus DALM.
Orthis striatula D'ORB.
Strophalosia productoides MURCH.
Dielasma sp.
8. Marly limestone of Si-tché-yi.¹⁾
- Spirifer concentricus* SCHNUR
Nucleospira takwanensis KAYS.
Conchidium (Sieberella) galeatum DALM.
Athyris concentrica BUCH.
Atrypa reticularis L.
A. explanata SCHL.
Strophalosia productoides DAV.
Metriophyllum poshiense MANSUY
Endophyllum yunnanense MANSUY
Cyathophyllum roemeri M.-E. & H.
C. helianthoides GOLDF.
C. obtortum M.-E. & H.
Cystiphyllum americanum M.-E. & H.
C. vesiculosum PHILL.
Smithia hennahi M.-E. & H.
Favosites subregularis MANSUY
F. sphaericus HALL.
Aulopora tubaeformis GOLDF.
Pachypora polygonalis MANSUY
Stromatopora sp.

1) Si-tché-yi--Chinese characters unknown.

Eifelian.

Orthis striatula DEFR.
Plectambonites rhomboidalis PHILL.
Dielasma curvirostris MANSUY
Retzia yileangensis MANSUY
Meristella flayellei MANSUY
Megalanteris archiaci DE VERN.

7. Calcschist with *Calceola* of Po-shi.

Calceola sandalina LMK.
Cyathophyllum roemeri M.-E. & H.
C. helianthoides GOLDF.
C. vesiculosum PHILL.
C. americanum M.-E. & H.
Smithia hennahi M.-E. & H.
Metriophyllum poshiense MANSUY
Endophyllum yunnanense MANSUY
Favosites sphaericus HALL.
Aulopora tubaeformis GOLDF.
Streptorhynchus umbraculum SCHL.

6. Violet calcschist with corals of He-mo.¹⁾

Cyathophyllum roemeri M.-E. & H.
C. helianthoides GOLDF.
Pachypora sp.
Favosites sphaericus HALL

5. Coarse sandstone of He-mo.

Actinopteria deprati MANSUY
Tentaculites irregularis MANSUY
Meristella sp.
Retzia sp.
Leptaena sp.

4. Hard grey limestone of Lan-nin-tsin.²⁾

Spirifer jouberti OEHL et DAV.
Pterinea lineata GOLDF.

Lower Devonian.

1) He-mo } Chinese characters unknown.
 2) Lan-nin-tsin }

3. Yellow marl schist of Pa-mao-tseu.¹⁾
Retzia plicata MANSUY
Linoptera inopinata MANSUY
Tentaculites irregularis MANSUY
2. Limestone of Pa-mao-tsen and Tao-ta-tchin.
Conchidium (Sieberella) sieberi BUCH.
Spirifer cf. *nudus* SOW.
1. A complex of fine grained sandstone, marl and variegated marly-limestone of Ki-tse-tchong.²⁾
Cypridinia (Entomis) sp.

FRECH who had opportunity to undertake the revision of Leclère's collection of Devonian fossils from Yun-nan, made certain alterations in the specific identifications once attempted by MANSUY³⁾ :—

Upper Upper Devonian.

- Rhynchonella huoti* DE VERN. Tien-sin-kouang.
R. reniformis SOW. (*R. letiensis* of MANSUY e.p.) Ta-i-ti.⁴⁾
R. pugnus var. *alta* CALVIN (*R. letiensis* of MANSUY e.p.) Ta-i-ti.
Spirifer verneuili Ta-i-ti.
S. pachyrhynchus VERN. Tien-sin-kouang.⁵⁾
Retzia ulothrix DE KON. mut. *indosinensis* FRECH. Tien-sin-kouang.

Lower Upper Devonian.

- Tornoceros simplex* v. BUCH (*T. retrosus* of MANSUY) La-li-ha.⁶⁾

Upper Middle Devonian.

- Stringocephalus burtini* DEFR. Po-si.⁷⁾
Cupressocrinus abbreviatus GOLDF. Si-ni-kao.⁸⁾
Rhynchonella procuboides var. *lungtungpeicensis* KAYS. Si-ni-kao.
Murchisonia coronata VERN. Tsin-pao.⁹⁾

1) Pa-mao-tseu } Chinese characters unknown.
 2) Ki-tse-tchong }

3) FRECH: in RICHTHOFEN's China, vol. V., pp. 33-45.

4) Ta-i-ti = Ta-hi-ti.

5) Tien-sin-kuoang

6) La-li-ha = La-li-he.

7) Si-ni-kao

8) Po-si = Po-shi.

9) Tsin-pao

} Chinese characters unknown.

M. angulata La-gni-tsin.¹⁾

Macrocheilos arcuatum SCHLOTH. Si-ni-kao.

Dalmanella striatula Si-ni-kao.

Spirifer mayeri HOLZAPFEL (*S. curvatus* of MANSUY) Po-si, Si-n-kao.

Athyris concentrica Po-si.

Cyathophyllum douvillei FRECH Ta-i-ti.

C. halloides FRECH Lo-nan.²⁾

C. ceratites GOLDF. Lo-nan.

C. vermiculare GOLDF. Lo-nan.

Cystiphyllum vesiculosum GOLDF. (*C. sp.* of MANSUY) Si-ni-kao.

Favosites cristatus Po-si.

F. sp. ?

Very few localities of Devonian fossils are known at present in other parts of southern China, although there is great probability that the sedimentaries of this age are distributed there also.

The type of sedimentary succession in eastern Sze-chuan, southern Shan-si and western Hu-pei has been given in one of the preceding chapters, mostly based on observations by WILLIS-BLACKWELDER, ABENDANON and NODA. The doubtful fauna of Ta-miau-ssii in a pink limestone, a local bed either at the top of the Sin-tan shale or at the base of the Wu-shan limestone, being excluded, there is no record of Devonian rocks in this vast region; for the Sin-tan shale, 540 m. thick which was considered by WILLIS and BLACKWELDER as probably representing Gotlandian and Devonian, is, in my opinion, still older, the lower part surely belonging to Ordovician and hence the upper part also to Ordovician or at most to Lower Gotlandian.

On the other hand, there is an extensive development of sedimentaries along the lower Yan-tze-kiang, which were referred by RICHTHOFEN to Silurian and Devonian, though lacking any fossil evidence except the case of the Gotlandian rocks of Lun-shan, on the east of Nan-king, already cited in another chapter. "Beiden Formationen rechne ich die mächtig entwickelten, wesentlich klastischen Schichtenreihen zu, welche teils

1) La-gni-tsin = Lar-nir-tsin.

2) Lo-nan = 路南

unter der tiefsten nachweisbaren Stufe des Carbon in gleichförmiger Lagerung folgen, teils, ohne Beziehungen zu jenen erkennen zu lassen, jünger sind als das Sinische System. Es gehören dazu:

die mächtigen Sandstein und Tonschiefer des Tung-kwan-shan¹⁾ (Wild boar range);

die Sandsteine und Quarzite des Hsiau-Hau-shan²⁾;

die kieseligen Dolomite des Strohschuh-Canals bei Nan-king;

die roten Schiefertone, Dolomite und Quarzite des Hwa-shan³⁾;

die Quarzite und Schiefertone bei Tang-shui⁴⁾;

ein Teil der halbmetamorphosirten Schichtgesteine bei Tshönn-kiang-fu⁵⁾

die Sandsteine des Lu-shan am Po-yang-See⁶⁾;

ein gewisser Teil der Schichtenfolge am Tsien-tang-kiang⁷⁾;

die Sandsteine bei Tung-lu-hsien.⁸⁾

In noch mächtigerer Entwicklung und von noch ausschliesslicher klastischem Character sind in Hunan und Kwangtung Schichten-Systeme vorhanden, welche wahrscheinlich das Silur und Devon vertreten.⁹⁾

The following remark of E. TIESSEN, additional to the preceding, is of great importance;

“Nach der ältesten Auffassung (PUMPEL, KINGSMILL) wurde dem Devon eine überragende Bedeutung beigemessen, die in den Forschung des Verf. (RICHTHOFEN) sehr vermindert erscheint, aber vielleicht noch immer in grösseren Umfang zum Ausdruck kommt, als sie bei genauerer Erkundung sich herausstellen wird. Als devonisch werden nicht nur die den Lu-shan am Po-yang See zusammensetzenden und das sinische Ta-hau-shan System im Norden begleitenden quarzitischen Sandsteine, sondern auch mächtige Schichtmassen von verschiedener, aber meist klastischer Art im Nan-king Gebirge bezeichnet. In den ersten Veröffentlichungen des Verf. über das Nan-king

1) Tung-kwan-shan } Chinese characters unknown.

2) Hsiau-hau-shan }

3) Hwa-shan = 華山

4) Tang-shui = 湯水

5) Tshönn-kiang-fu = 鎮江府

6) Po-yang = 鄱陽

7) Tsien-tang-kiang = 錢塘江

8) Tung-lu-hsien = 東流縣

9) RICHTHOFEN: l.c. pp. 740-1.

Gebirge ins Besondere, und ebenso in den ältesten Ausarbeitungen und den Vorlagen zur geologischen Karte, spielt die devonische Formation eine Hauptrolle, die auch auf Blatt 46 des "Atlas" heraustritt. Auf Tafel V ist dann der Versuch gemacht worden, die seither gewonnenen Aufklärungen zu einer Gliederung dieser ganzen Gruppe vorsichtig zu verwerthen. Eine Abweichung von der älteren Darstellung bringt namentlich der Nachweis des untercarbonischen Alters für den früher gleichfalls zum Devon gerechneten Kalkstein des Hsi-hsia-shan hervor; Da dem den Hsi-hsia¹⁾-Kalk überlagenden Sandstein (Nan-king Sandstein der älteren Darstellung) nun gleichfalls ein jüngerer Alter beigelegt werden muss, bleiben für das Devon nur die mächtigen Sandsteine im Liegenden des Kalksteins. Diese wären also mit den erwähnten ähnlichen Gesteinen des Lu-shan²⁾ und des Ta-hau³⁾-Systems zu identifizieren. Daran würden sich mit einiger Wahrscheinlichkeit die hangenden Quarzite und Schiefertone des Lun-shan und die liegenden Gesteine des Tang-shui-Profiles anschliessen.

Eine Uebersicht über die Stellung des Devon im Nan-king Gebirge würde vorläufig folgende Schlüsse ergeben:

Gegend von Tshönn-kiang-fu: Die von Verf. hier als Silur oder Devon bezeichneten halbmetamorphischen Gesteine sind vielleicht noch von ober-sinischem Alter.

Der Frontzug (Hsiang-shan⁴⁾ und Wu-tshou-shan⁵⁾ und ihre Fortsetzung nach Westen): Die sehr mannigfaltig zusammengesetzte, in ihrem Verband ungeklärte, auch durch metamorphischen Character schwierige Schichtenreihe ist von Verf. hier nicht erwähnt, im Entwurf zu Taf. V ganz allgemein zum Devon gestellt worden. Der Gehalt an Quarz und Eisenerz in dem Marmor, der an den Hsi-hsia-Kalk erinnert, sowie das Vorkommen von Graphit führt jedoch zu der Frage, ob in diesen durch Porphyry veränderten Gesteinen nicht noch jüngere (carbone) Schiefer enthalten sind.

1) Hsi-hsia. Chinese character unknown.

2) Lu-shan = 廬山

3) Ta-hau

4) Hsiang-shan

5) Wu-tschou-shan

} Chinese characters unknown.

Der Lun-shan: Das Hangende des Unter-Silur ist zur Gruppe des Devon (oder Silur) zu rechnen.

Der Hwa-shan: Die liegendsten Schichten des Profils sind bereits oben als zum Silur-Devon gehörig bezeichnet worden. Auffallend ist die Einschaltung von Dolomit.

Gegend von Pa-hwei-miau¹⁾: Den das Unter-Carbon unterteufenden Quarziten und Schiefertönen würde die gleiche Stellung anzuweisen sein.

Der Hsi-hsia-shan: Devonische Sandsteine unterlagern den untercarbonen Kalkstein.

Am Strohschuh²⁾-Kanal: Die kieseligen Dolomite im Liegenden sind hier dem Silur oder Devon, früher dem (sinischen) Matsu³⁾-Kalk zugerechnet worden. Die Stellung der hangenden reinen Kalksteine und roten Quarzite nebst Conglomeraten bleibt fraglich. Vielleicht entsprechen diese Schichten vielmehr dem Carbon des Hsi-hsia-shan, was durch die obige Auffassung des in östlicher Fortsetzung gelegenen Wu-kung-shan⁴⁾ noch wahrscheinlicher wird.

Der Tshung-shan⁵⁾: Dass die Gesteine dieses Berges wahrscheinlich jünger sind, obgleich sie auf der geologischen Karte gleichfalls allgemein dem Devon zugeteilt sind, wird noch zu erörtern sein.

Die hypothetische Bestimmung des Devon in den beiden Profilen durch das alte Gebirge im nördlichen Tshe-kiang, wo freilich das Verhältniss zwischen Kalkstein und Sandstein ungeklärt bleibt, beruht auf einer Analogierung der Schichtenfolge mit der am Po-yang See und im Ta-hau System; und das gleiche gilt als Consequenz, unter Annahme einer regelmässigen Ueberlagerung, für die Auffassung der Sandsteine bei Tung-lu-hsien als Unter-Carbon, die oben als devonisch bezeichnet worden sind." ⁶⁾

Thus Lu-shan, near lake Po-yang, is coloured as Devonian on a geological map in RICHTHOFEN's China (Pl. 44); NODA, on the other hand, refers the

- | | |
|--|-------------------------------|
| 1) Pa-hwei-miau | } Chinese characters unknown. |
| 2) Strohschuh | |
| 3) Ma-tsu | |
| 4) Wu-kung-shan | |
| 5) Tshung-shan | |
| 6) RICHTHOFEN: China, vol. III, pp. 741-2. | |

rocks of this mountain to the Upper Sinian.¹⁾ At any rate, the latter geologist did not succeed in finding any organic remains suggesting the Devonian age in the district lying north of Lake Po-yang, that is in the frontier district of the three provinces of An-wei,²⁾ Kiang-si and Hu-pei.

Many years ago, T. OGAWA submitted to me for examination a lot of Devonian fossils said to have been derived from the vicinity of Ling-ling,³⁾ Yung-chou-fu,⁴⁾ prov. Hu-nan; it comprises :⁵⁾

Spirifer verneuili MURCH.

Crania obsoleta GOLDF. ?

Spirorbis omphalodes GOLDF.

Chaetetes parasitica KAYSER ?

Aulopora tubaeformis GOLDF.

NODA⁶⁾ who travelled along the upper course of the Hsian-kiang⁷⁾ from Yung-chou to Kwei-lin⁸⁾ in the province of Kwang-si, found the Upper Palaeozoic formation well developed in the district, and composed of two beds of limestone, two beds of clayslate and one of sandstone in alternation; although he provisionally referred this complex to the Carboniferous, yet the above mentioned occurrence of Upper Devonian fossils in the vicinity of Ling-ling renders it highly probable that at least a part of the complex or more likely its greater part must be assigned to the Devonian.

Moreover, FRECH⁹⁾ has very recently reported the occurrence of the Middle Devonian *Stringocephalus* limestone in Hu-nan, based on material collected by OEMICHEN; according to the information given by the latter to

1) See the geological map of southern China accompanying NODA's paper entitled Report on the survey work in the four provinces of Hu-nan, Kiang-si, Kwang-tung and Kwang-si. 1916. (in Japanese).

2) An-wei = 安徽

3) Ling-ling = 零陵

4) Jun-chou = 永州

5) H. YABE: Devonian Fossils from Hu-nan, China. Journ. Geol. Soc. Tokyo, vol., XI. pp. 443-445. 1904.

6) NODA. l.c. p. 13.

7) Hsing-kiang = 湘江

8) Kwei-lin = 桂林

9) FRECH: Beiträge zur Geologie Chinas. I. Ein neues Vorkommen des Stringocephalenkalkes in Hu-nan. Centralbl. f. M. G. P. 1914. pp. 193-202. FRECH: Ueber einige mitteldevonische *Bellerophon*-Arten. Centralbl. f. M.G.P. 1914. pp. 161-169.

FRECH, the Middle Devonian limestone covers an extensive area about 180–200 km. from north to south, extending from Heng-shan,¹⁾ along the Hsiang-kiang, far southward beyond the border of the province of Kwan-tung into its interior. The limestone is grey to black in colour, strongly folded, and forms in itself a thick complex; it is overlaid apparently concordantly by quartzose rocks and compact sandstones. The limestone was found by OEMICHEN to be most fossiliferous in an area of about 60 km. radius around Kiang-hwa²⁾ in southern Hu-nan; the fossils are, according to FRECH:—

Syringopora sp.

Endophyllum acanthicum FRECH

Favosites polymorpha GOLDFUSS

Bellerophon striatus FÉR.

B. memoriakokeni FRECH

Pleurotomaria delphinuloides D'ARCH. var. *subcostata* SCHLOTH.

P. delphinuloides D'ARCH. var. *bathyschistus* FRECH

Macrocheilos arcuatum GOLDF. var. *elongata* GOLDF.

M. arcuatum GOLDF. var. *schlotheimi* D'ARCH. et VERN.

indicating the Upper *Stringocephalus* limestone, and

Spirifer aperturatus SCHLOTH. var. *cuspidata* D'ARCH. et VERN.

indicating the Lower *Stringocephalus* limestone.

Most of his specimens, however, are so imperfect that it seems to me almost unreasonable to assign them to any definite species. The figures on Pl. XXVII. (figs. 8, 9 a–b, 10) are copies of those given by FRECH in his paper, and represent the specimens referred by him to *Bellerophon striatus* (fig. 9b), *B. memoriakokeni* (fig. 9a), *Pleurotomaria delphinuloides* var. *bathyschistus* (fig. 10) and *Macrocheilos arcuatum* var. *subcostata* (fig. 8.)

Finally it should be mentioned that MARTELLI and PELLIZZARI described certain Upper Devonian fossils from the province of Shen-si; they are:

1) Heng-shan = 衡山

2) Kiang-hwa = 江華

3) A. MARTELLI: Il devoniano superiore dello Schensi (Cina). Bolletino della societa geologica Italiana, XXI. pp. 349–369. 1902.

4) G. PELLIZZARI: Fossili paleozoici antichi dello Scensi (Cina). Riv. Ital. Pal., vol. XIX., pp. 33–44. 1913.

Loc. northern Shen-si, recorded by MARTELLI.	Loc. Lean-shan in the Tsin-ling-shan, recorded by PELLAZZARI.
<i>Spirifer verneuili</i> , type form	= <i>Spirifer disjunctus</i> var. <i>gortani</i>
<i>S. verneuili</i> var. <i>subarchiaci</i>	= <i>S. disjunctus</i> var. <i>subarchiaci</i>
<i>S. verneuili</i> var. <i>lonsdalii</i>	
<i>S. verneuili</i> var. <i>subextensus</i>	= <i>S. disjunctus</i> var. <i>subextensus</i>
<i>S. verneuili</i> var. <i>archiaci</i>	
<i>S. verneuili</i> var. <i>disjunctus</i>	= <i>S. disjunctus</i> var. <i>archiaci</i>
	<i>S. disjunctus</i> var. <i>lonsdalii</i>
	<i>S. disjunctus</i> var. <i>verneuili</i>
<i>S. anossofi</i>	<i>S. anossofi</i>
	<i>Cyrtia murchisoniana</i>
<i>Schizophoria paronai</i> MARTELLI.	
<i>Productus subaculeatus</i> MURCH.	
	<i>Crania obsoleta</i> GOLDF. ?
<i>Aulopora tubæformis</i> GOLDF.	= <i>Aulopora subcampanula</i> C. REED.
<i>Spirorbis omphalodes</i> GOLDF.	

The present collection contains the following Devonian fossils, which are derived from the provinces of Shen-si, Hu-nan, Sze-chuan, Kiang-si, Kwang-si, Kwei-chou and Yun-nan.

- 1) Ning-chang,¹⁾ Han-chung-fu,²⁾ prov. Shen-si (YAMADA Coll.).

Atrypa reticularis L. var. *richthofeni* KAYSER

A. reticulris L. var. *desquamata* SOWERBY

A. reticularis L. var. *auriculata* HAYASAKA

Rhynchonella parallelepipedæ BRONN

Athyrisina squamosa HAYASAKA var. *rhomboidale* HAYASAKA.

The occurrence of the last species indicates that the marly limestone is older Middle Devonian in age.

- 2) Ling-ling, Yung-chou-fu, prov. Hu-nan; the specimens were submitted to me some years ago by T. OGAWA.

1) Ning-chang = 寧羌

2) Han-chung-fu = 漢中府

Spirifer disjunctus Sow. var. *subarchiaci* MARTELLI

S. disjunctus Sow. var. *verneuili* MURCHSON

Crania obsoleta GOLDF.

Spirorbis omphalodes GOLDF. ? (not described in this paper).

Aulopora subcampanula REED

Monotrypa parasitica KAYSER

This is the well-known *S. disjunctus* fauna of the Upper Devonian.

- 3) Shuang-chin-tang,¹⁾ Tao-chou,²⁾ Yung-chou-fu,³⁾ prov. Hu-nan.

Tentaculites sp.

Probably Devonian.

- 4) Chin-tou-shan,⁴⁾ Ho-lu-kou,⁵⁾ Kiang-hua-hsien,⁶⁾ prov. Hu-nan (NODA Coll. No. 75).

A dark grey bituminous limestone from this locality contains:

Ampipora ramosa PHILL.

Youngest Middle Devonian.

- 5) Between Chia-ho⁷⁾ and Lan-shan,⁸⁾ prov. Hu-nan (ISHII Coll.).

A limestone with a very similar aspect to the preceding one contains numerous slender ramose stocks of a tabulata, probably belonging to a species of *Striatopora*; the limestone being quite decomposed, the specific determination of the fossil by means of thin sections is impossible. This limestone is assigned to Devonian with query. The tabulate coral is not described below.

- 6) West of Men-kan-shan,⁹⁾ Tien-chuen-chou,¹⁰⁾ prov. Sze-chuan (YAMADA Coll.)

Stromatopora eifeliensis NICHOLSON.

Plagiopora cfr. *denticulata* M.-EDWARDS et HAIME.

1) Shung-chin-tang = 双锦堂

2) Tao-chou = 道州

3) Yung-chou-fu = 永州府

4) Chin-tou-shan = 井頭山

5) Ho-lu-kou = 河路口

6) Kiang-hua-hsien = 江華縣

7) Chia-ho = 嘉禾

8) Lan-shan = 藍山

9) Men-kan-shan = 門坎山

10) Tien-chuen-chou = 天全州

Most probably Middle Devonian in age.

- 7) South of Pen-chao-tse,¹⁾ Chao-hua-hsien,²⁾ prov. Sze-chuan (YAMADA Coll.)

Favosites goldfussi M.-EDWARDS et HAIME

Athyrisina squamosa HAYASAKA

Athyrisina squamosa HAYASAKA var. *rhomboidale* HAYASAKA

Middle Devonian.

- 8) Shing-lung-pu,³⁾ Ta-chien-lu-ting,⁴⁾ prov. Sze-chuan (YAMADA Coll.)

Favosites goldfussi M.-EDWARDS et HAIME var. *major* FRECH

Middle Devonian.

- 9) San-toi-pa,⁵⁾ Chao-hua-hsien, prov. Sze-chuan (YAMADA Coll.).

Atrypa reticularis L. var. *richthofeni* KAYSER

Dalmanella striatula SCHLOTH.

Middle Devonian.

- 10) South of Ping-yi-pu,⁶⁾ Pin-wu-hsien,⁷⁾ prov. Sze-chuan (YAMADA Coll.)

Favosites aff. *forbesi* M.-EDW. et H.

Cyathophyllum heterophylloides FRECH

Cyathophyllum coespitosum GOLDF. var. *breviseptatum* FRECH

Middle Devonian.

- 11) Pei-shi-pu,⁸⁾ Pin-wu-hsien, prov. Sze-chuan (YAMADA Coll.)

Favosites sinensis YABE and HAYASAKA

Probably Devonian.

- 12) Kwei-lin,⁹⁾ prov. Kwang-si (ISHII Coll.); exact locality unknown.

Foraminifera (*Nodosaria*, *Lingulina* etc.)

Amphipora ramosa SCHULZ.

A. ramosa is a species characteristic of the so-called *ramosa* bank of Germany, England, etc.; upper Middle Devonian.

1) Pen-chao-tse = 偏橋子

2) Chao-hua-hsien = 昭化縣

3) Shing-lung-pu = 興隆鋪

4) Ta-chien-lu-ting = 打箭爐廳

5) San-toi-pa = 三磊垭

6) Pin-yi-pu = 平驛鋪

7) Pin-wu-hsien = 平武縣

8) Pei-shi-pu = 白石鋪

9) Kwei-lin = 桂林

- 13) Lao-cha-ting,¹⁾ Hsing-an-hsien,²⁾ prov. Kwang-si (NODA Coll.)

Stromatoporoid, gn. et sp. indet.

Striatopora cristata (BLUM.) GÜRICH.

Cyathophyllum heterophylloides FRECH

Alveolites ramosus ROEMER

Chaetetes tenuissimus FRECH

C. heterophylloides was first described from the lower Upper Devonian of Germany and then from the equivalent rock of the Mittelgebirge of Poland; all other fossils, however, indicate Middle Devonian age. As the fossiliferous bed of Central Asia with *Alveolites ramosus* and *Chaetetes tenuissimus* is regarded by FRECH to be of Middle Devonian age, I prefer to assign the Lao-cha-ting fossils to the same age. All the above mentioned fossils are found in a thin purple sandstone intercalated in limestone.

- 14) Mien-tien,³⁾ Shang-shui-tang,⁴⁾ prov. Kwang-si (YAMADA Coll.)

Dalmanella striatula SCHLOTH.

Spirifer zigzag ROEMER var. *undecimplicata* ROEMER

Athyris concentrica v. BUCH

Athyrisina minor HAYASAKA

Middle Devonian.

- 15) Between Wei-ning⁵⁾ and Tou-tang,⁶⁾ prov. Kwei-chou (YAMADA Coll.)

Dalmanella striatula SCHLOTH.

Spirifer disjunctus Sow, var. *verneuili* MURCH.

Upper Devonian.

- 16) Huan-kuo-chi,⁷⁾ Ta-kuan-ting,⁸⁾ prov. Yun-nan (YAMADA Coll.)

Solenopora ? sp.

Cylindrophyllum simplex YABE and HAYASAKA

Alveolites suborbicularis LAM. var. *minor* FRECH ?

1) Lao-cha-ting = 老茶亭

2) Hsing-an-hsien = 興安縣

3) Mien-tien = 麵店

4) Shang-shui-tang = 响水塘

5) Wei-ning = 威寧

6) Tou-tang = 頭塘

7) Huan-kuo-chi = 黃葛溪

8) Ta-kuan-ting = 大關廳

Surely Devonian, probably Middle ?

- 17) Yang-liu-shu,¹⁾ Ta-kuan-ting, prov. Yun-nan (YAMADA Coll.)

Favosites asteriscus FRECH

Cyathophyllum douvillei FRECH var. *sinensis* YABE and HAYASAKA

Middle Devonian.

- 18) Chi-li-pu,²⁾ Ta-kuan-ting, prov. Yun-nan.

Favosites goldfussi M.-EDW. et H.

Middle Devonian.

In the present material, therefore, there are no fossils indicating the Lower Devonian age, unless the *Tentaculites* rock from Shuan-chin-tang may represent this age. On the other hand, the Middle Devonian rocks are represented by their coral and brachiopoda faunas, and the Upper Devonian mostly by brachiopoda fauna. Very few forms of these faunas are found to be new to science, the greater part belonging to cosmopolitan types.

Thallophyta.

Corallinaceæ.

Solenopora, DYBOWSKI.

Solenopora ?? sp.

Pl. XXI., Fig. 7.

The figure shows a part of a small calcareous body in thin section and under high magnification; it appears as if composed of numerous, closely set, fine calcareous filaments, in parallel orientation. The filaments are all of the same breadth and uniform throughout their whole length (0.025 mm. broad). Owing to the recrystallization there is preserved no trace of septa-like structure in the section; it is a question whether such was absent from the body from the beginning. It is, however, very likely that the body was not primarily an aggregate of calcareous filaments, but of calcareous tubes,

1) Yang-liu-shu = 楊柳樹

2) Chi-li-pu = 吉利鋪

like a *Solenopora*; this character being not confirmed in the case of this fossil, I do not venture to assign it to any definite genus, though there is a great probability that we have here a form of *Solenopora* or of its allies.

Locality :—Neighbourhood of Hung-kuo-chi, Ta-kuan-ting, Chao-tung-fu, prov. Yun-nan.

Geol. age :—Devonian.

Foraminifera.

It is a rather striking fact that only a very limited number of the remains of Foraminifera have hitherto been recorded from the Devonian rocks of the world; this is striking, because first the Foraminifera are very abundant in the next younger Carboniferous rocks, and secondly because limestone is common in the Devonian formation everywhere. Hence it deserves special mention that a limestone from Kwei-lin, prov. Kwang-si, with *Amphipora ramosa*, contains many small foraminifera remains, provisionally referable to the genera *Nodosaria* and *Lingulina*; these are shown by the microphotographs on Pl. XXI. (Figs. 1-3).

Coelenterata.

Stromatoporidæ.

Amphipora, SCHULZ.

Amphipora ramosa PHILL.

Pl. XX., Fig. 3.

1872. *Amphipora ramosa* SCHULZ: Die Eifelkalkmulde von Hillesheim, p. 90, pl. XXII., figs. 5, 6; pl. XXII., fig. 1.
 1886-92. *Amphipora ramosa* NICHOLSON: British Stromatoporoids, vol. I, p. 109, pl. IX., figs. 1-4; vol., IV, p. 223, pl. XXIX., figs. 3-7.
 1896. *A. ramosa* GÖRICH: Das Palæozoicum im Polnischen Mittelgebirge, p. 129, pl. I, fig. 5.

Coenosteam in slender, slightly flexuous, cylindrical stems, from 2 to 3 mm. in diameter; traversed by a wide axial tube, $1/3-1/2$ as broad as the stem, and traversed by distant transverse tabulae. General structure of the coenosteam around the central hollow like that of a *Stromatopora s.s.*, composed of very flexuous trabeculae, neither radial pillars nor concentric laminae being recognizable; trabeculae more or less circular in cross section, and 0.18 mm. broad in average; interspace between the trabeculae very irregular, sometimes narrower and sometimes broader than, or almost equal to the trabeculae in breadth, and almost free from tabulae.

This species is said to be very variable in structure; the stems often show no axial canal, these being considered by FELIX to represent older branches. Certain stems, on the other hand, show a peripheral zone with large intertrabecular spaces; this zone is shown by none of the stems that appear in my microscopical section. We have compared the Chinese material and the typical specimens of the species from England and Moravia¹⁾ in thin sections, and confirmed their identity.

Locality:—Kwei-lin, prov. Kwang-si; Chin-lou-shan, Ho-lu-kou, Kiang-hua-hsien, prov. Hu-nan.

Very common in the Devonian rocks of England, Germany, Moravia and the Mittelgebirge of Poland; characteristic of the upper part of the Middle Devonian (*ramosa*-beds).

Stromatoporella, NICHOLSON.

Stromatoporella eifeliensis NICHOLSON.

Pl. IX., Fig. 10.

1892. *Stromatoporella eifeliensis* NICHOLSON: Brit. Foss. Stromatoporeoids. P. 208, pl. IV., fig. 2; pl. VII., fig. 3; pl. XI., figs. 1, 2; pl. XXVII., figs. 1, 2, 3.

1) This is a part of the original specimen of *A. ramosa* from Moravia described by Prof. FELIX in Leipzig; it was through his courtesy that I got a piece of the rock for microscopical study, during my short stay in Leipzig some years ago. I take this occasion to express my hearty thanks to Prof. FELIX.

1896. *S. eifeliensis* GÜRICH: Das Palaeozoicum im Polnischen Mittelgebirge, p. 117.
1890. *S. eifeliensis* NICHOLSON and HINDE: Western Australian Fossils. Geol. Mag., London. dec. III, vol. VII, p. 193, pl. VIII., figs. 7 a-c.
1908. ? *S. eifeliensis* COWPER REED: Devonian Fauna of the northern Shan States. Pal. India, N. S., vol. II., Mem. 5, p. 34, pl. IV., fig. 18.

Encrusting *Stromatoporella*, forming crust a little more than 5 mm. thick; surface undulating, though without showing any conspicuous eminences; astrorhiza well developed. 5 layers of horizontal calcareous skeleton and the corresponding number of the interspaces in 2 millimeters. Horizontal layer of the calcareous skeleton rather thick, being almost similar to their interspaces. Vertical pillars short, not continuous through two succeeding interspaces; of nearly the same thickness with the horizontal component of the calcareous skeleton. Tabulae extremely rare.

Obs.:—From the middle Devonian of Gerolstein in Eifel, Germany, the senior author once collected 3 parasitic forms of *Stromatoporella*, two of which belong to the already known species, *S. eifeliensis* NICH. and *S. curiosa* BARG.,¹⁾ while the third seems to represent a new species. In the internal structure, the first two are very allied to each other, both composed of horizontal layers of similar thickness, in alternation with interspaces of nearly the same breadth; in both, the interspaces are seldom interrupted by tabulae. These tabulae are exceedingly well developed in the third species which is further characterized by having the calcareous skeleton somewhat coarser in texture, its horizontal layers being separated by interspaces distinctly much wider than in the other species. The surface of the species shows often tuberosity, but the tubercles do not develop so prominent as in *S. curiosa*. *S. eifeliensis*, on the other hand, has its surface smooth and destitute of mamelons.

The single specimen from China, which is well preserved, agrees exactly in all essential features of the calcareous skeleton with the specimens of *S.*

1) NICHOLSON: Brit. Foss. Stromatoporoids, p. 213, pl. XXVIII, figs. 1-3. BARGATZKY: Die Stromatoporen des Rheinischen Devons. p. 55. 1881.

eifeliensis and *S. curiosa* from Gerolstein at hand; as it is not provided with any sharp eminences, on its surface, the writers believe they are justified in referring it to *S. eifeliensis*.

S. eifeliensis is a fossil common in the *Calceola* beds of Eifel; it is also known from the contemporaneous deposits of Poland, of Daheha on the Araxes¹⁾; and a very similar form is recorded from the Middle Devonian Padaukpin limestone of northern Shan States. Further, it is recorded from the Devonian of Western Australia.

Locality:—West of Men-kan-shan, Tien-chuen-chou, prov. Sze-chuan.

Geological Horizon:—Middle Devonian.

Tabulata.

Chaetetidæ.

Chaetetes FISCHER.

Chaetetes tenuissimus FRECH.

1885. *Chaetetes tenuissimus* FRECH: Nachtrag zu Korallenfauna des Oberdevons in Deutschland. Z. d. deutsch. geol. Gesell., vol. XXXVII., p. 954, figs. 14-16.

1894. *Ch. tenuissimus* FRECH: in SUESS' Beiträge zur Stratigraphie Centralasiens. Denksch. Mat.-Nat. Kl. K. Akad. d. Wiss., Wien, vol. LXI, p. 12.

1911. *Ch. tenuissimus* FRECH: in RICHTHOFEN's China, vol. V., p. 50.

Colony forming a thin crust, hardly 1.5 mm. thick, over a subsphaeroidal colony of *Alveolites ramosus*. Cells straight, columnar, polygona in cross sections, and surrounded by a rather thin wall; very narrow, numbering about 50 in a space of 10 mm. Tabulae numerous 0.18 mm. distant on an average, nearly straight or slightly concave above.

Under microscope, the Chinese specimen is quite identical with *Ch. tenuissimus* from the Middle Devonian of Eifel. The G. I. S. Collection

1) FRECH u. ARTHABER: Ueber das Palaeozoicum in Hocharmenien und Persien, p. 29.

contains a few specimens of this species from this locality collected by the senior author and identified by him with the type specimens of this species in the possession of Prof. FRECH. It is interesting to note, that FRECH found this species, in the collection of Devonian fossils from Tshon-Terek, incrusting *Alveolites ramosus* FRECH.

Locality :—Lao-sa-tei, Hsing-an-hsien, Kwei-lin-fu, prov. Kwang-si. The foreign localities of this species are Eifel in Germany (Upper Calceola beds) and Tshon-Terek, in the Tojun valley on the southern side of Tien-shan in Central Asia (Middle Devonian).

Favositidæ.

Alveolites LAM.

Alveolites ramosus A. ROEMER.

Pl. XV., Figs. 3a, 3b (core).

1885. *Alveolites ramosus* FRECH: Die Korallen des Oberdevons in Deutschland. Reprint of Zeitsch. d. deutsch. geol. Gesell., vol. XXXVII, p. 44, pl. XI., fig. 8.

1894. *A. ramosus* FRECH: in SUESS' Beiträge zur Stratigraphie Centralasiens. Denksch. Mat.-nat. Klasse K. Akad. Wiss., Wien, vol. LXI, p. 13, fig. 4.

1911. *A. ramosus* FRECH: in RICHTHOFEN's China, vol. V., p. 52, pl. 7, fig. 12.

The specific diagnosis of *A. ramosus* is given by FRECH as follows:

“Die Koralle bildet wenig verästelte Bäumchen oder knollenförmige, aus concentrischen Lagen aufgebaute Massen, welche zuweilen auch die regelmässig linsenförmige, für *Alveolites suborbicularis* charakteristische Gestalt annehmen. Die Röhren erscheinen im Querschnitt nahe der Oberfläche stark in die Länge gezogen: sie sind etwa viermal so lang als breit und unregelmässig in einander verschlungen. Im Inneren der Koralle ist in Folge der gegenseitigen Compression der Umriss mehr rundlich. In seitlichen Tang-

gentialschnitten erscheinen die Kelche durchweg parallel in einer Richtung gestreckt und haben ganz das Aussehen von feinen Leinengewebe. Die Wände der Röhren sind kräftig, nach der Mündung zu nicht verdickt und nur selten von Poren durchbohrt. Die Böden sind weniger zahlreich als bei *A. suborbicularis*. Die Septaldornen sind unregelmässig entwickelt und machen durch ihr vereinzelttes Auftreten das Bild des Querschnitts noch krauser und verworfener."

The present specimen from China, which forms a subspherical colony and shows concentric layers in cross section, exhibits all the features characteristic of the named species; there is no need of other special comment concerning the specimen.

The colony attains 2.5 cm. in diameter.

A. ramosus of MANSUY from the Upper Devonian of Ta-hi-ti seems specifically different from the present form; his species forms a stock of lamellar extension. By this feature as well as the external and internal aspects of its corallites, his specimen approaches the next species more than *A. ramosus*.

Locality:—Lao-chä-ting, Hsing-an-hsien, Kuei-lin-fu, Prov. Kwang-si. The foreign localities of this species are Harz in Europe (Lowest Upper Devonian); Tshon-Terek, Tojun-valley, on the southern side of Tien-shan in Central Asia (Middle Devonsian); through the courtesy of Prof. F. FRECH, the senior author had the opportunity of examining the specimens from these localities in the University of Breslau.

***Alveolites suborbicularis* LAM. var. *minor* FRECH?**

Pl. XV., Figs. 2a-b.

Cfr.—

1853. *Alveolites suborbicularis* M. EDWARDS et HAIME: British Fossil Corals p. 219, pl. XLIX., figs. 1, 1a.

1) MANSUY: Nouvelle contribution a la Paléontologie du Yunnan, p. 5, pl. I., figs. 5 a-c, 6.

1879. *A. suborbicularis* NICHOLSON: Tabulate Corals, p. 126, pl. VI., figs. 2, 2 a, 2 b.
1883. *A. suborbicularis* F. ROEMER: Lethaea Geognostica, p. 442, pl. XXVI., figs. 4 a, 4 b.
1885. *A. suborbicularis* FRECH: Die Korallenfauna des Oberdevons in Deutschland, p. 108, pl. VII., fig. 2.
1889. *A. suborbicularis* TOLL: Wissenschaftliche Resultat der zur Erforschung des Janalandes und der Neusibirischen Inseln ausgesandten Expedition, p. 28, pl. IV., figs. 2 a, b.
1900. *A. suborbicularis* var. *minor* FRECH and ARTHABER: Das Palaeozoicum im Hocharmenien und Persien. Beitr. z. Palaeontologie und Geologie Oesterreich-Ungarns u. des Orients, vol. XII., p. 188, text-fig. 40.
1902. *A. suborbicularis* N. LEBEDEV: Die Bedeutung der Korallen in den Devonischen Ablagerungen Russlands, p. 145, pl. I., figs. 6, 7.
1908. *A. suborbicularis* COWPER REED: Devonian Faunas of the northern Shan States, p. 20, pl. IV., figs. 3, 4, 4 a.
1912. ? *A. suborbicularis* MANSUY: Étude Géologique du Yun-nan oriental, Paléontologie, p. 64, pl. XI., fig. 9, pl. XII., figs. 1 a, b.

"Corallum forming masses of considerable size and variable form, consisting of concentrically superposed layers, attached parasitically to some foreign body, and having an elevated surface. Corallites very oblique, compressed, mostly subtriangular, with a long convex and two short concave sides, but very variable in form, though never regularly polygonal or cylindrical. Long diameter of the tubes about one-third of a line. Wall moderately but not excessively thick, not incrassated towards the terminations of the tubes, and pierced by few remote mural pores. Septa represented only by a single longitudinal ridge, which does not appear to be constantly present. Tabulae numerous, close-set, horizontal, complete."

The above specific diagnosis of this species was given by NICHOLSON who confined the species-name to the gibbous form, composed of successive concentric strata enveloping some central foreign body; this author hence tended

to exclude from this species other specimens which "form flattened or sub-hemispherical expansions, having their under surface covered by a wrinkled epitheca, attached to some foreign object by a pedunculate base, having the calices confined to the upper surface only, and not exhibiting any composition of the corallum out of concentric layers." FRECH, on the other hand, stated that the corallum of this species forms lenticular or irregular masses, composed of concentric layers.

FRECH distinguished var. *minor* of this species; this variety is characterized by being composed of much smaller corallites; the corallites of the type-form measure 1-1.25 mm. along the longer diameter, and 0.75 mm. along the shorter; while those of var. *minor* are only a half or one-third as large as the former. Further the mural pores are said to be numerous in the varietal form, though they are seldom present in the type form.

The figured specimen from China forms a colony of flattened expansion, apparently composed of a few concentric layers, and provided with calices restricted to the upper, somewhat concave, side only. The calices are very oblique; the corallites are depressed trigonal, attaining 0.36 mm. along the longer diameter and 0.15 mm. along the shorter; the calices are almost free from septa, provided with a few mural pores and numerous straight, complete tabulae, and surrounded by the wall which is never much thickened. Hence it is essentially a small-celled *A. suborbicularis*, and is provisionally referred to var. *minor* FRECH, although distinguished from the latter by having less numerous mural pores.

Locality:—Neighbourhood of Hung-kuo-chi, Ta-kuang-ting, Chao-tung-fu, prov. Yun-nan; found together with *Cylindrophyllum simplex* YABE and HAYASAKA.

Geological horizon:—Devonian.

Alveolites suborbicularis is known from the Middle Devonian of England, Devonian of France, Belgium, Spain, Germany, Poland, Central Russia, Urals, Petshora-Land, Transcaucasia, Altai, western and northern Siberia, northern Shan States, and Tchao-kwa, prov. Yun-nan. The same, or a closely allied species is also known from the Devonian of North

America. Var. *minor* is found in the Devonian of Armenia and the northern Shan States.

Favosites, LAM.

Favosites asteriscus FRECH.

Pl. IX., Figs. 7 a-b.

1899. *Favosites asteriscus* FRECH: Palaeozoische Korallen, in L. v. Lóczy's Wiss. Ergebn. d. Reise d. Grafen BÉLA Szécheny, p. 232, pl. VIII., figs. 3, 3 a.
1911. *Favosites asteriscus* FRECH: in RICHTHOFEN's China, fol. V., p. 47, pl. IX., figs. 2 a-c.
1915. *F. asteriscus* YABE and HAYASAKA: Palaeozoic Corals from Japan, Korea and China, p. 62.

Corallum massive, large, more or less discoidal, composed of numerous long corallites. Corallites straight, prismatic, always in complete contact; narrow, varying from 1 to 1.5 mm. in diameter; subangular in cross section, owing to non-uniformity of the wall in thickness; usually 4-6 sided. Mural pores few in number, but pretty large. Where three or more corallites come in contact, walls often become much thickened and appear translucent, thus giving rise to the appearance of lucid asterisks at almost all angles of the polygons in cross section. Tabulae numerous, more or less irregularly distributed, about 12 in a space of 5 mm., thin, sometimes very undulating, often incomplete and rarely coalescing. Septal spines rare, usually obsolete and seldom developing to long spines, one or two rows of them being found in a number of corallites, but not in all.

Obs.—This is *Favosites asteriscus* of FRECH, first described from the Devonian of Hoa-ling-pu, prov. Sze-chuan and characterized by beautiful lucid asterisks in cross section and numerous undulating and often incomplete, in-osculating tabulae, reminding of those of *Emmonsia hemisphaerica*, in longitudinal section; the first mentioned feature seems also really to be constant, because it is very characteristically exhibited by our example from quite a

new locality. Its real significance, however, is not quite clear to us, and hence we find ourselves justified temporally in following FRECH in putting the species in the genus *Favosites*.

FRECH mentioned that the translucent star-like thickening of the wall occurs only where four or more frequently five corallites come in contact, but never in the case of three (cfr. Pl. IX., fig. 2a in RICHTHOFEN'S China vol. V.). We found, however, rather frequent examples of this in our specimen; such slight difference being of course of no importance for the specific demarcation, we refer our specimen to the named species.

Locality and Geological Age :—FRECH found this species from the Middle Devonian of Hwa-ling-pu, prov. Sze-chuan; the single specimen at our disposal was collected by Prof. K. YAMADA of Kyoto Imperial University, at Yang-liu-shu, Ta-kuan-ting, prov. Yun-nan, in association with *Cyathophyllum Douvillei* FRECH. This association confirms the view of FRECH regarding the geological age of the coral limestone with *F. asteriscus* of Hwa-ling-pu.

***Favosites goldfussi* M.-EDWARDS ET HAIME.**

Pl. IX., Figs. 1 a-b, 2 a-b.

1915. *F. goldfussi* YABE and HAYASAKA : Palaeozoic Corals from Japan, Korea and China, p. 64.

It is not our present purpose to recapitulate in this place the discussion concerning the much disputed problem referring to the specific identity or distinction of the Devonian *F. goldfussi* and the Silurian *F. gotlandicus*. As a matter of fact, the slight difference of corallum in general form, of corallites in average size, of mural pores in distribution, of septal spines in development, as mentioned by M.-EDWARDS and HAIME,¹⁾ ROEMER,²⁾ FRECH³⁾ and GÜRICH,⁴⁾ are in fact not seldom found insufficient for their separation, so that there are still many followers of NICHOLSON'S⁵⁾ view.

1) M.-EDWARDS and J. HAIME: Brit. Foss. Corals.

2) FERD. ROEMER: op. cit.

3) F. FRECH: Die Cyathophylliden u. Zaphrentiden d. deutsch. Mitteldevon, Pal. Abhandl. vol. III., No. 3. 1886, etc.

4) G. GÜRICH: Leitfossilien, I., 1908 and II., 1909.

5) A. NICHOLSON: op. cit.

The senior author had an opportunity, in 1908, to compare the specimens from China with the rich material of *Favosites* preserved in the Geological Institute of the University of Breslau, with the kind sanction of Prof. F. FRECH, and found certain specimens of *F. goldfussi* from the Middle Devonian of Eifel macroscopically and microscopically almost indistinguishable from the Chinese specimens. One of the latter, in a small longitudinal section, shows very crowded tabulae and appears somewhat different from the other; but the large collection of Breslau has shown that both may belong to one and the same species. At present we have, in the collection of the Geological Institute of Sendai, numerous specimens of *Favosites* from Europe (mostly from Gotland, Eifel and Bohemia) and North America collected by one of us; detailed comparison of the Chinese specimens with them has led us also to the same conclusion, namely, that the former belong to *F. goldfussi* and not to *F. gotlandicus*.

One of our specimens, from Pen-chao-tse, Cho-hua-hsien, prov. Szechuan is a massive corallum composed of corallites nearly uniform in size, and about 2.5 mm. in diameter, and almost always hexagonal, seldom pentagonal or tetragonal in cross section. The wall of the corallites is thin and without any trace of septal spine; the tabulae are almost flat, counting 6-7 in a space of 5 mm. The mural pores are relatively large.

The second specimen, from Chi-li-pu, Ta-kuan-ting, prov. Yun-nan, is distinguished from the preceding one by having an indefinite number of septal spines which are preserved in a state hardly recognizable as such, and by very crowded tabulae.

Locality :—South of Pen-chao-tse, Chao-hua-hsien, prov. Szechuan, and Chi-li-pu, Ta-kuan-ting, prov. Yun-nan.

Geological Age :—Middle Devonian.

Favosite goldfussi M-EDWARDS et HAIME var. MAJOR FRECH.

Pl. IX., Figs. 3 a-b.

1899. *F. goldfussi* var. *major* FRECH: Pal. Korallen in L. v. Lóczy's Wiss. Ergebn. d. Reise d. Graf. SZÉCHENY, p. 232, pl. VIII., figs. 1, 1a.

1911. *F. goldfussi* var *major* FRECH : in RICHTHOFEN'S China, vol. V., p. 46, pl. IX., figs. 3 a-3 e, 4 a.

1915. *F. goldfussi* var. *major* YABE and HAYASAKA : Palaeozoic Corals from Japan, Korea and China, p. 65.

FRECH distinguished variety *major* from the typical form of *F. goldfussi*, on account of a constant difference of their corallites in diameter. The present specimen from Ta-chien-lu agrees quite well with the illustration of the former given by the author, the corallum being massive and composed of corallites which are uniform in size and generally measure as much as 5 mm. The spines are well but irregularly developed ; the mural pores are large, and arranged in two opposite rows. In our specimen, the tabulae are somewhat more closely set than in the original one ; they are always complete and almost always horizontal.

Locality :—According to FRECH, this variety is found from Hwa-ling-pu, prov. Sze-chuan, and Grottenberg near Bredelar in Westphalia ; the specimen now at our disposal is from Shing-lung-pu, Ta-chien-lu-ting, prov. Sze-chuan, and found together with an undeterminable species of *Striatopora*.

Geological Age :—Middle Devonian.

Favosites aff. forbesi M.-EDWARDS et HAIME.

Pl. IX., Figs. 5 a-b.

1854. *F. forbesi* M.-EDWARDS and HAIME : Brit. Fossil Corals. p. 258. pl. LX., figs. 2, 2a-2g.

1876. *F. tuberosus* ROMINGER : Fossil Corals of Michigan. p. 30, pl. IX., figs. 1-2.

1879. *F. forbesi* NICHOLSON : Palaeozoic Tabulate Corals. p. 56. pl. I., fig. 7 ; pl. II., figs. 1-3 ; pl. III., figs. 1, 2.

1882. *F. forbesi* LINDSTROEM : Silurische Korallen aus Nord-Russland und Sibirien. p. 6, etc.

1894. *F. forbesi* W. WEISERMEL : Silurgeschiebe Ostpreussens, etc. p. 468, pl. III., Fig. 1.

1902. *F. forbesi* P. POČTA: Anthozonaires et Alcyonaires in J. BAR-
 RANDE'S Système Silurien. p. 239, pl. LXXVII, figs. 5-9; pl. C,
 figs. 1-16.
1915. *F. aff. forbesi* YABE and HAYASAKA: Palaeozoic Corals from Japan,
 Korea and China, p. 67.

Corallum massive, composed of numerous prismatic or subcylindrical corallites of very varied diameter; the larger ones, often 2.5 mm. wide, are relatively few in number and intercalated in numerous smaller ones, which are very variable in diameter (some hardly attaining 0.5 mm.). Septal spines blunt, irregularly distributed, and often obsolete.

Obs.—This characteristic species of *Favosites*, easily distinguishable from the allied forms by its unequal corallites, appears also to be represented in our collection of the Chinese fossils. The typical form of the species is usually believed to be confined in Silurian rocks, but many varietal forms of it occur in the Devonian. Thus NICHOLSON¹⁾ described a form somewhat resembling the Chinese specimen, from the Middle Devonian of Gerolstein in Eifel, as of its variety, although this is now usually regarded as identical with *F. goldfussi* on the authority of FRECH and not allied to *F. forbesi*. More recently, however, POČTA,²⁾ finding some varieties of the latter in the Devonian F 2 of Konjeprus in Bohemia, put the occurrence of the coral of this type in Devonian rocks beyond doubt. The present specimen which is also no doubt of the Devonian age (being found in association with *Cyathophyllum caespitosum* GOLDF. var. *breviseptata* FRECH and *C. heterophylloides* FRECH), appears very similar to, if not quite identical with, the typical form of *F. forbesi* from Silurian. Owing to the want of material enough for the more detailed comparison, we think it premature to settle the question regarding their specific identity.

Locality:—South of Ping-yi-pu, Pin-wu-hsien, prov. Kiang-si. This species is recorded from the Silurian rocks of Europe, Asia, North America, Australia, and from the Devonian of Bohemia.

Geological Age:—Middle or Upper Devonian.

1) A. NICHOLSON: op. cit., p. 61, pl. II., Fig. 3; pl. III., Figs. 1-1b.

2) P. POČTA: op. cit., p. 241.

Favosites sinensis YABE and HAYASAKA.

Pl. VIII., Figs. 2 a-c.

1915. *F. sinensis* YABE and HAYASAKA: Palaeozoic Corals from Japan, Korea and China, p. 63.

Corallum cylindrical, about 25 mm. thick; composed of numerous sub-prismatic corallites, arranged almost vertically along the imaginary axis, then curving outward and finally emerging at or nearly at right angles to the surface. Corallites almost uniform in size, measuring about 1.5 mm. in diameter; polygonous, six-sided ones most predominating among them. Mural pores considerably large, arranged in a single row. Neither septal spines nor squamulae preserved. Tabulae numerous, 7-8 in a space of 5 mm., complete and very regularly horizontal, appearing in same levels all across the corallites. Walls very thick, gradually thinning out from the surface inward.

Obs.—This species, characterized by the concentric arrangement of tabulae, much resembles *Pachypora* in its general mode of growth. All species of *Pachypora*, however, have the corallites abruptly thickened near the surface, and the tabulae, in general, very reduced in number; but this is not the case in our species. There is in fact none of the forms of *Favosites* and *Pachypora*, so far as we are acquainted with, which is liable to be mistaken for this species.

Locality:—Pei-shi-pu, Ping-wu-hsien, Lung-ngan-fu, prov. Kiang-si.

Geological Age:—Devonian.

Striatopora, HALL.

A certain confusion prevails regarding the specific and generic nomenclature of the ramose Favositoid corals, which are very common in Devonian rocks and generally pass under the name of *Pachypora*. This generic name was first proposed by LINDSTRÖM for his *P. lamellicornis* from the Gotlandian of Gotland, and the author refused decidedly to extend this generic name to such Devonian species as are to be enumerated below; FRECH, on the other hand, maintained that the *Pachyporae* are nothing else than *Favosites* with

a thickened cell-wall near the surface of the corallum, simply in response to the ramose growth.

The ramose *Favosites*, or *Pachypora* of many authors, are very common, for instance, in the Devonian rocks of Rheinland, Germany, and among them, FRECH distinguished four species, *F. polymorpha* GOLDF., *F. reticulata* BLAINV., *F. cristata* E. et H., and *F. nicholsoni* FRECH. According to this author, *F. polymorpha* is characterized by its tuberous or branching corallum, the corallites of which are 0.8–2.0 mm. in diameter, crossed by numerous tabulae, but provided with no spines. *F. cristata*, on the other hand, is distinguished from the former by its corallites being traversed by but few tabulae and surrounded by a much more thickened wall. In *F. reticulatas*, the corallum branches copiously, sometimes anastomosig, and its corallites which never exceed 1 mm. in diameter, are provided with numerous spines. Lastly *F. nicholsoni* with a corallum similar in habitus to that of *F. reticulatas*, is characterized by having corallites with the wall thickened by secondary sclerenchymatous deposits which are more developed than in any of the preceding species.³⁾

The corals described by M'EDWARDS and HAIME under the names *F. cervicornis*⁴⁾ and *F. reticulata*⁵⁾ in the "British Fossil Corals" are according to FRECH specifically identical with his *F. polymorpha*; while his *F. nicholsoni* is based on *F. cervicornis* described by NICHOLSON from Gerolstein.⁶⁾

The name *F. nicholsoni* was, however, subsequently withdrawn by GÜRICH,⁷⁾ after consultation with FRECH, this being considered essentially identical with *F. reticulatus*. GÜRICH further transferred *F. cristata* of FRECH from the genus *Favosites* to *Striatopora*; the latter genus is distinguished by the circular apertures of its corallum, which sink more or less deeply below

- 1) G. LINDSTRÖM: Beschreibung einiger Obersilurischer Korallen aus der Insel Gotland. Bihang till K. SVENSKA Vet.-Akad. Handlingar, vol. XXI., 1895, p. 28.
- 2) F. FRECH: Die Korallenfauna des Oberdevons in Deutschland, p. 100.
- 3) F. FRECH: l.c.
- 4) M'EDWARDS and HAIME: British Fossil Corals, p. 216, pl. XLVIII., fig. 2.
- 5) M'EDWARDS and HAIME: l.c. p. 215, pl. XLVIII, figs. 1, 1a, 1b.
- 6) A. NICHOLSON: On the Structure and Affinities of the Tabulate Corals of the Palaeozoic Period, 1879, p. 82, pl. IV., figs. 3–3d.
- 7) GÜRICH: Das Palaeozoicum im Polnischen Mittelgebirge, 1896, p. 135.

the general surface and open at the bottom of an expanded polygonal cup, showing rudimental septal ridges on the bottom of the calices; further in *Striatopora*, the corallites are oblique to the surface of the corallum. The distinction of *Striatopora* from *Favosites* (*Pachypora*) is by no means easy, when the specimens at hand are worn on the surface; in thin section, *Striatopora cristata* is easily liable to be confounded with *F. reticulata*.

Striatopora cristata (BLUM.) GÜRICH.

Pl. XII., Fig. 3; Pl. XIX., Fig. 11.

1896. *Striatopora cristata* (BLUM.) GÜRICH: Das Palaeozoicum im Polnischen Mittelgebirge, p. 137.

1909. *S. cristata* (BLUM.) GÜRICH: Leitfossilien, Dévon, p. 105, pl. XXXII., figs. 3, 3a.

=*Favosites* or *Pachypora cristata* of many authors.

Two small pieces of ramose coralla are assigned to the genus, on account of their corallites being set very obliquely to the surface, though another essential feature of the genus—the cup shaped calices with septal striae on the floor—is not seen on either of these specimens. The larger specimen of the two is 7 mm. broad, and compared with *F. reticulatus* of the same diameter, it possesses corallites somewhat larger in diameter and appearing less crowded; it is in these features that the present examples approach *Striatopora cristata* rather than *Pachypora reticulata*.

Pl. XIX, Fig. 11, shows a ramose corallum in cross section from the piece of the same rock in which the other two are found; it is very probable that the former belongs also to the same species as the latter, though there are no characteristics by which it is distinguished from *P. reticulata* in thin section of the same orientation.

Striatopora cristata, as defined by GÜRICH, occurs in the Middle Devonian deposits of Rheinland and Poland; it is not clear that all or any of the fossils previously called by the name *Pachypora* or *Favosites cristata* really represent this species; the fossils bearing this name are known from Devonian and Gotlandian rocks of various parts of the world.

Locality :—Lao-sa-tai, Hsing-an-hsien, prov. Kwang-si ; found together with *Cyathophyllum heterophylloides* FRECH, *Alveolites ramosus* ROEMER and *Chaetetes tenuissimus* FRECH.

Geological age : Middle Devonian.

Plagiopora, GÜRICH.

Plagiopora cfr. *denticulata* M. EDWARDS et HAIME.

Pl. IX., Fig. 10.

1896. *Plagiopora denticulata* GÜRICH : Das Palaeozoicum im Polnischen Mittelgebirge, p. 144.

1906. *P. denticulata* GÜRICH : Leitfossilien, Devon, p. 105, pl. XXXII., fig. 4.

(On the preparation by YABE and HAYASAKA of the article on Palaeozoic corals from Japan, Korea and China, published in the Journal of the Geological Society of Tokyo, vol. XXII., 1915, a great mistake was made by a curious confusion in our notes, and the present species was there described under the name *Striatopora* cfr. *subequalis* M.-EDWARDS et HAIME. The remarks given in that paper concerning this species must be withdrawn and replaced by the following lines).

In the Palaeozoic fossils from China now at our disposal there is a single specimen belonging to the genus *Plagiopora* ; the specimen was, however, wholly encrusted with a colony of *Stromatoporella eifeliensis* NICHOLSON, and first came to sight after the specimen was sliced for the study of the latter form. By means of this section only, it is almost impossible to make any definite specific diagnosis of the *Plagiopora* ; but the Chinese form agrees very well in the form and size of its corallum, in the form and size of the apertures of its corallites, in the degree of the thickening of the wall, and in the frequency of the septal spines and tabulae with *Striatopora* (now *Plagiopora*) *denticulata* from the *Stringocephalus* limestone of Bergisch Gladbach near Köln. This direct comparison of both the sections was made by the senior author in the Geological Institute of Breslau with the kind permission of Prof. F. FRECH.

A similar form was lately described by MANSUY from Ta-hi-ti in prov. Yun-nan under the name *Alveolites* cfr. *denticulatus* M.-EDWARDS et H.

Locality:—West of Men-kan-shan, Tien-chuen-chou, Ya-chou-fu, prov. Sze-chuan (together with *Stromotoporella eifeliensis* NICHOLSON.)

Geological horizon: Middle Devonian.

Auloporidæ.

Aulopora GOLDF.

Aulopora subcampanulata COWPER REED.

1853. *Aulopora tubæformis* DAVIDSON: Fossil Brachiopoda from China. Quart. Journ. Geol. Soc. London, vol. IX., p. 358, pl. IX, fig. 16.
1886. *A. tubæformis* STUCKENBERG: Materialien zur Kenntniss der Fauna der devonischen Ablagerungen Sibiriens. Mém. Acad. Imp. des Sci. de St. Pétersburg, ser. VII., vol. XXXIV., No. 1, p. 13, pl. II., fig. 9.
1902. *A. tubæformis* MARTELLI: Il Devoniano sup. dello Schensi. Bol. Soc. Geol., It., vol. XXI., p. 368, pl. XIV., fig. 4.
1908. *A. subcampanulata* COWPER REED: Devonian Faunas of the northern Shan States. Pal. Indica, n.s., vol. II., Mem. No 5, p. 29, pl. IV., fig. 12.
1913. *A. subcampanulata* G. PELLIZZARI: Fossili Paleozoici antichi dello Scenci (Cina). Riv. Ital. di Pal. vol. XIX., p. 44, pl. I., fig. 1.

Davidson described an *Aulopora* from Kwang-si in the following way:

"A slightly produced crooping polypidium, adhering to shells or to other marine objects, and composed of a succession of trumpet-shaped, tapering, divaricated tubes, fixed by all their length, more elevated at their broadest extremity, which is perforated by a circular or ovular aperture; the gemmation takes place near the calyx, either on the same line as the parent cell, or laterally; the average length of each polypidium slightly exceeds 21 lines, and the greatest width near the calyx does not much surpass 1 line."

1) H. MANSUY: Nouvelle contribution a la Paléontologie du Yun-nan. Mém. Serv. Géol. de l'Indochine, vol. III., fasc. 2, p. 6, pl. I., fig. 8 a, b.

COWPER REED stated that this fossil, as well as those which have been described by STUCKENBERG from Siberia and by WENJUKOW from Russia under the same specific name, seems to him probably to be identical with his new species *A. subcampanulata* from the Middle Devonian of the Northern Shan States. According to COWPER REED, *A. tubæformis* GOLDFUSS, in the original sense of GOLDFUSS, is quite distinct from *A. subcampanulata*; the latter, being characterised by its large non-interlacing branches, with suddenly expanding calices, stands nearer *A. campanulata* MCCOY than any other European Devonian species.

The single specimen at hand which is attached on a *Spirifer* is provisionally referred to this species; the specimen is too imperfect for drawing.

Localities: Ling-ling, Yung-chou-fu, prov. Hu-nan (OGAWA Coll.). DAVIDSON described it from prov. Kwang-si, MARTELLI and PELLIZZARI from Schen-si, STUCKENBERG from Siberia, WENJUKOW from Russia, and COWPER REED from the northern Shan States.

Geological Age: Middle to Upper Devonian.

Incertæ Sedis.

Cylindrophyllum, YABE and HAYASAKA.

1915. *Cylindrophyllum* YABE and HAYASAKA: Palaeozoic Corals from Japan, Korea and China, p. 90.

Corallum composite, fasciculate; corallites long, erect, subparallel, only in contact at the point of gemmation; surface of the corallites transversely wrinkled and finely striated. No septa nor septal spines at all. Tabulae complete, moderately close, horizontal. Multiplied by lateral gemmation.

Obs.—The complete absence of septa is a characteristic very peculiar of the genus, which otherwise strikingly resembles *Fletcheria* M.-EDW. et HAIME. The latter, based on an upper Silurian coral *F. tubifera*, has the corallum similarly composed of subparallel, cylindrical corallites, multiplying by calicinal gemmation (?) and united laterally, neither by connecting tubes as in *Syringopora*, nor by mural expansions as in *Thecostegites*. Its wall is strong, being

surrounded by a thick epitheca. Tabulae complete and horizontal, well developed; septa rudimentary.

LAMBE¹⁾ referred more lately *Columnaria incerta* BILLINGS from the Chazy limestone of Canada to *Fletcheria*; according to this author, there are also in its corallites what appear to be very small spiniform septa, though such are not represented on the figures given by him, drawn in 5 × nat. size. Doubtless, therefore, the septa in the species, if they really exist, are of very diminutive size. In the present specimen from China, there is, on the contrary, absolutely no indication of the trace of septa in the inside of the corallites, in spite of the excellent preservation of the specimen. Nor is such indicated by fine vertical striae on the outer surface of the corallites, as sometimes happens.

The systematic position of *Fletcheria* is very variously interpreted; ROMINGER²⁾ took it to be identical with *Cannopora* (*Syringopora*) and NICHOLSON³⁾ probably identical with *Vermipora*, while LAMBE⁴⁾ put it near *Romingeria*.

The microscopical structure of the wall of the Chinese form agrees well with that of a *Syringopora*, though there is no secondary calcareous deposit in the interior of the corallites, so common in *Syringopora*. Nevertheless, we are not ready at once to accept the close relationship between *Cylindrophyl- lum* and *Syringopora*; it is indeed not quite excluded that the former may finally find its natural position among Cyathophylloid corals.

Type species:—*Cylindrophyl- lum simplex* nov. sp.

***Cylindrophyl- lum simplex*, YABE and HAYASAKA.**

Pl. VI., Figs. 3 a-b.

1915. *C. simplex* YABE and HAYASAKA: Palaeozoic Corals from Japan, Korea and China, p. 91.

Specific diagnosis as the generic; corallite 4-5 mm. in diameter, 6 tabulae in a space of 5 mm. in the mean.

1) L. M. LAMBE: op. cit., 1899. p. 48, pl. I., figs. 8, 8a. 9.

2) C. ROMINGER: Geological Survey of Michigan, vol. III., 1873-1876. Palaeontology, p. 86, pl. XXXIII., fig. 4.

3) H. A. NICHOLSON: Pal. Tab. Corals, 1879. p. 206.

4) L. M. LAMBE: op. cit. 1899.

Locality :—Neighbourhood of Hung-kuo-chi, Ta-kuan-ting, Chao-tung-fu, prov. Yun-nan.

Geological Age :—Devonian.

Tetracoralla.

Cyathophyllidæ.

Cyathophyllum, GOLDF.

Cyathophyllum (s.s.) *heterophylloides*, FRECH.

Pl. VIII., Fig. 5 ; Pl. XI., Figs. 5 a-c.

1885. *Cyathophyllum heterophylloides* FRECH : Die Korallenfauna des Oberdevon in Deutschland, p. 30, pl. I., fig. 2.

1896. *C. heterophylloides* GÜRICH : Das Palaeozoicum im Polnischen Mittelgebirge, p. 158, pl. II., fig. 7.

Corallum simple, cylindro-conical, attaining more than 2 cm. in diameter ; wall thin. Septa $32+32$. Longer septa extending to the center of the corallum where some of them are often united ; very thin and a little flexuous in their inner $1/3$ length, and rather abruptly thickened and straight in the outer $2/3$; cardinal septum slightly longer than the other. Shorter septa, in alternation with the longer, just half as long as the latter and similarly much thickened along their proximal $2/3$, though to a degree less than the corresponding part of the longer ones. Both surface of the thickened part of all the septa provided with numerous vertical carinae.

Vesicular dissepiments of small size abundantly developed in the peripheral zone which is little less broad than the $1/3$ of the diameter of the corallum ; the remaining central part occupied by numerous vesiculated tabulae which are more or less horizontal.

Obs.—No one will deny the close resemblance of this Chinese form to that figured by GÜRICH on his Pl. II., fig. 7 ; in the latter the carinae on the surface of the septa are apparently somewhat better developed than in the former ; otherwise there is no essential difference between them. Certainly it is questionable whether these two may reasonably be united with the type

of the species from Grund, first described by FRECH, in one species—*C. heterophylloides*; the type specimen of FRECH bears a little less numerous septa than the fossils from Poland and China, and shows the outermost layer of vesicular dissepiments occupied by horizontal but not oblique vesicles. For a while, however, we follow the opinion of GÜRICH, in taking all of them specifically identical; the question can not be settled without the detailed study of more material.

Localities and Geological Age:—South of Ping-yi-pu, Ping-wu-Hsien, prov. Sze-chuan, and Lao-sa-tei, Hsing-an-hsien, Kuei-lin-fu, prov. Kwang-si. At the first locality, this species is found in association with *Cyathophyllum caespitosum* var. *breviseptata*, and at the latter, with *Pachypora reticulata* and *Stromatopora*? sp.

Devonian, and probably Middle Devonian.

C. heterophylloides is known from Grund, Germany and Kadzielnia, Poland.

Cyathophyllum douvillei FRECH var. *sinensis* YABE and HAYASAKA.

Pl. IX., Figs. 11 a-b.

1911. *Cyathophyllum douvillei* F. FRECH: in RICHTHOFEN'S China vol. V., p. 42, Pl. X., fig. 1-2.
1854. *Spongophyllum sedgwicki* (ex parte) M. EDWARDS et HAIME: British Fossil Corals. p. 242, pl. LVI., fig. 2, 2a, b, c (non 2d, 2e.)
1912. *Cyathophyllum douvillei* H. MANSUY: Étude Géologique du Yunnan oriental. Paléontologie, p. 71, pl. XIII., fig. 3, 3a.

Corallum composite, massive, composed of numerous straight, columnar corallites. Corallites more or less irregular in cross section, 4-6-sided, some 4-6 mm. in diam. Walls of the corallites thin, but strong. Septa in two distinct orders; longer ones 14-16 in number, thin, but thickened at their base, not quite extended to the very center of the corallites. Shorter ones, in alternation with the longer, quite rudimentary, often hardly visible. Dis-

sepiment numerous in the central $\frac{3}{5}$ of the corallites, almost horizontal; peripheral part with vesicular endotheca, composed of numerous, oblique, semilunular vesicles arranged in three or more rows.

Obs.:—According to F. FRECH, *Spongophyllum sedgwicki* M. ED. et H. comprises two quite different forms; one a true *Endophyllum sedgwicki* M. ED. et H. (emend FRECH) and the other a true *Cyathophyllum* (*C. douvillei* FRECH). It is the latter which shows undeniable affinity to our specimen. They are essentially so similar as to leave no doubt about their specific identity, only a slight difference being recognisable in the outline of the corallites and in the relative breadth of their central and peripheral parts. The corallites of our specimen are not only more irregular and more varied in the outline than those of figured by M. EDWARDS, J. HAIME, F. FRECH and H. MANSUY, but have the peripheral part decidedly narrower in relation to the central part. On account of these slight differences we tend to regard our specimen at most as a variety of the Devonian coral already found from Torquay (England), Nismes (Belgium), and Ta-i-ti (southern Yün-nan).

Locality:—Yang-liu-shu, Ta-kuan-ting, prov. Yun-nan, China. Found in association with *Favosites asteriscus* FRECH.

Geological Age:—Middle Devonian.

Cyathophyllum (*Fascicularia*) *caespitosum* GOLDF. var. *breviseptata* FRECH.

PL. VIII., Fig. 7.

1886. *Cyathophyllum caespitosum* GOLDF. var. *breviseptata* FRECH: *Cyathophylliden und Zaphrentiden*, p. 72, pl. III., figs. 3-8.

1896. *Cyathophyllum caespitosum* var. *breviseptata* GÜRICH: *Das Palaeozoicum im Polnischen Mittelgebirge*, p. 170.

1901. *Cyathophyllum caespitosum* var. *breviseptata* PEETZ: *Beitr. z. Kenntniss der Fauna aus den devonischen Schichten am Rande des Steinkohlenbassins von KUSNETZK*, p. 204.

Although in possession of only a single thin section, transversely cut from an apparently fasciculate corallum, yet we believe we are not much misled

in refering it to the well known middle Devonian coral *Cyathophyllum caespitosum*, and probably to its variety *breviseptata* FRECH, which is distinguished from the typical form by its much shortened septa. The corallites, measuring some 13 mm. in diameter, are almost circular in cross section, though slightly elongated where two adjacent ones come into contact. There are some 50 septa, alternately long and short. The longer ones, twice as long as the shorter, never extend interiorly beyond $\frac{2}{3}$ the radial length of the corallites; their free end is often somewhat flexuous. The shorter septa are well developed. The vesiculated peripheral zone is narrower in this variety than in the typical form of the species, and it is just so in our specimen. Judging from the cut-end of tabulae appearing on the thin section, they must be rather numerous and closely set.

This variety of *C. caespitosum* was first described by FRECH from the middle Devonian of Eifel, in Germany, then recorded by GÜRICH from the Mittelgebirge of Poland and lastly by PEETZ from near Kusnetzk in Siberia. It differs but slightly from the specimen now at our disposal, namely by its hardly recognizable septa of the second order, which are considerably better developed in the latter.

Locality and Geological Age:—South of Ping-yi-pu, Ping-wu-hsien, Lung-ngan-fu, prov. Sze-chuan. Found together with *Cyathophyllum heterophylloides* FRECH. Middle Devonian.

Bryozoa.

Trepostomata.

Trematoporidae.

Monotrypa, NICHOLSON.

Monotrypa parasitica KAYSER.

Pl. XVIII., Fig. 4.

1883. *Chaetetes parasiticus* KAYSER: Devonische Versteinerungen aus dem südwestlichen China. In RICHTHOFEN's CHINA vol. IV., p. 95, pl. XI., fig. 3.

1886. *Monticulipora parasitica* STUCKENBERG: Materialien z. Kenn. d.

Fauna d. Devonischen Ablagerungen Sibiriens, p. 14, pl. II.,

fig. 17.

“Die Art bildet sehr dünne krustenförmige Ueberzüge auf fremden Körpern. Die kurz prismatischen, unregelmässig polygonalen, zuweilen gerundeten, dünnwändigen Zellen sind von ungleicher Grösse und erreichen im Maximum etwa $1\frac{1}{2}$ mm. Weite. An den Punkten, wo mehrere grössere Zellen zusammenstossen, liegen häufig andere sehr viel kleinere. Im Uebrigen zeigt sich keinerlei Regelmässigkeit in der Verteilung der Zellen verschiedener Grösse. Die Oberfläche des Stockes ist ganz glatt.”

We have a specimen probably identical with this species; it forms a very thin crust upon a shell of *Spirifer verneuili*, and is composed of prismatic cells, which are usually four—six-sided, and 0.24 mm. in average diameter. The cells are surrounded by their own walls; the apparently simple wall being in reality duplicate in structure: this indicates that the fossil does not belong to the genus *Chaetetes*, but to Monticuliporidae.

Locality:—From the vicinity of Ling-ling, Yung-chou-fu, prov. Hu-nan.

Geological Age:—Upper Devonian, KAYSER found it in the Middle Devonian of Ta-kwan, prov. Yun-nan, and STUCKENBERG in a Devonian limestone on the river Bega in the Minussinsk province, Siberia.

Pteropoda.

Tentaculitidæ.

Tentaculites, WALCOTT.

Tentaculites sp. pl.

Pl. XVIII., Fig. 1.

The figure shows the weathered surface of a small slab of a platy marly limestone, with numerous minute tubular bodies, some 3 mm. in length. By the application of a magnifier, they are found to represent one or possibly two

1) A. NICHOLSON: Palaeozoic Corals, *Monticulipora*, p. 80. 1881

species of *Tentaculites*, which especially belong to the group of *T. ornatus* Sow. One form is characterized by having sharp rings of equal elevation, 0.15 mm. apart on the average, and smooth internodes. The other is distinguished from it by having the rings, more crowded and of two different magnitudes, the thicker ring appearing in alternation with one or two weaker ones which are set at rather irregular intervals.

So far as we are aware, there is at present no record of the occurrence of Pteropoda limestone in the Chinese provinces; from Indo-China, however, MANSUY has reported a Pteropoda limestone from the district of Cu-le, which contains *Styliola* cfr. *clavulus* BARR.¹⁾ The present forms resemble this species in form and size, but are certainly *Tentaculites* and not *Styliola*, being provided with numerous sharp rings. MANSUY also found *Tentaculites* cfr. *subcochleatus*²⁾ and *Tentaculites*? sp.³⁾ in another Pteropoda limestone from Pien-Doc. These two forms are considerably larger than the Chinese fossils now at hand, and show a different sculpture. The two Pteropoda limestones from Indo-China are Lower Devonian in age.⁴⁾

Locality :—Shuang-chin-tang, Tao-chou, Yung-chou-fu, prov. Hu-nan (NODA Coll. No. 58.)

Geological age :—No other fossils being found in the rock, its geological age depends solely on the present fossils; *Tentaculites* being a genus ranging from Ordovician to Devonian, and especially abundant in Gotlandian and Devonian, I prefer provisionally to assign this *Tentaculites* limestone to the Devonian age, since we have at present no record of the development of rocks older than Devonian in Yung-chou-fu.

1) H. MANSUY: Contribution a la carte géologique de L'Indo-Chine, Paléontologie. 1908 p. 53, pl. XIII., fig. 11.

2) H. MANSUY: l.c. p. 53, pl. XIII., fig. 9.

3) H. MANSUY: l.c. p. 53, pl. XIII., fig. 10.

4) J. DEPRAT: Les séries stratigraphiques en Indo-chine et au Yun-nan. Mém. Serv. Géol. L'Indo-chine, vol. II., fasc. II., p. 71.

Brachiopoda.

(By I. HAYASAKA.)

Spiriferidæ.

Spirifer, SOW.

Spirifer disjunctus SOWERBY var.

I. General Remarks on *Spirifer disjunctus* SOWERBY.

In his monumental work on the fossil Brachiopods of Britain DAVIDSON includes a large number of "species" under the name of *Spirifer disjunctus* SOWERBY. He regards some of them as identical with, and some others as mere variations of, this species proposed by SOWERBY as early as in 1840. At that time there had been another name given to a form which subsequently was considered to be synonymous with *Spirifer disjunctus*, viz., *Spirifer verneuili*; this name was used by MURCHISON in the same year that SOWERBY published his *Sp. disjunctus*. Thus it is no easy matter to decide which of the two later palaeontologists ought to follow, unless the priority of the papers is ascertained.

Spirifer disjunctus was used by DAVIDSON in his monograph, while MURCHISON's denomination was accepted by GOSSELET, SCUPIN and KAYSER among those who wrote more or less comprehensive or voluminous papers. Other writers follow either SOWERBY's or MURCHISON's nomenclature in their works; these papers will be cited in the following pages, so they are not mentioned here.

Priority of nomenclature in this case is so difficult a thing to decide that GOSSELET, in his paper devoted seven pages to "Historique et discussion des noms." The reason why he preferred MURCHISON's denomination is suggested in the following words of his. "En résumé, la question d'antériorité ne pouvant pas être résolue, ou étant au moins bien discutable, on doit choisir comme autorité entre les bonnes figures et les bonnes descriptions de MURCHISON ou les mauvaises figures de SOWERBY, dont une seule est à peine déterminable et qui ne sont accompagnées que de quelques mots de diagnose, ou l'on ne trouve même pas mentionné le caractère fondamental de l'espèce, la simplicité des côtés sur les ailes." He did not, however, reach

any definite conclusion as to which of the two names should be accepted as having priority.

The first Chinese form recorded was described by DAVIDSON as *Sp. disjunctus* SOW. Here *Sp. verneuili* and with some doubt *Sp. archiaci* too of MURCHISON were regarded as synonymous. KAYSER, on the contrary, accepted MURCHISON's nomenclature for the specimens collected by VON RICHTHOFEN in China. In the year 1902, MARTELLI described a lot of specimens collected by some missionaries in the province of Shen-hsi. He also followed KAYSER in using *Sp. verneuili* for them; and beside that species there were five varieties recorded by him, namely, *archiaci* MURCH., *sub-archiaci* MARTELLI, *disjunctus* SOW., *lonsdalei* MURCH. and *subextensus* MARTELLI. Thus SOWERBY's species was considered by KAYSER as a variety of MURCHISON's species; in other words, the two forms were once more separated from each other, although not as independent species.

Very recently another Italian paper appeared which explicated some Devonian Brachiopods and two silurian fossils collected in the Lean-shan mountains in the province of Shen-hsi, likewise by missionaries. GIUSTINA PELLIZZARI, who is the writer of the paper, studied the species very much in detail. He distinguished seven varieties in the species which he denominated as *Spirifer disjunctus* SOWERBY. All the forms illustrated by GOSSELET were included under this denomination. He not only described these varieties separately, but formulated a key for the determination of the varieties of Shen-hsi.

The present writer is very much inclined to accept this Italian author's definition and circumscription of the species and its varieties, for several reasons.

GOSSELET's study on the variation of *Spirifer verneuili* is certainly a very excellent work. He had been able to collect almost every stage of the variations of the species for his undertaking. Especially his definition of the species is a very conclusive one, and deserves the approval it has received from most of the subsequent palaeontologists. The standard by which he classifies the species into subordinate groups is not, however, a very acceptable one, because it is the ratio of the width to the length of the shell. In such

a variable form as this the dimensions of the shell are by no means constant, and cannot be considered as of any value for classification. Of course GOSSELET himself observes that his divisions are not varieties in the ordinary sense, but rather groups of forms. He accepts that "un même individu passe avec l'âge d'un dans l'autre."

Thus it seems rather better to the writer to adopt PELLIZZARI's method of classification for the Chinese examples than that of GOSSELET, for the material of the former writer all originated in China. Moreover, PELLIZZARI's categories furnish sufficient subdivisions for the fossils at the disposal of the present writer.

PELLIZZARI's classification on the other hand is by no means a comprehensive one, if one tries to apply it to a much larger material, for instance, that of GOSSELET. Most of the specimens of GOSSELET may be grouped in one or the other of PELLIZZARI's categories, but there will be some left which will constitute transitional forms between some of them. Yet as far as the Chinese material is concerned the division proposed by PELLIZZARI holds good at least for the present.

GOSSELET's divisions are as follows ;

- | | |
|-------------------------|---|
| 1) <i>Cylindrici</i> : | Ratio of width to length greater than 3 |
| 2) <i>Attenuati</i> : | " " 3 —2.5 |
| 3) <i>Elongati</i> : | " " 2.5—2 |
| 4) <i>Hemicycli</i> : | " " 2 —1.60 |
| 5) <i>Proquadrati</i> : | less than 1.60 |
| 6) <i>Obovati</i> : | " " 1.70 and the greatest width beneath the hinge-line. |

The writer here ventures to reproduce the key to the classification proposed by PELLIZZARI, which runs as follows.

I. Cardinal line subequal or inferior to the maximum breadth of the shell. Outline of the typical form lyrate (or approximately rectangular, quadrate or semicircular).

A. Shell more or less depressed, or also swelled but not globular.

1. Area elongate, not distinctly triangular, at least 5 times as long as wide.

a) Apex prolonged, recurved. Outline not strongly transverse :

archiaci MURCHISON.

b) Apex less prolonged, slightly recurved over the area ; outline strongly transverse (width equal at least to $1\frac{1}{2}$ times the length) :

subextensus MARTELLI.

c) Apex shortest, acute, upright. Area lineal. Maximum breadth of the shell in its visceral part ; shell depressed : *vicari* n. f.

2. Area distinctly triangular, with length equal to 2-4 times the width apex not prolonged over the area, upright, acute :

sub-archiaci MARTELLI.

B. Shell large, globular, with a large and strongly recurved apex ; area high, with a large delthyrium of equilateral triangle : *gortani* n.f.

II. Cardinal line elongate ; shell winged. Outline of the typical form trapezoidal. Width equal to $1\frac{1}{2}$ - $2\frac{1}{2}$ times the length.

A. Area elongate, linal, many times longer than high. Apex small, less prolonged, a little recurved : *lonsdalei* MURCHISON.

B. Area triangular, from 3 to 6 times as long as wide. Apex upright, acute not prominent over the area ; *verneuili* MURCHISON.

If one compares these two tables of classification, one will be convinced at once that the latter is by far the more exhaustive, many points being taken into account one by one by the Italian naturalist besides the form of the shell.

It is not quite safe to judge of the true characteristics of a fossil merely from pictures and descriptions ; but if the two classifications can be compared something like the following relations will be found to exist between the varieties of PELLIZZARI and the groups of GOSSELET.

PELLIZZARI.

var. *archiaci* MURCH.

var. *subextensus* MART.

var. *vicari* PELLIZ.

GOSSELET.

Fig. 10 obovati.
 24 hemicycli.
 25 „
 28 „
 36 (?) obovati.

PELLIZZARI.	GOSSELET.
	Fig. 37 obovati.
var. <i>sub-archiaci</i> MARTELLI.	26 (?) hemicycli.
	30 "
	38 proquadrati
	39 obovati.
	44 (?).....
	45
var. <i>gortani</i> PELLIZ.	12 obovati.
	33 "
	34 "
	35 "
var. <i>lonsdalei</i> MURCH.	1 elongati.
	2 "
	6 attenuati.
	7 elongati.
	8 attenuati.
	9 "
	11 hemicycli.
	13 "
	14 "
	18 elongati.
	19 attenuati.
	21 elongati.
	22 "
	27 hemicycli.
	42
	43 (?).....
	48 (?).....
	59 elongati.
var. <i>verneuili</i> MURCH.	15 attenuati.
	20 elongati.
	23 "
	40 obovati.
	47 (?).....
	52 (?).....
	58 attenuati.

Fig. 3 of GOSSELET	transitional between <i>lonsdalei</i> and <i>verneuili</i> .							
4 "	"	.....	"	"	"	"	"	"
5 "	"	.....	"	"	"	"	"	"
29 "	"	.....	"	"	I.	and	II.	
41 "	"	.....	"	"	I.	and	2.	
50 "	"	.....	"	"	"	"	"	"

It is seen from the above table (1) that the majority of the specimens of GOSSELET belong to the variety *lonsdalei* MURCHISON; (2) that there is no group or variety of PELLIZZARI which includes the group *cylindrici*, the most extremely transverse form; and (3) that PELLIZZARI's varieties *vicari* and *gortani* contain no other forms than those grouped by GOSSELET in *obovati*, the lyrate type. Again, the variety *lonsdalei* represents all such moderately transverse forms as *attenuati*, *elongati* and *hemicycli*, but none of either *cylindrici*, *proquadrati* or *obovati*. The variety *archiaci* seems to have no equivalent form among the specimens which were studied by GOSSELET,

In a word, there seems to exist no correspondence between the classifications of the two naturalists when spoken of in an exact sense. Yet GOSSELET's division suggests the possibility of separating the species into several subordinate groups which are closely related to one another in a series. Here, GOSSELET may be quoted in order to suggest the mutual relations of these varietal forms. "Lorsque le Spirifère est jeune, il est de forme obovale; ce sont les ailes qui croissent ensuite le plus rapidement, augmentent la largeur de la coquille; plus tard, la croissance se produit principalement en longueur, le front s'élargit, les ailes s'arrondissent. Tel individu, qui appartenait au groupe des *elongati*, passe dans celui des *hemicycli*, puis dans celui des *obovati*. Il arrive même que les éperons se trouvent englobés dans la coquille." (P. 9.)

GOSSELET has given a very detailed diagnosis of the species, but the species itself is so inconstant a form that his description is not so valuable as it first appears. The species no doubt possesses the essential characteristics of the Genus *Spirifer*. Its most significant feature, however, is the extraordinary regularity of the surface ornamentation. "Les côtes du bourrelet et

du sinus sont plus fine que celles des ailes et bifurquées. Celles des ailes, sont au contraire toujours simples." SCURIN's diagnosis therefore seems most appropriate, though, if it were the description of some other species of the genus, it could hardly be said to be complete.

"Das Hauptmerkmal der Art, die als die variabelste der ganzen Gattung *Spirifer* gelten kann und von GOSSELET zum Gegenstand einer besonderen Monographie gemacht worden ist, besteht in den sehr zahlreichen, dicht gedrängt stehenden Rippen, die auf den Seitentheilen so gut wie immer einfach sind und höchstens auf Sinus und Sattel eine Dichotomie zeigen. Die übrigen Merkmale, wie Grösse, Umriss, Höhe der Area, Krümmung des Schnabels, Ausbildung von Sinns und Sattel, welche letzterer gelegentlich auch durch eine Medianfurche ausgezeichnet ist, unterliegen den weitgehenden Schwankungen und haben zur Aufstellung zahlreicher besonderer Arten geführt, über deren Zugehörigkeit zur vorliegenden Zweifel jetzt kaum noch bestehen."

Before going into the description of the forms at hand the writer gives the table of the synonymy of the species, which, however, does not include the works not personally consulted.

- 1853. *Spirifer archiaci*, SCHNUR :—Zusammenstellung u. Beschreib. sämmtl. im Uebergangsgeb. d. Eifel vorkommenden Brachiopoden, etc. Palaeontographica, 3, p. 205. pl. XXXV., fig. 3.
- 1853. *Spirifer verneuili*, SCHNUR :—ditto, p. 205. pl. XXXV., fig. 4.
- ? 1853. *Spirifer canaliferus*, SCHNUR :—ditto, p. 206, pl. XXXII., fig. 5.
- 1853. *Spirifer disjunctus*, DAVIDSON :—On some fossil Brachiopods, of the Devonian Age, from China. Quart. Jour. Geol. Soc., vol. IX., p. 354. pl. XV., figs. 1-5.
- 1864. *Spirifer disjunctus*, DAVIDSON :—Monogr. Brit. Dev. Brach., p. 23. pl. V.; pl. VI., figs. 1-5.
- 1867. *Spirifer disjunctus*, HALL :—Nat. Hist. New York. Palaeontology, vol. IV., p. 243. pls. XLI. and XLII.
- 1883. *Spirifer verneuili*, KAYSER :—Von RICHTHOFEN's China, vol. IV., p. 88. pl. X., fig. 3.
- 1883. *Spirifer officinalis*, KAYSER :—ditto, p. 85. pl. XII., fig. 1.

- 1884. *Spirifer archiaci*, TSCHERNYSCHEW :—Materialien z. Kenntn. d. devon. Ablagerungen in Russland. Mém. Com. Géol., vol. I., No. 3, p. 13. pl. II., fig. 5.
- 1885. *Spirifer disjunctus*, ROEMER :—Lethaea erratica. Palaeontolog. Abhandl. 2, p. 135. pl. XI., figs. 8, 11 and 12.
- 1887. *Cyrtia Murchisoniana*, TSCHERNYSCHEW :—Die Fauna d. mittl. u. ober. Devon am West-Abh. d. Urals. Mém. Com. Géol., vol. III., No. 3, pl. XIII., figs. 3-7.
- 1894. *Spirifer verneuili*, GOSSELET :—Étude sur les Variations du *Spirifer verneuili*. Mém. de la Soc. Géol. du Nord, vol. IV., I.
- 1902. *Spirifer disjunctus*, HUDLESTON :—Fossils from the Hindu-Khoosh. Geol. Magaz., Decade IV., vol. IX., p. 54. pl. II., figs. 9-12.
- 1902. *Spirifer verneuilli* et var., MARTELLI :—Il Devoniano Inferiore dello Schensi (Cina). Boll. della Soc. Geol. Ital., XXI., p. 353. pl. XIV., figs. 1-17.
- 1912. *Spirifer verneuili*, MANSUY :—Étude Géol. du Yun-nan Oriental, II., Paléontologie. Mém. Serv. géol. de l'Indochine, vol. I., fasc. II., p. 83. pl. XV., fig. 8.
- 1912. *Spirifer verneuili*, var. *yunnanensis*, MANSUY :—ditto, p. 80. pl. XV., fig. 4.
- 1912. *Spirifer verneuili*, var. *persica*, REED :—Devonian Fossils from Chitral, Persia, Afghanistan and the Himalayas. Records of the Geol. Surv. of India, vol. XLI., pt. 2, p. 101. pl. 8, figs. 3-5.
- 1912. *Spirifer verneuili* var. *archiaci*, REED :—ditto, p. 104.
- 1913. *Spirifer disjunctus* et var., PELLIZZARI :—Fossili paleozoici antichi dello Scensi (Cina). Rivista Ital. di Pal., vol. XIX., p. 34. pl. I., figs. 4-7.

The material for the present paper consists of several examples collected by Prof. K. YAMADA in China, one lot in the province of Hu-nan, and the other in Kwei-chou. These two, however, do not coincide at all, although each of them no doubt is a variation of the species. Those from the former

locality belong to the variety *sub-archiaci*, while the latter lot represent the variety *verneuili*.

In addition to these, there are several specimens belonging to this species that were bought by Prof. Y. YABE of the Women's Higher Normal School in Tokyo during his journey in China. Their exact locality, therefore, is not known. They too will be mentioned together with those collected by YAMADA, as each of them represents one or other of the varieties of PELLIZZARI.

Spirifer disjunctus and its varieties were all placed under the denomination of *Spirifer brodi* WENJ. by LOEWE. It is not, however, very clear why he preferred WENJUKOFF's nomenclature to either that of SOWERBY or that of MURCHISON, which had been so popularly used in palaeontology. Besides, his material seems to the present writer so very poor that it is rather dangerous to give any definite name to it. The present writer would like to omit it from the synonymy of *Spirifer disjunctus*, or, at most, he would regard it as an incomplete specimen of a *Spirifer disjunctus* sens. lat.

MANSUY described two forms from Yun-nan, one as *Spirifer verneuili* and the other as a new variety, to which he gives the name *yunnanensis*. The former seems to represent a type very near to *Spirifer disjunctus* var. *gortani* of PELLIZZARI, while the latter is nothing but a *Spirifer disjunctus* var. *sub-archiaci*, which is also represented in the present material.

A Persian variety described by COWPER REED represents a type of *Spirifer disjunctus* var. *lonsdalei*, although the detail of its characteristics is quite obscure. To this was reasonably united a form mentioned by HUDLESTON as *Spirifer extensus* Sow. It is because of its having extraordinarily strong ribs and grooves on each side of the sinus and the fold respectively that a new varietal name *persica* was proposed by REED. Besides, the ribs on the fold and sinus, he says, are fewer than in an ordinary adult example of the species. The same thing occurs in one of the varieties to be described below—the variety *verneuili*.

It is not, however, a peculiarity which is confined to this variety alone, but there is in general such a tendency in the fossils of this group. In other

words, there are a number of transitional stages in this respect. Thus the writer is not inclined to accept the proposal of REED. GÜRICH has already remarked that these are the characteristics of the species *Spirifer verneuili* (= *Sp. disjunctus*), but not those of any particular variety.

Geological Age :—"Seine Hauptverbreitung fällt in das untere Oberdevon. Bisweilen geht er bis zu den carbonischen Grenzschiefern z. B. in Armenien." (LOEWE :—op. cit., p. 43.)

II. *Spirifer disjunctus* var. *sub-archiaci* MARTELLI.

Pl. XXIII., Figs. 23 and 24; Pl. XXIV., Fig. 1.

- 1853. *Spirifer archiaci*, SCHNUR :—loc. cit.
- 1853. *Spirifer disjunctus*, DAVIDSON :—loc. cit.
- 1864. *Spirifer disjunctus* DAVIDSON :—loc. cit.
- 1883. *Spirifer verneuili*, RAYSER :—loc. cit.
- 1883. *Spilifer officinalis*, KAYSER (Pars) :—loc. cit., figs. 3a-b.
- 1884. *Spilifer archiaci*, TSCHERNYSCHEW :—loc. cit.
- 1887. *Cyrtia murchisoniana*, TSCHERNYSCHEW :—loc. cit.
- 1894. *Spilifer verneuili*, GOSSELET (pars) :—op. cit., figs. 30, 38, 39, etc.
- 1902. *Spilifer verneuili* var. *sub-archiaci*, MARTELLI :—loc. cit.
- 1902. *Spirifer verneuili* var. *lonsdalii*, MARTELLI (pars) :—op. cit., pl. XIV., fig. 8.
- 1902. *Spirifer disjunctus*, HUDLESTON (pars) :—op. cit., figs. 11 and 12.
- 1912. *Spirifer disjunctus* var. *yunnanensis*, MANSUY :—loc. cit.
- 1913. *Spirifer disjunctus* var. *sub-archiaci*, PELLIZZARI :—loc. cit.

Shell somewhat swollen, but in no way globular: the ventral valve far more convex than the dorsal. The hinge-line is almost equal to or a little shorter than the maximum width of the shell. Ventral valve with a large cardinal area, which is hardly pointed out over the beak. The area is distinctly triangular and concave, with a delthyrium of an equilaterally triangular form. The beak is rather obtuse and upright. At the tip of the beak begins a median sinual depression which is either triangular (or V-shaped) or some-

what flattened at the bottom. It is from the begining very distinctly defined, and its width increases very rapidly toward the anterior margin where the sinus stretches out like a tongue. Corresponding to this sinus there is a fold along the median line of the dorsal valve. The fold also is very clearly separated from the lateral portion of the valve even at the extremity of the beak. Along the median line of the sinual folding there is a very slight flattened or concave line, which is especially well exhibited at the marginal portion of the dorsal valve. Length of the area is more than three times its height. Thus the outline is somewhat lyrate.

Dimensions :—

Length.	Width.	Thickness.	Height of Area.	Hinge-line.
23 mm.	32 mm.	20 mm.	ca. 9 mm.	ca. 30 mm.
28 „	36 „	22 „	ca. 11 „	36 „
24 „	32 „	21 „	9 „	30 „

(Locality unknown).

Locality :—Neighbourhood of Ling-ling, Yung-chou-fu, prov. Hu-nan.

Geological Age :—Upper Devonian. This species is a very widely distributed one, and has been recorded from various part of the word, as for instance, Germany, Belgium, England, Spain, Russia, Persia, North America, Hindu-Khoosh and New South Wales.

III. *Spirifer disjunctus* var. *verneuili* MURCHISON.

Pl. XXIV., Figs. 2.

1882. *Spirifer verneuili*, KAYSER (pars) :—op. cit., figs. 31-m.

1894. *Spirifer verneuili*, GOSSELET (pars) :—op. cit., figs. 15, 20, 23, 58.

1913. *Spirifer disjunctus* var. *verneuili*, PELLIZZARI :—loc. cit.

The shell rather transverse, with its maximum breadth along the hinge-line; cardinal extremities prolonged into wings. Anterior border somewhat parallel to the hinge-line, thus showing trapezoidal outline, especially when viewed from the dorsal side. The shell is moderately swollen, but not globular. The beak is somewhat acutely pointed but upright and not curved over the area beneath. The latter is triangular and very much longer

than high, being about 4-5 times as long as it is high, with an equilaterally triangular delthyrium. The median sinus on the ventral valve is already very distinctly developed at the top of the beak; it is prolonged anteriorly in a tongue-like extension and curved up almost vertically in front, showing a large upfold of the margin in front view. Corresponding to the sinus is a fold on the dorsal valve which is likewise distinct throughout the whole length of the shell. On the ventral valve there are two radial ribs extraordinarily wider than the others; they form the boundaries between the sinus and the lateral portions of the shell. On the dorsal valve, on the contrary, two peculiarly wide and distinct grooves separate the median fold from the alar parts; these grooves exactly correspond to the thick ribs on the opposite valve.

Dimensions :—

Length.	Width.	Thickness.	Height of Area.
19 mm.	36 mm.	8 mm.	(Ventral) 4 mm.
11 „	20 „	5 „	(„) ca. 2 „
—	ca. 24 „	5 „	(Dorsal.) —
<hr/>			
21 „	35 „	16 „	4.5 „ (Locality unknown.)

Remarks :—This variety differs from the preceding one in having a much more elongate hinge-line and consequently much more lineal ventral area. The maximum breadth of the shell is in this form represented by the hinge-line itself, which is not usually the case with the preceding form. The outline, therefore, of the present variety is somewhat trapezoidal in contradistinction to the lyrate form of the former. The sinus and folds are much less well defined in the present fossil than in *Sp. disjunctus* var. *sub-archiaci*.

Locality :—Between Tou-tang and Wei-ning, Ta-ting-fu, prov. Kweichou. Associate fossil is

Dalmanella striatula SCHLOTHEIM.

There is one other more complete example of the species bought at Peking by Prof. Y. YABE. The locality is of course unknown.

Geological Age :—Upper Devonian.

IV. Varieties of *Spirifer disjunctus* Sow, from unknown localities in China.

In describing the two varieties of *Spirifer disjunctus* collected by YAMADA it has already been noticed that there is one example of each of them which was bought in China by Y. YABE. There are three other varieties, in PELLIZZARI'S sense, among these purchased examples; they are A) *Spirifer disjunctus* Sow, var. *vicari* PELLIZZARI, B) cfr. var. *gortani* PELLIZZARI and C) var. *lonsdalei* MURCHISON. Although they do not seem worthy of description, it may be of some interest to give their pictures which satisfy the diagnoses of these forms given by PELLIZZARI.

A) *Spirifer disjunctus* Sow. var. *vicari* PELLIZZARI.

Pl. XXIV., Fig. 3.

1913. *Spirifer disjunctus* var. *vicarii*, PELLIZZARI :—op. cit., pp. 36 and 39. pl. I., fig. 7.

“Conchiglia grande, depressa, con le valve della medesima grandezza, a contorno nettamente lirato, poco più largo che alto. Area allungata, lineare, cinque volute più lunga, che alta, con apertura triangolare, equilatera. Apice della grande valva piccolissimo, acuto, diritto, non rigonfio. Lobo nettamente delimitato; seno svasato, con limitè un po' incerti. Linea cardinale leggermente inferiore alla massima larghezza della conchiglia, che è verso la metà dell' altezza. Seno e lobo percorsi da 12 pieghe; più di 30 pieghe corrono su ciascuna della regioni laterali.”

Dimensions :—

Length.	Width (Hinge-line).	Thickness.	Height of Area.
25 mm.	34 mm.	18 mm.	ca. 4 mm.

Remarks :—The material consists of only one example of rather good preservation. There is a slight but somewhat remarkable difference between the specimen and the figure given by PELLIZZARI. First of all the Chinese fossil has a prolonged hinge-line, thus having quite acutely pointed cardinal extremities. Then the median sinus and fold appear to be somewhat better

defined in the present material than in that of PELLIZZARI. At any rate both the fossils are lyrate in outline and in most of the essential points, such as the aspect of the area, the surface sculpture and the form of the beak, they are sufficiently resemblant to make the identification quite reasonable.

This variety differs from *Sp. disjunctus* var. *sub-archiaci* in possessing a less distinctly triangular, or rather a lineal, area, and a smaller delthyrium there. The hinge-line also is not equal to the maximum breadth of the shell itself in the last mentioned form.

The outline of the present variety separates it at once from *Sp. disjunctus* var. *verneuili*, which has some affinity to the former. The latter is much more transverse than the former, with quite well developed pointed alar expansions.

B) *Spirifer disjunctus* SEW. cfr. var. *gortani* PELLIZZARI.

Pl. XXIV., Fig. 5.

1902. *Spirifer verneuili*, MARTELLI (pars):—op. cit., figs. 1 and 2.

1913. *Spirifer disjunctus* var. *gortani*, PELLIZZARI:—loc. cit.

“La forma in esame si distingue nettamente dalla a contorno lirato per la globulosità della conchiglia e la grandezza e curvatura dell'apice. L'area è concava, subtriangolare, a limiti natti e salienti, di larghezza pari a 5 volte l'altezza, con apertura triangolare equilatera amplissima; si presenta sottilmente striata per lungo e per trasverso. L'apice della valva ventrale è molto grande e elevato, così da dominare dall'alto l'area e l'apice della valva dorsale. Il seno ampio fin dall'apice, è meglio delimitato che il lobo. Riporto qui le dimensioni del mio esemplare, e insieme quelle dell'esemplare figurato dal de Verneuil.”

Dimensions:—

Length.	Width (Hinge-line).	Thickness.	Height of Area.
22 mm.	22 mm.	18 mm.	9 mm.

Remarks:—According to the diagnosis of PELLIZZARI this form is characterized among other points by having its beak strongly curved. Besides, it is a form very globular in habitus. These two points are not, strictly speaking,

realized in the material at the writer's hand. Especially, the area in the latter is rather upright although more or less strongly concave. In its general habitus, however, the writer's example is quite coincident with that of the Italian palaeontologist, and consequently the fossil is taken to be a form closely approximate to the latter. If, however, there had been a number of specimens of the same habitus collected from known localities, the writer might have given a new varietal name to them.

C) *Spirifer disjunctus* Sow. var. *lonsdalei* (MURCHISON) MARTELLI.

Pl. XXIV., Fig. 4.

1902. *Spirifer verneuili* var. *lonsdalei*, MARTELLI (pars):—op. cit., fig. 10.

? 1913. *Spirifer disjunctus* var. *lonsdalei*, PELLIZZARI:—op. cit., p. 41.

There are two examples of this variety at the author's disposal, both having been bought in China, one (No. 1) by Prof. Y. YABE and the other (No. 2) by Mr. S. NODA. In this paper only the former is pictured. Mr. NODA's specimen was obtained by him in the province of Hu-nan.

This fossil is characterized by several points. The outline of the shell is trapezoidal, and is wider than long, with a long hinge line representing the maximum width of the shell: the thickness is very inconspicuous: the area is linear and very low.

Dimensions:—

	Length.	Width.	Thickness.	Height of area.
No. 1.	22 mm.	34 mm.	18 mm.	ca. 4 mm.
No. 2.	20 „	31 „	12 „	ca. 4 „

Judging from its description, the one examined by PELLIZZARI seems to be coincident with that described and pictured by MARTELLI and also with those of the present writer. However, PELLIZZARI does not cite MARTELLI's paper in the list of synonymy of his *Spir. disjunctus* var. *verneuili*. Neither does he give any picture of his specimens. The writer is not able to decide the matter here.

V. *Spirifer disjunctus* Sow, and *Cyrtia murchisoniana* DEKON.

In the present paper *Cyrtia murchisoniana* is mentioned as synonymous with *Spirifer disjunctus* var. *sub-archiaci*. The writer's intention, however, is not to put all the fossils ever recorded as *Cyrtia murchisoniana* under *Spirifer*. It is only the Uralian form described by TSCHERNYSCHEW that is to be so treated.

According to SCHUCHERT, *Cyrtia* is a genus distinct from *Spirifer* within the Sub-family Spiriferinae. It is distinguished from *Spirifer* by having an unusually high ventral area, with its narrow delthyrium closed by a perforated pseudodeltidium, resulting from fused deltidial plates." Notwithstanding, there are such forms among the species of *Spirifer* which have an equally high ventral area, as for instance, *Spirifer disjunctus* Sow, of the Devonian, and *Spirifer distans* Sow, and *Sp. cuspidata* MARTIN of the Carboniferous. Thus the height of the ventral area seems not very important as a generic characteristic.

As to the perforated pseudodeltidium SCHUCHERT's idea represents the general opinion concerning its systematic significance. In the course of his description of *Spirifer cuspidatus* Sow., DAVIDSON discards M'COY's view of the species as a *Cyrtia*: he says, "No specimen of *Sp. cuspidata* I have hitherto been able to examine has exhibited the deltidium in its entire condition, but which, in all probability, was not perforated by a circular foramen, as is in true types of the subgenus *Cyrtia*, such as *C. trapezoidalis* and *C. Murchisoniana*."

In the same work DAVIDSON observes that *Sp. cuspidata* may have a perforated pseudodeltidium. He says, "Subsequently, however, Mr. J. P. WOODWARD showed me the internal cast of the ventral of a specimen in the British Museum, thought to have belonged to *Sp. cuspidata*, and derived from the dolomitic Carboniferous limestone of Brendon hill in which there is evidence that the deltidium was in reality perforated by a circular foramen, as in *Cyrtia*." Thus it seems that M'COY's opinion which was first rejected by DAVIDSON in the text after all proved to be correct. It is, however, not certain whether the specimen WOODWARD showed to DAVIDSON was

really the same thing as *Sp. cuspidata* of the latter. Another possible interpretation is that DAVIDSON could not detect the perforation in his own examples, although it was really present.

At any rate *Spirifer* and *Cyrtia* may represent different groups. They may not be two distinct genera, as SCHUCHERT considers them to be, but they are not likely to be united as one genus as in the Grundzüge der Palaeontologie of ZITTEL. As to the above incident of DAVIDSON and WOODWARD, the writer thinks that the first of the two explanations of the dilemma is the more probable; for, DAVIDSON's material of *Sp. cuspidata* seems not at all so insufficient as to have led him to overlook the perforation of the pseudodeltidium.

With regard to the original fossil of DE KONINCK, SCUPIN's conclusion "Die Gattung (bezw. Untergattung) *Cyrtia* ist daher einzuziehen und die bisher unter diesen Namen (in DAVIDSON'schem Sinne) vereinigten Formen sind der Gattung *Spirifer* s. str. zuzurechnen," may hold on one hand. But if the Chinese form described by DAVIDSON is to bear the name *Cyrtia murchisoniana*, then the case is fundamentally different. *Cyrtia murchisoniana* and *Spirifer disjunctus* are two independent forms although they are very closely related to each other. Of course the genus *Cyrtia* may be united to *Spirifer*, as SCUPIN and others think, if the species of *Spirifer* without exception have a perforated pseudodeltidium. This, however, cannot be said to be decided at present.

Cyrtia murchisoniana was originally denominated a *Spirifer* by DE KONINCK, and it was DAVIDSON who removed it to the genus *Cyrtia* of DALMAN. DAVIDSON who at one time recognized *Cyrtia murchisoniana* as a form independent of *Spirifer disjunctus*, eleven years later regarded it as synonymous with the latter. In this case there may have been a large number of specimens of a form called *Sp. murchisoniana* by DE KONINCK, some of which were different from, while the others were coincident with, *Sp. disjunctus* SOW. Those with perforated pseudodeltidium may have been considered as *Cyrtia*; while those without it may have been identified with the *Spirifer*. In his monograph DAVIDSON says that *Sp. murchisoniana*, with several other forms, may be a mere synonym or a variation of *Sp. disjunctus*. He, however, does not mention his own *Cyrtia murchisoniana* from China among the syn-

onyms of *Sp. disjunctus* in his monograph. Thus it is certain that at least the Chinese form is different from *Sp. disjunctus* of DAVIDSON's circumscription, although the relations between the former and *Sp. murchisoniana* of DE KONINCK are not very clear. As to this point HALL expresses a similar opinion: "it appears to me that the species figured in the Geology of Russia (i.e. *Spirifer Murchisoniana* DE KONINCK) is distinct from the Chinese specimens figured by Mr. DAVIDSON." DAVIDSON himself gives no explanation at all about the relations between these forms in his monograph, and consequently subsequent writers have been quite at a loss.

Later on, however, it seems that the Chinese fossil first described by DAVIDSON as *Cyrtia murchisoniana* became the type instead of the prototype of DE KONINCK. Thus, for example, KAYSER, PELLIZZARI and others give figures of their *Cyrtia murchisoniana* entirely coincident with those of the Chinese forms in DAVIDSON's paper on Chinese Devonian Brachiopods.

Now let us turn again to the Uralian fossil described by TSCHERNYSCHEW as *Cyrtia murchisoniana*. It differs from the Chinese form, first of all, in the outline of the shell. There is no perforation at all observable on the pseudodeltidium. It is no way a *Cyrtia murchisoniana* of DAVIDSON, although it may be comparable with the original Russian species of DE KONINCK, which is inaccessible to the present writer. If the latter is the case, then it is, in other words, identical with *Spirifer disjunctus*. But TSCHERNYSCHEW cites the Chinese form of DAVIDSON as well as of KAYSER in the synonymy of his *Cyrtia murchisoniana*. He seems therefore of the opinion that *Spirifer verneuili* and *Cyrtia murchisoniana* are identical. Yet in his paper only one of the papers concerning *Sp. verneuili* (= *Sp. disjunctus*) is quoted, and consequently it must be concluded that he recognized the distinction between these two forms. Then his classification of the Uralian as *Cyrtia murchisoniana* must be abandoned if the circumscription of the species by DAVIDSON and others is adopted.

A similar and rather ambiguous interpretation of the species, under the name of *Cyrtia murchisoniana* DE KON., was repeated quite recently by LOEWE. His material, as far as one can judge from the picture, seems to have been very poor; it is not very clear how such an excellent diagnosis

could have been constructed from the examination of such unfavourable examples. At any rate, both the forms of *C. murchisoniana* from China (DAVIDSON and KAYSER) and from the Ural are regarded as synonymous by him. In his description it is stated, "Der Schlossrand ist erheblich kürzer als die Maximalbreite der Schale," while with the Uralian form this is by no means the case. The hinge-line is, in the latter fossils, subequal or equal to the maximum width of the shell just as in LOEWE's *Sp. brodi*. After having said that *Sp. murchisonianus* is distinguished from the group of *Sp. verneuili*, by its having among other points a perforated pseudodeltidium, LOEWE adds that these two forms are easily confused, "da die Beobachtung des Pseudodeltidiums nur bei besonders gut erhaltenen Exemplaren möglich ist." But this cannot be accepted as a reason for bringing together the Chinese and the Russian forms. He had better have put TSCHERNYSCHEW's fossil in the synonymy of his *Sp. brodi*.

Also among a small number of specimens purchased by Prof. Y. YABE in China there are forms representing the type of *Cyrtia murchisoniana* of DAVIDSON, KAYSER or PELLIZZARI. Thus the existence of *Cyrtia murchisoniana* of DAVIDSON's circumscription has been proved by the writer to be real. GOSSELET says "Le *Cyrtia Murchisoniana* ne diffère guère du *Spirifer Verneuili* que par des détails d'organisation interne et particulièrement par les plaques dentaires." Similar things have been said by many other palaeontologists, as one can find in such a paper as that above cited. As to this point the writer cannot say much, because he has not been able to examine the internal features of the fossil. This can be regarded as established only after many of the specimens of the group or groups have been studied minutely. There may be every stage of transition among them, just as in the case of morphological variations.

Spirifer ziczac ROEMER var. *undecimplicata* ROEMER em. SCUPIN.

Pl. XXIII., Figs. 25 and 26.

1885. *Spirifer undecimplicatus*, CLARKE:—Die Fauna des Ibergkalkes
Neues Jahrb., Beil.-Bd., III., p. 394.

1900. *Spirifer ziczac* var. *undecimplicata*, SCUPIN:—Die Spiriferen
Deutschlands. Palaeontolog. Abhandl., N. F., IV., 71. pl. VI., fig. 8.

This variety is rather easily distinguished from the type species, although their separation as distinct species may not be appropriate, as SCUPIN has already remarked. CLARKE, who followed ROEMER in accepting the specific value of *Sp. undecimplicatus*, described it very excellently though quite briefly. According to him it is characterized by 5 (sometimes 6) strong ribs on each side of the sinus. The sinus itself as a rule bears a single fold, or sometimes one more in addition. These ribs are crossed by undulating growth lines, and the surface usually shows fine granulation.

On the other hand *Spirifer ziczac* is characterized by him in the following manner. Usually the sinus possesses one fold, but often two or three, which may be more or less irregularly arranged. There are 10 to 13 radial ribs on either side of the sinus or the median fold. The surface sculpture consists in fine, irregularly zigzag lines that appear to converge in the grooves between the radial ribs. These lines are most conspicuously distinct on the sinus, where the sculpture has a feathered appearance. They are at times interrupted and then look somewhat granulous.

The difference between these two forms is indeed very conclusive as far as the descriptions above quoted alone are concerned. SCUPIN's critical study however, concludes that *Sp. undecimplicatus* is but a variety of *Sp. ziczac* ROEMER. The former differs from the latter, SCUPIN says, only "durch etwas geringere Zahl gröberer Rippen sowie durch bedeutendere Grösse." ROEMER counted 8-10 radial ribs on each side of the sinus in *Sp. ziczac*, though CLARKE defined the number to be 10-13. It can be reduced to 6, observes SCUPIN, in the typical species of *Sp. ziczac*, and this number "übertrifft die der ROEMER'schen Originalabbildung von *Spirifer undecimplicatus* nur um 1 und kann nach der Angabe CLARKE's auch beider von ihm aufrecht erhaltenen Art

errecht werden." Moreover, in SCUPIN's material there is one example which is hardly separable from the variety, still having a large number of ribs. The ribs are almost equal in strength to those of *Sp. ziczac* in the neighborhood of the cardinal region.

For the reason that the area is high and that the sinus becomes relatively wider in the later stage, SCUPIN decided to call *Sp. undecimplicatus* a variety of *Sp. ziczac*. The present writer would add to these differences another peculiarity on account of which the material at his disposal is to be identified with the variety, but not with the species itself. It is the anterior, tongue-like elongation of the sinus. In either ventral or dorsal view according to the figures of the type species drawn by SCUPIN the anterior margin is somewhat straight and appears more or less parallel to the hinge-line (figs. 9 and 10). On the contrary, the variety *undecimplicata* has its front margin somewhat prolonged just as in the specimen now at hand. The size of the Chinese examples is not very conspicuous and is inferior to figures 9 and 10 of SCUPIN's work, i. e., to the type species of *Sp. ziczac*. The characteristics, however, are comparable with the variety rather than with the type species.

In the Chinese specimens as well as in the figures of the variety drawn by SCUPIN, the hinge-line seems to slope down somewhat laterally, while it is nearly straight in the pictures of *Sp. ziczac* s.s. This, however, may not be regarded as a characteristic of any importance, as there seem to be transitional cases (for instance fig. 9a of SCUPIN).

From what has been said above the characteristics of the Chinese examples are probably well understood by the reader, but for convenience's sake the following description is given.

Shell tranverse, ventricose, ventral valve being remarkably more gibbous than the opposite, somewhat irregularly pentagonal with rounded angles in ventral view; hinge-line a little inferior to the maximum breadth of the shell, which is just below the former. Cardinal extremities are rounded. Ventral beak quite high and pointed, rather strongly recurved over the area, which also is very high and concave; there is a delthyrium at the center. The valve is most strongly vaulted at a short distance from the beak. A distinct sinus begins very close to the beak and widens and deepens more or less rapidly.

anteriorly, ending in a short projection at the front. In the sinus there is a single rib which begins at a point half way from the beak to the anterior margin. On each side of the sinus there are five radial ribs which are rounded on the top and quite simple; those at the boundary of the sinus and the lateral portion are especially strong. Interspaces are narrower than the ribs themselves. Dorsal valve less convex, attached to the ventral by a nearly straight hinge-line which is very slightly inclined toward the cardinal extremities. Beak is very obscure, hardly projecting over the hinge-line. The valve is uniformly curved antero-posteriorly. There is a large median fold which strictly corresponds to the sinus of the opposite valve. This fold is very high so that the lateral curvature is by no means uniform. On the fold, along its median line, is a depression corresponding to the intersinual fold or rib of the ventral valve. This median fold of the dorsal valve is separated from the lateral portions by two extraordinarily deep furrows, much more remarkable than those in alternation with the ribs on each side of the fold. There are about five of them on each of the alar portions of the shell. Under a magnifier there are very fine, undulating growth lines which are concave on the ribs and convex in the intercostal furrows. Besides, there are still finer radial striae on the whole surface of the shell, also visible only with the aid of a magnifying glass.

Dimensions :—

Length.	Width.	Thickness.	Hinge-line.
9 mm.	10 mm.	5 mm.	8 mm.
12 „	10 „	8 „	10 „

Remarks :—There are only four examples from China now at the writer's hand, two of which, however, are very well preserved, and consequently make good material for determinations. The most striking difference between the Chinese and the German forms is of course in the size of the shell. This was considered by SCUPIN as one of the standards that separate the variety from the type, as already mentioned above. Indeed, in point of magnitude the Chinese examples must be identified with *Sp. siczac*. The ventral area, however, is very high in relation to the length of the shell, and also, as already remarked, the sinus is prolonged anteriorly. Moreover,

there are only about 11 radial ribs, which fact justifies the name proposed by ROEMER.

On the other hand, there are examples of larger specimens of the type species ever described or illustrated. There are many of them among the specimens of HALL which in point of size are comparable with the variety pictured by SCUPIN. The same will hold good for the illustration of the species in TSCHERNYSCHEW's work. With regard to this point CLARKE's measurements of the two forms are worthy of mention, for in them the size relation is entirely the reverse. According to him the type species is 28 mm. long and 35 mm. wide, while the variety (or his species) measures 20 mm. by 25 mm.

Locality:—Between Mien-tien and Shang-shui-tang, Nan-ning-hsien, Fan-ning-fu, prov. Kwang-hsi. Also at Mien-tien. Found in association with *Athyris concentrica* and *Dalmanella striatula*.

Geological Age:—In Germany this is found in the Iberg Limestone, which is the lower division of the Upper Devonian. In America *Spirifer sicca* is recorded from the Hamilton Group, or the upper division of the Middle Devonian. The Chinese fossil seems to represent the Middle Devonian Age as in America, for it is found in association with *Athyris concentrica*.

Atrypidæ.

Atrypa, DALMAN.

Atrypa reticularis LINNE, var. *richthofeni* KAYSER em. FRECH.

Pl. XXII., Figs. 11 and 16; Pl. XXIII., Fig. 7.

1883. *Orthis richthofeni*, KAYSER:—VON RICHTHOFEN'S China, vol. IV., p. 92, pl. XIII., fig. 2.

1911. *Atrypa reticularis* var. *richthofeni*, FRECH:—Ditto, vol. V., p. 33.

VON RICHTHOFEN collected this species at Lung-tung-pei in the eastern portion of the province of Sze-chuan together with *Orthis Mac Farlanei* and

Rhynchonella procnoides. It was described as an *Orthis* by KAYSER, who regarded it as a new species. On re-examining the material described by him, FRECH came to the conclusion that it is not an *Orthis* but an *Atrypa*, and that it represents a new varietal form of *Atrypa reticularis* LIN. It not only shows the characteristic surface sculpture, but also has a structure which is wanting in *Orthis*, namely spirals inside the shells. FRECH established the existence of the spirals by etching one of the specimens labelled "*Orthis Richthofeni*"

The form of the shell is not like that of the ordinary *Orthis*, and much more closely resembles the long known *Atrypa reticularis*. Besides "*Orthis richthofeni*" in both valves lacks the cardinal area, which is always present in *Orthis*. In a word, FRECH is justified in naming the Chinese fossil Brachiopod an *Atrypa* instead of an *Orthis*, as it was first called by KAYSER.

Nevertheless KAYSER's diagnosis is a very excellent one, leaving no essential points untouched. It holds very well with the material now at the writer's disposal. It runs:—Gehäuse von gerundet quadratischem Umriss, von mässiger Dicke. Der grade Schlossrand ebenso lang oder nur wenig kürzer, als die grösste Breite der Muschel. Die Schlossecken bilden rechtwinkelige, zuweilen etwas gerundete, kurze Flügel. Ventralklappe nur in der Buckelgegend etwas gewölbt, im Uebrigen flach und durch die Erhebung des Randes sogar etwas concav. Der letztere ist sehr scharf und nur auf der Vorderseite ein wenig nach oben abgelenkt, sonst gradlinig. Schnabel sehr klein und schwach gekrümmt. Dorsalklappe stark convex, besonders am Buckel, der an die Ventralschale angepresst ist und zuweilen etwas über dieselbe überhängt. Weder ein Sinus noch ein Sattel vorhanden. Oberfläche mit zahlreichen nässig feinen Rippchen bedeckt, von denen die seitlichen etwas nach aussen umgebogen sind. Dieselben vermehren sich durch vielfache Theilung und Einschaltung neuer Rippen in verschiedener Entfernung vom Rande. Ausserdem sind noch zahlreiche etwas schuppige, mässig starke Anwachsstreifen vorhanden."

As to the inner structure, nothing is accessible to the writer as far as the material at hand alone is concerned. KAYSER, however, says, "Im Innern der Dorsalklappe werden zwei kurze, divergirende Zahnplatten beobachtet."

The radial striae are rounded and fine, being separated from each other by spaces of about the same width. Three striae and two interspaces occupy a space of 3 mm. along the front margin.

Remarks :—In the fossil now being considered, the dorsal valve is so strongly convex that on viewing it anteriorly, posteriorly, or laterally, it looks like a hemispherical body, the length and the width not being very widely different. The ventral valve, on the other hand, is very low and is a little convex in the neighbourhood of the beak. It is concave along the margin excepting the hinge-line. The concavity is somewhat less conspicuous along the anterior margin, where there is a very gentle upfolding.

These are the points that separate the variety from the type species of LINNAEUS. On this point FRECH very appropriately observes, "Die ungewöhnliche Dicke der kleinen Schale sowie die flügelartige Verbreitung an der Schlosslinie gestatten vielleicht die Beibehaltung des KAYSER'schen Namens als Bezeichnung einer Varietät der *Atrypa reticularis*."

Nevertheless there is an *Atrypa reticularis* which has a very high dorsal valve—almost as high as this variety. It is that which was described and figured quite recently by MAYNARD from the New Scotland Formation (Lower Devonian) of New York.¹⁾ In it, however, the ventral valve is not that of the Chinese variety, but has the habitus of the type species. Hence, both valves taken together, the American example must be considered as an extraordinarily thick variation of the species, if it is not a constantly thicker form. Otherwise, it might be called a variety of *A. reticularis* LIN., especially when the thickness of the form is considered in correlation with its geological antiquity.

Localities :—1) Ning-chang, Han-chung-fu, prov. Shen-hsi.

VON RICHTHOFEN collected the original examples at Lung-tung-pei in the north-eastern border of the province of Sze-chuan. It is, however, doubtful whether he really got the material at that place as KAYSER seems to have believed. In the second volume of his China, RICHTOFEN remarks, "Man verkauft hier (Lung-tung-pei) devonische Brachiopoden, welchen eine besondere Heilkraft zugeschrieben wird."²⁾ The writer supposes that the specimens

1) Maryland Geol. Survey, Lower Devonian, p. 392, pl. LXVII., figs. 26-28. 1913.

2) China, vol. II., 599.

That VON RICHTHOFEN obtained came from Ning-chiang-chou (Ning-kiang-tschou of RICHTHOFEN), because these two places are quite near to each other, though they lie in different provinces. Lung-tung-pei is a little hamlet on the road from Ning-chiang-chou in Shen-hsi to Chau-tien-chönn in Sze-chuan.

2) South of San-toi-pa, Chao-hua-hsien, Pao-ning-fu, prov. Sze-chuan.

In the first locality this species was found in association with *A. reticularis* var. *desquamata* and *Rhynchonella parallelepipedata*, while in the second locality it was accompanied by *Dalmanella striatula* SCHLOTHEIM.

Geological Age :—Middle Devonian,

According to KAYSER the associate fossils, *Rhynchonella procuboides* var. and *Orthis MacFarlanei* represent the Upper Devonian Age. YAMADA, however, collected it with another variety, *desquamata* and *Rhynchonella parallelepipedata* at one and the same place, thus apparently establishing its Middle Devonian Age. On the other hand this fossil was found in company with *Dalmanella striatula* which is present throughout all the stages of the Devonian Formation but most predominant in the Middle Devonian. Again *Dalmanella striatula* was discovered by YAMADA in the province of Kwang-hsi in association with *Spirifer ziczac* var. *undecimPLICATA*, which lived from the later part of the Middle Devonian to the early part of the Upper Devonian Age. In the province of Kwei-chou the said *Dalmanella* was collected together with *Spirifer disjunctus* var. *verneuili*, an Upper Devonian fossil.

As has been said above, RICHTHOFEN seems to have purchased specimens of various species at Lung-tung-pei, so it is not very clear whether the species mentioned by him as occurring in this district were really yielded by one locality.

***Atrypa reticularis* LINNE var. *desquamata* Sow. nom.**

Pl. XXII., Figs. 12-15.

1854. *Terebratulula insquamosa*, SCHNUR:—Zusammenstellung u. Beschreibung sämtl. im Uebergangsgeb. d. Eifel vorkommenden Brachiopoden, etc. Palaeontographica, 3. p. 182, pl. XXIV., figs. 5a, b; pl. XLIV., fig. 2.
1854. *Terebratulula zonata*, SCHNUR:—ditto, p. 182. pl. XXIV., fig. 6.
- 1864-71. *Atrypa desquamata*, DAVIDSON:—A Monogr. Brit. Dev. Brach., 58, pl. X., figs. 9-13; pl. XI., figs. 1-9.
1867. *Atrypa reticularis*, HALL:—Nat. Hist. New York, Palaeontology, IV., p. 316, pl. 51, figs. 10-24.
1871. *Atrypa reticularis* var. *desquamata*, KAYSER:—Die Brachiopoden des Mittel-u. Ober-Devon d. Eifel. Zeitschr. d. deutsch. geol. Gesellschaft, XXIII., p. 544.
1883. *Atrypa reticularis* var. *desquamata*, KAYSER:—Devon. Versteinerungen aus dem südwestl. China. V. RICHTHOFEN'S China, IV., p. 82, pl. IX., fig. 2.
1884. *Atrypa desquamata*, TSCHERNYSCHEW:—Materialien zur Kenntn. d. devon. Ablagerungen in Russl. Mém. Com. Géol., vol. I., No. 3, p. 19. pl. III., fig. 4.
- 1892-1907. *Atrypa desquamata*, WHIDBORNE:—A Monogr. of the Devon. Fauna of the South of England, vol. II., p. 117. pl. XIII., figs. 13-15.
1912. *Atrypa desquamata*, MANSUY:—Étude Géologique du Yun-nan Oriental, II., Paléontologie. Mém. Serv. Géol. de l'Indochine, vol. I., fasc. II., p. 73.

It is a well known fact that this variety, or species of some palaeontologists, differs from *Atrypa reticularis* Sow. in several less important points. According to WHIDBORNE, who regards it as an independent species, the chief characteristics are "its flatness, its general transversness (though some examples are circular), the frequent and sometimes strongly marked median depression in the dorsal valve, the flatness of its margins, its large flat wide-

area, its exposed foramen, its erect and elevated beak with angular sides, and the frequent divarication of its ribs close to the margin.¹⁾” He seems, however, to have laid a little too much stress upon some of the points above mentioned. Thus, for instance, the median sinual depression is not seldom observed in the type species of *Atrypa reticularis* too. The flatness of the margin also is not a peculiarity confined to *A. desquamata* alone. As *A. reticularis* is a form which has a very wide range of distribution both geologically and geographically it consequently shows the greatest variation in form and size of any fossil ever recorded. The characteristics observed in a small number of specimens therefore must not be overestimated. In this respect DAVIDSON²⁾ had already remarked that *A. desquamata*, which he provisionally regarded as an independent species, might be a variety of *A. reticularis* Sow. A form which must be separated at least as a variety, by the present writer, was named *A. reticularis* by HALL in the work above cited—so closely are these two names related to each other. KAYSER in this way established the relations between these two forms, *A. desquamata* being separated as a variety of *A. reticularis*. His description runs:—“ Von nahezu kreisförmigen oder subquadratischem Umriss, breiter als lang, Schnabel wenig gekrümmt, so dass Area und Stielöffnung sichtbar bleiben, Stirnrand gerade oder nur wenig nach oben abgelenkt. Falten stärker als bei der Hauptform, Anwachsringe in grösserem Abständen.³⁾” Thus a part of the examples figured by SCHNUR as *Terebratulula insquamosa* and those described as *T. zonata* were classified under this variety. As *Atrypa reticularis* is a very variable species, palaeontologists may feel inclined to identify *A. desquamata* with it. As far, however, as our present knowledge of these forms is concerned, there seems to be a constant series of diversities between them. The shell of *A. desquamata* is on the whole more oblong and thinner than the other. The beak is less incurved and consequently the foramen is not concealed in the former. These characteristics are recognized in the material from China now under consideration, when compared with the type

1) WHIDEBORNE: - loc. cit.

2) DAVIDSON:—op. cit., p. 59.

3) KAYSER:—op. cit., p. 544. 1871.

specimens, as well as with the figures of a number of specimens from Europe.

GIRTY¹⁾ observes that in America *A. desquamata* "is nothing more than *A. reticularis* with an erect beak, area, and unconcealed foramen; and the same appears to be equally true of the European forms. This character or group of characters seems scarcely of specific value; but in any case the same peculiarities of surface, etc., which distinguish *A. missouriensis* from *A. reticularis* serve to differentiate it from *A. desquamata* also."

In his recent paper HERBERT LOEWE²⁾ also remarks that there are numerous (intermediate) forms among such forms as *A. reticularis*, *desquamata* and *aspera*, so that the latter two must be regarded as nothing but varieties of the type species *A. reticularis*. In the synonymy of his description of the named species he mentions, besides *A. reticularis* of previous authors, *A. desquamata* and also *Terebratula prisca*.

The best comparative of the Chinese specimens is the material described by MANSUY from the province of Yun-nan. His specimens were collected from the Upper Devonian rocks of Lu-nan and east of Po-shi in the said Province. The figures are very excellent art, but the description is by no means sufficient. The reason why he raised *A. desquamata* to a species is of course not obvious. It seems, however, that in Yun-nan, or at least in the field for which he is responsible, *A. desquamata* predominates in the upper division of the Devonian formation, for he remarks, "Ce fossile est presque aussi commun dans le Dévonien supérieur que *Atrypa reticularis* dans le Dévonien moyen."³⁾ Therefore if the same holds regularly for the fossil in all localities the specific independence of *A. reticularis* and *A. desquamata* may be regarded as conclusive. HALL, however, has cited several examples of the form from the Corniferous (Onondaga) limestone under the name of *A. reticularis*.

Here should be noticed a form recorded from the upper division of the Middle Devonian of the Eastern Alp as a new variety of *A. desquamata* by FRECH.⁴⁾ According to the author it is an *A. desquamata* in all essential

1) GIRTY:—Monogr. U. S. Geol. Survey, XXXII., pt. 2, p. 503.

2) LOEWE:—Die nordische Devongeschiebe Deutschlands. Neues Jahrb., Beil.-Bd., 35, p. 59. 1913.

3) MANSUY:—loc. cit.

4) FRECH:—Ueber das Devon der Ostalpen, Zeitschr. d. deutsch. geol. Gesellschaft, XLIII., p. 680. pl. XLIV., fig. 1. 1891.

points, but differs from it first of all in having a far more prominently pointed erect beak as well as in being smaller and with finer striae and fainter concentric wrinkles on the surface. The writer, however, infers that it is only a young example of the typical *A. desquamata*, because, in the smaller examples found in the Chinese material some exhibit exactly the same features. Or it may represent another variety of *A. reticularis*, if the above mentioned peculiarities are shown to be constant.

There are seventeen specimens of the Chinese form at the writer's disposal. They were all collected by Prof. K. YAMADA of the Kyōto University several years ago at Ning-chang in the province of Shen-hsi. Most of them are quite well preserved, although the surface sculpture is often worn away. The characteristics of the variety are very excellently shown by them collectively.

The shell is usually a little wider than long and comparatively thin; sometimes it is as long as it is wide. Both the valves are convex, the dorsal valve exceeding in this respect the ventral valve. The hinge-line is straight and long, but does not represent the greatest latitude of the shell, which is just in front of the former; as is its habitus, the shell gradually narrows anteriorly, thus taking so to speak an inversely trapezoidal shape. In exceptional cases, however, there are forms that take a circular outline also. The ventral valve is convex around the beak region, the latter pointing out somewhat strongly but not incurving. Toward the margin the ventral valve gradually becomes flattened, and in some cases even a little turned down, so as to form a slight concave portion inside the margin. The area is quite high, showing a foramen on the top; deltidial plates are discrete. The front margin is slightly deflected upwards, forming a median flattening or even depression upon the surface which corresponds to the median fold traceable on the middle of the anterior border.

The dorsal valve is far more convex than its opposite, the gibbosity being especially remarkable along the median line of the shell; there are narrow flattenings on the two postero-lateral corners. The beak is less pointed and there is no area. Inside the anterior margin the shell forms a saddle on the

surface by the co-operation of the median convexity of the valve and the sinus of the margin.

The surface of both valves is ornamented with a great number of radial striae in alternation with as many interspaces. The striae gradually widen, and increase their number by the interpolation of new ones at various distances from the beak on the one hand, and on the other by dichotomy, the latter being confined to, or at least predominating in, the anterior part of the shell. The width of the striae is in no way constant even in specimens of nearly the same magnitude: in some specimens they are prominent, while in others they are rather low. The interspaces are somewhat narrower than the striae themselves. The width of the latter varies from about $1/3$ mm. to $1/2$ mm.

Beside these radial striae there is a smaller number of concentric undulations on the shell surface which look like so many concentric striations. They are especially abundantly developed in the marginal portion of the shell. Inside each of these concentric lines the radial striae widen, though very slowly, and on passing over it become somewhat narrower again: the concentric lines are in this way far more conspicuously exhibited than they otherwise would have been.

In a specimen in which the shell is almost entirely torn away something of the interior structure is accessible (Pl. XII., fig. 14). The adductors are not very clearly impressed but the impressions of diductors are quite clear on the cast of the interior of the ventral valve. Vascular impressions is partially exhibited. Two vascular trunks start from beneath the impression of the diductors on both sides and are divided into smaller vessels anteriorly and laterally. The ovaries are not visible in the present specimen, probably because they are hidden underneath the divaricators. There seem to be several remarkable differences with respect to the internal structures of the Chinese fossil and those described as *A. reticularis*, for instance, by HALL and EASTMAN. But these apparent differences are probably due to the fact that while the impression of the Chinese fossil exhibits the aspect of the surface of the mantle, those mentioned by HALL and EASTMAN show the impression of the structures inside the mantle.

On the dorsal mould there are seen the impressions of adductors and the edge of the median septum. On the inside both the valve seem to be provided with numerous pits, suggested by the very great number of warts on the surface of the impression.

Dimensions :—

Length.	Width.	Thickness.
25 mm.	28 mm.	14 mm.
30 "	35 "	18 "
30 "	36 "	18 "
33 "	38 "	19 "

Locality :—Ning-chang, Han-chang-fu, prov. Shen-hsi.

At this locality *Atrypa reticularis* var. *richthofeni*, *Rhynchonella parallelepiped*a and some other fossils were found in association with the present variety of *A. reticularis*. VON RICHTHOFEN's collection at Lung-tung-pei may also have originated here, for he did not collect *in situ* at that locality, which is very near to Ning-chang.

Geological Age :—Middle Devonian.

***Atrypa reticularis* LINNE, var. *auriculata* nov.**

Pl. XXIII., Figs. 2 and 3.

It is a very popular opinion among palaeontologists that *Atrypa reticularis* is one of the most variable species of Brachiopods. There is indeed a large number of varietal forms of the species, each of which is likewise not very constant in shape. The present writer, however, does not know of any recorded form that is comparable with the one from China now to be described. The species *Atrypa reticularis* and its varieties have been so well studied, that it may not seem proper to add to them one more new variety. This the writer himself acknowledges, and does not mean in describing the form to insist upon the independence of the new varietal name. Had he been able to examine many specimens of the species and its varieties from various corners of the world, he might have been able to find some intermediate types linking the present fossil to the type species or to some one of its varieties.

The most striking characteristics of the new form are 1) its projecting auricular expansions and 2) the very coarse radial striae upon the surface of both the valves. In all essential points other than these the fossil resembles the type species very closely. There is, however, another thing that may be worthy of note; that is, the somewhat stronger development of the concentric lines of growth that give rise, with the co-operation of the radial striae, to a sculpture that is characteristic of the variety *aspera* SCHLOTH. This is not, however, so conspicuous in this form as in the latter, and the Chinese fossil is more resemblant to the type species than to this variety.

The Geological Institute of Sendai possesses a great number of specimens of *Atrypa reticularis* from various localities, either bought or collected by Prof. YABE in Europe and America. All of these examples have been examined one by one, but none of them has proved to be comparable with the Chinese fossil either in shape or in the sculpture of the shell. This fact constitutes another argument in support of the writer's proposing a new varietal name for the Chinese fossil.

The ventral valve is far less convex than the dorsal, and sometimes is even nearly flat. Hinge-line is very long and straight and projecting beyond the lateral border of the shell, forming somewhat semicircular auricular expansions on either side. The ventral beak is very low, its top being only a little above the hinge line; it is not crooked. The opposite beak is lower and strongly incurved and lies beneath the ventral beak. No area is observed. If the peculiar auricular expansions are disregarded then the shell is nearly equal in length and breadth, and consequently becomes lenticular. Along the anterior border of the shell there is a flattening on the ventral valve, which causes an upward fluctuation of the margin. This median flattening, however, is not traceable beyond a short distance from the anterior margin; on the contrary, there is a tendency to form a very gentle, hardly recognizable folding which is somewhat obvious in the umbonal region. The dorsal valve is highest at the central portion and slopes down rather abruptly in all directions. But it has an inclination to become high along the median line, just as in the case of the opposite valve. This is much more conspicuous than in the other

valve, but it is not especially striking in the umbonal portion of the valve. The anterior border is concave.

The surface is covered with quite wide and consequently not very numerous radial striae or ribs that are rounded on the top. They increase anteriorly by means of intercalation. In width the interspaces are nearly equal to the ribs themselves. Concentric growth lines are rather extraordinarily well developed, and in reality are concentric lamellae. The radial ribs are traversed by them and look like so many radial series of scales. 4 or 5 ribs are counted in a distance of 5 mm. along the anterior border.

Dimensions :

Length.	Width (along auricular expansions).	Thickness.	Hinge-line.
22 mm.	30 mm.	13 mm.	23 mm.
24 „	—	16 „	23 „
24 „	34 „	18 mm.	24 „

Locality :—Ning-chiang, Han-chung-fu, prov. Shen-hsi.

Associate fossils are ;

Atrypa reticularis var. *richthofeni*

„ „ var. *desquamata*

Rhynchonella parallelepipedæ.

Geological Age :—Middle Devonian.

N.B.—The papers consulted are, beside those mentioned in the synonymy of the preceding varieties, the following.

HUDLESTON :—Fossils from the Hindu-Khoosh. Geol Magaz., New Ser. Decade IV., vol. IX., p. 49. 1902.

Maryland Geological Survey, Devonian. 1913.

H. LOEWE :—Die nordischen Devongeschiebe Deutschlads. Neues Jaharb., Beil.-Bd., 35 p. 58. 1913.

Athyridæ.

Athyris, M'COY.

Athyris concentrica VON BUCH, sp.

Pl. XXIII., Figs. 4 and 19.

1853. *Terebratula concentrica*, SCHNUR :—Zusammenstellung u. Beschreibung sämmtl. im Uebergangsgeb. d. Eifel vorkommend. Bra-

- chelopoden, etc. Palaeontographica, 3, p. 191. pl. XXVII., fig. 3; pl. XLIV., fig. 8.
1865. *Athyris concentrica*, DAVIDSON :—Monogr. Devon. Brach., p. 14. pl. III., figs. 13, 16, etc.
1868. *Spirigera concentrica*, DAMES :—Ueber die in der Umgebung Freiburgs in Nieder-Schlesien auftretenden devonischen Ablagerungen. Zeitschr. d. deutsch. geol. Gesellsch., vol., XX., p. 496. pl. X., figs. 6 and 7.
1871. *Athyris concentrica*, KAYSER :—Die Brachiopoden d. Mittel- u. Oberdevon der Eifel. Zeitschr. d. deutsch. geol. Gesellsch., vol. XXIII., p. 547 and 548.
1884. *Athyris concentrica*, TSCHERNYSCHEW :—Materialien zur Kenntniss d. devon. Ablagerungen Russlands, pl. I., fig. 21.
1885. *Spirigera (Athyris) concentrica*, ROEMER :—Lethaea erratica. Paläontol. Abhandl., 2, p. 83. pl. XXXIV., fig. 3.
1902. *Athyris concentrica*, HUDLESTON :—Fossils from the Hindu-Khoosh. Geol. Magaz., Decade IV., vol. IX., p. 54. pl. III., fig. 2.

Athyris concentrica is one of the species of Brachiopoda which have a very great range of variation. As early as in 1853, SCHNUR already recognized the fact and subdivided the Eifelian specimens into four minor groups. Subsequently KAYSER included under the specific name not only all the four species described by SCHNUR, but also such forms as *A. ventricosa* SCHNUR, *A. gracilis* SANDB. and *A. eifeliensis* SCHNUR as its varieties. Moreover, three other varieties were equally added to the list by him, namely, var. *tumida*, *pentagonalis* and *squamosa*. It is with *A. concentrica* s. s. of this naturalist that the Chinese fossils have been identified.

There is quite a large number of specimens of the species at the writer's disposal, all of them having been collected in the province of Kwang-hsi by Prof. K. YAMADA of the Kyōto Imperial University. They seem to have originated at three different localities, as they are separated into three lots, each with a label bearing different numbers; these localities, however, can not be widely distant from one another, but rather very closely located. The

rocks that yielded this fossil at the three spots must therefore belong to one and the same formation with a very widely extended exposure.

The figures given by SCHNUR very well represent the characteristic features of the Chinese specimens, although they are in no way literally identical with each other. As a whole the Chinese fossils are smaller in size than those from Europe. However, among the European examples, there are also in reality such smaller forms as are comparable with the average forms from China. Other differences are due to the unfavourable conditions in which the Chinese fossils had been preserved as well as to the way in which they were collected. Most of the Chinese specimens have not such conspicuous growth lines as are mentioned by DAVIDSON. He says that the growth lines are "numerous close, concentric, regular, imbricating laminae." In the Chinese specimens they must without doubt have been worn away. The growth lines are not very clear in the writer's material; they are somewhat distinctly observable along the marginal portion, but become more and more indistinct toward the beak.

In all essential points, however, the diagnosis given by either SCHNUR, DAVIDSON or KAYSER holds equally good for the Chinese species. In this paper the description of KAYSER is adopted for the sake of convenience in order to explicate the characteristics of the material from China.

"From circular to transversely oval in outline, mostly wider than long, but also the reverse, with rounded cardinal edges. Two valves almost equal and more or less strongly vaulted, and strongest on the beak (Buckel) where the shell usually attains its greatest height. The greatest width is mostly in the middle. Ventral valve with a comparatively well developed sinus which becomes significant first at a little before the middle of the shell. Corresponding to it there is an equally well developed fold on the dorsal valve. Somewhat swollen, moderately long, blunt beak is usually crooked and lies on the beak region of the opposite valve; penetrated by a large rounded pedicle aperture. Surface with numerous lamellar, somewhat closely imbricating, concentric growth lines." The spirals are shown by polishing the

11; they are laterally directed.

Dimensions :—

Length.	Width.	Thickness.
7.5 mm.	8 mm.	5.5 mm.
8 ,,	9 ,,	6 ,,
10 ,,	12 ,,	8 ,,
14 ,,	15 ,,	10 ,,
16 ,,	19 ,,	13 ,,

Localities :—Three places between Mien-tien and Shang-shui-tang, Nan-ning-hsien, Nan-ning-fu, prov. Kwang-hsi. This species seems to be very abundant in these localities ; for there is a piece of a dark grayish limestone of a moderate size which is, so to say, a heap of a large number of the species cemented by the limestone. Several other fossils have been collected in association with this species in these localities ; they are

Dalmanella striatula

Spirifer ziczac var. *undecimplicatus*

Athyrisina minor.

Geological Age :—Middle Devonian. According to H. LOEWE this species " tritt bereits im tiefen Unterdevon auf und geht durch das Mittel- und Oberdevon hindurch, wo sie sehr häufig ist.¹⁾" But the associate fossils very likely represent the Middle Devonian age.

Athyrisina, nov. gen.

Among various kinds of of Brachiopods from the Palaeozoic Formations of China there are three Athyroid forms rather closely related to one another, but having no identical genus among the hitherto known forms. The shell is ornamented with coarse radial ribs and is provided with a median sinus and fold in the ventral and dorsal valves respectively. A circular pedicle hole truncates the more or less strongly recurved ventral beak. There is no cardinal area in either of the valves. At first sight this fossil is liable to be

1) H. LOEWE :—Die nordischen Devongeschiebe Deutschlands. Neues Jahrb., Beil.-Bd., 35, p. 57. As to the species described by this author as *Spirigera concentrica*, however, the writer cannot regard it as surely identified, because the figure given is by no means a good one.

taken for an *Atrypa* rather than an *Athyris*; for the shell of an *Atrypa* is "radially plicated,¹⁾" while there is hardly any record of such radial ribs in *Athyris*.

Several specimens, however, were cut and polished in the course of the study, and it was proved that these forms possess spirals inside which are directed laterally as in the case of *Athyris*, not dorso-medially as in the forms belonging to the group of *Atrypa*, or the subfamily *Atrypinae* WAAGEN.

Now, there are other groups, in which the shells are radially plicated, spirals laterally directed, and beak perforated, namely, those classified as belonging to the family *Rhynchospiridae* HALL and CLARKE.²⁾ Of those genera placed in this family by SCHUCHERT, *Rhynchospira* HALL, *Trematospira* HALL, and *Parazyga* HALL and CLARKE are especially resemblant to the Chinese fossils. Thus the writer was quite at a loss to find the position of these peculiar fossils in the known forms of Brachiopoda: he was very much inclined to regard them as new species of a certain one of the above mentioned genera.

Another course was tried by the writer in this direction. The artificial key to the genera of Brachiopoda schemed by GRABAU and SHIMER³⁾ was scanned by him, and the Chinese fossils were found to fall in either of the two genera, *Parazyga* or *Trematospira*. First of all the shell has a marginal beak, but lacks a cardinal area: its hinge-line is somewhat straight but very short. Within the category having these characteristics the fossils are subdivided into trimelloid, linguloid, pentameroid, rhynchonelloid and terebratuloid or athyroid forms. The present fossil is athyroid in outline and consequently belongs to the last group. Furthermore the shell is radially striated with a sinus and a fold. The beak of the pedicle valve is truncated by a foramen, although the shell is not so very transverse as in *Parazyga* or *Trematospira*. It is not clear whether the plications or striae possess minute spines or not.

This result is quite coincident with the last, and it seems that this is the position to which the Chinese fossils may most adequately be ascribed.

1) SCHUCHERT:—EASTMAN'S Text-book of Paleontology, vol. I., p. 409. 1913.

2) SCHUCHERT:—op. cit., p. 413.

3) GRABAU and SHIMER:—North American Index Fossils, vol. I., p. 177-187. 1919.

The former of these two genera is a type characteristic of the Devonian formation; while the latter is confined to the Silurian and the Devonian formations of North America. Thus, in point of geological age, too, the above conclusion seem most probable, or even almost decisive: for at Ning-chiang this fossil was discovered in company with other Brachiopods that represent the Devonian age, namely, *Atrypa reticularis* var. *desquamata*, var. *richthofeni* and *Rhynchonella parallelepipedæ*.

According to SCHUCHERT, however, in the family Rhynchospiridae the shell structure is "abundantly punctate," while it is impunctate in the family Athyridae. On examining the shell structure of the Chinese fossil it was found to be entirely impunctate. The impunctate structure of the shell constitutes the sole essential difference between the present fossil and the genera above quoted. In all outward characteristics the new fossil is allied to the Rhynchospirid genera, but in point of shell structure it is an Athyroid genus.

Thus the question is transferred to the determination of the relative importance of the two structural features, i. e., the shell structure and the presence or absence of radial striae on the shell surface. The meaning of the punctae of the shell is at present not clear. But PERCIVAL¹⁾ in his study on *Terebratula* has determined (1) that "the shapes of the individual punctae depend to a great extent on the state of preservation"; (2) that in both the valves "there is in general a progressive increase in density from the umbo outwards"; and (3) that "the amount of variation in a species is so great as to make the density almost valueless as a specific character." In any case, the presence or absence of such punctae seems to be of great importance, for, in certain families they are entirely absent while they are very abundant in certain others—this is true as far at least as our present knowledge of Brachiopods is concerned. In every textbook much stress is laid upon shell structure as one of the most important characteristics.

On the contrary there are forms either striate, smooth or concentrically costate in one and the same family or even in the same genus. The most

1) F. G. PERCIVAL:—On the Punctuation of the Shells of *Terebratula*. Geol. Magaz., Feb., 1916. p. 51.

popular example is found in Spiriferidae. In this family SCHUCHERT¹⁾ proposed a Subgenus Spiriferinae beside the other two Reticulariae WAAGEN and Martiniinae WAAGEN. The last sub-family is "with a smooth surface," while Reticulariae is spinous on the surface. In the diagnosis of the first sub-family nothing is said about the surface sculpture. From these examples it is suggested that surface aculpture is in present palaeontology not regarded as so significant as shell structure. It is this course that the writer has been led to follow in deciding the systematic position of these peculiar Chinese Brachiopods. They are placed in the family of Athyridae, and are to be named *Athyrisina*.

The characteristics of the new genus have been made known in the foregoing lines somewhat in detail but in a rather disjointed way. A generic diagnosis therefore will now be given before entering into the description of the species.

Shells biconvex, ventral valve somewhat exceeding the other in gibbosity. Length somewhat inferior to width, the outline being transversely elliptical or obtusely rhombic. Hinge-line short. Ventral valve most convex in the umbonal region, and its beak obtusely pointed and curved, slightly overhanging the hinge-line; it is truncated by a circular pedicle hole. At the top of the beak begins a distinct median sinus, which is narrow but deep in the umbonal region, but gradually widens anteriorly ending in a tongue-like prolongation of the anterior margin. Dorsal valve has a median fold in correspondence with the sinus of the opposite valve, and the anterior margin is strongly concave in the middle to meet the tongue-like prolongation of the ventral valve. Dorsal beak very low and crooked, so that it is hidden beneath that of the opposite valve. Ventral area indistinguishable or but slightly developed. The surface of both the valves is ornamented with coarse radial ribs that seldom increase on the lateral portions. In the sinus or on the fold the ribs are somewhat less distinct and less prominent; intercalation and dichotomy take place here. There are usually many concentric but fluctuating growth lines that are somewhat scaly or lamellar. The shell structure is impunctate. The spirals are laterally directed.

Remarks:—As has already been stated, this genus morphologically

1) SCHUCHERT:—op. cit., p. 410-414.

most closely resembles certain genera of the family Rhynchospiridae. The only distinction is that the shell is impunctate in the new genus, and this leads the writer to place it in the family Athyridae. If the new Chinese forms are to be classified under Athyridae, the definition of the latter family must suffer a slight but important change. For it is said that in Athyridae, the shells are smooth, lamellose, or spinose, but not radiated by ribs¹⁾; while there are many coarse radial ribs in the new Chinese genus.

As to the jugum, however, nothing is accessible to the writer, and consequently it is not clear to which of the two subfamilies this genus should be united. It appears, however, that he may be led to establish a new, or third, subfamily of Athyridae, distinguished from the others by possessing radial ribs on the surface of the shell. This can only be decided by further comparative studies of similar groups of fossils.

Genotype :—*Athyrisina squamosa* nov. gen. et sp.

Beside this type species there are two other forms that belong to the genus, one being a variety of the genotype, and the other being an independent species. They are

Athyrisina squamosa var. *rhomboidale* nov.

Athyrisina minor nov.

Geological Age :—Middle Devonian. As to the determination of the geological age of the present genus, readers are requested to refer to the following pages on which the individual forms are explicated.

***Athyrisina squamosa* nov. sp.**

Pl. XXIII., Fig. 5, 6, 16 and 17.

Outline slightly transverse, biconvex, the ventral valve being higher than the other. Hinge-line short and somewhat curved; and about half of the maximum breadth of the shell. Ventral valve has a distinct median sinus, which begins at the tip of the beak and extends from the front margin in the form of a tongue. The beak is not very acutely pointed and terminates in a

1) See EASTMAN'S Text-book of Paleontology, vol. I., p. 417. 1913.

round pedicle opening. Area is hardly recognizable beneath it. The dorsal beak, which is less prominent, is crooked and extends beneath the ventral beak. The median fold is not very prominent, but is clearly recognizable in the anterior region, where the fold rises quite abruptly above the level of the lateral portions, in correspondence with the sinual depression of the ventral valve. The surface of both the shells is covered by a rather small number of radial ribs, there being about 10 or 11 of them on either side, while 3 or 4 somewhat thinner ones are counted on the fold or in the sinus. The ribs on the lateral parts sometimes increase in number anteriorly by interpolating new or younger ones at various distances from the beak; but the increase of the ribs is most remarkable in the sinus or on the folded portion in the middle of the shell. Thus sometimes 5 ribs are found in these parts. The lateral and the anterior margins fluctuate as the result of the coarse radial ribs and interspaces that are in alternation with the former. Lateral ribs are about 0.8 mm. wide on an average, but only 0.5 mm. in the sinus. Here the interspaces are much wider; the reverse is true on the fold. There is a large number of fluctuating growth lines that are very prominent being convex in the interspaces and concave on the ribs. They are so prominent that the surface looks just as if it were provided with a great number of scales. This scaly aspect is distinct over the whole surface of both the shells, but more so in the anterior part. The shell structure is not punctate, but fibrous, and extraordinarily thick.

Dimensions :—

Length.	Width.	Thickness.	Hinge-line.
23 mm.	25 mm.	18 mm.	16 mm.
24 "	24 "	17 "	14 "
26 "	30 "	20 "	18 "

Locality :—Pen-chao-tse, Chao-hua-hsien, Pao-hing-fu, prov. Sze-chuan, where this was collected together with a variety which is described below.

Geological Age :—Middle Devonian.

Athyrisina squamosa var. *rhomboidale* nov.

Pl. XXIII., Figs. 7 and 18.

In all essential characteristics this is coincident with the type species. For example, the shell is extraordinarily thick, and is ornamented with very thick radial striae on the surface. Median sinus and fold are equally well developed. The spirals are laterally directed. This variety, however, is distinguished from the type species by its outline which is somewhat more of the transverse type. The type species is rather discoidal in form, the length and the width not being very different. In this variety the hinge-line is not appreciably shorter than the maximum breadth of the shell which is just below it, and it is also quite straight. The beak and the median sinus of the ventral valve, however, being equally projecting as in the type species, the outline of the shell is consequently obtusely rhomboidal; hence the name *rhomboidale*. This variety is also uniformly thinner than the preceding species. Ventral area is little better developed in this form. The beak is somewhat obliquely truncated by the pedicle opening.

Dimensions :—

Length.	Width.	Thickness.	Hinge-line.
19 mm.	24 mm.	12 mm.	17 mm.
19 „	23 „	15 „	18 „
20 „	26 „	15 „	20 „
25 „	31 „	16 „	24 „

Remarks :—The variety is no doubt different from the type species in many points as mentioned above. In the material now at the writer's disposal there is hardly any specimen that represents a type transitional between this and the preceding species. However, it may happen in future that such forms will be found. In such case these two will of course be united, and the varietal name will then be abandoned. To speak the truth, there is only one specimen which appears to represent the type species in all essential features, and yet it has a somewhat rhomboidal outline (Pl. XXIII., fig. 17). The writer, however, is not inclined to place it just between these two forms because it is so very closely related to the type species.

Localities :—Per-chao-tze, Chao-hua-hsien, Pao-ning-fu, prov. Sze-chuan ; Ning-chiang, Han-chung-fu, prov. Shen-hsi.

In the second locality several other brachiopods were discovered, of which the following determine the geological age of the rock that yielded them.

Atrypa reticularis var. *desquamata*
var. *richthofeni*

Rhynchonella parallelepipeda.

From these associate fossils it seems that the present fossil is of the Middle Devonian. As this fossil was collected in association with the type species described just above, the latter also is a fossil indicative of the Middle Devonian Age.

Geological Age :—Middle Devonian.

Athyrisina minor nov. sp.

Pl. XXIII., Figs. 8-12.

Shell small and somewhat circular in outline, and more or less strongly biconvex, ventral valve being usually more gibbous than the opposite one. Hinge-line very short and curved. Ventral valve uniformly curved in the longitudinal direction, but the dorsal valve is most convex in the visceral region, a little in front of the beak ; on the whole it is rather flatter than the other. Ventral beak more or less acutely projecting and strongly recurved ; its end is obliquely truncated by a circular pedicle hole. There is no visible cardinal area beneath the ventral beak. Median sinus is already developed in the beak region, but first becomes distinct in the visceral part. It rises almost vertically at the anterior margin, quite suddenly becomes deeper and wider anteriorly, and ends in an angular prolongation at the front margin. Dorsal beak not prominent, but hidden beneath the opposite beak. Median fold developed only on the anterior half of the shell, rising very abruptly above the level of the lateral portion of the shell. The margin forms a zigzag, owing to the angular and high radial ribs on each side of the shell, that are separated

by equally wide interspaces. Along the anterior border the rib is about 1 mm. wide. In the sinus there are two or three narrow ribs in alternation with interspaces nearly twice as wide as the ribs themselves, which measure about 0.5–0.8 mm. in breadth at the anterior extremities. When there are three of them in a sinus the one at the middle is the widest. The two ribs forming the boundary between the sinus and the lateral parts look extraordinarily high because of the depth of the sinus in the front region. The ribs are simple and seem never to increase in number anteriorly. On the median fold of the dorsal valve. The ribs are usually wide and the interspaces narrow. The growth lines are not very distinct but they really exist and form fluctuating lamellae, which are convex in the intercostal spaces and concave on the ribs. Shell is very thin.

Dimensions :—

Length.	Width.	* Thickness.	Hinge-line.
13 mm.	13 mm.	9 mm.	5 mm.
14 „	15 „	10 „	7 „
15 „	15 „	11 „	7 „
15 „	15 „	12 „	5 „

Remarks :—Within this species the range of variation is somewhat remarkable with regard to morphological features. The anterior prolongation of the sinus is in some examples very long, while in others it is not so conspicuous. Then, too, the number of the radial ribs is by no means constant. In some examples 8 of them may be counted on one side of the shell, although, on the other hand, some have only 6.

In the younger examples the sinus and fold are very indistinct, but in all other points the specific identity is not a matter of any great difficulty. In such small specimens the ribs are very distinctly developed, so that they might be called plications rather than ribs.

From the preceding forms this is discriminated first of all because of the small size of the shells. There is not one among quite a large number of specimens which equals the preceding forms in point of size. The smallest examples of the other forms are separable from the present by their peculiar shape and the characteristic features on the surface of the shells.

The ribs of this species are very prominent and of a brilliant luster because of their great height and width as well as of the faint concentric lines.

Another point to be mentioned is the obliquity of the pedicle opening against the beak. In the genotype *A. squamosa* the truncation is nearly perpendicular to the imaginary axis of the pointed beak, and is never oblique against it. This peculiarity is quite constant in the species of the new genus. Of course the pedicle hole is not so strictly perpendicular in the variety *rhomboidale* as in the type species, but it is much more strongly curved in this species. In contrast with the very thick shell of the preceding forms the shell of this species is very thin.

All these points may suffice to draw a line separating from the genotype the present form as the second species. From the fact that the shell is constantly smaller than the latter, this is called *Athyrisina minor*.

Locality:—Between Shang-shui-tang and Mien-tien, Nan-ning-hsien, Nan-ning-fu, prov. Kwang-hsi.

In the same locality a number of other Brachiopods were found in association, namely;

Dalmanella striatula

Spirifer ziczac var. *undecimplicata*

Athyris concentrica.

Geological Age :—Middle Devonian.

Rhynchonellidæ.

Rhynchonella, FISCHER.

Rhynchonella parallelepipeda, BRONN.

Pl. XXIII., Figs. 13-15.

1853. *Terebratula angulosa*, SCHNUR :—Zusammenstellung u. Beschreibung sämmtl. im Uebergangsgebirge d. Eifel vorkommenden Brachiopoden nebst Abbild. derselben, p. 185. pl. XXV., figs. 5.
1853. *Terebratula subcordiformis*, SCHNUR :—ditto, pl. XXV., figs. 6a, b, c, h, i, k.

1865. *Rhynchonella primipilaris*, DAVIDSON :—A Monogr. Brit. Devon. Brachiop., p. 66. pl. XIV. figs. 4-6.
1871. *Rhynchonella parallelepipeda*, KAYSER :—Die Brachiopoden des Mittel-u. Ober-Devon der Eifel. Z. d. d. g. G., XXIII., p. 507.
1872. *Rhynchonella parallelepipeda*, KAYSER :—Studien aus dem Gebiete des Rheinischen Devon, III. Die Fauna des Rotheisensteins von Berlin in Westfalen. Z. d. d. g. G., XXIV., p. 678.
1883. *Rhynchonella parallelepipeda*, KAYSER :—Devonische Versteinerungen aus dem Südwestlichen China. Von Richthofen's China, vol. IV., p. 77. pl. VIII., fig. 1.
1892. *Rhynchonella parallelepipeda*, WHIDBORNE :—A Monogr. Devon. Fauna, South of England p. 129. pl. XV., fig. 10.
1905. *Rhynchonella parallelepipeda*, SCHMIDT :—Der oberste Lenneschiefer zw. Letmathe u. Iserlohn, Z. d. d. g. G. LVII., p. 551. pl. XXI., fig. 4.
- ? 1908. *Rhynchonella parallelepipeda*, MANSUY :—Contribution a la Carte Géol. de l'Indochine, Paléontologie. p. 52. pl. XIII., fig. 1.
- ? 1908. *Rhynchonella* cf. *parallelepipeda*, MANSUY :—ditto, fig. 2.
1913. *Rhynchonella parallelepipeda*, LOEWE :—Die nordisch. Devongeschiebe Deutschlands. Neues Jahrb., Beil.-Bd. 35. p. 65. pl. III., figs. 6 and 12.

In outline the shell is a nearly equal-sided, rounded pentagon, consisting of two convex valves, ventral and dorsal. Usually the thickness is not very conspicuous but is very variable. It is a little wider than long with an erect beak. The hinge-line is long and almost straight; it is a little shorter than the greatest width of the shell. At various distances from the beak,—most usually in the center of the ventral valve—begins a sinual depression which is rather shallow but quite wide throughout; it has nearly parallel sides and forms a rectangular tongue-like prolongation at the anterior margin just closing up the space which is left by the dorsal valve as the result of the rectangular upfold of its front margin. The valve in its lateral and antero-lateral marginal portions is bent up nearly perpendicularly to its surface. The median sinus is bordered on both its

sides by two scarps that descend very steeply into the sinus; they converge posteriorly at a very obtuse angle, where the sinual depression begins. As the beak is erect and pointed, there is a small area under it, although in none of the specimens is it very clearly exhibited. The dorsal valve is a little more convex than the opposite one and has a less prominent small beak. Corresponding to the rectangular tongue of the ventral valve the anterior margin is rectangularly up-folded. On the surface of the dorsal valve, therefore, the median portion is abruptly vaulted above the surrounding portion; it is visible, however, for a small distance from the anterior margin just as in the case of the depression on the opposite valve. The sides of this median fold make an almost vertical slope toward the lateral portion. At the margin the valve also is deflected vertically downwards, and consequently the margin of the shell has not thin edges, but is, so to say, surrounded by a vertical wall.

On the surface of both the valves there is a variable number of radial striae in alternation with interspaces of inferior breadth. In the median sinus or on the fold there are as a rule 7-8 of the striae, but sometimes more; on the lateral portion there are about 18 of them. These striae are very thin in the beak region, but gradually widen toward the anterior border. They are not likely to increase in number anteriorly in any way.

Dimension :—

Length.	Width.	Thickness.
13 mm.	18 mm.	11 mm.
13 "	16 "	11 "
16 "	19 "	13 "
16 "	20 "	14 "
18 "	19 "	11 "
18 "	20 "	13 "
18 "	21 "	11 "

Remarks :—The Chinese specimens, on the whole, are much larger than those from Europe; this is very obvious when one compares the above measurements as well as those given by KAYSER in VON RICHTHOFEN'S China, vol. IV. with those found, for instance, in the paper by LOEWE. His largest specimen measures 18 mm., 19.5 mm., and 11.5 mm. in length, width, and

thickness respectively. All of the specimens of this species collected by YABE in Gerolstein, Eifel, are much smaller than those from China. Of them the largest measures 14 mm., by 17 mm. by 12 mm., but all the others are remarkably smaller. KAYSER's specimens (1871) measure some 14 mm., by 18 mm., by 12.5 mm. Extraordinarily large specimens from Indo-China were mentioned as a species very near to the present one. In some respects they indeed quite closely resemble *Rhynchonella parallelepipedal*. Neither the description nor the figures, however, being very clear, the true nature of the Indo-Chinese fossils is quite obscure. The present writer is not inclined to include these forms in the species now under consideration.

That *Terebratulal subcordiformis* SCHNUR is identical with *Rh. parallelepipedal* has long since been admitted by palaeontologists. The writer, however, hesitates to include the specimens represented by SCHNUR's figures 6d, e, f, g. Although the author notices that these last figures show the "Gehäuse junger Thiere," their form is somewhat too divergent from the typical form of the species.

LOEWE, in his paper above quoted, includes DAVIDSON's *Rh. implexa* in his *Rh. parallelepipedal*, for which the reason is quite obscure to the present writer. The former shows no sign at all of the peculiarities of the latter species. DAVIDSON uses for this species the name *Rh. primipilaris* instead of *Rh. parallelepipedal*, regarding the two as synonymous. If they were really identical, DAVIDSON's nomenclature ought to be regarded as justified. However, on examining, the figures of the former species drawn by SCHNUR, the writer finds that DAVIDSON's circumscription of *Rh. primipilaris* was not correct. SCHNUR's idea of *Rh. primipilaris* must no doubt hold good, for LOEWE does not cite it in the synonymy given in his paper. KAYSER, also, in all of his papers excludes it from the synonymy. Thus *Rh. parallelepipedal* must hold its position in the genus of *Rhynchonella* as an independent species. In *Rh. primipilaris* the ribs dichotomize, or trichotomize while they are usually single throughout in the present species. WHIDBORNE, however, remarks that there are some specimens in which the ribs occasionally are dichotomous in a very subordinate degree, and he doubts the idea of KAYSER¹⁾ that the two forms are separated in this point.

1) KAYSER:—op. cit., pp. 510 and 512, 1871.

There are two very similar species, namely *Rh. pila* SCHNUR¹⁾ and *Rh. orbigniana* DE VERN.²⁾ In form and habitus these three are very much alike, and they would no doubt belong to one and the same group of the genus, if it were to be divided into several groups. However, if one examines the pictures of these forms given in SCHNUR's work as well as his descriptions, individual characteristics may be found sufficient to distinguish any one of them from the others. There is a number of specimens of each of *Rh. pila* and *Rh. orbigniana* derived from the Eifel in the Geological Institute of Sendai. They were also examined by the writer in the course of the present study, and the fact that these forms differ radically from *Rh. parallelepipeda* BRONN, was confirmed.

Locality :—Ning-chiang, Han-chuang-fu, prov. Shen-hsi. In association with

Atrypa reticularis var. *desquamata*,

A. reticularis var. *richthofeni*,

Athyrisina squamosa.

Geological Age :—This is a species very abundant in the Middle Devonian rocks of Europe. It is especially common in the *Calceola*-bed of the Eifel and Belgium ; i.e., the lower division of the Middle Devonian.

Orthidæ.

Dalmanella, HALL and CLARKE.

Dalmanella striatula SCHLOTHEIM.

Pl. XXIII., Figs. 20-22.

1853. *Orthis striatula*, SCHNUR :—Zusammenstellung u. Beschreibung, etc., p. 215, pl. 38, fig. 1.

1859. *Orthis multistriata*, HALL :—Nat. Hist. New York, Palaeontology, III., p. 176, pl. XV., fig. 2.

1865. *Orthis striatula*, DAVIDSON :—Monogr. Brit. Dev. Brachiop., p. 87, pl. 8, figs. 4-7.

1) and 2) SCHNUR :—op. cit., pl. XXVI.

1871. *Orthis striatula*, KAYSER :—Die Brachiopoden d. Mitt.-u. Ob.-Devon d. Eifel, p. 598.
1883. *Orthis striatula* KAYSER :—V. RICHTHOFEN'S China, vol. IV., p. 90. pl. 13, fig. 1.
1884. *Orthis striatula*, TSCHERNYSCHEW :—Materialien zur Kenntniss d. dev. Ablagerngen in Russland, pl. III., fig. 18.
1902. *Orthis striatula*, HUDLESTON :—Fossils from the Hindu-Khoosh, p. 53. pl. II., fig. 7.
1909. *Schizophoria striatula*, var. *australis*, KINDLE :—The Devon. Fauna of the Ouray Limestone, p. 21. pl. I., figs. 4-8 pl. II., figs. 1-5 ; pl. III., fig. 1.
1812. *Orthis striatula*, MANSUY :—Étude Géologique du Yun-nan Oriental, Pt. II., p. 53 and 67. pl. IX., fig. 4.
1913. *Orthis striatula*, LOEWE :—Die nordischen Devongeschiebe Deutschlands, p. 31.
1914. *Dalmanella striatula*, QUIRING :—Zusammenstellung der Strophomeniden d. Mitteldevons der Eifel, etc., p. 118.

Except that the size is quite small, the Chinese materials now to be considered are identical with the species named above. Yet one of the three lots is of the usual size. In one example which was collected in the province of Kwei-chou (fig. 22), the dorsal valve is not more convex than the opposite one, not like is usually in the case with the species. In all the other examples the characteristics of the species are very well represented. In one of the specimens from the province of Kwang-hsi (fig. 21) which is practically of the same dimensions as that from Kwei-chou, the relative depth of the valves is exactly as in the regular relation : and these two examples in all other essential points, are hardly separable. Of course, if there were a number of specimens of both types, then they might be distinguished as two varieties, provided the above mentioned difference was persistent. This, however, the writer, cannot decide because there are only five specimens of these smaller types, one from Kwei-chou and four from Kwang-hsi.

Of all the examples of the species ever described and illustrated, the majority are indeed of quite conspicuous dimensions. They are, as a rule,

very strongly swollen, and the ventral valve is provided with a shallow but rather wide sinus which begins at the middle of the shell. Consequently the anterior margin of the shell is convexly deflected in the ventral valve, while in consequence it is concavely deflected in the dorsal. If, therefore, the Chinese specimens at the writer's disposal are to be compared with those adult examples there may really exist rather remarkable apparent differences between them. The largest specimens from the province of Kwang-hsi, however, are comparable with some of them.

There are also smaller or younger examples¹⁾ illustrated by many authors which are comparable with these smaller examples from China. In such younger specimens the sinus is less conspicuously developed, or even not developed at all, the front margin then being nearly straight. "The specimens," says KINDLE, "vary widely among themselves with reference to the depth of the sinus at the front, but this variation is mainly a developmental feature, the sinus being slightly indicated in the younger shells, and very deep in mature specimens."²⁾ There is even one specimen among the examples hitherto described, namely one Russian fossil described by TSCHERNYSCHEW³⁾ in which the ventral valve is somewhat deeper than its opposite.

The difference of the Chinese specimens from the typical forms is thus of rather an unimportant nature, and does not militate against identifying the former with *Dalmanella striatula*.

This species had been most popularly known as an *Orthis* until it was removed to the genus *Schizophoria* by GIRTY.⁴⁾ Very recently QUIRING, in his monographic study, came to place it in the genus *Dalmanella*. These two last genera are regarded by HALL and CLARKE as subgenera of *Orthis*.⁵⁾ According to SCHUCHERT,⁶⁾ however, these three genera are far more widely

1) SCHNUR:—op. cit., pl. XXXVIII., figs. 1h, i, k;—HALL:—op. cit., pl. 15, figs. 2a, b, c;—DAVIDSON:—op. cit., pl. XVII., figs. 7, 7a;—TSCHERNYSCHEW:—op. cit., pl. III., fig. 18;—KINDLE:—op. cit., pl. I., fig. 4; pl. II., Fig. 1a;—MANUYS:—op. cit., pl. IX., figs. 4a, b.

2) KINDLE:—op. cit., p. 21.

3) TSCHERNYSCHEW:—op. cit., pl. III., fig. 18.

4) GIRTY:—Twentieth Ann. Rept. U. S. Geol. Survey, Pt. 2, p. 39. Cited after KINDLE, op. cit., 1909.

5) ZITTEL:—Grudzüge der Palaeontologie, I. Abt. Invertebrata, p. 275. 1910.

6) EASTMAN:—Text-Book of Paleontology, vol. I., 1913.

separated ones; for *Orthis* and *Dalmanella* typify the Family Orthidae WOODW., while *Schizophoria* is a genus belonging to the Subfamily Rhipidomellinae SCHUCHERT of the Family Rhipidomellidae SCHUCHERT. They are said to differ from one another in interior peculiarities, although their external characteristics are rather similar.

There is not sufficient material at the present writer's disposal to allow him to examine either the shell structure or other internal characteristics. Consequently he is not able to determine the phylletic position of the species; he can therefore but follow the most recent and most reliable result of QUIRING in regarding the species as a *Dalmanella*. *Dalmanella striatula* from China is described in the following manner.

Shell biconvex, transversely oval in outline, rather small in size. The two valves sometimes almost equally convex, but usually the dorsal is somewhat deeper than the other. Hinge-line very short, only a little longer than $1/3$ of the greatest width of the shell; cardinal angles rounded. The ventral valve is most strongly vaulted at or in the neighbourhood of its umbonal region, but very smoothly slopes down anteriorly.

The ventral area is quite high, triangular, with a delthyrium at the middle. The beak is pointed, but only very slightly curves over the area. The median sinual flattening is not very obvious in the smaller examples, but the anterior margin of even such specimens is somewhat deflected upwards and suggests the possible existence of a wide flat sinus when mature. In the larger patterns it is very well developed. The dorsal valve has its maximum depth at the center, and it slopes down very smoothly in four directions. The anterior half, however, is, strictly speaking, somewhat flattened rather than convex. The area is much lower than that of the opposite valve, and is directed almost perpendicularly to the latter. The beak is acute but not crooked over the area. The tops of both the beaks are equally high. The anterior border is concave in correspondence with the convexity of the opposite valve. The surfaces of both the valves are equally ornamented with very fine thread-like radial striae that increase in number either by implantation or dichotomy at various distances from the beak: they are rounded on the top. The interspaces are narrower than the striae themselves. The

striae are curved outward in the lateral portion of the valves, but they run straight away in the median portion. 3-4 of the striae occupy a distance of 1 mm. along the anterior margin.

Dimensions :—

Length.	Width.	Thickness.	Hinge-line.
15 mm.	20 mm.	9 mm.	9 mm.
13 "	15 "	4 " (dorsal)	7 "
9 "	11 "	5 "	4 "

Localities.—1. Between Mien-tien and Shang-shui-tang, Nan-ning-hsien, Nan-ning-fu, prov. Kwang-si ; 2. Between Wei-ning and Tou-tang, Wei-ning-chou, Ta-ting-fu, prov. Kwei-chou ; 3. South of San-toi-pa, Chao-hua-hsien, Pao-ning-fu, prov. Sze-chuan.

In the first locality this species was found in association with *Athyris concentrica* and *Spirifer ziczac* var. *undecimplicata*. The associate fossil in the third locality is *Atrypa reticularis* var. *richthofeni*. On the other hand this species was accompanied by an upper Devonian species, *Spirifer disjunctus* var. *verneuili*, in the second locality.

Geological Age :—*Dalmanella striatula* is existent through all the stages of the Devonian formation, but it is most common in its middle division.¹⁾ It is a "sehr häufiges, bereits im Unterdevon auftretendes, durch das ganze Mitteldevon hindurchgehendes, auch im Oberdevon vorhandenes Fossil."²⁾ The Chinese species represents two stages of the Devonian, namely, the specimens from the first and the third localities are of the Middle Devonian age, while those of the second locality represents the Upper Devonian.

1) LOEWE:—op. cit., p. 53.

2) KAYSER:—op. cit., 1871, p. 599.

CHAPTER VI.

Lower Carboniferous.

FRECH¹⁾ maintained the development of the Lower Carboniferous, with faunas quite similar to those of the European Lower Carboniferous, in northern as well as southern China, and at the same time believed Lower Carboniferous age of certain coal bearing series of China. The palæontological evidences by which his view is sustained are as follows:—

1. Po-shan,²⁾ Shan-tung; limestones, in alternation with coal seams, contain

Spirifer duplicicosta PHILL.

S. bisulcatus SOW.

Orthothetes crenistria PHILL.

Productus semireticulatus FLEMM.

P. punctatus SOW.

P. humboldti D'ORB.

P. sublaevis de KON.

P. longispinus SOW.

P. granulatus PHILL.

Bellerophon hiulcus SOW.

Loxonema walciadorence de KON.

Macrocheilus cf. *intermedius* de KON.

Phymatifer pugilis PHILL.

Naticopsis cfr. *globulina* de KON.

Orthoceras sp. •

Crinoid stems.

2. Hei-shan,³⁾ Shan-tung; limestones in alternation with coal seams, contain

Spirifer duplicicosta PHILL.

S. bisulcatus SOW.

Orthothetes crenistria PHILL.

1) RICHTHOFEN's China, vol. V., pp. 60-91.

2) Po-shan = 博山

3) Hei-shan = 黑山

Productus giganteus MART.

P. semireticulatus FLEMM.

P. humboldti D'ORB.

P. longispinus SOW.

Macrocheilus cfr. *intermedius* de KON.

"Die durch F. v. RICHTHOFEN in Nordchina, prov. Shan-tung, gesammelten Fauna stimmen vollkommen mit dem europäischen Kohlenkalk von Visé, von Derbyshire und von Hausdorf (Schlesien) überein.

"Abgesehen von einem schönen *Macrocheilus*, der dem mangelhaft abgebildeten *Macr. intermedius* KON, (Visé) jedenfalls sehr nahe steht, liegen ausschliesslich Arten vor, die mit europäischen vollkommen übereinstimmen. Ein nur auf die Faciesbeschaffenheit zurückführender Unterschied besteht darin, dass die Spiriferen (*Spirifer duplicicosta*) die an Zahl bei weitem vorherrschende Thiergruppe bilden, während die grossen *Productus*-Arten zurückzutreten. Nur *P. longispinus* ist häufig, während von dem typischen *P. giganteus* nur ein Bruchstück (bei Hei-shan) gefunden wurde. Ausserdem ist bei Po-shan-hsien *Phymatifer pugilis* in Menge vorhanden.¹⁾"

3. I-tchou-fu,²⁾ Shan-tung.

Rhynchonella pugnus var. *sulcirostris* PHILL.

In another paper³⁾ I have already expressed doubt about the occurrence of the Lower Carboniferous in Shan-tung. I. HAYASAKA who on my suggestion lately visited the first locality could find there no trace of Lower Carboniferous limestone. The coal bearing series with the *Lepidodendron oculis-felis* flora intercalates at its base a number of limestone layers with *Fusulina* and brachiopods, and the whole complex overlies unconformably thick Ordovician limestone. It is worthy to note that Mr. OGAWA once collected brachiopods (*Productus semireticulatus*, which HAYASAKA now believes to be a form comparable with var. *hermosanus*), and another species of the same genus which is believed by myself probably to be identical with *P. scabriculus* and is by HAYASAKA compared with *Productus aculeatus* described by SCHELLWIEN.

1) FRECH: l.c. p. 63.

2) I-tschou-fu = 沂州府

3) H. YABE: Is Lower Carboniferous really developed in Shan-tung, China? Journ. Geol. Soc. Tokyo. vol. XXIII. 1916.

from the Trogkofel beds of the eastern Alps) at a place near Po-shan which he believed to be the very spot where RICHTHOFEN collected the fossils that were subsequently studied by FRECH. It was in this same limestone with brachiopoda that *Fusulina* was found.

4. San-tiau-ho¹⁾ (Shan-tsching-hsien),²⁾ 110 Chinese li NW of Ping-yang-fu,³⁾ prov. Shan-si; a hard bituminous shale in the coal-bearing series contains

Productus semireticulatus FLEMM.

P. longispinus SOW.

Chonetes hardrensis PHILL.

Orthoceras sp.

Euphemus orbignyi PORTL.

Myophoria insignis de KON.

Edmondia consobrina de KON.

Macroodus obtusus PHILL.?

Cardiomorpha oblonga de KON. var. *minima* FRECH.

Solenomya primaeva PHILL.

„Die ganze Art des Vorkommens, die zwischen Kohlenflötzen auftretenden Schiefer mit ihren Zweischalern, Brachiopoden, den vereinzelt Gastropoden und Orthoceren erinnert mehr als irgend ein anderes chinesisches Vorkommen an die marinen Einlagerungen des productiven Carbon in Oberschlesien.“⁴⁾

5. Yang-tschoŋg-hsien,⁵⁾ Shan-si.

Productus semireticulatus FLEMM.

It may be added that FRECH found *Enteletes meridionalis* from the same locality, but in a different rock; this is a species decidedly Permian in age.⁶⁾

6. Lien-tschwang⁷⁾ near Tai-yang,⁸⁾ south of Kau-ping-hsien,⁹⁾ Shan-si.

Productus semireticulatus FLEMM.

Productus longispinus SOW.

1) San-tiau-ho = } Chinese characters

2) Shan-tsching-hsien = } unknown.

3) Ping-yang-fu = 平陽府

4) FRECH: l.c. p. 65.

5) Yang-tschoŋg-hsien = 陽城縣(澤州府)

6) FRECH: l.c. p. 68.

7) Lien-tschwang = } Chinese characters

8) Tai-yang = } unknown.

9) Kau-ping-hsien = 高平縣(澤州府)

7. Near Tai-yuen-fu,¹⁾ Shan-si.*Orthothetes crenistria* PHILL.*Productus semireticulatus* FLEMM.

We have at present good reason to believe that the principal coal-bearing series in Shan-si, like that of Shan-tung, southern Manchuria and northern Corea, is Stephanian in age; it is a question still unsettled whether there may really exist an older coal-bearing series with intercalation of marine sediments which contain the Lower Carboniferous fauna cited by FRECH. The geological notes given by RICHTHOFEN²⁾ himself, as well as those by WILLIS-BLACKWELDER,³⁾ only confirm us in the opinion that the general rock-succession in Shan-si is quite similar to that in Shan-tung, the thick "Kohlenkalk" of RICHTHOFEN being succeeded upward by a coal-bearing series and a "Ueberkohlendstein." The Kohlenkalk of RICHTHOFEN represents the upper part of the Cambro-Ordovician Ki-chou⁴⁾ formation of WILLIS-BLACKWELDER; the above mentioned marine fossils are found not in the "Kohlenkalk," but in the overlying coal-bearing series. The latter, called the Shan-si system by WILLIS-BLACKWELDER, shows at its base obscure sign of unconformity,⁵⁾ as is also the rule in southern Manchuria and northern Corea; so far as we are aware at present, there is absolutely no evidence in favour of the view that there are in Shan-si two coal-bearing series, one of the Permocarboniferous and the other of the Lower Carboniferous age. The simple inference from the geology of Shan-tung and the land adjacent leads me to doubt the development of Lower Carboniferous rocks, marine as well as coal-bearing formations, in the tracts in Shan-si traversed by RICHTHOFEN and WILLIS-BLACKWELDER. Hence the marine fossils described by FRECH need revision.

8. Near Hsin-tan, between the Mitau and the Lukan gorges of the Yangtse-kiang; as once cited above, the limestone contains

Zaphrentis delanoui M. E. & H.*Z. guerangeri* M. E. & H.

1) Tai-yuen-fu = 太原府

2) RICHTHOFEN: China, vol. II., chap. VIII. and IX.

3) Research in China, vol. I., I, section II.

4) Ki-chou = 冀州

5) Research in China, vol. I., I, p. 147.

Michelinia favosa GOLDF.

Battersbyia sp.

In chapter III., above, I have fully stated what we know at present about the stratigraphical sequence of Ordovician-Permian rocks in this district, and that the evidence from this side is not quite in favour of FRECH's opinion regarding the geological age of the coralline limestone.

9. At Hsi-hsia-shan¹⁾ along the Yang-tse-kiang, below Nan-king, prov.

Kiang-su ; a limestone similar to the preceding contains

Hallia gigantea MICH.

Lonsdaleia floriformis FLEMM.

Lonsdaleia papillata FISCH.?

Zaphrentis spinulosa M. E. & H.

Battersbyia sp.

Syringopora ramulosa GOLDF.

Fistulipora minor M'COY.

This is the second locality of Lower Carboniferous coralline limestone in southern China. The limestone which was first believed by RICHTHOFEN to be Devonian in age, is now accepted as being Lower Carboniferous on the authority of FRECH, who determined the corals enumerated above.

The Hsi-hsia-shan section shows, according to RICHTHOFEN, the following succession of rocks (in descending order) :²⁾

7. Quartz sandstone with indeterminable plant impressions.
6. Thin-bedded marly sandstone and sandy marl, of reddish and yellowish colour ; 30 m. thick.
5. Dark grey limestone and marl in alternation, with dark, partly carbonaceous shale with indistinct plant remains. The Lower parts of these beds are fossiliferous ; the fossils are of the same forms as those found in the underlying rocks.
4. Dark grey limestone with black flint nodules ; the Lower Carboniferous corals identified by FRECH are obtained in this horizon.
3. A thick complex of sandstone and conglomerate with quartz pebbles.

1) Hsi-hsia-shan = Chinese characters unknown.

2) RICHTHOFEN: China, vol. III., p. 727.

2. Friable quartz sandstone and shale in alternation.

1. Variegated shale, with layers of manganiferous clay iron-stone.

We see, therefore, that the coralline limestone forms a part of a thick complex of clastic rocks, essentially composed of quartz sandstone and conglomerate, sometimes intercalating carbonaceous shales.

RICHTHOFEN, on the other hand, observed in the Tsu-shan section of the same district, the following succession of rocks (in descending order):¹⁾

5. Limestone.

4. Coal bearing series.

f. Dark sandy, carbonaceous shale with a coal seam.

e. Brown sandstone with indeterminable plant impressions.

d. Grass-covered and hidden.

c. Black, fossilless siliceous shale.

b. Grass-covered.

a. Black sandstone and limestone in alternation; the limestone is fossiliferous—*Productus* and other brachiopods, bryozoa, a gastropod and a tetracoral. Lower Permian according to FRECH.

3. Thick bedded limestone, with numerous flint nodules; fossiliferous—*Fusulina richthofeni* SCHWAGER—in its upper portion.

2. Quartz sandstone and conglomerate.

1. Granite.

From the palaeontological evidence, bed 3 and the lower part of the bed 4 are surely Lower Permian in age; hence it follows that the underlying quartz sandstone and conglomerate may represent the uppermost Carboniferous.

The comparison of these two sections gives us an idea, whether Nos. 2-4 in the Tsu-shan section may not possibly represent all the complexes in the Hsi-hsia-shan section, although TIESSEN pointed out another possibility viz., that No. 2 in the former section may be the equivalent of Nos. 6-7 in the latter.²⁾

LÓCZY also was at Hsi-hsia-shan; he likewise found there "Carbonkalk" and siliceous shale intercalated in a thick complex of quartz sandstone and

1) RICHTHOFEN: China, vol. III., p. 716.

2) RICHTHOFEN: China, vol. III., p. 743.

conglomerate, and collected in the dark limestone some foraminiferal remains; it is stated that SCHWAGER took notice of them as representing a new genus closely allied to *Schwagerina*.¹⁾ The details of the foraminifera are, however, nowhere given by SCHWAGER or by LÖRENTHEY; but it seems to me almost incredible that a type of foraminifera very like *Schwagerina* ever existed in the Lower Carboniferous time. If the assumption concerning the stratigraphical correlation of the coralline limestone, advanced above, is taken into consideration together with this account on the foraminifera contained in the same limestone, then we find that the Lower Carboniferous age of the said rock is by no means free from doubt.

10-13. There are a number of coalfields in the vicinity of Tshung-king-fu²⁾ in the southern part of Sze-chuan; the coal bearing series intercalates also marine sediments, limestone and other clastic rocks, and the fossils found by CREMER in these marine sediments are regarded by FRECH³⁾ as indicating Lower Carboniferous age. CREMER noticed at Ban-dji-kou⁴⁾ (10) 15 li SSE of Nan-tshwan,⁵⁾ the following rock-succession, in descending order:

Hard, compact dark bluish limestone with *Productus plicatilis* Sow.

Soft, yellowish sandstone with *Productus semireticulatus* FLEMM, *P. plicatillis* Sow., *Orthothetes crenistria* PHILL., *O. radialis* PHILL.
10 cm. thick.

Hard, bluish crystalline limestone. 40 cm. thick.

Reddish brown shale. 10 cm. thick.

Reddish brown shale, with ferruginous nodules.

Rocks unexposed. 20-30 cm.

Shale with strings of pyrite.

Coal seam 1.36 m thick.

Shale.

Hard grey limestone.

1) LOCZY: in Wiss. Ergeb. d. Reise p. Grafen B. SZECHENYI, vol. I., p. 355.

2) Tshung-king-fu = 重慶府

3) FRECH: in RICHTHOFEN'S China, vol. V., pp. 81-86.

4) Ban-dji-kou = Chinese characters unknown.

5) Nan-tschwan = 南川

At Lui-hwang-tshang¹⁾ (Méi-tan-kou-örr)²⁾ (11), 20 li SE of a temple on the Tschönn-fu-shan,³⁾ CREMER observed:

Thick bedded grey limestone with *Spirifer glaber* var. *symmetrica*,
Athyris ambigua, *Dalmanella resupinata*, *Productus plicatilis* and
P. cfr. cestrensis.

Shale

Coal seam

Shale, with pyrite strings,

? Limestone

At Ho-she-bien⁴⁾ (12) 25 li SE of Nan-tschwan-hsien, likewise:

Massive limestone

Yellowish white sandstone, 20-30 m. thick, intercalating a 0.5 m. thick
limestone layer.

Rocks not exposed. 1-2 m.

Coal seam, 1.5 m.

Grey and white shale, with red flecks. 8 m. thick.

Yellowish sandstone. 5 m. thick.

Thick limestone.

Soft greenish grey shale.

Yellowish sandstone.

Greyish green sandstone.

Finally at Tshönn fu-shan (13) 100 li SSE of Nan-tschwan, CREMER found in a bituminous limestone *Dalmanella resupinata* MART., *Euomphalus amoenus*, KON., and *E. mitis* KON.

YAMADA who travelled through the adjacent district of Nan-tshwang-hsien, Ki-kiang,⁵⁾ brought back no fossils suggesting Lower Carboniferous, although he got *Lyttonia nobilis* WAAGEN at Ki-kiang.

14. Tou-tang,⁶⁾ east of Wei-ning,⁷⁾ Ta-ting-fu,⁸⁾ prov. Kwei-chou. YAMADA's collection contains splendid examples of *Orthothetes crenistria* PHILL.

1) Lui-hwang-tshang =
2) Méi-tan-kou-örr =
3) Tschönn-fu-shan =
4) Ho-she-bien =

Chinese characters
unknown.

5) Ki-kiang = 葵江
6) Tou-tang = 頭塘
7) Wei-ning = 威寧
8) Ta-ting-fu = 太定府

from this locality; FRECH who examined one of the specimens which is figured on Pl. XXIV, of this paper, recognised the Lower Carboniferous age of the fossiliferous rock. HAYASAKA confirms this specific identification and expresses the opinion that the examples show certain features peculiar only to those derived from the Lower Carboniferous and Devonian. On the other hand, a number of specimens of *Productus* from Gai-kia-ping,¹⁾ SE of Wei-ning, which FRECH identified with *P. giganteus*, do not belong according to HAYASAKA to the Lower Carboniferous species, but represent a form closely allied to *P. yunnanensis* LŐCZY of a much younger geological age.

15. In the province of Yun-nan, Lower Carboniferous rocks are well developed; the annexed list compiled by DEPRAT²⁾ shows their distribution, the order of their succession and their fossil contents.

Region of the upper Blue river, Environs of Yi-leang, ³⁾ of Yi-long ⁴⁾ etc.	Region of Lonan and Po-shi.	Region of Hoa-keuou. ⁶⁾
h V. Limestone of Tou-mou-nyi ⁵⁾ with <i>Martinia glabra</i> <i>Productus cora</i> <i>Orthothetes crenistria</i> <i>Endothyra crassa</i>		
	h IV. Black calcschists of Hoa-keuou, of Chan-keuou, ⁷⁾ of Je-chouei-tang ⁸⁾ with <i>Chonetes papilionacea</i> <i>Productus striatus</i>	
		h III. Yellow marl shale of Hoa-keuou with <i>Glyphioceras</i> <i>Aviculopecten dupontesi</i> <i>Productella spinulosa</i> <i>Polypora</i> sp.
	h II. b, Brown calcschist of Tien-sen-kouang ⁹⁾ et Lo-a-tien, ¹¹⁾ with <i>Productus striatus</i> <i>Mourtonia cayeuxi</i> <i>Euomphalus crocalostomus</i> <i>Naticopsis neritimoides</i>	

1) Gai-kia-ping = 艾家坪

2) DEPRAT et MANSUY: Étude géologique du Yun-nan oriental. 1 partie. DEPRAT: Géologie générale. 1912. p. 102. 3) Yi-leang = 宜良 4) Yi-long = 易隆

5) Hoa-keuou = 6) Tou-mou-nyi =

7) Chan-keuou = 8) Je-chouei-tang = 9) Tien-sen-kouang = } Chinese characters unknown.

Region of the upper Blue river Environs of Yi-leang, of Yi-long etc.	Region of Lo-nan and Po-shi	Region of Hoa-keuou
	h II. a, Red sandstone without fossils and a marly shale of Tien-sen-kouang, Lo-a-tien,	
h I. Shell marl and marly sandstone with <i>Spirifer subconicus</i> <i>Spiriferina insculpta</i> <i>Rhynchonella angulata</i> <i>Orthis</i> sp. <i>Proetus ellipticus</i>		

One of the most interesting fossil faunas in the present material is that collected by Mr. Y. ISHII from Hwang-tu-pu,¹⁾ Chi-yang-hsien,²⁾ prov. Hunan. The locality is in the southern part of the said province, a little north of Yung-chou: hence it is in, or at least near, the district where the marine Upper and Middle Devonian rocks are known to be extensively developed as mentioned in the preceding chapter. ISHII's collection comprises, according to HAYASAKA, three species of brachiopoda which follow:

Spirifer bisulcatus Sow. (abundant)

Athyris royissii L'EVILLE. (abundant)

Rhynchonella pleurodon PHILL. (rare)

Of these fossils, the first is essentially a Lower Carboniferous species, although it occurs also in the younger, Trogkofel beds of the Carnic Alps; the second possesses a more extensive vertical range, being known from the Uppermost Devonian to the Permian; and the third, which is also essentially a Lower Carboniferous and Uppermost Devonian species, is recorded from the Upper Carboniferous of Moscow. The fauna, indeed, can be Uppermost Devonian or Lower Carboniferous in age, and further detailed correlation is impossible on the material at hand.

The aforementioned facts, seem to warrant us in concluding that the marine Lower Carboniferous deposits are developed to a certain extent in the

1) Hwang-tu-pu = 黃土鋪

2) Chi-yang-hsien = 祁陽縣(永州府)

province of Yun-nan and also in Kwei-chou (if *Orthotheses crenistria* from Tou-tang is not from a Devonian stratum). But we lack any convincing evidence in favour of FRECH's assumption, that the Lower Carboniferous sea overflowed the most part of southern and northern China. On the contrary, the impression that I get from a general survey of all the facts known in this connection is that the fossiliferous bed of Hwang-tu-pu may rather represent either a stage transitional from the Upper Devonian to the Lower Carboniferous, or at most the lowest division of the Lower Carboniferous, rather than any higher stages of the latter; so it seems to me most likely that the extensive Upper Devonian sea shrunk gradually towards the end of this period from the interior of China, until in the Lower Carboniferous age it became almost confined to the present area of Yun-nan (and also a part of Kwei-chou?) in the southern part of continental China, the more northeastern part, including what is now Hu-nan, and Kiang-si, being then uncovered by marine water, the remnant of which seems to have existed there, if at all, only at the very beginning of the Lower Carboniferous.

As seen from the above explanation, it is only provisionally that we treat the following fossils in the present material under the heading of Lower Carboniferous:

1. East of Tou-tang,¹⁾ Wei-ning-chou, Ta-ting-fu, prov. Kwei-chou (YAMADA Coll., No. 53.)

Orthotheses crenistria (PHILL.) FRECH.

It was found in a dark shale.

2. Hwang-tu-pu, Chi-yang-hsien, prov. Hu-nan (ISHII Coll.)

Spirifer bisulcatus SOWERBY.

Athyris royssii L'ÉVEILLÉ.

Rhynchonella pleurodon PHILLIPS.

These were found together in a gray shale, being accompanied by fragments of crinoid stems and a *Fenestella*.

Brachiopoda.

(I. HAYASAKA).

Strophomenidæ.

Orthotetes, FISCHER.

Orthotetes crenistria (PHILL.) FRECH.

Pl. XXIV., Figs. 6 and 7.

1911. *Orthothetes crenistria*, FRECH :—v. RICHTHOFEN'S China, vol. V., p. 76. pl. 10, fig. 6.

The specimens now under consideration were first studied by Prof. FRECH when Prof. YABE showed him the specimens several years ago. Of the three lots of the species from the different localities in China then known to him, the present material was selected as the type or the representative. One of the two specimens was figured by him, and his description was based on it.

The species was first introduced as *Spirifera crenistria* by PHILLIPS in the second part of his "Geology of Yorkshire" (1836), and subsequently, as far as the writer is informed, such generic names as *Streptorhynchus*, *Orthis*, *Orthothetes* (*Orthotetes*), *Schuchertella* or *Schellwienella* were attached to it. In 1908, GIRTY¹⁾ planned a general classification of the Carboniferous Orthotetinae, and many of the allied genera was arranged and correlated to each other. According to his system, the shells of *Orthotetes* are not plicated and have "moderately developed dental plates in the ventral valve, which converge and unite, inclosing with the pseudodeltidium a triangular pyramidal chamber." Moreover, the convergent dental plates unite at their junction to a median septum to form "a triradiate structure."

On examining the Chinese specimens that are represented by two inner casts of the shell, one finds that the dental plates, or FRECH'S "Zahnstützen" are not convergent, but on the contrary, they are divergent, and also rather short. They lack a median septum which is continuous with dental plates in *Orthotetes*. Thus the Chinese species represents an independent type to which

1) G. H. GIRTY:—The Guadalupian Fauna, p. 164. 1908.

GIRTY gave no distinct name whatever, but numbered it 6 in his table. This is the group which SCHELLWIEN placed in the genus *Orthotetes* of WAAGEN¹⁾ (i.e. *Schuchertella* of GIRTY), but must be different from the named genus of GIRTY's circumscription. With regard to the internal structure of the fossil FRECH observes that it "zeigt zwei kräftige divergierende Zahnstützen, die nicht sehr weit in die Schale hineinreichen."²⁾ Whether his "Zahnstützen" represent the same thing as are in general called the dental plates is not quite certain, yet at all events, the Chinese fossil really has such a structure as FRECH observed.

If, therefore, GIRTY's classification is authoritative, then the present fossil must not be regarded as an *Orthotetes* s.s., but it would, together with several forms in SCHELLWIEN's collection³⁾ form a new group, such as was numbered 6 by GIRTY. No new or better subgeneric name is here proposed because it belongs to GIRTY's work, but the writer follows FRECH's expression of *Orthotetes crenistria*.

Though different from the ordinary forms, the Chinese fossil finds equivalents in some of the old known examples of the crenistriated species of *Orthotetes*. Thus, for instance, if one supposes a specimen in DAVIDSON's monograph (pl. XXVII., fig. 9) to possess the interior features represented by figures 5 and 6 in the plate XXVI., it will be the equal of the Chinese species now being considered. Another form remarkably allied to the latter is *Orthotetes crenistria* PHILL. var. *Kellii* M'COY which has been described and illustrated by VON ARTHABER from Armenia. As far as the external form is concerned,—for the interior is inaccessible—the two forms, the Chinese and Armenian, are almost coincident. There must, however, be a reason for FRECH's having identified or even compared them in the work describing Chinese fossils. He was no doubt well acquainted with the Armenian form. Therefore, although M'COY's variety far more closely resembles to the Chinese fossil than the

1) E. SCHELLWIEN:—Beitr. z. Systematik d. Strophomeniden d. ob. Palaeozoicum. Neues Jahrb. 1901, I., p. 6.

2) RICHTHOFEN's China, vol. V., p. 77.

3) E. SCHELLWIEN:—l. c.

4) F. FRECH and ARTHABER:—Palaeozoicum in Hocharmenien und Persien, p. 200. 1900.

form described as *Orthotetes crenistria*¹⁾ by ARTHABER, the writer dares not call the Chinese brachiopod by any other name than that given by FRECH.

Regarding his group 6, Girty says that it comprises species "Devonian and early Carboniferous." *Orthotetes crenistria* var. *Kellii* M'COY also represents lower Carboniferous age. Therefore the Chinese fossil is likely also to indicate a period not younger than the lower Carboniferous. In this connection a word may be added in conclusion. The fossil may be described somewhat in the following way, but not more in detail because the material is not at all suited for that.

The ventral valve is rather conspicuously concave, the beak probably being twisted downwards. Hinge-line is somewhat shorter than the maximum breadth of the shell. The dorsal valve is very strongly convex, apparently somewhat flattened along the median line. The shell on the whole is wider than long. Interiorly the ventral valve has the impressions of adductores and divaricatores, the latter being radially striated and surrounding the former. The muscular impressions as a whole have a transversely elliptical outline. The twisted beak is broken away, but the divergent dental plates are shown in the transverse section on the partially preserved area. The internal surface of the dorsal valve possesses a low short median septum which longitudinally traverses the faint muscular impressions of the adductors. The inner surface of both the shells is ornamented with fine, distinct, rounded costæ that fade away posteriorly, but become very distinct on the anterior and lateral margins. These radial costæ are much more distinct in the dorsal valve than in the ventral. In the marginal region narrower subordinate costæ appear in the intercostal spaces. By means of the repetition of this process there are often seen three or more smaller costæ intercalated between the larger ones. In addition to these radial costæ there are also transverse or concentric ones that are very faint, and are almost unrecognizable when the surface of the cast is magnified by a lens. They are extremely obsolete on the inner surface of the dorsal valve, but are somewhat stronger in the opposite valve. Thus on the interior surface of the ventral valve, the visceral portion looks as

1) FRECH und ARTHABER:—l. c.

if there were numerous warts very regularly arranged crosswise. The radial costæ number about 5 or 6 in a space of 5 mm. where the intercalation of thinner ones takes place on the dorsal valve. They are somewhat more widely apart from each other.

In another specimen, also a cast but of the exterior surface of a ventral valve, the radial costæ are very narrow, but evenly prominent along the whole of their course. They increase in number anteriorly by means of interpolating new costæ between the older ones. The whole surface is traversed by concentric striæ that are very faint but clearly recognizable. The interspaces are much wider than the costæ themselves. This specimen closely resembles that from the Tournaisien of Belgium (Pl. XXIV., fig. 7). It is very strange that FRECH's attention was not attracted to the distinction of the outer and inner surfaces of the valves.

Dimensions (partially estimated):—

Length.	Width.	Thickness.	Hinge-line.	Length of septum.
ca. 60 mm.	ca. 70 mm.	30 mm. +	ca. 60 mm.	20 mm.
Width of the muscular impression.			Length of the same.	
25 mm.			17 mm.	

Locality:—East of Tou-tang, Wei-ning-chou, Ta-ting-fu, prov. Kweichou.

Geological Age:—Lower Carboniferous. In the neighbourhood of this locality *Productus cora* and *Prod. aff. yunnanensis* were found by Prof. K. YAMADA. The latter two seem to be Upper Carboniferous or Permo-Carboniferous because the *Prod. cora* of that locality represents the younger type which was described by DIENER¹⁾ from the Permian of the Shan States; while *Prod. yunnanensis* is a permo-carboniferous²⁾ species. Thus there seem to be two stages of the Carboniferous Formation developed in that neighbourhood, provided Girty's schedule is strictly followed.

This is the only species among the fossil brachiopods from China which is strictly lower Carboniferous. It is very interesting that in the vast territory

1) C. DIENER:—Anthracolithic Fossils of the Shan States, p. 19. 1911.

2) L. v. Lóczy:—Wissenschaftl. Ergebn. d. Reise d. Graf. BÉLA SZÉCHENYI in Ostasien, III., p. 125, pl. VI., figs. 1 and 2. 1899.

of China there are no other localities where a lower Carboniferous fossil has been discovered. Almost all of the so-called lower Carboniferous species of FRECH and others are in reality those that exist through all the stages of the Carboniferous even up to the Permian. For instance the brachiopods from Shan-tung that were reported by FRECH as lower Carboniferous forms are not confined to that period but reach far upwards.¹⁾

Orthotetes of the other sense than that of FRECH also is not strictly a lower Carboniferous form, for it has been recorded from the Permo-carboniferous formations of China and Indo-china by LÓCZY²⁾ and MANSUY³⁾ respectively.

Spiriferidæ.

Spirifer, SOWERBY.

Spirifer bisulcatus, Sow.

Pl. XXIV., Figs. 8 and 9.

- 1836. *Spirifera bisulcata*, PHILLIPS :—Geol. Yorkshire, II., p. 218. pl. IX., fig. 14.
- 1854. *Spirifer bisulcatus*, SEMENOW :—Fauna der schlesischen Kohlenkalkes. Zeitschr. d. deutsch. geol. Ges., VI., p. 334.
- 1858. *Spirifera bisulcata* DAVIDSON :—Monogr. Brit. Carb. Brach., p. 31. pl. VI., figs. 6-9 ; 13-17.
- 1898. *Spirifer bisulcatus*, DE KONINCK :—Descriptions of the Pal. Foss. of New South Wales, p. 192. pl. XIV., figs. 5, 5a, 5b.
- 1900. *Spirifer trigonalis* var. *bisulcata* ; SCHELLWIEN :—Die Fauna der Trogkofelschichten, etc., p. 73. pl. XI., figs. 4-6.
- 1900. *Spirifer bisulcatus*, SCUPIN :—Die Spiriferen Deutschlands, p. III, pl. X., fig. 6.

1) I. HAYASAKA :—On the Carboniferous Brachiopods from the Po-shan Districts in Shan-tung (in Japanese). Jour. Geol. Soc. Tokyo, vol. XXIV., p. 159. 1917.
 2) L. v. LÓCZY :—op. cit., p. 85. pl. I., figs. 22-27.
 3) H. MANSUY :—Mission du Laos. Mém. Serv. Géol. l'Indochine, Vol. I., Fasc. IV., p. 121. p. 36.

- ? 1909. *Spirifer bisulcatus*, SOMMER :—Die Fauna des Culms von Königsberg bei Giessen. Neues Jahrb., Beil.-Bd., XXVIII., p. 632. fig. 2.
- ? 1911. *Spirifer bisulcatus*, FRECH :—VON RICHTHOFEN'S China, vol. V., p. 72. pl. 11, fig. 2.
- ? 1913. *Spirifer bisulcatus*, MANSUY :—Faune du Carb., inferieur du Tran-ninh. Mém. Serv. Géol. l'Indochine, vol. II., fasc. V., p. 32. pl. V., fig. 4.

Spirifer bisulcatus is essentially a lower Carboniferous species, although it has been described in far younger formations, for instance, in the Trogkofel beds. The first record of this species in China is that of FRECH, who described it as in material collected in Shan-tung by VON RICHTHOFEN. FRECH'S material, however, seems to have been very poor and fragmental, so that he could not give a picture of a complete example of the species. It seems to the writer that it is not quite safe to give any definite specific name to such an incomplete fragmental fossil. The restoration that FRECH attempted (Fig. 2a) is rather arbitrary; other palaeontologists than he might have imagined the complete form of the fossil in an entirely different way. "The furrows which bound the mesial fold on the upper valve are scarcely more prominent in this (species) than in several others," says PHILLIPS in his diagnosis of the species. There is nothing to show this characteristic in the examples of FRECH. The areal aspect (Fig. 2d) resembles that of *Spirifer Tschernyschewi* STUCKENBERG rather than that of an ordinary *Spirifer bisulcatus*: the former is an upper Carboniferous species discovered at Samara, in Russia.

A large number of specimens of the species the majority of which are fragmental, were collected by Mr. Y. ISIH in the province of Hu-nan. They were found together with several other species of Brachiopods all of which represent the lower Carboniferous in Europe. Among these specimens there are several complete ones which are very well preserved and consequently form the basis of the diagnosis which will follow.

In order to distinguish *Spirifer bisulcatus* from the allied forms *Sp. trigonalis* and *Sp. integricosta*, SCUPIN, in his monograph, says that the "ausgesprochene Neigung zur Theilung der Rippen, vor allem derjenigen auf

Sinus und Sattel" is the most noteworthy of the characteristics of this species. In reality the dichotomous increase of the ribs takes place on the fold and in the sinus in the Chinese examples also. But the lateral ribs are very regular and simple in the latter, dichotomy being seldom met with. In this respect the Chinese specimens now at hand do not appear quite coincident with the species *Sp. bisulcatus* according to the circumscription of SCUPIN, who says. "Die Zahl der Lateralrippen ist sehr verschieden, je nach dem ein mehr oder weniger grosser Theil derselben eine Theilung erfährt." The writer long hesitated over this point.

On the contrary DAVIDSON says that these radial ribs "are simple, and rarely bifurcated, but increase occasionally by intercalations at various distances from the beak." This species is separated from *Sp. stiratus*, also an allied form, in having "einfache, weniger zahlreiche, aber dafür breitere, gerundete Rippen, die sich gelegentlich teilen." DE KONINCK's observation is here very noteworthy: "In young specimens most of these folds are simple, while in adults the two or three folds adjoining the ventral furrow and the dorsal ridge are bifurcated. SCUPIN's figure, though not very clear, shows the fact asserted by DE KONINCK, one or two of the ribs next to the median sinus appearing to be dichotomous. In the Chinese specimens now under consideration the same thing is observed in some of the larger examples. Thus the latter are identified with *Sp. bisulcatus* Sow.

The shell is rather broader than long, the hinge-line representing the maximum breadth; outline, oval or subrhomboidal. Both valves are almost equally convex and nearly equally curved. Each valve has a strongly crooked beak; the two beaks almost touch each other. The ventral umbone is very high above the hinge-line and pointed outwards. Beneath it is a high, triangular but concave area with a delthyrium in the middle. The dorsal area is not exposed, the umbonal expansion being very inconspicuous and hardly overhanging the hinge-line. The sinus on the ventral valve is already distinct at the tip of the beak, and gradually increase in width anteriorly; it is moderately deep. Corresponding to it there is a distinct fold on the dorsal valve, also traceable up to the beak. Each valve is ornamented with from 30 to 40, rounded, wide, simple radial ribs. Those on the fold or in the sinus are

somewhat narrower than those on the lateral portion of the shell owing to their dichotomous increase. On the dorsal fold the ribs show an inclination to arrange themselves into three groups. Two ribs separating the median sinus of the ventral valve from the lateral portions are extraordinarily broad, and show dichotomy. Corresponding to these two peculiar ribs, there are two especially deep grooves or furrows limiting the two sides of the mesial fold on the dorsal valve. The interspaces in alternation with the ribs are nearly half as wide as the ribs. Lateral ribs are very simple and distinct even in the umbonal region. These ribs and grooves are traversed by a small number of concentric growth lines which are not very distinct. Each of the ribs is provided with very fine, concave striae, which are visible only with the aid of a magnifier.

Dimensions :—

Length.	Width.	Thickness.
20 mm.	22 mm.	15 mm.
25 mm. +	30 mm.	21 mm.

Locality :—Huang-tu-pu, prov. Hu-nan.

This was collected there in association with

Athyris roissyi L'ÉVEILLÉ.

Rhynchonella pleurodon PHILLIPS.

Geological Age :—Lower Carboniferous (?).

Athyridæ.

Athyris, M'COY.

Athyris royssii L'ÉVEILLÉ.

Pl. XXIV., Figs. 10-14.

1857. *Athyris Royssi*, DAVIDSON (pars) :—Monogr. Brit. Carb. Brach., p. 84. pl. XVIII., figs. 8, 9, 11.

1862. *Athyris Royssii*, DAVIDSON :—On some Brachiopoda collected in India by A. FLEMING, etc. Quart. Jour. Geol. Soc., vol. XVIII., p. 27. pl. I., fig. 6.

1883. *Athyris Royssii*, WAAGEN :—Salt-Range Fossils IV., p. 475. pl. XXXIX., fig. 10; pl. XL., figs. 6, 7, 8, 11, 12.
1887. *Athyris Royssii*, DE KONINCK :—Faune du Calcaire Carb. de la Belgique, p. 85. pl. XIX., figs. 19-28.
1890. *Athyris Royssii*, NIKITIN :—Dépôts carbonifères et Puits artésiens dans la Région de Moscou. Mém. Com. Géol., vol. V., No. 5, pp. 68 & 166. pl. III., fig. 8.
1897. *Athyris Royssii*, DIENER :—The Permo-Carboniferous Fauna of Chitichun, p. 59. pl. X., figs. 1, 2, 3, 6.
1909. *Athyris Royssii*, SOMMER :—Die Fauna des Culms von Königsberg bei Giessen. Neues Jahrb., Beil.-Bd., XXVIII., p. 629.

Quite a large number of well preserved specimens were collected by Mr. Y. ISHII in the province of Hu-nan. All the specimens are rather small there being hardly one that in point of size will equal those figured by DAVIDSON or DE KONINCK. They are almost of the same dimensions as those from the *Productus*-limestone of Salt-Range, figured by WAAGEN. Some of them have yielded to some diastrophic pressure and are somewhat strongly deformed.

This species has been usually regarded as representing the Lower Carboniferous age in Europe, as for example, in Belgium and in Britain. It is very noteworthy that it has been recorded from the *Productus*-limestone in southern Asia, as DAVIDSON's and WAAGEN's papers show us. On the other hand according to WAAGEN, *Athyris royssii* in Europe does not seem to be restricted to the mountain-limestone, but seems to pass up in its typical shape into the Permian formation.¹⁾ The present material, therefore, may also indicate such a formation in the province of Hu-nan. But, on the other hand, it was collected together with *Spirifer bisulcatus* and *Rhynchonella pleurodon*, the former of which also passes up to the Permo-Carboniferous formation, while the latter is essentially Lower Carboniferous as far as the present knowledge is concerned.

For the determination of the specimens not only the papers above cited have been consulted, but also several specimens of *Athyris royssii* from Europe have been brought into comparison. Among a number of Belgian examples there are several younger ones, which are almost of the same small

1) WAAGEN: op. cit. p. 479-8.

size as the Chinese fossils, so that they cannot be discriminated from the latter when the two are mixed together. Two of such specimens are pictured on one of the plates in this paper for the sake of reference.

In all essential points the Chinese fossils are really nothing but *Athyris royssii*; all the peculiarities that separate the species from any of the allied species will equally distinguish the Chinese species from those latter. The only thing that cannot be left unmentioned is that none of the Chinese specimens possess spines on the concentric growth lines or lamellæ on the surface of the shell. The species seems to be characterized by this feature with several other points, for DAVIDSON remarks that *Athyris royssii* is distinguished from a very closely allied form, *Athyris planosulcata*, by its spines, which are very different from the surface sculptures of the latter.¹⁾ SOMMER even identified a fossil from the Culm of Königsberg bei Giessen with this species on account its possessing such spines.²⁾ Such minute things as spines, however, are preserved in the fossil state only in very rare cases. It is not an every-day thing that one should find the spines of any *Productus*. The same must also be true of the surface ornamentations of the *Athyris*. In reality, it seems that there have been very few examples ever discovered with the details of the surface features preserved uninjured; there are very few records of such fossils. In reality, however, there are a few specimens among the materials from China that have radial ribs upon the concentric lines.

As WAAGEN³⁾ has remarked this species is very variable with regard to the degree of the development of the median fold of the shell. According to DE KONINCK the dorsal valve has a median fold which occupies in adult specimens not more than the anterior half of the shell; this fold corresponds to a sinus "assez profond de la valve opposée."⁴⁾ DAVIDSON, however, says, in his diagnosis of the species, "The valves are almost equally and uniformly convex up to a certain age, after which a broad mesial fold of greater or

1) DAVIDSON:—Monogr., p. 185.

2) SOMMER:—loc. cit.

3) WAAGEN:—op. cit., p. 475.

4) DE KONINCK:—op. cit., p. 85.

lesser elevation is gradually formed in the dorsal valve, and a corresponding sinus in the ventral one." This sentence suggests that the sinus or the fold of the shell is not necessarily discovered in young, small examples of the species. SOMMER's material seems a very small one, for he describes it as 4 mm. by 9 mm. in size. Of this specimen he says, "Sinus und Sattel fehlen völlig." It is therefore not strange that in all of the Chinese fossils sinus and fold are very obscurely developed or even absent; for they are all rather small examples.

It is not, however, clear why the specimens from the province of Hu-nan are all so small; they all belong to one and the same stage of growth. With respect to this point the writer suspects that these fossils may represent a variety of the species. Among all examples ever described, however, there are many that are of nearly the same size, and all of them are included in the specific name of *Athyris royssii*. The writer, therefore, does not try to separate the Chinese forms as a variety of the species.

The diagnosis states: The shell is rather small, generally transversely oblong in outline, but sometimes circular, composed of two almost equally convex valves. The ventral beak is small and somewhat pointed, incurved, truncated by a circular pedicle opening of varying magnitude; this hole is contiguous with the beak of the opposite valve. In most of the specimens there is hardly a median sinus that is distinctly recognizable, although in some of the larger examples the shell is somewhat flattened along the median line.

The dorsal beak is obtuse, only slightly pointed, and crooked in beneath the opposite one. The mesial fold corresponding to the sinus of the ventral valve is scarcely developed at all; in some smaller specimens the shell is even very slightly flattened medially. The margin of the shell is prolonged as a lamella, the two valves being already in contact inside the very margins. The surface is ornamented with numerous concentric lines of growth which are somewhat lamellar or scaly. The borders of these lamellæ are likely to have been provided with spines, as it is shown in a few of the specimens by radial ribs with rounded tops. The hinge-line is inferior to the greatest breadth of the shell, and not straight but slightly slopes down laterally. In

one of the broken specimens, which shows the interior of the shell, it is observed that the spirals are directed laterally.

Dimensions :—

Length.	Width.	Thickness.	Hinge-line.
13 mm.	16 mm.	8 mm.	10 mm.
14 mm.	17 mm.	8 mm.	10 mm.
15 mm.	18 mm.	9 mm.	11 mm.
15 mm.	18 mm.	8.5 mm.	11 mm.
18 mm.	20 mm.	13 mm.	14 mm.

Remarks :—As already stated by DAVIDSON one of the forms most closely resembling this species is probably *Athyris planosulcata*. The concentric growth lines of the Chinese specimens are sometimes more or less prominent and then look something like inconspicuous lamellæ. They are, however, by no means equal to the lamellæ that characterize the species just mentioned above. With regard to this point DAVIDSON's notice in his monograph should be consulted.

Athyris expansa PHILL.¹⁾ also is not fundamentally different from the species just under consideration. This, however, is not so small a species as the latter. Also the ventral beak of the former is quite obtuse and not pointed as in the latter. Moreover, *Athyris expansa* seems to be somewhat more elongated transversely in outline than *A. royssii*.

There is another species which it is necessary to compare with the present, namely, *Athyris membranacca* DE KON.²⁾ The small examples of this species too are without sinus or fold on the valves respectively. It has a habitus very similar to that of *Athyris royssii* of China. DE KONINCK's species, however, is much less transverse in form; it is also inferior in thickness to *Athyris royssii*. Thus the latter species appears to be a form between *Athyris planosulcata* and *A. membranacca*.

Locality :—Huang-tu-pu, prov. Hu-nan. Associate fossils are :

Spirifer bisulcatus.

Rhynchonella pleurodon.

1) Phillips:—Geology of Yorkshire, II., p. 220, 12. X., fig. 18. 1835.

2) DE KONINCK:—op. cit., p. 89, pl. XI., figs. 1-5.

Geological Age :—As has been already mentioned, the species is existent up to the Permian formation in Asia as well as in Europe. According to SOMMER, "Das Vorkommen dieser Art beschränkt sich in Belgien auf Tournai. Sie soll aber schon im obersten Niveau des Oberdevons und anderseits im Fusulinenkalk des Obercarbons von Russland vorhanden sein." The Chinese species, however, may represent the Lower Carboniferous Age, because among the accompanying fossils there is *Rhynchonella pleurodon* which is at present believed to be confined to the Lower Carboniferous except in the neighbourhood of Moskou.¹⁾

Rhynchonellidæ.

Rhynchonella, FISCHER.

Rhynchonella pleurodon PHILLIPS.

Pl. XXIV., Figs. 15-23.

- 1836. *Terebratula pleurodon*, PHILLIPS :—Geology of Yorkshire, II., p. 222. pl. XII., figs. 25, 26, 28.
- 1836. *Terebratula ventilabrum*, PHILLIPS :—ibid., p. 223. pl. XII., figs. 36, 38, 39.
- 1857. *Rhynchonella pleurodon*, DAVIDSON :—Monogr. Brit. Carbon. Brach., p. 101. pl. XXIII., figs. 1-14, 16, 21.
- 1878. *Rhynchonella pleurodon*, TRAUTSCHOLD :—Die Kalkbrüche von Mjatschkowa, p. 358. pl. XXXVII., figs. 7, 8.
- ? 1887. *Rhynchonella pleurodon*, DE KONINCK :—Faune du Calcaire Carbonifère de la Belgique, VI. partie, p. 51. pl. XV., figs. 1-23.
- 1887. *Rhynchonella læta* DE KONINCK :—ibid., p. 54. pl. XV., figs. 24-51.
- 1890. *Rhynchonella pleurodon*, WALTER :—Ueber eine Kohlenkalkfauna aus der ägyptisch-arabischen Wüste. Z. d. d. g. G., XI. II., p. 433. pl. XXIV, fig. 9.
- ? 1898. *Rhynchonella pleurodon*, DE KONINCK :—Descriptions of the Palæozoic Fossils of New South Wales, pp. 75 and 170. pl. IX., Fig. 4.

1) TRAUTSCHOLD :—Die Kalkbrüche von Mjatschkowa, p.

1909. *Rhynchonella pleurodon* SOMMER:—Die Fauna des Culms von Königsberg bei Giessen. Neues Jahrb, Beil.-Bd., XXVIII, p. 630. pl. XXIX., fig. II.

Several specimens of this species were collected by Mr. ISHII in the province of Hu-pei, together with *Spirifer bisulcatus* and *Athyris royssii*. In this fauna the last species is the most predominant, while *Rhynchonella pleurodon* is the rarest, at least in this collection. Moreover, only a very few are well preserved, so that the characteristics of the species are revealed in such examples alone. One thing that must be remembered is the fact that the Chinese specimens are on the whole remarkably smaller than those known from various other parts of the world. In all essential points, however, the fossils at the writer's hand are really nothing but *Rhynchonella pleurodon*. Although in the dimensions of the specimens the Chinese fossils differ to some extent from the figures of PHILLIPS, they are coincident morphologically. The same is the case with the figures in the pictures by the other authors whose names are given above.

The palaeontologist whose circumscription of the species is the most comprehensive is no doubt DAVIDSON. This is seen at once if his monograph is read through or his figures are examined. *Rhynchonella mantia*, Sow., *Rhynchonella ventilabrum*, PHILL., *Rhynchonella davreuxiana* DE KONINCK and *Rhynch triplex* M'COY were by him united to this species. Thus this naturalist stands as the opposite extreme to the one represented by DE KONINCK. The present writer is not disposed to follow either of the two in circumscribing the species. For instance it seems better to the writer that *Rhynchonella mantia* as represented by the figures of DAVIDSON, should be retained as an independent species different from *Rhynchonella pleurodon*.

Also in this paper the writer is inclined to abandon the species *Rhynchonella lata* DE KONINCK which was proposed as a new species by the author. Judging from what is said in the description as well as from the pictures, the latter "species" cannot differ much from the present species, although there may be apparent differences between the two forms. DE KONINCK confesses that the separation of these two forms as independent was carried out after long hesitation. According to him they differ in dimensions, in description,

and in the number of the radial ribs. These differences are constantly existent, and when taken in connection with the difference of their geological age, led DE KONINCK to regard them as independent species.

However, the pictures of the two species now under consideration given in the work of DE KONINCK on the Belgian Carboniferous Brachiopods, do not present the diverse features that one would expect from the verbal explanation in the text. Neither in point of size nor in the form and the number of the ribs, can the two be separated as fundamentally distinct from each other. There are transitional stages in both of the two forms, some of which are very closely allied in spite of being drawn as different species. This fact will be readily appreciated if one examines the pictures somewhat more carefully. Upon the geological age of the two forms DE KONINCK seems to have laid somewhat too much stress. According to TRAUTSCHOLD this species was found at Mjatschkowa in association with *Spirifer mosquensis* and other upper Carboniferous fossils. The Russian material seems to be quite well determined or identified, and consequently, TRAUTSCHOLD may be relied upon as a reporter of the upper Carboniferous *Rhynchonella pleurodon*. The species may thus be regarded as existent up to the lower part of the upper Carboniferous. Therefore the difference in the horizons in the lower Carboniferous must be overestimated as specific difference. Fundamentally speaking the difference of geological horizons must not be taken as the basis of specific distinction, but the opposite course may be followed.

The Australian examples described as of the species just under consideration by DE KONINCK are not very well characterized. The configuration of the specimen is widely different from those drawn in his previous work. If this can be called *Rhynchonella pleurodon*, then the specimens of his *Rhynchonella lata* no doubt represent individual variations of *Rhynchonella pleurodon*. The writer is unwilling to accept unreservedly the Australian form as *Rhynchonella pleurodon*.

Of a large number of the figures of the species drawn by previous authors, the ones most resembling the present specimens from China are those of fig. 2, pl. XXIII., of DAVIDSON's monograph and figs. 3, 7, 8, 9, 41, 42, and 43, pl. 15 of DE KONINCK'S Faune du Calcaire Carbonifère. Mere comparison of

the Chinese specimens with the said figures is sufficient for the identification of the former with *Rhynchonella pleurodon*. The only difference noteworthy between them, as has already been stated, lies in the diversity in size, the Chinese examples being remarkably smaller. The following verbal description may be helpful for understanding the nature of the Chinese specimens.

The shell is roughly speaking transversely oval in outline, composed of a very strongly convex dorsal valve and relatively flat ventral one. The beaks are pointed, especially the ventral one, which extends somewhat beyond the opposite beak. There seems to be a circular pedicle foramen at the attenuated extremity of the ventral beak, although it is not very obvious in the present material. The cardinal area is hardly recognizable. In the umbonal region of the ventral valve there rises along the medial line something like a low ridge which has a very strong curvature and becomes much depressed in the anterior half or $2/3$ of the shell. In other words, the median sinus of the ventral valve is recognizable first at a considerable distance from the beak, the shell being raised along the median line within that distance. On the contrary the lateral portion of the ventral valve is concave instead of being convex, and consequently two of the radial ribs between the median sinus and the lateral parts rise very abruptly and conspicuously above the surface of the median sinus. The dorsal valve is more or less evenly and strongly convex, with a slightly prominent median fold corresponding to the median sinus of the ventral valve. Although the median fold is not very conspicuous in relation to the sinus, the anterior margin is somewhat rectangularly concave, and the concavity is occupied by the tongue like prolongation of the ventral valve. The surface of both the valves are ornamented with rather few, prominent, angular, radial ribs, of which three are found in the median sinus of the ventral valve; on each side of the ventral valve six of them occur. On the median fold of the dorsal valve there are four of them, and on each of the lateral parts there are five. The ribs being very strongly angular, the margin exhibits a very remarkable zigzag, of which the crests or angles are very acute on the lateral parts in the ventral valve, while they are so on the anterior or the median part in the dorsal valve.

Dimensions :—

Length.	Width.	Thickness.
9 mm.	10 mm.	5.5 mm.
15 mm.	17 mm.	10 mm.

Remarks :—The above diagnosis is based chiefly on a small specimen which is the most complete among the examples at hand. The number of the ribs is small because the shell itself is small. The shell is also less transverse than those figured by DAVIDSON or DE KONINCK, and this also would be expected from the smallness of the specimen itself. "In the fry the shell is at times somewhat triangular, the width being equal to the length, but with growth the shape becomes more transverse, and rapidly increases in depth or convexity," remarks DAVIDSON. DE KONINCK describes the number of the ribs in the median sinus as varying from 4-7 in this species, and in reality in none of the larger examples is the number below 4. But if the pictures of the small examples are taken into account this number can be reduced to three or even less (for instance in figures 17-20). Thus the Chinese specimens are nothing but smaller or younger examples of *Rhynchonella pleurodon*.

Locality :—Huang-tu-pu, prov. Hu-nan.

At this locality this species was collected together with *Spirifer bisulcatus* and *Athyris royssii*.

Geological Age :—Of the three species of Brachiopods found in this locality the present species is essentially confined in Europe to lower Carboniferous rocks, although it has been reported from the upper Carboniferous at Mjatschkowa. The other two have a very wide range of distribution both vertical and horizontal, and reach up to the Permocarboniferous formations. The only species therefore that determines the geological age is the present one. As, however, the latter is not absolutely restricted to the lower Carboniferous, the writer is much troubled as to the final determination of the geological antiquity of the fauna.

It is noteworthy that the three species from the very locality are somewhat smaller than the same from the other parts of the world.

