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中華遠古之文化

緒言

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袁復禮譯意

數年來、余在中國北方諸省調查地質上之第三紀第四紀地層、遂連類而及于遠古人跡之研究。初人時代未有銅鐵、僅用石器。而石器又分爲新舊二代。在中國從未得『舊石器時代』之人跡。雖桂葉式之石片零星發現、亦不能爲舊石器時代之確證。蓋後人每沿襲前代器形、因形以定時代、易致誤會也。卽『新石器時代』之遺跡亦不無疑問。今所發見最多散佈頗廣者、似當屬之新石器時代之末期。蓋石器陶器等極多而毫無金屬器物可見、則其時代當在銅器未發明或未普及以前。而陶器形態多與商周銅器形狀近似、則其時代又未必過于遼古。此在各種器物尙未精密考定以前、所可約略論定者也。

地質學與考古學雖範圍不同、而實際研究往往互相爲用。其關於方法者、如判別古代器物之新舊、文化發達之次第、爲考古學之要事、皆不得不借助于地質學之測繪地形鑒定地層諸方法。而關於觀察結果者、例如在河南等省所見溝濠壁立、皆由河流沖刷作用而成。而此作用實發軔於古址湮沒之後、由此可推知沖刷作用之速率。此則由考古結果而入于地質之推論矣。

余雖粗知地質而於考古學實非所專修。更以圖書缺乏、參考無資。而所以敢貿然爲之者、誠見地質學與考古學互相爲用、且以此項研究在中國可爲者甚多故也。地質調查所丁文江翁文灝二所長亦以此相勉、遂以餘力從事搜討。數年以來、所得結果如關於奉天錦西縣沙鍋屯洞穴遺址之調查、現已付梓。並承協和醫院步賴克醫學博士担任研究該處所見人類遺骨、不日亦將發刊。又如河南澠池仰韶村所得結果、亦將由余與步博

士會同研究、編纂付梓。今之所以先草此短篇者、蓋方擬至陝甘諸省一行、調查地質、順便亦仍將此事繼續研究。恐行期較久、故先以大概著爲此篇貢獻於世。希教正焉。

此次研究純取『以現時現象爲研究過去歷史之標準』爲宗旨。中國民族富保守性、每致遠古器皿之形式尙有沿襲至今而不變者。且器皿形式或導源甚遠、不僅限于遠古漢人。例如半月式之長方刀蓋爲遠古蒙古族中尙未分析之支派所遺留、則其由來者遠矣。

叙述次第、當先略論中國器物之源流、如半月式長方刀、石圭、戈等。再次論古代遺址之情形。復次乃及人種與年代等之關係。

中國器形之源流

長方刀　日本考古學者鳥居龍藏著『南滿遠古人種考』述半月式及長方式石刀甚詳。石質多爲青綠石、或頁岩、或砂岩。刃直且利。背厚、邊圓。或直或彎、用作握柄（見第一版圖）。鳥居氏又曾考亞洲珠克齊人及美洲愛司基摸人皆曾用與此同式之石刀、又此二種人現今所用鐵刀亦尙具此形。經詳細考查、此形之石刀實爲歐洲所無。其與之近似者則一種火石石鋸而已。故余以爲此長方形式足可爲亞洲民族及其血統相連之美洲民族之特徵。蓋不特于白令海峽東西二大陸遠古遺址可得之、卽現時該處所用鐵器亦仍沿襲石器之形也。

民國九年春余在中國北方旅行。於無意中發見此形今尙流行。北數省割高粱之刀（通稱銍鐮）有半月形、長方形、梯式方形不等。具二孔（見第二版圖）。背有皮或布包裹。更有帶繫於二孔、以備割高粱穗時、手可伸入、用力較易。此銍鐮與滿洲所出之半月石刀形極脗合。（據章鴻釗先生云此種半月形刀、農政全書謂之粟鑒、云

與鉦鐮制不同）

余發現此刀後、即購刀器多種、以供參考。後經研究、多有自此半月式刀演出者。俟他日編『器形源流考』當詳論之。茲先述一于街市上習見之物、而於其淵源察之者蓋少。

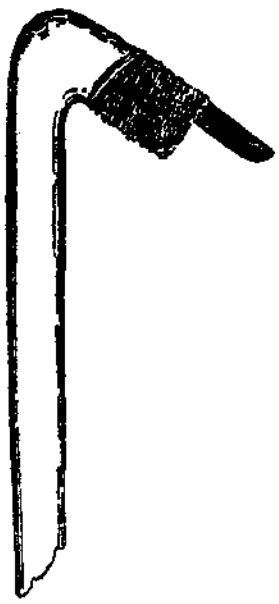
北京街市荷担而售物者往往各有其發音之標幟、以喚人注意。如賣布之搖鼓、買冰粉之銅碟、理髮之鐵叉是。至於磨刀所用者有二種。一爲喇叭一爲鐵滑連。此俗所謂鐵滑連者頗有研究之價値。此物係長方形之鐵片共四、每片有二孔、用繩連穿、繫於木柄、前後搖動即順次作金聲。磨刀者之行語謂之金圭、亦以其形似古士大夫所執之圭也。

欲證金圭之源、須再述割高粱之鉦鐮。除鉦鐮形狀有高與寬同者外（第二版第二圖、）尙有製皮所用之割皮刀、其高間亦與鉦鐮相等。如與此二種相較則磨刀所用之鐵片純由四枚帶二孔之高長方刀所演出、殆無疑義。余首次於街上偶見此物時、即有此念。棄車細審、果見此四鐵片雖已不作刀用、而其一面具刃、直如刀然。再詢之磨刀人、彼只知該行沿用此物相傳已久而已。按此即『物器經久其用意不能徵考』之證。在昔當由一敏巧之磨刀人思如以四刀連穿一處、搖擊成聲、當足表明『磨刀者在此』之意。日後留傳遂失原意矣。

如自生物家眼光觀之、割高粱之鉦鐮可譬作動物之單獨體。磨刀者之金圭可譬作動物之聯生體。此聯生體具新功用、而仍有由遺傳得來之單體原形之刀刃。由是上推則此物由新石器時代長方石刀流傳至今可無疑義矣。

錄　木匠用器亦有可遠溯其源者。如椎（第二版第四圖）每於近今初闢之野蠻種族中使用頗廣、據索拉氏

云此物可回溯至舊石器時代之麥革達林期。至於直隸河南所見木匠所用之鐍（第三版第一一三圖）亦頗可注意。（鐍如橫斧、作削木用大小不一、大者較多。章鴻釗先生云即斤）。此鐍之鐵部、考古學者稱之爲帶槽之鑿斧。形如鑿。有孔而不穿通、以備實木柄其中。値金屬器缺少而價昂時。此器極爲適宜、以其用金屬少也。故歐亞二洲銅器時代。此器流行頗廣、形式有極雅秀者。近世則用斧漸廣。今斧之特性在乎其質完全爲金屬、而帶槽之鑿斧只刃處爲金屬、其餘大部皆爲木。此其大較也。今世之初開化人種尙有用帶槽鑿斧者。愛勿博雷爵氏曾在西比利亞及非洲數處見之（見所著『歷史以前之時代』第二十九頁圖）。寇魯空氏於中國西南部山苗中亦得二種、（見一八八五年所著『山苗遊紀』第二百九十八頁）。



第一圖

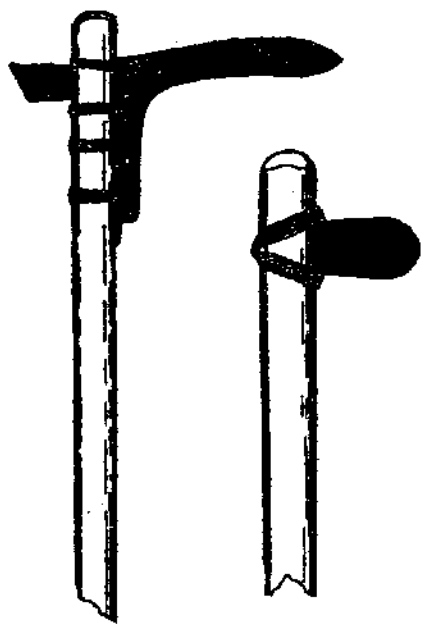
石斧與柄之安置法

故今在中國北部發見帶槽鑿斧形之鐍、實堪注意。銅器亦常有此形、益增可研究之價値。就予所見中國帶槽之銅斧已有多種、待他日當復詳論之。今僅列一銅斧以資參考。較今世之鐍細而秀雅。但形極近似、當有相關處無疑（第四版第二圖）。研究銅器歷史之專家孟德禮雅氏嘗著一書詳述歐洲石製銅製之斧。由簡單之石器至複雜之銅器、其形式皆順序遞演、歷歷可證。中國斧形之沿革尙未能得有此詳細次第。然亦有石斧之形足可證爲後世銅鐵斧之遠祖者。

泰西之斧與東亞之斧亦頗不同。歐洲銅器時代之斧刃、竪置與柄平行。中國之鐍刃橫置、與柄成一直角。參閱第四版第二圖銅斧、即見其不等均之側面、及梯式之橫剖面。故在東亞多橫斧、在歐西爲竪斧、似各有其所從

來之歷史。

在中國與各式石斧同見者、有一種石鑿。如安置於柄則當如第一圖、其用當亦如石斧、其刃側面不對稱、與銅鐵鐕同。故余嘗設想此石鑿或即帶槽鑿斧之蛻形。然此僅爲現時暫且假設之論。日後繼續研究方能見此論能否成立也。



第二圖

a 石戈

b 銅戈

戈之安置法

戈、茲再述一中國銅器時代流行頗廣之兵器、此即中文所謂戈者、釋爲刺穿兵器之一。而解釋戈之根本問題、頗與其木柄如何安置有關。那威考古學家謝特力希氏以戈與歐洲銅器時代初期之平頭斧相同。如以常見古銅戈及金石書籍中之圖（如金石索等）考之、此論頗似可據。但有可疑者即普通持論多以爲主刃直上與木柄平行。而金石索所印漢武梁壁刻像人物、持器如戈而刃直上者數四。就中以紂像爲尤顯、且注文亦謂之戈。余嘗與余友袁復禮君討論此事。袁君意以爲或係二物。其單獨無長木柄者爲戈。而其他刻像中則爲他物（如帶鉤之矛）。注係後人補作、不免出於臆度耳。（復按據周禮考工記『冶氏爲戈、廣二寸、內倍之、胡三之、援四之、倨句外博、重三鋝。』內同納、納入于柄也。「胡」須下垂、近柄與柄平行。以「內」貫入于柄。「援」橫出、用以繫人而鈎引之。段氏說文解字注所引程瑤田所考、頗詳確。）

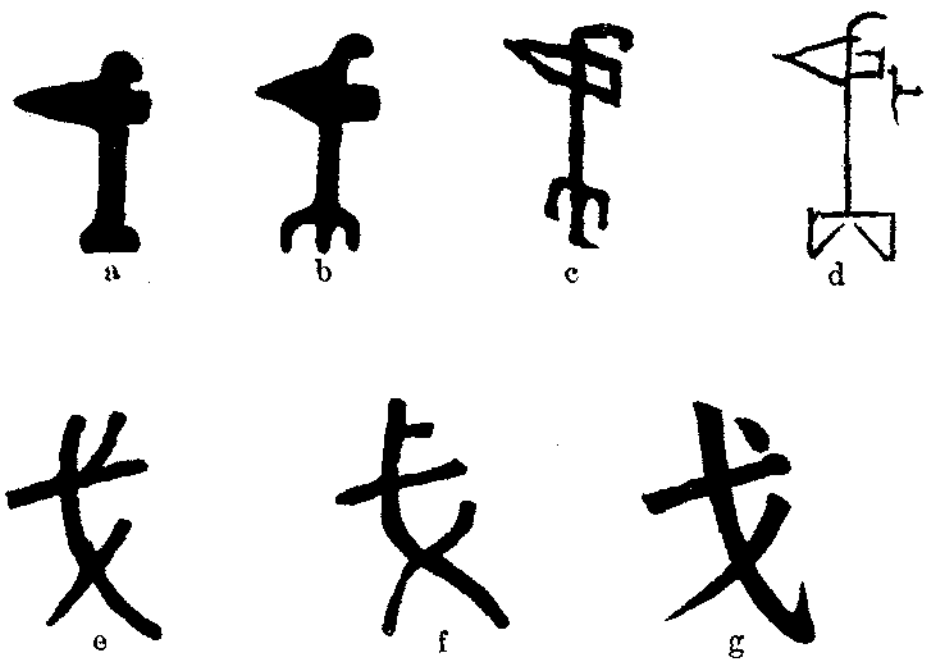
第五版圖二至六皆戈圖。據售古玩者云多出自古墓。圖二表b明安柄之式。古代銅器常有戈字像形古文、益足證其安置之法。如圖三之上行所示諸字皆是顯係爲平頭戟式。又饒有興味者、即中國古文像形戈字與義大利銅器時代初期利古利亞石壁所刻之平頭戟圖字近似。惟此僅表明其時文化發達至於同等之階級非必謂中西平頭戟同出一源也。況此外利古利亞刻石尙有與古戈字迥異處。又據下論諸理由、予以爲中國之戈實爲中國所獨自發明者也。

前曾述及謝特丁希氏所論矣。謝氏以爲中西平頭戟同一源。惜予不能得謝氏所論麥細恩及巴比侖之平頭戟而檢閱之。但義大利及北歐之平頭戟以及利古利亞刻石書籍所載均與中國大相逕庭。

余曾在直隸北部得一石器。其爲石戈無疑。較所見商周銅戈均爲簡單。本此器研究之、余以爲與歐洲平頭戟迥異之戈當爲中國獨自發明。此戈奇特、頗耐研究、如第五版第一圖即是。第二至第六數圖皆係銅戈、與石戈同列、由簡單入繁複、可順序排列。其間關係殆非偶然。

以上所論中國金屬器物數種、如鉞鐮鏃戈等、或爲近今物、或爲銅器時代或鐵器初期時物。然重要之點在其形所自出之石器遠祖、皆可於中國北部土中得之、足爲近今與遠古文化連接之實證。問題所在乃在知製用此石器者爲何人種。而此人種與三代及近今中國人種有何關係。

中國學者大抵以爲中國有史以來即知利用金屬。故發現石器時輒以爲蠻夷人種之遺、非漢族物。亦或以爲散居邊境之戎狄、在中國有史時彼尙保守石器文化。吾摯友章鴻釗先生近著石雅一書即持此論。又一九一二年勞弗爾氏曾刊玉考一書。於當時所知中國石器亦考證極博。然勞氏所見石器實不爲多。彼於此問題之



第三圖

a. 奇觚室吉金文述　戈文之演形
b. 夢郼草堂吉金圖彝　大矛文
c. 陶齋吉金續錄　立文
d. 仝 b 鹵文　戈矛文
e. 說文古籀補　鼎文
f. 仝上　戈文
g. 今文

意見可略述如左。

『中國石器時亦見之、但甚鮮少。中國從未有石器存積一處、形色俱備、而能使吾人定論其人其時無金屬之助而專恃石器爲生者。或石器工業發達完備足可供給一地之需要者。故據現在所知者言之、不能謂有中國石器時代。更從中國典籍考之。尤無所謂中國人之石器時代也。』

勞氏此論、十年前事也。如據今日所知、則須更改矣。蓋吾人已發現規模宏大之遺址、極力搜尋從未得一金屬器。而所得者爲石、爲骨、爲鹿角、爲猪牙、爲貝殼所製諸器、計百餘種。佈散於黃河流域河南一帶、有史以來即爲中國人種發祥之地者也。所遺石器表明當時石器工業發達完善、足可供給該處人民之一切需要。此皆事實證明無可疑者。特是此項石器時代之文化

究爲漢族祖先之所有、抑係漢族以前之他種所遺、此問題固尙須多加研究、方能解決。而勞氏從前之意見似終當就此新事實、再加考慮、而不容遽爲如前之論定矣。

一九一四及一九一五二年中日人鳥居龍藏氏曾著二書、前已述及。鳥居氏於吾人對於東蒙南滿石器頗增見聞。彼以爲該器等製用當或晚在秦漢時、爲現居蒙古人先祖之遺物。惟鳥居氏未爲地形及地層詳細之考察、故其所引以爲證之漢幣與銅器是否確與石器同出一時代、殊未敢遽爲懸斷。就余經驗所及則從未見有此結合也。

古代文化之遺址

茲詳述三年來在中國北部河南諸省對於新石器時代遺址之研究。

吾人初得石器、在民國八年。彼時地質調查所技師朱庭祜君在奉天熟河一帶調查。採集石器多種。其地點中有數處即鳥居氏曾經過者。此後每有採集。於民國九年採集員劉長山復自河南一處帶回零碎石器數百件、其中頗有可取者。去年（民國十年）一年中余始得機會親自按法採掘、計在二址、略述如次。至於詳論、當再於古生物誌中發表之。

奉天錦西縣沙鍋屯洞穴　民國十一年孟夏余曾至奉天一行、調查煤礦。同時於普通地質及考古方面亦頗注意。旋以美博物館黃君及予之採集員白萬玉之力、覓得一石穴。穴中有古代器物甚多、且有人類骨骸。遂電招余友步萊克博士會同研究。步君担任研究人類骨骸。

此穴在奉天西南錦西縣境內、由京奉鐵路女兒河車站分支至通裕煤礦支路。支路末站爲沙鍋屯站。站南三

里發現此穴。其地距海濱五十公里、而穴中曾得數種海生介殼、殆非人力移置不克達此。成穴之岩石爲元古界滬沈系之燧石石灰岩。傾度西北二三度或三五度。此處並無地質上之破裂帶及變動情形。此洞穴之成因、殆係潛水流行石灰岩細小裂縫間、次第冲刷溶解而成者。穴口高二公尺。穴長五·五公尺。寬二·五公尺。經土沙移盡後。穴口中含一層、清晰可辨。厚十五公分。位于土面下六十公分之處。此層余與步博士名之爲骨層。其中積骨頗夥、物器亦多得于此層。

此穴土壤之上或其上部數公分之中、曾得宋代古錢二枚。此二錢位於穴中土壤之最上部、顯係宋時或以後之人携入者。然決不能即此推定全部土壤悉後于宋。亦不能謂土中器物盡出宋後。以是可見古物採集不可不細定地層上下。否則新舊混淆、有不致誤者鮮矣、

土壤中所得器物皆具『新石器時代』形態、首足注意者爲磨光之小石斧四枚、石刀、石箭鏃數具、石髓作之鑽錐、更有多數石鈕、石珠、及一小雕刻物、長三十二公里、獸形如貓。此珍物係步博士在骨骸層中發現者。

此外尚有數種石器饒有興趣者如多數扁平圓圈是。大小不等、石質亦不一、惟形象均與玉器中如金石家所謂之「瑗」者相似。（參閱勞弗爾氏玉考第一五四頁）此亦可謂爲此石器時代及較新中國文化連鎖之一証。石瑗者玉瑗之先祖也。此後採掘所得。此種形態同似之點尚多。石瑗之外尚有以貝殼所製之瑗頗夥。率多破碎不整。大抵係由淡水動物蠙類之具殼所製。大小不等。直徑自一百公釐甚有小至十一公厘者。皆極薄。亦不寬。寬者不過八公厘。一貝瑗其直徑或達百公釐、而寬只五·五公厘而已。所不可解者如此纖細物有何功用。

至於此古人種已有精美之藝術、製此貝瑗、更足奇也。

此外尙有數骨器、均甚美觀。一長器、形如羹匙。一鑿刀、三小錐針、一縫針（針藏寘骨中）。骨器中之最大者爲一大錐、與丹麥新石器時代遺址發現之錐完全相似。其質係屬鹿角。

此址所採陶器極不完整、但頗有研究之價值。助手羅森娜女士極費功力、始克從多數破片中集成一陶器原形。此器上之奇美花紋爲吾人素所未見。此外器血上有具花紋或刻紋者、亦此址特點、爲在河南得者所無。河南所得陶器較多而亦較全、詳見後述。奉天陶器有與之相似者三點、茲述之。

一、在奉天沙鍋屯尋得一器如碗形。經羅森娜女士由多數碎片湊合幾成全形。質細、色黑、磨礪甚精。與河南仰韶村所得者極似。

二、奉天所得諸器中有二塊陶器、爲三足器之足。雖皆破碎、然可推定爲鬲之足無疑。此三足之鬲、在河南遺址所得頗多。據古籍所載至周朝尙用之。

三、奉天洞穴之下層得紅地黑花之陶器數片。面極光平。此種複色磨光之陶器、亦河南所得諸器中最富興味而有研究價值者。

其他相同之點尙多。雖河南石斧與奉天者異、然亦有與奉天之小石釜相同者。余始在河南採掘時、以爲河南無貝殼器、當爲與奉天遺址不同之點。但未幾師丹斯基博士即覓得一貝瑗、與奉天所見者完全相同。此後復又得一瑗。余遂舍余之初意、而以爲奉天洞穴之文化當與河南大致同時。其所以稍有不同之處、或由地理之關係、非必時代前後之不同也。

奉天洞穴尙有一事應述及者、即曾得多數骨骸也。獸骨固有之、然人骨較多。所稱爲骨層者。幾盡爲人骨所散佈。步賴克博士報告骨骸可辨識當有四十餘體。男女自嬰童至老年者皆有。散佈層中、極無規則。亦未有二骨連置一處、如天然結構者。即如頭骨腿骨等、多亦破折不完甚至零碎不堪檢視、初余以此凌亂散布之骨、殆爲野蠻人種噬食人肉之証。但步博士意見以爲尙無實據可證之。余嗣思此或與宗教儀式有關、假定此穴爲祭祀之所、以人享神容或有之。多數之貝瑗或即與此儀式有關者也。

河南澠池縣仰韶村遺址　吾人於河南考古之發端、余前已略述之。蓋自採集員劉長山由河南某村帶回石器數百件後、余即預料此村左近當有石器時代遺址。故久思得一機會實地調查。遂於十年孟夏實行前往。其地即仰韶村。在隴海鐵路澠池縣車站北十五里。澠池縣城位於一小河流域之北、河兩岸平坦、作東西行。地勢由縣城向北漸高、略似高原。北至二十里許始遇山嶺。山爲寒武紀及寒武紀以前之岩石所成、地層傾向東南。仰韶村卽位於山南之高原。高原爲第三紀紅土所成、被河渠冲刷溝壕累累、深有三十至五十公尺者。

十年四月二十一日予由澠池縣向仰韶村北行、在此村南約二里處過一深溝。（其兩邊土壁矗立、一如山峽。蓋此爲是地之普通景象。）過此溝之北、道旁溝壁地層剖面顯露如下。第三紀紅土在下層。覆其上而不整合者有土如灰、頗富陶器碎片。初見之、余即以爲即太古遺址、可得石器者。余即在該灰土層底詳細採掘。數分鐘後果得一小塊陶器。紅色黑花、磋磨光平。彼時余於美國學者本柏里氏在中亞細亞安諾地方所採集紅色及黑色之細陶器尙未有所聞知、尤不知歐洲新石器時代及新石器時代後期之複色陶器、故予當時以爲此優

秀器皿絕非遠古石器時代之遺物、遂亦未甚措意。後二日、余復沿道旁溝壁灰土層各址詳細尋之、數小時後果於灰土中拾得一精細石斧。此斧形狀已如前文所論、後經調查方知此等石斧實爲此處常見之物。此後他種器物逐漸發現。吾人始知此址面積廣濶、遺留器物甚多。破碎陶器尤夥、其中多有磨光而帶采色者。

是年秋季呈請中國政府准許復至澠池縣仰韶村採掘、蒙農商總次長及地質調查所所長會辦極力贊許、河南省長官及澠池縣知事亦均盡心襄助。採掘共一月餘、自十月二十七日起至十二月一日止。並得中國助手五人、同爲採集。又步賴克博士亦曾一至其地、協助考驗骨骸遺址。然因不能久駐、發現一骨骸遺址後、即行回京。故其後執行掘挖諸事余皆委之地質調查所古生物學名譽技師師丹斯基博士。斯博士亦慨然應允、兼之手術精細、測量精確、深堪感佩。

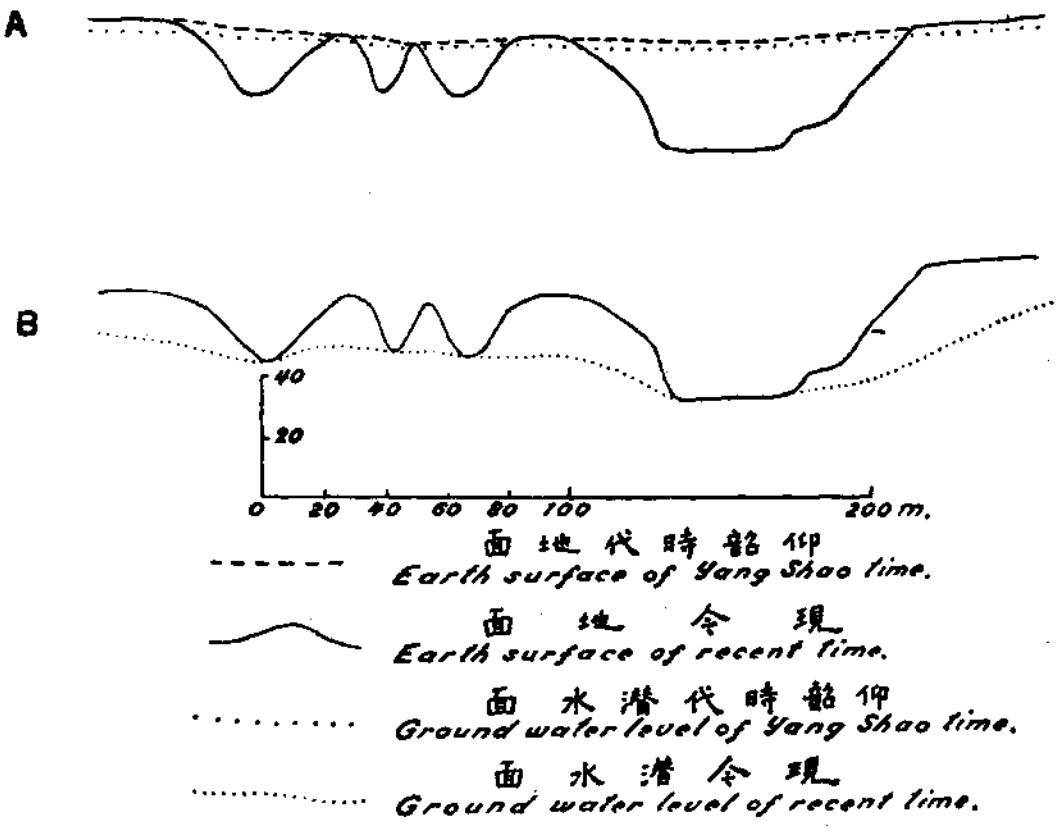
仰韶村遺址甚廣。其面積、自村南端起南行至東溝西溝接連處、南北爲九百六十公尺、東西爲四百八十公尺。北部少有採獲、南部於每公尺中必有灰土層厚一至五公尺不等、平均約三公尺。此文化遺址及左近溝壑地形、均經地質調查所調查員袁復禮君詳細測量。並按縮尺四千分之一、及等高線距離五公尺、繪有地圖、以供參考。

欲知此仰韶遺址之面積、茲舉數址以作比較。歐洲有名之丹麥遺址不僅以其『新石器時代初期』之特異、亦以其器物存貯之豐富、故頗著名。據霍恩氏云其長爲一百至三百公尺、其廣五十至一百五十公尺、厚一至三公尺。俄國士耳基斯坦曾經本柏里氏調查者、其遺跡多爲圓形或長圓之土山。其亞諾北址長一百公尺。土層堆積厚十至十五公尺。但此厚層實包有自新石器時代至鐵器時代之數層。爲時既久、則其厚度自不足奇。今

就河南仰韶村言之、按之所含諸器僅一短期、如前述之長九百六十公尺、寬四百八十公尺、厚平均三公尺計之、則可知在石器古人時代其地當爲一大村落無疑矣。

除有臨時試探掘挖外、吾人採掘地點計有十七。均詳於袁君之地圖中。余未及將所掘地點之容量、詳爲計核。約略計之、實不足原址千分之一。

余前述及東西二大溝圍繞此址、驟思之殆以爲天然堑限、早已存在。石器時代之人民當可用作守禦、以防攻襲。但是年春季余卽得與此論相反之實証。據步師二博士採掘時、此証益明。經詳細考察猶確見此二溝在石器時代實尙未有也。溝旁兩壁左近、常有土錐矗然孤立、不易登臨。此等土錐上皆有灰土層（見第四圖）。蓋在石器時代灰土層皆連續不斷、成一平原。後被冲刷、始成今日現象。此址南端一孤立土錐、卽係經冲刷作用而成者。而其所含灰土又非初次所沉



第四圖　仰韶古代遺址南端之剖面
表明冲刷作用及潛水降落之關係

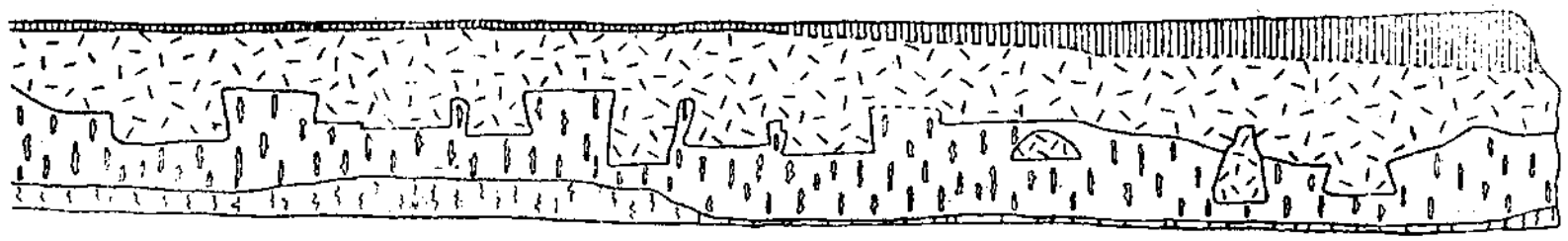
積。其中砂礫陶片等等皆略成層形、顯係河流冲積而成。故此錐頂之層狀灰土實爲古河身無疑。然較今日溝底小河已高四十公尺、則當日河流水平之高可想見矣。

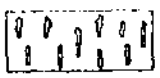
由是可見古時地形當與今日迥然不同。推而廣之亦必非一地之特異、中國北部蓋皆若是。使此說皆可證實、則知中國歷史時期內地形已大變遷、其影響於人生者必當甚大、而詳細研究爲不容緩矣。

仰韶遺址尙有一事當爲敘述者、如第五圖所示道旁土壁所露之剖面是。底部爲紅土層、其上部爲文化紀之灰土。此二土層接觸處、灰土層每作袋狀、包於紅土層上部。形如長筒、而上下直徑不一。計其直徑一·九至二·八公尺、深〇·五至一·五公尺。此種袋形層中、未曾發現骨骸、故不能指爲墳墓。又中皆實以此址各處尋常所見之灰土、而所藏陶器及他器物又復極爲破碎。推究其成因、在未經灰土湮沒之前、形狀頗似地穴。或即古時石器時代人民所居之地穴。在歐洲石器時代同期之遺址數處、亦有同式圓屋、或亦仰韶袋形土層之原意歟。但仍有不可解者、蓋據所有器物觀之仰韶古紀人民之文化已燦然大備。所用器具繁多、兼亦有粗重者。而謂其猶蟄居此窄小之洞穴茅屋、殆未合也。

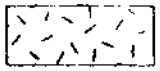
歐洲古址尙有他種可與此仰韶穴室相比、即所謂窖穴者是。德人佛雷爾氏曾述阿爾塞司省阿希亥穆及司徒茲亥穆新石器時代遺址。第六圖即表示阿希亥穆第B及P之窖穴、及仰韶袋狀之土穴。三穴皆同一縮尺所繪、是表其圓錐形之近似也。阿爾塞司省內所發現之窖穴、曾經學者研究皆以爲地下收藏器物之所。據佛雷爾氏所述似兼作儲藏及住室二者之用。總而言之、據現在所得結果吾人對於袋形層尙未得一充分之了解。蓋吾人初次調查、偏重於地形及地層方面、希望將來得便關於袋形層處、再爲詳查、或可多得新證也、

第五圖　仰韶古代遺址道旁露出土層(表明袋形窯穴)

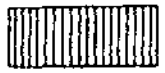




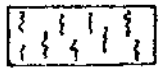
新土層紅統土
Red Pliocene clay.



仰韶文化紀土層
者層成剷沖經未而有圖
Culture Soil, unstratified, intact.

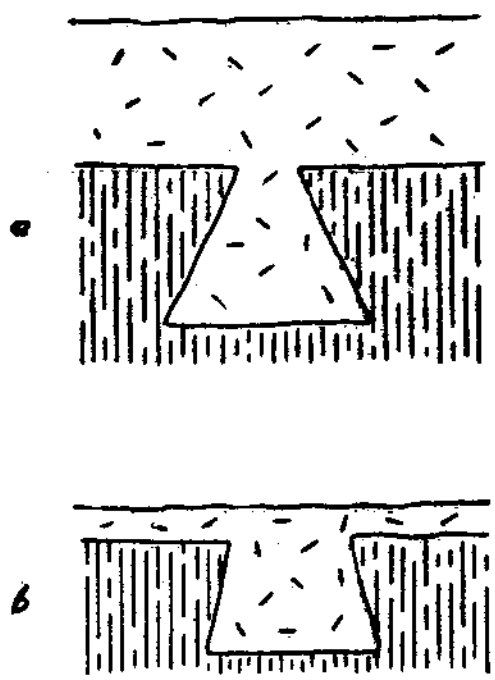


仰韶文化紀土層
者運搬人後經
Culture Soil, removed by later farming.



未露頭者
Covered.

Scale 1:200



(a) 河南仰韶古代遺址之袋狀土穴

(b) 愛爾塞司之阿施戛姆之 B 及 P 袋狀土穴

茲就仰韶遺址所採器物之形狀、敍述如次。

石斧極多、形式大小不一。無孔。其用法蓋置柄於孔、柄或爲木製、或爲骨製、如第六版第十四至十七圖所示皆是。更有石鑿、及如鑿刀之石斧如近世之鐍者。小者手持之、作修琢之用。大者置柄中、作斧用、據石器之大者觀之、如耨、如耡、可知在該石器時代亦已有農業矣。更有石或泥燒製之圓錠、作紡織上合線底墜之用、紡織材料當出於植物、可知當時亦已有種植矣。又如陶器上之印文、有繩印或布印者、其繩印顯係苧麻所編之繩、亦可見其時已種苧麻。

長方石刀碎片甚多、中有一完整者。只具一孔、此爲區域內所特見者。

少數石杵、作磨搗之用。

扃平石環與奉天石穴所得者相類（第六版七圖）。此外尙有剖面作三角形之瑗、或係作鐲用者（第六版三至六圖）。

頁岩所製之石鏃頗常見、形亦不一（第六版八至十一圖）。此外更有骨製、甚有以貝殼製者。形式多奇異、俟後詳細研究、對於當時文化當有所供獻。又一泥器、形式特別。據師丹斯基博士意以爲矢人作護指之用者（如中國班指）。

此外更有尖削之器多種。爲骨或角所製。有少數精小縫紩之骨針（第六版十二及十三圖）。穿孔之工皆頗精細。余等初得此等針時、以爲該石器時代當屬較近之時期。後余詳查、在歐洲舊石器時代末期、曳魯垂恩及麥

骨製之他器作錐用者外、尙有他種。其功用尙未及細考。

此外可提及者有二斧、爲鹿角所製。與丹麥棄秦密頓遺址所得者頗相似。

惟仰韶遺址所得諸器中、最顯著者確爲陶器。破碎塊片數既衆多、散布復廣、惟完全者極希。自骨董家眼光觀之、殊少意味。但據所得碎片、加之科學研究、足使吾人知仰韶遠古時代文化之階級。但余研究陶器今始着手、茲不過簡略述之而已。因便利起見、將陶器暫分二類分論之。

一、粗陶器、灰色上有印紋或刻紋、(參閱第七版五至七圖)。多係手製、工亦粗糙。但亦有經『陶人之磨輪』推圓者、薄而小、手工精細。手製之陶器其製法多先由布或麻繩作模形、外敷以泥、然後燒之。故各器每有此印紋。有刻紋者或使印紋不甚明顯、然印紋究係燒陶時所印無疑。

二、此類較前者精緻。色多紅、因燒時火力強養化所致。其上每有黑色或間有白色花樣者。面皆磋磨光平、至於器上之花樣、於篇尾當詳述之。

石器遺址之年代

關於此古址最重要之問題乃其年代。自初在仰韶村發見石器以迄今日、余時時於此注意、而按所得證據研究之、迄未能得一完全之解決。茲略述之如下。

從仰韶遺址全部而論、似當爲新石器時代之末期。如與歐洲同時同期者相比、凡在彼之重要器物在河南仰韶等處亦皆得之。如石斧、石刀、獵人及戰士所用之石鏃骨鏃、及婦人用之石鐲骨針等皆是。夫一民族如已知利用金屬、則必不致盡用石骨等作精巧之器。吾人以五星期之功力悉心採掘、曾未得一金屬物。惟最後數日、

一頑童曾以一銅鏃來見。余初欲受之以待後日之考查、幸經袁君返復追究、得知此童貪圖微利特由村北他處携帶至此、詐言得之於遺址灰土層中。然實灰土中則確未見含金屬也。

此遺址中尙有特點、初見之、或誤爲冶金之證者。蓋各處皆發見綠色或黑色之渣滓、多孔而輕、常作長滴形。顯爲易溶化之流質所凝而成。余初見之、即以爲與燒陶有關、後得一器果足證明。此器一端仍爲完好之陶器、而他端則爲無定形而帶孔之燔煙。則其關係可知也。

就地形觀之、如此址堆積後又有由冲刷作用所成之深溝、亦足知此址年代古遠。溝澮生成既在此古文化紀之後、而地形變遷甚爲深遠。以尋常地質學家眼光觀之、或不敢信於地史上短少時間遽能有此現象也。

又可証爲歷史以前所成者、即此次所得物器甚多、其上從無文字。按河南龜甲文爲商代遺物、已爲歷史上最古時代。而仰韶遺墨絕無文字其爲時更古、可概見矣。

上所述多指河南文化土層當屬於新石器時代、但亦有器物似証明其時代稍近者。如陶器之鼎鬲等物、歷史時代如周已有之。或謂既有鼎形便可定其時代爲周、而僅有石器並無銅器則可以推知仰韶遺址當爲周代戎狄之遺跡。然此論實不可通。蓋就吾人所知周代已屬銅器時代之末紀、銅器之用既久且廣、即使戎狄雜處中原、而復屬石器文化、恐亦不能不受漢人銅器文化之影響。況地近洛都東北孔道、交通便利、多與外界接觸者乎。故予意以爲仰韶紀土層屬於石器及金屬器時代之過渡期、與地中海左右之所謂石銅時代者相吻合。

此論之一証爲磨輪所製之陶器。弗雷爾氏於一九〇七年、曾歷數陶人之磨輪。其著述略謂陶人之磨輪在新石器時代中、發軔於近東。埃及新石器時代中之泥器、皆爲磨輪所製。此磨輪約於西歷紀元前三十世紀自埃

及傳佈於小亞細亞。（輳依第二城。）西歷紀元前二十世紀至希臘。西歷前十世紀至羅馬、以及於歐洲中部、今德法之地。其時正在鐵器第二期、所謂拉典期者是。

惟與上說略有出入者、如霍恩氏於一九一七所著之『遠古文化』中以爲在埃及有金屬器之始、即所謂石銅時代或新石器時代之後期者、時代頗古。要當在西歷紀元前五千年至三千年之間、銅器與磨光之石斧、燧石器、及未經磨輪所製之陶器、同地發現。所憾者余不能得弗林得培楚意等專論埃及歷史前古址之著作、詳爲參証。但據上二說、雖其間稍有衝突、然亦足証明在地中海東部一隅、於石器時代已有陶人所用之磨輪、至於較近時代始輸入歐西諸國。又足可紀者本柏利氏於俄屬土耳基斯坦安諾遺址所得之陶器、在初期（安諾文化層第一第二期）均係手製。至第三期始用磨輪製。至於安諾文化層當屬何時代、則本柏利與彼所聘之考古學家施密特二人意又復不同。本氏於一九〇八年所刊之土耳基斯坦探測記中、以爲安諾第一期當爲石銅時代、而其年代約在西歷紀元前九十世紀。然至一九一八年本氏對於安諾層意見、復有更改。以爲安諾第一層當純屬新石器時代、其年代當在西歷紀元前六十世紀以前。施密特氏對於安諾諸層年代問題則頗爲慎重。彼以最古之第一層約在西歷紀元前三十世紀中（見土耳基斯坦探測記第一册一百八十六頁）。從上述各方面意見、可以約略推定仰韶時代。仰韶層所存之陶器既多數爲磨輪所製、似可證明其已非新石器時代。然如將來或能証明遠東所用之磨輪非由西方傳來、乃係獨自發明者、則其時代便不能強相比附。然即就其他器物觀之、究覺年代較近。未可輕持分別發明之說、置外國研究中之結果於不顧也。據此理論、則吾人當知仰韶層不能古於石銅時代、或尙屬銅器時代。

解決此問題、尙須多加研究、自無可疑。然就今所知、已足代表古代文化中之重要時代。應有名稱、以便討論。余即取本地之名而名之爲仰韶文化時代。此時代之遺跡、河南他處亦有發現。即奉天錦縣沙鍋屯遺址、亦與此同時。

仰韶文化與中國人種之關係

論述至此、則仰韶文化是否爲華族所有、抑係戎狄蠻夷之文化、乃一最重要問題應待解決者。在中國南部者、現尙有獰獰苗子等族。在中國北部者。則爲蒙古族之支派。今所當知者、即此仰韶文化是否屬漢族、抑屬蒙古族。此問題似頗易解、據現在所知各事觀之、皆可決定其爲漢族文化。與此論似有衝突者、惟有葬儀或有不同耳。蓋師丹斯基博士所發見之古人遺骸之位置大抵頭部多在東南、現代漢人風俗則葬時位置多係頭北面南、然亦有不一律者。

自仰韶器物形狀觀之、則全似爲漢族遺蹟。推想此址歷史、當係一生聚已繁之村落、農業亦已甚發展者。所有獸骨盡屬豕類、亦有以猪骨作鏃刀環玦者。察其種屬要當屬家畜之猪、而非野豕。今之漢族固仍以猪肉爲食品大宗。而蒙古人則未嘗有此。

在仰韶村採掘時、土中時有陶器碎片。往往有烟燻遺痕附着於上。後得二三物較爲完整者、其器之形像與現代北京街市上所售之沙鍋頗近。又自仰韶村採得一瓦製之尊、其形式與古物陳列所所保存之周代銅尊亦極相似。尤堪注意者、爲一種三足器、足部爲空袋式、每於仰韶灰土層發見之。（如第七版六圖及第八版第一圖）九年夏於仰韶村初得一足、余助手羅森娜女士卽以爲當與古物陳列所之周鬲足相近似。嗣所得較全、

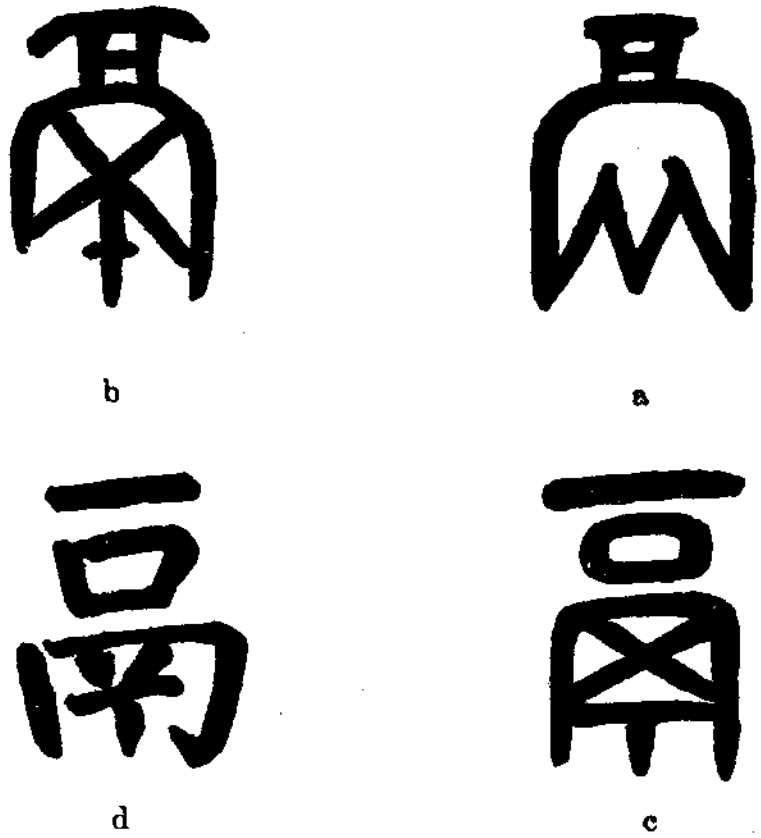
而形狀益明。惟河南所得之瓦鬲、全部較高而細、並具一耳、餘均與銅鬲逼似。袁君復禮曾示余古籀文之鬲文及鬲之訓爲瓦器。而此數鬲文（第七圖）又多係周代鼎彝刻文、更顯係爲周鬲像形文字。則周銅鬲與仰韶村瓦鬲之關係、更無疑矣。然此二者之關係亦可有二解。一、如以鬲足可表明時代爲周。則仰韶石器當爲周時雜處夷狄之遺跡、二、卽仰韶石器爲周代以前漢族之器物、其形狀至周時仍沿襲不變。前言他種器物之形狀尙有沿襲至今日者、如謂周時器形脫胎於石器、自更無不可。雖人種研究、須俟步賴克博士考察骨骸後、方能定論。然余箇人意見、則以爲仰韶文化之人種當爲現代漢族之遠祖、或與漢族極近之一民族。（又中國民族已屬支派複雜、漢族之名實亦不能盡表之。）換言之、據已發現之各器觀之、余以爲仰韶遺址、實爲未有文字記載以前漢族文化所遺留也。

使余誤解、而仰韶古址爲周時戎狄所居之地、則此項戎狄亦必已受幾許中國文化之鎔陶、故所呈諸器形狀多與漢族銅器相近似、誠然則亦遠古之中華文化也。

仰韶文化與古代外國文化之關係

仰韶陶器中、尙有一部份或與西方文化具有關係者。近與俄屬土耳基斯坦相通、遠或與歐洲相關。施采色而磨光之陶器、卽其要証。此項陶器於仰韶層中發現極多、雖殘破不全、而大概形態不難推見。（第九至十二版）其器體積不大、形式簡單、多作碗狀、其所用陶土之質較他種陶器所用較細。器質頗薄、工作精美、面多磨光、紅地施以黑白花紋。

與此相似之陶器、歐洲新石器時代或其末期亦有之。如意大利西西利島之啓龍尼亞、東歐之格雷西亞、及俄



第七圖

a. 說文古籀補召仲鼎 鬲文

b 仝上毓仲鬲鬲文

c 篆文

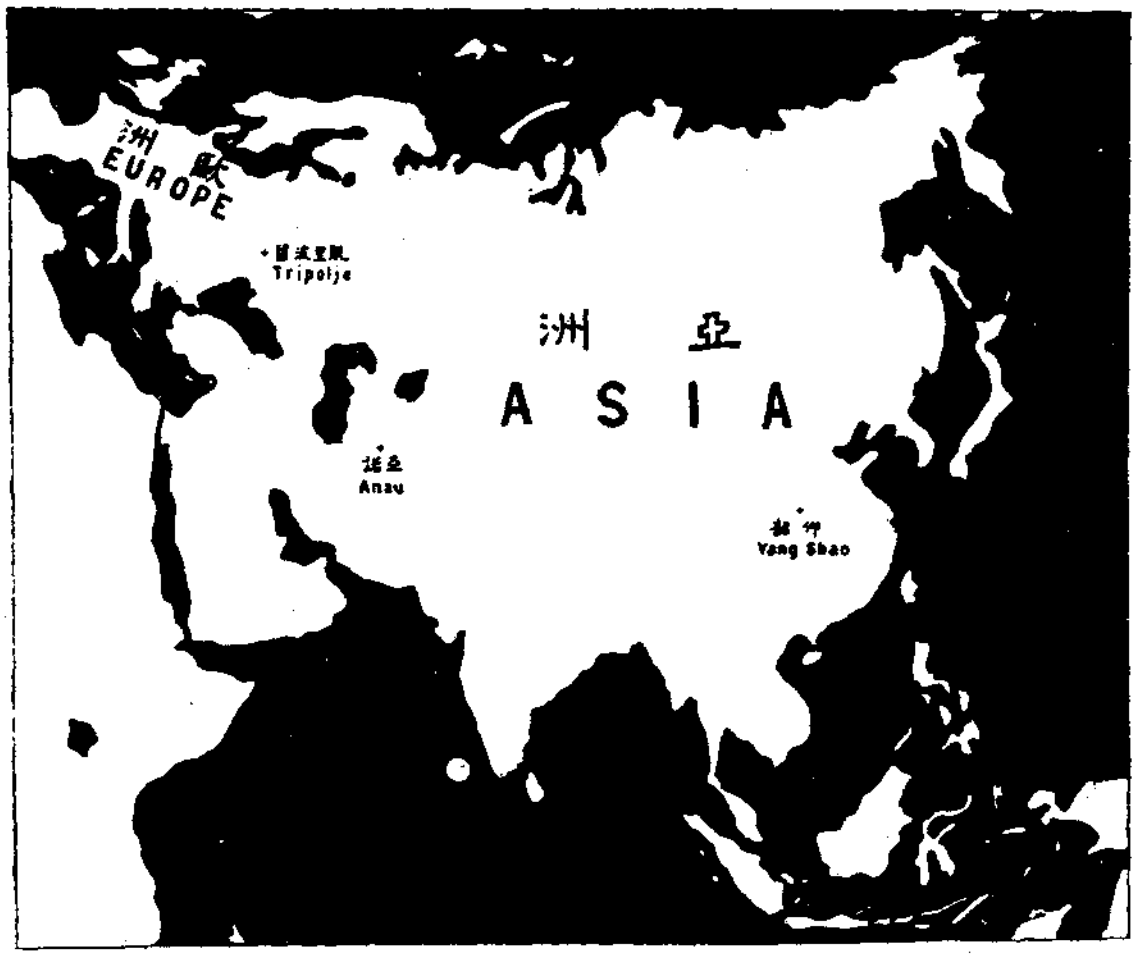
d 今文

鬲文之演形

以爲該帶古代氣候於人類生活當較適宜、則東西藝術流傳亦非不可能也、明矣。

此項東西之交通、有可以事實証明者。例如第四紀之初、人類尙未繁殖以前、亞洲所產之駝鳥曾遍佈此帶。東自山東、西至黑海以北之草地、迄今遺有鳥卵化石爲証、在石器時代與銅器時代之間、由上述之著采陶器亦

國西南之脫里波留、俄屬土耳基斯坦安諾地方、皆曾發見。各處之器。各有特點。然與河南仰韶古器之器工花紋、皆有極似之點。(第十三版)夫花紋樣式、固未必不能獨立創作、彼此不相連屬。然以河南與安諾之器相較、其圖形相似之點、既多且切、實令吾人不能不起同出一源之感想。兩地藝術、彼此流傳、未可知也。誠知河南距安諾道里極遠、然兩地之間實不乏交通孔道。西藏高原之北、西伯利亞之南、東自太平洋、西至黑海、其間或爲麓地、或爲草田、或爲沙漠。據本伯利氏及杭廷吞氏之研究、



證亞東河南與西方安諾、脫里波留、及歐洲之西西利曾有交通。

中國歷史中、自漢以後或因爭戰、或因通商、皆與西方諸國有交通。據阮納赫、勞弗爾、閔思諸氏考証、皆謂在歷史記載之初、中國即與西方細鮮人種及土耳基人種藝術上、有互相採取之關係。又余於民國九年在內蒙調查、沿直隸北邊所見石像、與裏海以西一帶旱地所得者極爲相似。當爲一種土耳基人所遺留。此亦東西交通之一証也。

此篇以上爲民國十一年一月在文友會講演之稿。彼時予以爲石銅時代東西有交通之証。可供參考者、惟賴施密特及本拍利二氏之作。嗣余欲與諸考古學家解決此重要問題、乃將第十三版圖及陶器數片、送瑞典國皇太子殿下鑒定。殿下固精於考古學者、五月間復往遊倫敦、更與英國博物院諸專

家互相討論。英人赫步森氏對於仰韶陶器之意見如下。

『紅陶器帶黑色采紋、顯與近東石銅時代諸址所發見者、同屬一類。其地址及時代如下。

(甲)巴比侖、據浩魯氏云在蘇梅利安期之前、即西歷紀元前三千五百年。

(乙)波斯東界。

(丙)小亞細亞、約在西歷紀元前二千五百年至二千年間。

(丁)安諾及脫里利留。

(戊)希臘北部之塞撒利、約在西歷紀元前二千年至一千二百年間。

以年代論、此種陶器歷時頗久。自西歷紀元前四千年起至紀元前一千五百年止。爲新石器時代文化之一徵。從前歐洲學者以分佈範圍、自近東至俄屬土耳基斯坦。今既在河南亦有發見則可見其東西流傳之遠、其間所有連接二地、如中國新疆等地、亦應有同類發見之望也。

然中國仰韶陶器、究屬何年代乎。如上所言、似可謂此種陶業、創始於巴比侖。後乃四外流傳。中國地處極東。達到之時日、自當較後、但中國夏代(西歷紀元前二二〇五至一八一八年)銅器之用見廣、而仰韶遺址從無金屬器物、此又似爲時代較古之証。約略計之、當不能在西歷紀元前二千年至一千五百年以後也。然製此等陶器所用之磨輪、商代(西歷紀元前一七六六至一一五四年)已見之文字記載。(見陶說)則又見其與中國文化關係之密切矣。』

此外余亦曾函商德國柏林博物院考古學家施密特博士。施氏即前曾在安諾實地研究者。施氏答覆之意見、

略述如下。

『仰韶與亞諾二處陶器相同之點、並不充份。欲詳爲比較、除花紋樣式外、如製造之技術、所用之采色、及表面磨光之程度、亦均須注意。

安諾第一層之時期與脫里波留並非完全同時。蓋安諾時代較古也。如欲確定河南陶器與西方諸地之關係、須先知河南古址之確定年代。不特與中國歷史作比較、亦應與西方各地之時代作一比較、方可。且花紋形式不必定爲某種文化之特徵。當從全體觀之、方能確作根據。又欲定二處年代之先後、尤當注意於地層次序等確實可靠之証據。然後方能言及文化與歷史之關係也。』

由上二人所言觀之、英國郝伯森氏論斷較速。以中國之器與近東各處、大可比較。德國施密特氏則取一格外謹愼態度。承認此項發見之重要、而以爲仍須繼續研究、方可明定其與他處之關係。二氏意見所以迥異者。亦以郝氏嘗見寄去之陶器標本數具、而施氏僅從圖上見之耳、然余以爲施氏愼重態度、深爲可法。要當繼續研究、方能定論也。無論如何、得郝施二專家之品評、足証仰韶遺址實有研究之價值。仰韶與近東各地之交通、暫可作一假定之理想。再按事實研究、以肯定或否定之、可也。

此項理論與中國人種之來源、極有關係。前有法國拉古波力氏曾倡中國文化西源之說、然多無根據。後包魯氏亦有是說。在當時雖似亦風動一時、然據近世學者研究結果、多以拉氏等之說。殊無科學根據。爲不足信矣。中國古史亦常有西方種族屢次東遷之說。吾人就考古學上証之、亦謂此著采之陶器、當由西東來、非由東西去也。蓋據郝伯森氏云、浩魯氏已証明巴比倫在西歷紀元前三千五百年即有多采陶器。然仰韶陶器。有與三

代銅製鼎鬲相逼似者。且當時陶工已用磨輪、皆足証明其時代當與中國有史之時相去不遠。當在去今四五千年前之間、是即遠在巴比侖之後。如果出於流傳、則必自西東傳矣。

使他日可証明製陶器之術來自西方、則其他文化或種族之特性亦可由此輸入。余書至此、不禁思及黑得離思克博士之論矣。黑氏爲美國著名人種學家、於民國九年嘗至北京講演。曾謂『漢族大都乃黃櫻民族。但頗有表徵遠古時、與白種血統有所混合。於較近時亦稍有之。』

因仰韶遺址之發現、使中國文化西源又復有希望以事實証明之。然欲完全解決此問題、爲日尙遠。是在考古學家、人種學家、及言語學家同力合作。去固執之成見、爲誠實之討論、庶能漸達眞理。尤望中國學者、對此注意、共起研究、其能供獻於此學者、自更不可量也。

附圖說明

第一版

半月形及長方形之石刀、(各圖按原物大小縮成一半)。

第一圖　長方形之石刀、係由紅色堅質石灰岩所製成。刀口附近有一深孔。河南澠池縣仰韶村產。

第二圖　石刀無孔者、係綠色之石所製成。刀背甚寬、計約一公分有半、其形狀既簡單而又無孔、故該物係余所見石刀中之最簡陋者。直隸宣化縣白廟所產。

第三圖　長方形之石刀、係由灰色之石所製成、中部有一孔。

第四圖　石刀、中有孔、其形似在半月形與長方形之間、係由紅色含鐵之砂岩所製成。直隸龍關縣潘道村所

產。

第五圖　形似半月形之石刀、惟刀背稍寬。其形大致與第二圖相仿、惟有二大孔、係由綠色之石所製成。熱河綏東縣慶雲寺所產。

第二版

長方形、梯形、及半月形之鐵刀、（各圖按原物大小縮成一半）。

第一圖　梯形刀、邊曲折、刀背有皮帶以便執握、直隸懷來蟬家窰所產。

第二圖　高梯形刀、背有布、並附以布帶、產地與上同。

第三圖　梯形刀、背之內部有布、表面有皮、並附以皮帶。產地與第一圖同。

第四圖　形似半月。直隸宛平縣官子所產。

第五圖　長方形。熱河圭寧縣頭道溝所產。

第六圖　梯形、直隸懷來縣新保安所產。

按本版中下列之圖、形狀與上列三圖相似、惟多一布製或皮製之背面及皮帶而已、去其布面與皮面、亦見有小孔二箇、與一圖至二圖同。

以上諸標本、均來自直隸與熱河、其地多高粱、故原文中疑其爲收割高粱之器。該器產地、又爲蒙古人所雜處、尤以元朝爲最多。章君鴻釗、曾於石雅有言、該器非中土所創、而爲蒙人所原有、其後傳入內地者也。其『粟堅』二字、爲明代以前所未見、更可爲此說之左證云。

對於章君所舉之証據、余無甚意見。惟此種刀器、在中國分佈甚廣、或可視爲遠古所遺傳者。近今南京有長方形而無孔之一種鐵刀。河南有大鐵刀、中有二孔、亦作長方形。該兩省遠在蒙人範圍之外。再據余所知、今日之蒙古人、並無用此種可以割高粱之刀器、並聞舊時亦無此物。余以爲仰韶之標本、爲中國初代文化之遺跡。果爾、則第一版附圖所示之形式、當爲中國人類歷史以前所應有者。

第三版

木匠所用之器及鐵滑連、今日北京猶用之。

（第一圖至第三圖按原物大小縮成十分之一。第四圖縮成。第六圖縮成六分之一。）

第一圖　木匠用之大錛。

第二圖　木匠用之大錛。

第三圖　木匠用之小錛。

第四圖　木匠用之錐鑽。

第五圖　利刃用之鐵滑連。

第四版

鐵錛之進化（各圖按原物大小縮成一半）。

第一圖　非對稱式之石鑿、由綠色岩石製成。河南澠池仰韶村產。

第二圖　非對稱式之大銅斧。熱河灤平縣上牢城產。
該標本由某墳中掘出、某君購之、復由某處購得。
此斧有三種、形各不同。又有七首削刀數柄、狗馬之石墜及鈕子甚多、並尙有其他物件。其詳將另言之。該物所
屬時代較近、似無疑意。但決不致再新於眞正之銅器時代也。
第三圖　現在北京木匠所用之鐏、

第五版

戈之進化史。（各圖按原物縮成四分之一、其中第二圖所示者、係金石索所載、致能表其大致而已。）
第一圖　戈、由綠色細粒之變質岩所製成。直隸龍關縣湯池口所產。
第二圖　銅質之戈、載於金石索第十一頁、所謂商舟戈是也。據云係商朝之物。
第三圖　銅質之戈、雪得利所繪、根據如第二圖。
第四圖　銅質之戈、附有銅靑。得自河南新安縣安樂村某坟中。此外尙有大斧。
第五六圖　銅質之戈。由北京古玩鋪中購來。按古玩鋪中頗多類是之品、購時務宜注意。第五圖所示者、已有可
疑之處。然其爲仿古時眞品而製成者、似無疑焉。
本版諸圖、按次排列、意在表示其形式變遷之序。雖然、可以指示形式變遷與時代進化相符之証據、與
夫確有年月之器具、則未曾有所得、祇能俟諸異日矣。
第五版第一圖之石戈、標本祇有一種、故仍有可疑之處。或者此物係仿照古時之銅戈而製成者、例如第二圖

是也。然石戈究較銅戈爲簡陋、既厚且粗、兩方相稱。而刀根甚厚、且寬於刀刃、並附有兩肩角、似爲納入於柄中所用（見插圖2A）設。該肩角果作是解、則頗有意味可尋。蓋其後之銅戈、不用肩角而代以孔、以便穿綫、而納入之。戈之最近者、有胡、用以插入木柄、使之牢固而設。

綜上所述、可以言戈之發達程序如左。

第一圖　石質、側面對稱、有肩角、刀頭與肩角同寬。

第二圖　銅質、側面微現對稱、有肩角、刀頭狹於肩角、無孔。

第三圖　側面不對稱、有肩角、刀頭狹於肩角、有孔。

第四圖　側面極不對稱、微有胡、肩角退化、有孔二。

第五圖　胡顯明、上肩角消滅、有孔四。

第六圖　胡長與刀口之長相等、無上肩角、有孔五。

以上所言、不過敘戈之大致變遷而已。他日如得確定時代之物、再詳細研究之、當更有意味也。

第六版

仰韶文化時之製作品（各圖按原物縮成一半）。

均自仰韶村得來。惟第十二十三圖所示兩針、係來自不招寨。距仰韶之西約十里、與仰韶所產同類之物共處、故其爲仰韶文化無疑。如第十二十三兩圖所示之針在仰韶村亦有之。

第一圖　硬泥之甩頭。

第二圖　紡織輪、由紅色石灰岩所造成。

第三圖　泥環、環面有花紋。

第四圖　小骨環。

第五圖　硬泥環。

第六七圖　石環。

第八圖　石矛尖。

第九十一圖　板岩製成之箭頭。

第十二三圖　骨針。

第十四圖　短圓之綠色石斧、稍不對稱。

第十五圖　白色大理岩之鑿、側面不對稱。

第十六十七圖　綠色石斧。

第七版

仰韶時代單色之陶器（除六七兩圖係得自不抬寨外、餘均仰韶村所產、各圖均按原物縮成五分之一。）

第一圖　磚紅色陶器碎片、可以品成一尖錐底之陶罐。本圖中之碎片是否屬於同一陶器、尚大有可疑。碎片厚五至八公厘。罐口有向外捲之邊緣。但罐甚窄、（見第九圖）邊之直徑爲八·八公

分、口之直徑爲四・二公分

罐口附近之內外兩面、均有圓式細綫、似爲輪工製造之遺跡。然罐之一大部份、爲手製之品。

底部碎塊之表面、有綫之印痕、從底尖向四面射出。其項部一塊、適位於邊緣之下、有兩種線印紋互相交割成四十七度之角。

第二圖　棕灰色之陶碗。附有砂礫、故甚鬆、厚五至七公厘。邊之內部有同心圓線、表輪工之製作、否則、將視其全爲手工所製。罐有足、飾以指印、面粗、內部黑色。

第三圖　無足之碗狀陶器。深棕灰色。較第二圖中所示者細、無可見之砂礫、罐口向內漸厚、（見圖十所示）、邊高六・四公分、口之直徑十七・九公分、足之直徑爲六・四公分。

之附近外面、有同心圓圈線、表輪工之製作、但碗底及其餘各部份不整齊、顯然爲手工所製。碗之外面已經磨光、近邊之部、已經磨成黑色光滑之面。余於第十版第三圖所示之奉天洞穴中之陶罐已詳言之、且與黑色之皮相比較。碗牆甚薄、三至四公厘。高九・四至九・七公分、口之直徑二〇・四公分、足之直徑七・五公分。

第四圖　大杯。淺灰色、厚四公厘。底及表面有輪工遺跡。內部粗而不平。底部之表面有四箇不整齊之槽（不若圖上所繪之整齊。）表面平滑、並有光澤。

第五圖　鼎、灰色、厚五至六公厘。無輪工琢磨之遺跡。表面有籃印紋、其上更有不整齊之粘土繩、環腰而圍之。小耳兩枚、各有指印。

三足成長方形、中有支柱、上升三十公厘、而與鼎牆相合。口徑二百一十四公厘、平底之徑一百三十一公厘、體

高一百四十九公厘、足高七十四公釐、全體高二百二十三公厘。

第六圖　鬲、深灰棕色。腿厚三至七公厘。手工製成者。腿與體均有蓆印紋。腿與體之內邊亦有蓆印紋、但不如在表面者之清晰。頸與柄無印紋、其面粗而不整齊。頸與體均有深槽以點綴之、表面黑灰色或黑色。頸之內部一部份因火力燒成黑色。不整齊之口徑爲九六至九九公釐、全體高一百六十六公釐、以頸爲止高一百二十四公釐、柄長七十五公釐、柄寬三十五公釐。

第七圖　鬲、與第六圖同、惟較大而已。淺棕色、其內部有一黑色之薄層、外部亦然、惟不甚顯著耳。腿與體之內外面有蓆印紋、惟均不甚顯明。頸光滑、幷不點綴而與體有別。面灰色有幾部份棕色。口徑一百三十七公釐。全體高二百六十三公釐、頸高四十七公釐、柄長一百〇六公釐、其下段狹窄處占三十二公釐、上段占四十公釐。

第八版

鬲之由粘土（第一圖）與銅質（第二至第三圖）製成者。（按原物縮成三分之一）

第一圖　不招案所產之粘土鬲。紅棕色、腿與腹之表面均有蓆印紋。頸光滑、惟有同心圓綫、想爲輪工磨擦之遺跡。細察之、圓綫之下仍有半顯著之蓆印紋。全器之表面幾盡爲黑色。柄之保存者祇一小部份、柄之對面有一土質之窿起物、在頸之低部。全器之高二百二十四公釐、頸高三十五公釐、口徑一百三十二公釐。

第二第三圖　銅質之鬲、據云係周朝所製、屬北京古物成立所、得該所所長之允許、而後印得之。第二圖之鬲、高一百五十五公釐、口徑一百五十七公釐。第三圖之鬲、以邊緣爲止、高計一百四十公釐、口徑一百四十公釐、

第九至十二版

仰韶村所產之着色陶器（按原物縮小一半）。

凡圖中之黑色、卽原物之黑色處、惟在第十版第四圖、第八圖、與第十一版第十四圖、則代表原物之紅色。圖中有細點之處、表原物磚紅色或紅色條紋之部、惟第十一版第十四圖表一半圓色碗狀陶器之半。仰韶又產一碎塊中選出之最佳者。完全者未曾覓得。第十一版第之表面。圖中白色處、卽原物之白色處。

該四版中所示之陶器、係由仰韶村所產無數多色陶器碎塊中選出之最佳者。完全者未曾覓得。第十一版第十四圖表一半圓色碗狀陶器之半。仰韶又產一碎塊中選出之最佳者。完全者未曾覓得。第十一版第是也。該器之邊、繪有狹而黑色之綫。七版共有圖三十八幅、每幅詳情、姑不細述、但就陶質、輪製之工、形狀、花紋、顏色、諸端總論之如左。

陶質　本類陶器所用之泥質、似已經淘洗、故粒細而勻、與單色陶器中大碗所用泥質之粗細不同。且大都已燒成磚紅色。（安特生所著沙鍋屯洞穴層中第十二版第一圖之顏色、似與此相近惟太黃而已）他如第九版第二圖之厚片標本、則未經烘燒而養化者、故在器牆之中間、可見原有灰色之泥層。

陶器標本之未經養化者則現灰色。第十一版第十四圖所示者、似最有意味。全體灰色、但沿邊而至三道帶綫之最下部、則爲磚紅色。從其裂縫中可見此種紅色係烘燒之結果也。近邊緣處紅色、由此漸下則有灰色之中心、更下則裏外均爲灰色。該紅色灰色之裝飾、爲有意烘燒而然、似無疑焉。

『附註。近今得到一種仰韶文化期之陶器。質薄、色灰、惟有紅色之邊、寬約十二至十五公釐、由是而下

漸爲灰色。察其斷口該紅色確爲烘燒而成。其烘燒時或有顏料塗於其上、則未可知。該器爲已經所得材料中之最美麗者。』

第十一版第十二圖則爲另一標本、由黃白色之泥質所製成。

修飾形狀之技能　多數之着色陶器、均經過磨輪之工。其中粗糙者數種、則純爲手工所製。惟經過最後手工之磨括者、磨輪之遺跡當然消滅。除可疑者數例外、其餘則敢斷言爲磨輪所製。

形狀　仰韶村之着色陶器、大小適中、形狀簡單、尤以半圓形之碗狀而有平底之陶器碎塊爲最多。惟第十四版第四圖所示者、似較爲複雜。第九版第二圖第十版第三圖與第十二版第一圖、亦較爲複雜。有着色圓綫之邊緣碎塊、亦復不少。例如第九版第四圖、第十版第四圖第八圖第九圖、第十一版第十一圖、第十二版第二圖、又十二版第三圖等均是也。余等在仰韶村並未獲得此種陶器下半部之碎塊、然想象其大致如第十四版第一圖第十版第七圖第十版第九圖與第十四版第五圖。

第九版第五圖表示陶器之剖面、底部縮小。與此相仿之碎塊、尙有三片。

第十一版第十三圖所示爲一陶器之碎塊、其全體似爲扁圓式（參觀十四版第三圖）而口部縮小者。該標本亦爲邊緣之碎塊。口低而直。

花紋　花紋種類不一。似乎仰韶時代之人類不喜守舊、故將祖傳之花紋屢加改變、生無窮之種類。此種不同之花紋、實難以文字形容其詳、下列各種、祇可表其花紋種類之大概。

一、較大之碗狀陶器。口之週圍、有黑色條紋、第十四版第四圖表此種條紋之狹者、寬不過數公釐耳。第九版第

一圖所示之條紋、寬四十四公釐。尙有一碎塊有黑紋、寬約不及五十六公釐。尙有一碎塊之條紋爲紫紅色。二、碗狀陶器之富於花紋者。第九版第二圖表示一碗狀陶器。無花紋、惟口部有二黑線、二線之間有三角形。第十二版第一圖之三色陶器、花紋較多。但其底部之碎塊所留甚少、故不能證明該器底部無花紋也。沿邊之花紋帶更形複雜、包括各種三角式、與一曲線、又有一點。

第十一版第十二圖所示、係一小碎塊。其花紋大致係兩箇三角式顚倒相接而已。此種花紋於秀賽期所產之陶器中、似頗多見（比較茅幹氏之專著第十三卷第六版第七版第八版第二十七版又第三十一版）

第十一版十四圖所示、係一碗狀陶器。頗有意味。沿口有斜交黑線帶一道、其下有平行線三道、其下更有各種花紋、每種由三箇S形之平行線組織而已。底部有一圓線、其上加以波浪形之曲線。斜交線之花紋有用於直帶者、例如第十一版第七圖是。此圖所示之標本、與同版第九圖所示者相同。惟第九圖無斜交線而仍爲白地。第十一版第一圖與上舉二圖、似亦有多少關連之處。

第十一版第八圖亦有斜交線之花紋。

此外尙有形式較小而已經磨光之碗狀陶器。例如第十一版第二圖至第五圖是也。其中三四兩圖似係仿效花狀圖形而成。第十三版四、六、八圖所示、與前舉各陶器之花紋有別。但所得標本、頗不完美、故無從知其詳。

三、捲口之陶器。裝飾簡單、例如第十二版第三圖是也。時或花紋非常複雜、包括曲線帶、三角式、及圓點等（第九版第四圖與第十版第五圖）。捲口陶器中亦有橫線帶、爲兩三行橫線之間夾有斜交線而成者。他處所產捲口陶器、如第十四版第一第二圖又第五圖所示、亦有同樣之花紋。如第十一版第十四圖所示之半圓式碗

狀陶器、亦有同樣之花紋。就大致而言、似乎某種器具、應有某花紋、其實頗多不一。

顏色　仰韶文化期之陶器、非經詳細研究、不能盡舉其實。其顏料之來源、亦當在攷察範圍之內。今所言者、不過其大要而已。

色彩以直接敷於磚紅色灰色或白色之陶器者爲多。間有以紅色長條爲底層者、然爲數甚少。（見沙鍋屯洞穴層第十二版第二圖可知所謂紅色長條之陶器也）下所言者、凡陶器之磨光面、色條等均視爲顏色。因此磚紅之陶器而有黑色文彩者、即稱謂雙色。其有白色與黑色之紋彩者、即稱三色。

磚紅色之底部、有黑色之文彩者最多、例如第九版諸圖是也。第十版中多數之圖亦然、惟其中第四圖則有紅色而繪於灰色之陶質。第十一版第一至第九圖則有黑色文彩而繪於紅色之底層。所謂底層者、恐即紅色長條也、第十一版第十圖係一紅色之陶器、黑繪白文。第十一版第十一圖第十三圖之陶器色彩已經消退、不易辨識。第十一版第十二圖則有黑色文彩而繪於白色陶質。第十一版第十四圖之色彩、係由烘燒之法而得、已如上述。而其文彩係繪於深紅之部。

第十二版第一圖爲三色之陶器。其沿邊緣之部、有白色條文、其上復蓋以黑彩、在邊帶之下、該器磚紅色之一小部、明晰可見。

第十二版第七第九兩圖、繪法相同。上部有白色條紋、界以黑線、與下部之磚紅色相別。

第十二版第二第四第六第八諸圖之陶器、原地係磚紅色。其上加以白色條紋、其上再繪以黑彩。

第十二版第三圖之陶器、係磚紅色、沿口有黑色闊綫二條、中間夾以紅色、其餘則均爲白色。

第十二版第五圖所示之陶器、棕地黑采。此外尙有白色陶器碎塊一方、其上繪有六條光線之黑色星、中間有一紅點、似爲火漆一類之物。又有灰棕色碗狀陶器碎塊一方、其上有大而且圓之點、沿邊圍以有珠光之白線。

第十三版

仰韶、亞諾、脫里波留三處陶器之比較。(除第十五圖外各圖所示均按原圖大小)。

河南所產之陶器標本、惟第一第二第四第七圖四種係仰韶村所產、其餘得自新發見之產地、將於古生物誌詳言之。

第一圖即九版三圖之標本。采第四圖即十一版七圖之標本。第一至第七圖均有黑色文采、陶質原地係磚紅色采。惟第四圖所示者似有紅色條。

第五第六第八諸圖之陶器、有黃白色之條紋繪於陶質上、復加以黑色之線與點。

亞諾之陶器圖、均採自虛密特脫之著作(見本派里著之土耳其斯坦調查記第一卷。)第九圖即虛密脫特第二十三版第五圖、第九圖即其二十三版第一圖、第十一圖即二十二版第一圖、第十二圖即二十四版第五圖、第十三圖即二十七版第二圖、第十四圖即三十版第二圖。所有標本、均有黑色繪於黃白色或深紅色之陶器。

脫里波留之標本(第十五圖)係得自明斯(Mimns)雪西恩斯(Scythians)與希臘、見一百三十六頁第三十圖。淡黃色、或深棕色。

民國十一年以來仰韶文化期之標本、所得日漸增多、其與近東及歐洲東南部之多色陶器相關之處、亦逐漸

明瞭、故不俟各種標本專著之完成、即將第十四版至十七版加入本書、以表各種最顯著之陶器。

第十四版

著彩色之陶器。（各圖均按原物縮成四分之一）

惟第四圖所示之陶器係仰韶村所產、其餘產地係新發見者。

第一圖由兩種標本湊合而成、裝飾形狀、兩者相同、表面紅色、內部灰色、厚三至六公釐。該器有狹窄之捲口。

紅地黑采、捲口之下、有斜線帶、帶下有橫綫二道、其下二・五公分處、另有一帶、由三橫線組織而成、與上帶用直線相連。五公分之下、又有一橫線、自此以下無文采。在此橫線與第二帶之間、有曲線之文采、其形如X及ω。兩耳、上有指紋。

第二圖　質地色彩如第一圖。厚五公釐、該器最寬部份之下、有兩耳、在X與ω狀文采之上部。陶質磚紅色、加以黑色之文采。而文采與第一圖同、惟祇限於該器之上部。此爲所得陶器中之最大者、口徑二八八公釐。無底之碎塊、盡高三三〇公釐、故該器全高約三七〇公釐。

第三圖爲一碎塊、祇有口部而無底部、湊合而成、即本圖所示。表面紅色、內部灰色、陶質表面之紅色、沿邊一帶、可以見之。其餘有文采之部、有白色條、其上覆以黑色或紅色。所繪者、大半黑色。環腰有三橫線、其居中一線、紫紅色。直線之第二行亦爲紫紅色。『眼』之兩旁、有二點。所謂『眼』狀之文采、其來源實不得而知、惟其下行所繪、實與秀寨(Hsiu-chai)所產之陶器相似（見英文中插圖第十三）。

他如橫線直線之連合式、似與秀寨第二期之文化同。

當本篇著作將半之際、作者得到特茅幹氏所著之秀謇採掘品（ Mémoirs de la Délegaton en Perse par De-Morgan ）參考後、知遠東近東新石器時代秀謇與仰韶二處所產之物、似同屬一源也。

第四圖所示之器亦由碎塊湊合而成。全器均經烘燃成紅色、厚五至七公釐、有磨輪及黑色文采、沿邊有線、寬八公釐。

第五圖之器完全因採掘時碎成數塊、陶質淡紅黃色、全體曾經烘燃、厚三至四公釐、形狀不整齊、沿邊有磨輪線、繪以紫紅色、頗美觀。邊之下即斜線帶及橫線、中夾以直線、並有兩種細波浪紋、所繪者殊不整齊。口徑一三五至一三九公釐、底徑七十一至七十二公釐、高一〇三公釐。

第六圖示一淺而寬之碗狀陶器。陶質灰色、厚三至五公厘、內部有不整齊之括痕、外面已經磨光、繪以紅色、沿邊有二線、近底部亦有二線、兩者之間、有螺旋形之花紋、與沿邊線之在下者相連。口經一七〇公厘、底經七十二公厘、高四十七至六十二公厘。

第十五版

各圖按原物大小縮成四分之一。

各標本均係仰韶村所產、惟第一第六兩圖所示者係採自不招寨。

第一圖陶質棕灰、厚五至六公厘。底部有孔、排列甚密、徑七至八公釐。邊牆之底部有孔一道、器之下部三分之二有筐印紋、在其餘之三分之一、已經不清楚、惟與頸部同有磨輪線、又有耳一（或原有二個）。平面長方而兼橢圓式、直面三角式、上部有深槽二、但下部光滑。

高二九五公釐、口徑二〇八公釐、

余初以爲該器係一漏斗、細察之、則又以爲不然。蓋底圈生於底面、凡有細孔之處、有石灰質、顯然爲沸水蒸發之遺跡。因此余以爲該器架在他器之上、用以蒸發食物者。即如第六圖所示之鬲、或即所謂他器者是也。此種鬲器與他種不同之處、即在該器之內部有一橫圈、與頸底相連是也。顯然爲架他器之用。

雖然、余亦未敢自信。蓋所謂鬲者、似不足以架若大若重之器。惟民國十一年春、余以所得各標本、請教於天津之華石斧先生。據云古時有甗、即架於鬲、而爲蒸食物之用者。然則、余說似亦可通。

查匋齋古金續錄第一卷第一、二、四各頁有銅器圖、其形狀或與所論之陶器有相關之處。蓋其狀如壺、架於鬲器。設將來研究日深、所得漸多、而能証明仰韶期之文化與籀文銅器確有相關之處、則更幸矣。（按甗字從瓦、然則銅質之甗、果脫胎於陶器乎。）

第二圖之陶器質棕色、精細、厚三・五至六公厘。有高足者足空而架一盆狀之器。足有七孔、足徑二十至二十三公厘。上部盆狀之器、其外部有橫脊。盆之內部、分爲兩部、邊緣部微斜、中部深凹。表面磨光、無明顯之磨輪遺跡。高二百十五公厘。上部盆形之器、直徑二百〇二公厘。

第三圖之杯有大柄、粗糙手工製成、高五十七公厘、口經五十九公厘。

第四圖之陶質紅棕、厚三至六公厘、有捲邊、外面有不清晰之斜籃印紋、蓋以三條高起之橫線。全器頗不規則、顯然爲手工所製。惟製作邊緣之時、似略用磨輪、因其上邊稍有圓線也。高一百十三公厘、邊緣直徑一百十七公厘。

所得標本中兩塊黑色、三塊磚紅色、故湊合之後、顏色絕然不同。其中數塊、似破碎後已經火燒者。

第五圖棕色陶器、手製之杯、有耳。耳較第三圖所示者小、高六十八公厘、口徑十公厘。

第六圖焉之碎塊、似爲所有標本中之最奇特者。其腿較普通者寬大、內部頸底有橫圈如圖所示、其用處似與第一圖之器同。全器有蓆印紋、頸部刻有三橫線、表面黑色。腰部有不明顯之籃印紋、上部光滑、高三百〇六公厘。

第七圖長頸之瓶、陶質棕紅色、表面黃棕色、手工製成。下半

第十六版

各圖按原物大小縮成四分之一。

標本採自仰韶村、惟第一第八圖之器、係採自不招寨、而第五圖之器爲另一地點所產。

第一圖陶器淺灰色、厚祇二至四公厘、故易碎。底缺。然同地有相似陶器之碎塊、內中有底有面、故合而觀之可知該器之底部平坦。近底之邊牆光滑。表面大部份有豎狀籃印紋。腰部更刻有四橫線、腰與底之中間又有六橫線、最上一線與頸部之間光滑。該處籃印紋全然消滅、但刻有三線。頸部內外光滑、惟有細線、想係磨輪之遺跡也。器之內部不整齊、而有斑點、顯然爲手工所製。自頸部以上爲輪工所製。

腰部直徑二百七十公厘、口之直徑一百七十二公厘、全器之高三百六十公厘。

第二圖之陶器質灰綠色、甚粗糙、厚七至八公厘。盆小、有三足。外面有高起之線二、與十五版四圖同。內部邊緣之側面、已如圖所示、該部份有磨輪線。高一百〇九公厘、口徑二百二十四公厘。

第三圖之小盆、陶質精細、灰棕色內外光滑、足之下部有高起之線、高六十九公厘、口經二百〇二公厘。

第四圖陶質精細、紅棕色、厚四公厘、底平、直經八十公厘。器之表面甚奇特、既經磨平而塗黑、故頗似皮質所製。高一百十二公厘、最寬處直徑二百四十二公厘。直口之徑二百〇四公厘。

第五圖陶質粗糙、棕色、壺狀、有波浪形之高起線。內面不平、外面深黑、略有光澤。高一百八十三公厘、最寬之部直徑二百二十三公厘、口徑一百七十六公厘。

第六圖陶質深灰色、內外面均光滑、屬鬲之小者。足短、頭寬大、有大耳下垂至一足。高九十六公厘、口徑一百〇一公厘。

第七圖陶質紅棕色、係一小壺之碎塊。表面除頸部外有深而明晰之蓆印紋、底部有一狹帶、光滑無紋、高一百二十公厘。

第八圖壺之碎塊、有一大耳。陶質灰色、內部頗不整齊、外面有斜方網形之脊、並繪以黑色。捲邊光滑、有磨輪線。

第十七版

各圖均按原物大小縮成五分之一、第一圖器採自不招寨。二、三圖之器採自仰韶村。四圖之器得自另一地點。

第一圖之大陶器、色灰、雜質甚多、厚六至十公厘。其表面初有蓆印紋、近腰部有斜方花文蓋於蓆印紋之上、惟中有一段空白。又有九條光滑橫帶、各帶相離均勻。外面邊緣飾以豎狀低脊、邊牆之最低部有六孔、分爲二組、直徑二十至二十五公厘。該孔與底圈相近。全器似由手工製成。高約五百六十公厘、口徑三百六十公厘、邊牆之底直徑二百〇三公厘。

第二圖之器灰色、係一粗製陶器之碎塊。底尖、內部甚粗糙、顯爲手工所製。外面有斜紋籃印紋、惟近尖之處光

滑。口之形態、無從而知。尖厚七公厘、上部厚三公厘。第三圖器之形狀奇特、色灰、厚五至七公厘。七部似爲一簡單之壺、其底稍圓、從壺之邊牆起、有一外牆直向下垂、兩牆交界處之外牆有大孔共六枚、沿孔黑色。余以爲該器係爐之一種、其孔蓋用以洩烟者。器之一部。有一口、似爲裝燃料之處。

第四圖大陶器。底形如錐、製造精細、爲仰韶文化之特品。色磚紅、牆簿、祇三或四公厘。口失缺、故未能知其實在形狀。內部不整齊、有淺窩。外面有繩印紋、從尖底向四方射出、各線紋排列頗有規則。故疑其爲一種布質之印紋。有兩耳、加於印紋之上。器長約五百七十公厘。最寬處約二百四十六公厘。

同一地點、又得他種器皿之碎塊無數、湊合之、如插圖十四所示。與第十七版四圖不同之點如下、牆厚五至七公厘。布印紋較粗、近尖之部有粗線紋、器之形狀更尖長、底端較尖、耳柄正在最寬處之下。

總計仰韶村之尖底器皿、已有三種。其一即如前所記、牆簿、色磚紅、有細布印紋。其二如七版一圖所示、爲一小而底尖之器皿、亦作磚紅色、有線紋、頸窄。其三卽十七版二圖所示、器寬大、有籃印紋色灰。

按中國近來猶用尖底之陶器、如插圖十五所示。該陶器爲余從垣曲縣至京漢鐵路黃河鐵橋時、由某船上得之。黃棕色、無文采。據云係新安縣關口所產。斯干的納維亞新石器時代之陶器、底尖者頗多、然較仰韶產者爲粗糙。地中海東部各國、與埃及各朝代亦多尖底之器。因就近無參考書、故不能詳言而比較之。

山西保德縣三趾馬層

三趾馬層於山西北部及毗連之陝西界內散佈最廣而發見化石者只山西保德縣之冀家溝河曲縣之南沙窪及陝西府谷縣之五蘭溝三處

冀家溝面積最大南北長四千八百公尺東西長四千公尺地爲高原、經河刻劃、溝澗縱橫。三趾馬層即於溝澗中現露、此層底部爲砂礫層、厚四公尺。更下爲石炭紀煤系。三趾馬層最厚者達六十五公尺係黏土作成惟中亦含粗鬆砂礫層及石灰層結核自底部上溯約至二十五公尺處遇化石層、厚僅五公尺。所得化石暫爲核定如左

哺乳類

奇蹄類　三趾馬　硬角犀　無角犀　巨角犀（中國新見之屬）

偶蹄類　鹿　羚羊　『麒麟』（中國新見之屬）

肉食類　鬣狗　狸屬　貓屬　劍齒虎　狗熊

鼬鼠屬

長鼻類　四脊齒象　多脊齒象　象祖

齧齒類　獺屬　松鼠屬　豕

鳥類　鴕鳥

爬虫類　鱷屬　龜屬

南沙窪及五蘭溝二址面積較小而地層情形略同所有古生物皆表示草原情形而吉拉夫屬(『麒麟鹿』)及豕屬又證明其地有樹與水池者除此三址外率無化石故知其時氣候乾旱遍地皆成草原偶或一時一處雨水豐足池沼草木得以發展動物亦因之萃集其中焉

直隸周口店發現骨化石報告

師丹斯基著
謝家榮譯

周口店乃京漢路琉璃河支路之終點、以產石灰岩著名。車站北不數步有西向之谷名老牛溝、該處南坡爲奧陶紀石灰岩、北坡爲石炭紀煤系、骨化石卽發現於溝內石灰岩坑之最東部。該處壁立之灰岩層、距坑面約六公尺、其中一部變爲砂土、似爲昔時一洞穴、後被砂土充填者。今因開坑、遂得發現。稍上復爲石灰岩、顯爲洞穴之頂。砂土層之東面底部、有一狹形之管、向下貫穿甚深、爲黃色硬砂岩所充塞。以上所述砂土層及硬砂岩中、皆含有同類之骨化石。

據余之觀察、頗覺此處洞穴之深、似與狹管之深相若、祇爲一石灰岩薄壁所阻、遂不得窺其全豹耳。砂土自下而上之層次厚薄、據予所測約如次。其傾角大致甚平、約七度、層向北十八度東。

剖面(甲)

(一)黃砂岩厚度未詳、含化石甚多、又有石灰岩塊及鐘乳石等。

(二)淡黃色砂土厚十五公寸。

(三)深棕色泥土厚四·五公寸。

(四)淡黃色泥土厚六十五公寸。

(五)深棕色呈層理之泥土厚二十一公寸。

(六)棕色泥土厚三十三公寸、與(七)之界限頗不清切。

(七)泥砂(Loamy Sand)含砂岩夾層、厚八〇公寸、含陸地介類。

(八)石灰岩之角礫層、無層次、含陸地介類及骨化石。

剖面(乙)

(一)似剖面(甲)中之(一)。

(二)淡黃色砂土、厚一七公寸、含骨化石甚多。

(三)似剖面(甲)中之(三)。

(四)淡黃色泥土。厚六公寸。

(五)紅色成層之砂、一半已堅結、厚三〇公寸。

(六)紅砂岩、厚十五公寸。

(七)泥土、頂部呈棕色、底部黃色。厚十六公寸。

(八)紅色厚層之砂、厚八〇公寸。

(九)與剖面(甲)之(八)相仿。

以上各層中、皆有骨化石。惟巨大動物遺骨、祇限於地層(一)及(二)、此外各層所產、皆屬小動物遺骨。巨大骨化石之普通者。爲下顎骨及齒骨、若頭骨則殊未之見。又有肢骨脊骨鹿骨及無數散骨。小動物骨以二種嚙齒類(Rodents)之肢骨爲最多、其中亦有下顎骨。此外若田鼠類鳥類及食虫類(Insectivore)之化石亦有之、惟不甚多耳。

如詳分巨大動物之骨化石、則有馬與犀牛各一種。又有偶蹄類(Artiodactyla)動物多種、如豕如鹿、其下顎骨

皆特別較厚。又有反芻類(Ruminants)之小動物數種、尙未詳細考察。尙有一似牛類(Bovine)之大獸、頗易鑑識。食肉類、則有劍虎(Machairodus)一、與 M. horribilis Schlosser 相似。小熊一、又有似狐狸大之小獸一種。頂部之紅砂層及角礫層中、含兩種陸地介類。其中之一甚普通、與附近現代所生者相似。此洞昔時或曾爲數種食肉獸所居、常搏殺野獸、攜歸洞中、以作食物、幷碎肢骨、吸取其髓、因之完全之肢骨、今不多見。齧齒類或亦曾居此洞中。

上述之骨化石中、因無古馬 Hipparion 而有眞馬、故其時代必較古馬期爲新。或屬上新統(Pliocene)。

中國山西新發見之犀類化石

林斯頓原著
孫雲鵬譯

當一九一七年吾人與中國地質調查所立有契約、共同採集及研究中國哺乳類動物化石、數年以來、成績卓著、丁文江所長對於原定計畫、仍願繼續辦理。此類化石又承瑞典愛勃塞來大學威曼 Wiman 教授代爲鑒定。經費則由瑞典政府供給、及由瑞典私人捐助、此類化石經鑒定後、皆歸中國地質調查所出版、短篇論說則刊入彙報、長篇地質論文則列入專報、（如中國北部新生界）長篇古生物著作、則歸入中國古生物誌。標本以一半分贈瑞典愛勃塞來古生物標本室、一半留置中國地質調查所陳列館。

就近年採集所得、新發見之種類甚夥、且關於形態學上、頗饒興趣、其最著者爲長頸鹿科 Giraffidae 之一種、即麒麟 Chilinotherium 是也。中國古多麒麟、稱爲獸中之聖、據章鴻釗氏研究之結果、麒麟亦即葛來夫 Giraffe、嗣又經威曼教授之研究、遂名其種曰 Tingi、係贈與丁所長之榮譽、吾人頗希望威曼教授寄來論文、俾得早日出版、

最近其弟子林斯頓君、寄來新發見之犀類化石論文一篇、此種犀類動物、與板齒犀 Elasmotherium 相類、經林斯頓氏定爲巨齒犀 Sinotherium lagrelii、以種名贈與瑞典來格雷冉君、Mr. A. Lagrelius 來君係贊助此項經費之最熱心者。

北京一九二二年安特生

年來安特生博士對於採集中國哺乳動物化石頗爲熱心、最近發見新種犀類臼齒一枚、余定爲巨齒犀 Sinotherium lagrelii。此種化石係近左下顎之第三臼齒、損壞已過半、齒根及原齒 Protocone 均破碎、齒長

一〇、五種、（由外緣量）外部齒冠 Crown 高九種、最寬處六種、此類動物較板齒犀尤大、然二者極可比較。（見伯蘭特 Brandt 氏板齒犀屬頭殼構造概論）齒殼 Enamel 紆曲、凹處均充塡膠灰 Cement、是其特徵。其外邊蓋以膠灰薄層、撐面中間膠灰頗不發達、每成三角形淺穴、否則其構造幾與標式犀類 Typical 無異。外緣 Ectoloph 直、冠脊 Crista 脊 Crochet 反前脊 Antecrochet 均發達、原齒大且收縮、無齒盤 Cingulum 僅存其遺跡於外緣 Ectoloph 及中緣 Metaloph 之間、狀似圓錐。板齒犀與巨齒犀同隸犀科、不過前者之齒較後者稍爲進化、齒殼紆曲則一也、惟巨齒犀齒殼紆曲僅限於前緣 Protoloph 及外緣中部、板齒犀則全齒皆然、此即二者之區別。就此兩種生產地質年代證明之亦頗相合、如板齒犀生長於洪積統、今此齒則發見於山西保德縣中新統上部 Early Miocene 或上新統下部 Late miocene 地層中、是層每含有高原動物、如古馬麒麟（卽長頸鹿）羚羊之屬。齒窩 Fossettes 每爲膠灰所充滿、原齒突起且縮小、亦爲巨齒犀與板齒犀相似之點、巨齒犀雖較進化、然實保存標式犀類臼齒性質、具有顯明齒根 Roots、故余置巨齒犀 Sinotherium lagrelii 于板齒犀附科中。（此科昔有兩種皆屬第四紀）雖此次發見之齒構造與短足犀 Teleocerine 及原犀 Aceratheres 均有相似之點、然對於板齒犀原始問題及置板齒犀于奧斯朋氏 Osborn 所分之六種犀類中、尤未十分充當。奧斯朋謂原犀 Aceratherium incisivum 有前角、並推測板齒犀或由此進化而來、惟板齒犀科動物在上新統初葉已甚進化且巨大、似此問題、豈易解決。予意與其視板齒犀爲原犀之分支、毋寧謂爲同一祖先之爲愈也。

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CONTENTS.

AN EARLY CHINESE CULTURE.

BY

J. G. ANDERSSON.

Monuments speak their own language, and are entitled
to a fair and impartial hearing on their own merits.
B. Laufer. The beginnings of porcelain in China.
P. *144.*

During the researches which I have carried on during the last few years in the Tertiary and Pleistocene deposits of Northern China I have also paid attention to the appearance of Early Man in these regions.

So far no undoubted evidence of Palæolithic Man has been discovered. The isolated find of a big laurel-leaf point of the characteristic Solutrean type of culture is of little significance as such implements might have survived into later times.

Also undoubted Neolithic Man can hardly be said to have been proved to occur in these regions. But we have traced the wide distribution in Northern China of an early culture which during our excavations has so far yielded no metal objects and which as a whole must be said to be of a late Neolithic type. The doubts concerning its age are based upon the pottery which includes many varied forms and shows close affinities to the bronze vessels of Early Chinese dynasties, specially Chou.

As will be shown in the following pages, we have, for the time being, left the chronological question to some extent open, hoping that our future researches will throw fuller light upon this problem.

It might seem that the study of this archaeological material dating from a time, slightly preceeding or perhaps coinciding with the dawn of Chinese history has little to do with the realm of geology.

Still it was soon realized, in the course of our studies, that only careful mapping on a very large scale and painstaking stratigraphic recording of the results of the excavations would ensure immunity from errors which are apt to complicate the chronological problem. Furthermore, it was found toat some of the richest sites of this ancient culture exhibit a geological problem of singular interest, namely a cycle of vertical erosion which set in only after the ancient dwelling places had been abandoned.

Under these circumstances I have felt that I had to carry on this line of research in spite of the severe handicap experienced by an amateur archæologist in a remote region, with few books and no collections for comparison. A powerful impetus to follow up the initial discoveries was the decision of the Directors of the Geological Survey Dr. V. K. Ting and Dr. W. H. Wong, that, amongst the existing scientific institutions of the Chinese Government, the Geological Survey is best prepared to carry on these field researches in a strictly topographic and stratigraphic manner.

An outward sign of the active interest which these two gentlemen take in this work is their decision to include the forthcoming monographs on these early sites in the *Palæontologia Sinica*. The first of these monographs, written by me, "The Sha Kou T'un Cave Deposit", is now in print. The description of the human bones collected in this site, prepared by Dr. Davidson Black, will follow later.

In the same spirit Dr. Black and I are now working on the material collected during our excavations of the Yang Shao site in Honan; Dr. Black will describe the human skeletal remains, while I will be responsible for the topographic description and the monograph on the artifacts.

At this stage, when I am preparing to leave on a journey into NW China, Shensi and Kansu, in order, amongst other investigations, to follow up this line of research in the remote interior, it has been considered advisable to lay before the public a brief statement of our results as they stand at this moment. §

A guiding idea in this research has been the study of the past in the light

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§. This paper was originally read on January 24th 1922 before the Wen Yü Hui (文友會), an association of Chinese and foreign scholars in Peking.
Later on, a part of it was read before the general meeting of the Anatomical and Anthropological Association of China in Peking the 27 of March the same year.

of the present. The Chinese people has, with remarkable conservatism, preserved features which lead backwards to a remote ancestry, not only to the early Chinese, but, as seems to be the case with the semilunar-rectangular knives, much further, to the undifferentiated Mongolian stock.

I then deem it preferable to begin with the description of some few well established evolutionary series of implements, the semilunar-rectangular knives, the celts and the Chinese *hache poignard* (戈). Then I shall proceed to review the ancient sites and to discuss their ethnological and chronological relationship.

As the paper was originally prepared as a lecture, it has not been burdened with too many details as to localities etc. To make up for this deficiency a descriptive index of the plates is added at the end.

Through his investigations among the early sites of Manchuria and Eastern Mongolia§ the Japanese archæologist Torii has made us familiar with a peculiar kind of stone implement, which can properly be named a *semilunar*, or, in other instances, a *rectangular knife*. They are mostly made of greenstone, slate or sandstone, with a straight cutting edge and a thickened, rounded, straight or curved backside which served as handle (Pl. I). Torii also called attention to the fact that similar stone-knives, mostly semilunar in shape, are found in the ancient sites of the Asiatic Chukchee, as well as of the American Eskimo. Knives of the same type, but now made of iron, are still in use among these two Arctic peoples.

So far as I have been able to find, these knives have few parallels among European types of implements. There are semilunar saws of flint, but the semilunar, and the nearly related rectangular knife seem to be a characteristic feature of Mongolian Asiatic peoples and their descendants on the American continent.

It has been mentioned above that the semilunar knife is found on both sides of Bering strait, not only in the ancient sites, when they are made of

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§. *R. Torii and K. Torii.* Populations primitives de la Mongolie Orientale. Journal of the College of Science. Tokyo Imperial University. Vol. XXXVI, Art. 4. 1914.
R. Torii. Populations préhistoriques de la Manchourie Méridionale Ibid. XXXVI, Art. 8. 1915.

stone, but also, made of iron, and still used as an implement of the Arctic tribes.

To my pleasant surprise I found in the beginning of 1920 that the type has survived to the present time also in China. In the *kaoliang* area of Northern China an iron blade is used, semilunar, rectangular, or trapezoidal in shape and pierced by two holes (Pl. II), just as is the case with the Manchurian semilunar stone knife. The back-side of this iron knife has a coating of cloth or leather and a strap for the thumb (Pl. II, fig. 1-3), and it is used to cut the spikes of the kaoliang. The discovery of this remarkable tool, an undoubted descendant of the semilunar stone knife, started me on a survey of different kinds of Chinese knives, and I soon found that probably a considerable number of types may be derived from the semilunar stone knife. A large collection, bearing on this problem, is in my hands, and I hope to be able to discuss it at some length on a later occasion. But for the present I shall feel content to mention only a single derivate of the rectangular knife, an instrument certainly well known to every visitor of Peking, but perhaps not fully understood as to its genetic significance.

A prominent and picturespue feature of the Peking street life is formed by the several kinds of pedlars, many of which try to attract the attention of their customers by different kinds of musical instruments. The cloth-seller sounds a miniature drum, with wooden handle and two balls fixed to short strings; the lemonade seller beats two brass bowls; the barber plays a big tuning fork etc. The knife-sharpener who traverses the streets with his whetstone, uses one of two instruments, either a trumpet or a peculiar contrivance consisting of four rectangular elongated iron plates perforated by two holes through which runs a string holding the iron plates loosely attached to a wooden handle (Pl. III, fig. 5). When this instrument is put into action by a rytmic movement it produces a characteristic metallic sound.

In order to explain the origin of this instrument. let us for a moment return to the rectangular kaoliang cutter and note that amongst the several types there is one which is just as high as broad (Pl. II, fig. 2). It may be added that the harness-maker uses a knife without holes, very similar in shape to the high kaoliang cutter, but still higher. When these two knives are taken into consideration, it is not difficult to offer a genetic explanation of the knife-shar-

peuer's instrument as being originally four high trapezoidal knives, each perforated by two holes which were tied together with a string to form a sounding instrument. The idea first occurred to me, when on a certain occasion I met in the street a knife-sharpener playing his instrument. I jumped out of the ricksha to examine more closely the instrument and found to my immense delight that each of the four plates were sharpened to an edge along the lower margin. They were real knives in spite of the fact they were never intended to be used as such. The man who carries the instrument does not know why he has given an edge to each blade. His only explanation is that it is an old habit to do so, and this custom is one of the many instances of the persistent survival of features which have lost their original meaning and purpose. Once in the past, a clever knife-sharpener got the luminous idea of tying four knife blades together to form a sounding instrument, a fitting anouncement to the customers, that the man who sharpens the knives has come.

A biologist would express the relation of the kaoliang cutter to the knife sharpener's musical instrument by calling the former a solitary type, while the latter is a colony of four, which has taken up a new function but has retained the cutting edge as a persistent rudimentary character.

The discovery, that the knife sharpener's annunciatory instrument is probably a modern descendant of the Neolithic rectangular knife, started me upon a survey of various types of modern Chinese tools, and I soon found in many of them primitive features which can be carried back to a distant ancestry.

Especially satisfying in this respect are the carpenter's tools (Pl. III), such as, for instance, *the drill* (Pl. III, fig. 4) which is a distinct species of the *bow-drill*, so widely distributed among several primitive modern peoples and which is by Sollas tentatively traced back as far as the late Palæolithic Magdalenian culture. §

Another extremely remarkable tool used by the carpenter in Chihli and Honan and probably also in many other parts of China is the Pen (錛), an adze (Pl. III, Fig. 1-2) generally of considerable size but also occurring in smaller types (Pl. III, Fig 3).

The iron part of the Pen is, in the terms of the archæologist a socketed celt, a wedge with a socket to receive the wooden handle. This tool was very

§ Sollas. Ancient Hunters. P. 464.

appropriate in times when metals were rare and precious, and consequently it was in common use all over Eurasia in the Bronze Age where it is represented by numerous, often very gracefully shaped varieties.

In modern times the socketed celt is largely replaced by the true axe or adze, the chief characteristic of which is that the whole axe-head is metal with a hole for the handle, whereas in the socketed celt the larger part of the head is of wood and only the cutting edge is metal.

Socketed celts made of iron are still in use among certain peoples at the present time. For instance they are used in Siberia and in certain parts of Africa, according to Lord Avebury. (Prehistoric Times, page 29, where a figure is given of a Kalmuck celt). A. R. Colquhoun figures two types of socketed celts used by the Shan tribe in SW China §.

The occurrence of the Pen (鎒), a typical socketed celt, in Northern China is a remarkable feature, and its significance becomes more evident when we note that socketed celts made of bronze are frequently met with among the metal arms and tools which have been preserved from early historic times. I know a considerable number of widely different types of Chinese socketed bronze celts and hope to be able sometime to give them a fuller illustration, but for the present purpose it may suffice to call the attention to a bronze celt which is much more slender and graceful in shape than the modern iron Pen, but is otherwise so closely suggestive of this modern tool that there can hardly be any doubt about the genetic relation between the two (Pl. IV, fig. 2).

The famous explorer of the chronology of the Bronze Age, Oscar Montelius, whose death science has recently had to deplore, has, in his fundamental work on the typological method, given an admirable exposé of the intricate but unbroken European series of transitions from the simple stone celt of Neolithic times to the graceful and richly decorated metal celt of the Bronze Age.

No such series is so far known from China, but I may be justified in calling attention to a type of stone celt which, to judge from its shape, might possibly be a prototype of the socketed celt of bronze and iron.

First, let us note a difference between the socketed celts of the Western World and the majority of those of the Far East. The majority of socketed celts of the Bronze Age of Europe were evidently *axes*, that is, the edge was

§. Colquhoun. Amongst the Shans. 1885. Page 298.

lengthwise with reference to the handle. The Chinese Pen is an *adze:* its edge is transverse with reference to the handle. So is also the case with the bronze celt Pl. IV, fig. 2, as can easily be seen from its assymetrical side profile and the trapezoidal cross-section. It can also be added that the majority of other types of Chinese bronze celts are adzes, so with reference to the socketed celts there seems to have been a liking for *axes* in the West and an equally pronounced taste for *adzes* in the Far East.

Together with numerous stone axes of various shapes there occurs in China very commonly an assymetric stone chisel (Pl. IV, fig. I) which probably was hafted as indicated by Fig. I and which so far as its use is concerned,

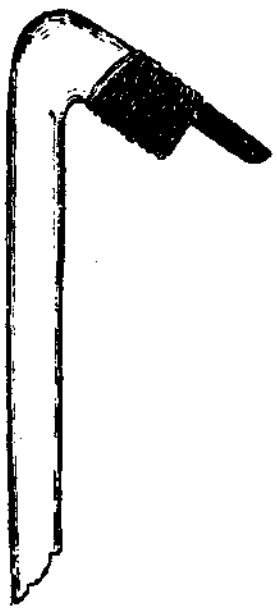


Fig. I. Probable mode of hafting of the stone adze shown in Pl. IV. fig. I.

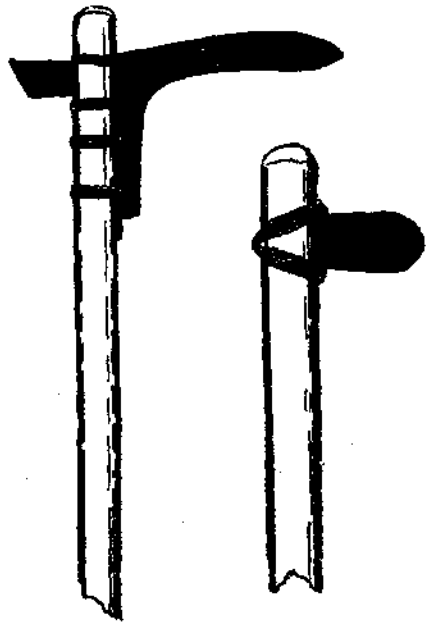
was a true stone-adze. The common liking for *adzes* which we have found expressed in the assymetric stone chisels, as well as in the bronze and iron Pen, leads us to suggest that the assymetrical stone chisel is possibly the prototype of the later socketed adzes. This is for the moment to be accepted only as a working hypothesis at the very best and must be proved or refuted by future research.

Let us now turn to a type of arms which is, as far as known to me, no longer in use, but which was evidently a favourite weapon in the Chinese

Bronze age. Let us first consider it so to say from a Chinese point of view and then discuss its origin and possible relationship to similar arms in the western world.

It is called *Ko*[1] (戈) in Chinese, and ordinary dictionaries define it as being a kind of spear. The fundamental question for the interpretation of the *Ko*[1] is the question how it was hafted. A Norwegian archæologist, H. Shetelig, has compared the *Ko*[1] with the Hache poignard of the early Bronze Age of Europe §, and it is evident that the shape of the typical *Ko*[1] as we see it figured for instance in the Chin Shih So (金石索) speaks very strongly in favour of this interpretation. But a puzzling fact is, that there occurs in another volume of the Chin Shih So a figure of a sculpture from the Han Dynasty showing a man carrying a weapon which is called *Ko*[1] in the description, and which looks entirely like it, but which is hafted like a spear or halberd.

I have asked my friend Mr. P. L. Yuan to help me to clear up this question, and after an investigation into the matter he has arrived at the conclusion that there were probably two different types of weapons, one a halberd as figured in Chin Shih So, Vol. 3, figure of Cho (夏紂像) on the table of Wu Liang Szu (武梁詩) of Han Dynasty, the other the Ko[1] here discusssed,



2 b 2 a

Fig. 2. Probable hafting of the stone and bronze Ko[1].
2a. Stone Ko[1], *same specimen as Pl. V. fig. 1.*
2b. Bronze Ko[1], *same specimen as Pl. V. fig. 6.*

§. *H. Shetelig.* Vaaben og redskaber fra Kinas bronsealder.
Vestlandske Kunstindustrimuseums Aarbog. Bergen 1913-1917, P. 10-13

technically a real hache-poignard, hafted as indicated by figure 2b which is a reconstruction of the specimen figured in Pl. V. fig. 6,

That these bronze weapons, some specimens of which are figured in Pl. V. fig. 2-6, and which are frequently found in tombs of the early dynasties, were really hafted as shown by fig. 2b is strongly supported by the fact that the archaic type of the character Ko[1] which is often found upon bronze vessels of those early dynasties and which is shown in the upper row of fig. 3 unmistakably pictures an "hache-poignard". In fact it is interesting to note the striking

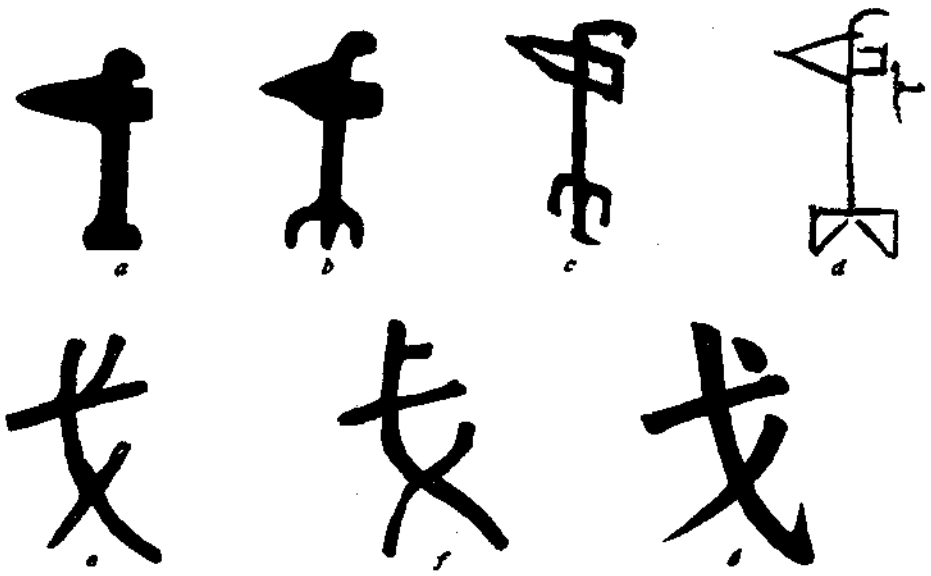


Fig. 3. *Development of the character Ko*[1]. (戈)

(a) from Ch'i Ku Shih Chi Chin Wên Shu (奇觚室吉金文述). Chapt. 10. Sheet 24.
Inscription on a spear head (大矛).

(b) from Mêng Wei Ts'ao T'ang Chi Chin T'u (夢郼草堂吉金圖). Vol. I. Sheet 19.
Inscription on a vessel named Yih (彝).

(c) from Tao Chai Chi Chin Hsü Lu (陶齋吉金續錄). Vol. II. Sheet 20.
Inscription on a halberd (Li Ko Mao, 立戈矛).

(d) from Meng Wei Ts'ao T'ang Chi Chin Lu. Vol. I. Sheet 37.
Inscription on vessel Lu (卣).

(e) from Shuo Wên Ku Chou Pu (說文古籀補). Chapt. 12.
Inscription on a Ting (鼎).

(f) from Shuo Wên Ku Chou Pu. Chapt. 12.
Inscription on a Ko (戈).

(g) modern type of the character.

similarity between those early pictograms of the Chinese Ko[1] and figures of the hache-poignard of the early Bronze Age of Italy as they are shown by contemporaneous rock wall engravings in Liguria. It is apparent that these similarities between Chinese and Italian pictograms of the Bronze Age are to be regarded largely as parallelism in the primitive pictorial art of those days and by no means as a proof of common origin of the Chinese and the Western hache-poignard. There are certain features of the Ligurian rock engravings which radically differ from the archaic Chinese character Ko[1], and for reasons given below I am inclined to think that the Chinese Ko[1] might be an autochtonous type.

Schetelig, in the paper cited, is of the opinion that the Chinese and the Western haches poignards are probably of common origin. Unfortunately I have not access to the descriptions of the Mycenean and Babylonian haches poignards referred to by Schetelig, but I am familiar with the hache poignard of Italy and northern Europe, not only from the Ligurian rock engravings referred to but from illustrations of several specimens which evidently belong to a type of weapon widely different from the Chinese Ko[1].

The fortunate discovery in Northern Chihli, of an undoubted Ko[1] made in stone, and representing a type much more primitive than any of the known bronze Ko[1] of the early dynasties has suggested to me the possibility that the Chinese Ko[1] which is so very different from the haches poignards of the Western World might be an autochtonous Chinese type.

This unique and very remarkable specimen is figured in Pl. V, fig. 1, and the following figures 2-6 of the same plate illustrate a number of metal Ko[1] which seem to fit in with the stone specimen in a beautiful typological series, running from the archaic stone prototype to the metal Ko[1] of slender elegantly finished shape. For the details regarding this series of Ko[1], I must refer the reader to the description of the plate at the end of this paper.

We have now surveyed a number of Chinese metal tools: the kaohang knife, the Pen and the Ko[1], partly modern, partly dating from the Bronze Age or the early Iron Age. In this survey they have all been carried back more or less definitely to prototypes of stone which have been found buried in the soil of Northern China. They link the present time in such a distinct way with a very remote past that we are certainly justified in asking: Who were the

people which shapened and used these stone implements, and what is their relation to the Chinese of early dynasties and through them to the modern Chinese ?

It has been the idea of Chinese scholars, that the Chinese people knew the use of metals as early as Chinese culture can be traced back in time, and that every discovery of stone implements in China has to be interpreted as originating from the aboriginal peoples who lived in this part of Asia prior to the arrival of the Chinese, or from Barbarian tribes who may have lived in a Neolithic culture stage on the outskirts of the Chinese empire even in comparatively late historical times. This view has been recently advocated by my highly esteemed colleague Mr. H. C. Chang in his important work *Lapidarium Sinicum* which has just appeared as a memoir of the Geological Survey.

In 1912 appeared Laufer's admirable treatise on Chinese Jade, in the first chapter of which he gives an exhaustive discussion of all that was known at that time about stone implements in China.

Very few stone implements were at his disposal for examination, and he summarized his opinion of the question as follows:

"These implements are found scattered in certain parts of the country and are generally scarce".

"No deposits of stone implements, so-called work-shops, have as yet been found anywhere in China which would allow the conclusion that man, without the aid of any metal, depended solely on stone utensils at any time, or that a stone industry for the benefit of a large local population was carried on to any extent. It is therefore, in the present state of our knowledge, not justifiable to speak of a stone age of China, and still less, as we shall see from a consideration of native records, of a stone age of the Chinese". §

This conclusion must now be modified as we know of large work-shops, in which extensive excavation has not revealed a single metal object, while hundreds of tools of stone, bone, deer antlers, pig tusks and mussel shells have been found. There exists no longer any doubt, that a stone industry for the benefit of a large local population has been carried on to a very considerable extent in Honan, in the Yellow river valley, the region which is marked by the historical records as the craddle of the Chinese race. Still it is by no

§. Loc. cit. P. 54—55.

means clear whether those culture strata were formed by a proto-Chinese or a pre-Chinese people or eventually by a Barbarian tribe, living in Honan in early historical time. The question *Early Chinese or Barbarian ?*, as in my opinion the Chinese scholars will prefer to formulate the problem, will require much more research before it is definitely solved. And it is to be hoped that Laufer will give the new facts a careful consideration, and that this most scientific of students of Chinese antiquities will bring to bear his immense learning on the discussion which must follow before this fascinating problem is fully elucidated.

In 1914 and 1915 there appeared the two works by the Japanese archaeologist Torii already quoted in which he greatly increased our knowledge of the stone implements which occur in Eastern Mongolia and S. Manchuria. He considers his finds at dating in part from early Chinese dynasties, even as late as Han, and interprets them as derived from the ancestors of the modern Mongols. It is possible that Torii is right in these conclusions, but his monographs are so lacking in stratigraphic and topographic details, that it is difficult to form an opinion about the evidence furnished by him regarding the occurrence of Han coins and other bronze objects in association with stone implements. Such association has never been noticed in our own excavations.

I will now give a brief account of the researches which I have undertaken during the last three years in sites of Neolithic type in Northern China and in Honan.

The first stone implements in our possession were collected in 1919 by Mr. T. O. Chu, a geologist of the Geological Survey in Fengtien and Jehol, partly from the sites described by Torii. Numerous finds of the same kind were made by my private collectors in Northern Chihli, and in 1920 one of them, Liu-Chang-Shan (劉長山), brought home a most remarkable set of several hundred, in part very beautiful, stone implements, all collected in a single locality in Honan. In the course of 1921 I found the much longed for opportunity to undertake regular excavations in two of these sites,

and in the following pages I will give a brief and preliminary account of the results of this work which will be more fully treated in later monographs§.

In the early summer of last year (1921) I travelled in SW Manchuria for the purpose of surveying some coal fields. Attention was at the same time paid to features of general geological or archæological interest, and, thanks to the efforts of Mr. James Wong, a young member of the Andrews' expedition§§ and my private assistant Pai (白 萬 玉) we were able to locate a cave which yielded material of considerable archæological interest. As the cave deposit abounded in human skeletal remains I wired to my friend Dr. Davidson Black asking him to come at the earliest possible date to participate in the field work. I take this occasion to thank Dr. Black not only for the readiness with which he responded to my call and for his charming and fruitful collaboration in the field but also for the important part he will take in the whole enterprise by preparing the monographic description of the human skeletal remains§§§.

The cave in question is situated in SW Fengtien province, in Chin-Hsi-Hsien (錦 西 縣). The exact location is 3 li S of Sha-Kuo-T'un (沙 鍋 屯) railway station, the terminus of a branch-line connecting the Ta-Yao-Kou (大 窯 溝) coal mine with Nu-Erh-Ho (女 兒 河) station of the Peking-Mukden line.

The place is 50 km. distant from the sea coast, which is worth noticing, as 2 or 3 species of marine mollusk shells, evidently carried to the place by man, have been found in the cave deposit.

The cave is located in the chert-banded Precambrian (Sinian) limestone which in this place dips N 33° W 35°. There is no special disturbance or fracture zone visible to account for the formation of the small cave which is probably a product of the dissolving action of water along small fissures in the limestone.

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§. The description of the Sha Kuo T'un cave deposit is now in press, and the monograph on the Yang Shao site is in preparation. Others are planned to follow, all to appear in the Palæontologia Sinica, Ser. D.

§§. Mr. Wong is a member of the great American Expedition under the leadership of Dr. Roy Chapman Andrews. He was upon Dr. Andrews' request attached to my Fengtien expedition in order that he might become familiar with our method of carrying on reconnaissance work. I am much indebted both to Dr. Andrews and to Mr. Wong for the valuable work done by the latter in the early part of the cave exploration.

§§§. Also to appear in the Palæontologia Sinica, Ser. D.

The cave is 5.5 meters long by 2.5 meters broad with a height near the mouth of 2 meters counted from the roof to the rock floor as this was exposed when the filling of sediment was removed.

The cave was largely filled with loam, gray in the lower and black in the upper part. This loam was rich in fragments of charcoal and other debris left by the early inhabitants of the cave. The thickness of the cave filling was 1.2 meters, and through the whole deposit could be followed a rather well-defined bed, about 15 centimeters in thickness and situated 60 centimeters below the surface of the deposit. This layer was named by myself and Dr. Black the "big bone-bed", because of the immense number of human bones which had accumulated in it. In this layer was also found the vast majority of artifacts.

Nearly the whole of the cave-filling was dug through by Dr. Black, and myself, and our finds can be summed up as follows:

At the surface of the cave deposit, or at any rate in the uppermost few centimeters, we found two coins one of the Sung, the other of the Chin Dynasty. They may have been brought there in comparatively recent times and have evidently nothing to do with the rest of the artifacts. However, I want to lay special stress upon the discovery of these coins, as they would have caused an awkard confusion, had not the stratigraphic position of the finds been properly recorded.

All the other objects in this deposit are of Neolithic type. Four small polished stone axes, some scrapers and arrow heads and a borer made of chipped, flint-like chalcedony, first deserve mentioning. Numerous buttons and beads of stone as well as a small sculptural object, 32 millimeters in length and figuring some animal, probably a cat. This most remarkable little object was found by Dr. Black amongst the human bones.

There still remains another interesting group of stone objects, namely a number of flate polished broad stone rings of various sizes and kinds of rock but all closely resembling in shape the jade rings of the type Yuan (瑗) of Chinese antiquarians (see Laufer: Jade, page 154 and following). These finds are of special interest as they presented some of the first instances of similarity between these early sites and later Chinese cultures, similarities which have become increasingly manifested in the course of our work.

These stone rings of the type Yuan are relatively few in number but there

also occur rings of another material, namely those which are cut out of mussel shells, in all probability shells of large freshwater mussels. These mussel shell rings, represented mostly by fragments, occur in very large number and they form, in many respects one of the puzzles of this cave deposit. They are of very varied size from 100 to only 11 millimeters in diameter, but they are all very thin. Not one is more than millimeters broad and the largest fragment, which must represent a ring a little more than 100 millimeters in diameter, is only 5 millimeters broad. It is difficult to understand how so exceedingly delicate objects could serve a purpose, and still more surprising is the fact that these ancient people were able to cut these thin rings from the mussel-shells with such perfect workmanship.

There are several beautifully worked bone implements, a spoonlike elongate tool, a chisel, three small awls and a sewing needle which was discovered in a container made of a hollow bone. The biggest of the bone implements it a large awl which is absolutely similar to the awls which have been found in the early Neolithic kitchen-middens of Denmark and which have been identified as made from the leg-bones of a deer.

The pottery found in this deposit is very fragmentary but offers several points of much interest. In one case my collaborator Miss Rosenius has, by patient work, been able to reconstruct the shape of a vessel with beautiful and singular ornament, unique so far amongst our finds. There are also other fragments with very characteristically incised ornaments, which are not known from the Honan sites, but in many respects the Fengtien pottery offers striking similarities to our large and much better preserved collections of pottery from the Honan deposits which will be described in the succeeding pages.

There are three features which I will mention specially as indicating a direct relationship of this deposit to the Honan culture:

1: There was found in the Sha-Kou-T'un cave a nearly complete bowl (restored by Miss Rosenius from a very large number of small fragments) of fine, nearly black ware, neatly polished, which much resembles vessels of the same kind of earthenware found at Yang-Shao-Tsun in Honan.

2: There are in our collection from Fengtien two fragments of tripod-legs which in spite of their fragmentary nature can be identified as forming a small part of a Ko[4], a most characteristic type of tripod, abundant in the Honan

sites and also recorded in ancient Chinese documents as in use in the Chou Dynasty.

3: In the bottom layer of the Fengtien cave were also found some few fragments of a most characteristic fine smooth pottery with painting in black upon red. Such black and red polished pottery is, as we shall see, one of the most fascinating features of the Yang Shao site in Honan.

There are also in the other groups of artifacts similarities between the Fengtien and the Honan deposits. The majority of the stone axes found in Honan belong to other types but among them are some few which are quite similar to the small axes found in the Fengtien cave.

In the beginning of our work in Honan I considered the absence of the thin mussel shell rings, so characteristic of the Fengtien beds as a distinctive difference between the two deposits, but one day Dr. Zdansky found a mussel ring entirely of the Fengtien type in the culture stratum of Yang-Shao-Tsun in Honan, while another specimen was found subsequently.

As a summary of my present opinion, I am inclined to consider the Fengtien cave deposit as approximately contemporaneous with the Honan site. There are very radical differences in the composition of the furniture of the two sites, but these may be due more to the widely different geographical situation of the two areas than to any considerable difference in age.

There is still one important feature to be mentioned in connection with the Fengtien cave, namely the large accumulation of human bones. Some animal bones were also found in the cave deposit, but these were entirely subordinate in number when compared with the startling abundance of human skeletal remains which form by far the larger part of the volume of collections brought home by us. These human bones were found abundantly everywhere in the "big bone bed", and parts of it was practically an accumulation of them. Dr. Black reports that he has identified more than 40 individuals of different sexes and ages, from small babies to very aged persons. The bones occur scattered very irregularly through the bone bed and it was exceedingly rare to find two bones still attached to each other in normal articulation.

Not only this, but the skeletal elements, such as legbones and skulls, were found to be in a very broken state, the skulls in fact being mostly reduced to pitiful fragments.

At first, I thought that here was evidence of cannibalism in the broken and scattered condition of these bones, but Dr. Black tells me that there is hardly any convincing proof of this. Later I have considered the possiblity of the cave being a place where some religious ceremonies including the sacrifice of man had taken place. Possibly the immense abundance of the mussel shell rings could be explained as connected with some such ritual performance.

I have already mentioned that the first impulse to our archæological work in Honan was a rich find made by my collector Liu and consisting of several hundred stone implements, mostly axes and chisels, bought from the inhabitants of a single village. Apparently a site of Neolithic type was to be found near that village, and I was looking for an opportunity to undertake a preliminary examination of the local conditions. In April of 1921 I visited the place and my first experience there may be worth telling.

The locality in question, a village named Yang Shao Tsun, is situated 15 li N. from Mien Chih Hsien, a station of the Lung-Hai railway. Mien Chih city is located in a small valley running E-W, from the border of which the ground rises gently and uniformly northwards for a distance of 20 li to the foot of a range of hills consisting of Cambrian and Pre-Cambrian rocks which are uniformly tilted southeastwards. The sloping plateau upon which Yang Shao Tsun is situated consists of Tertiary red clays and loess into which are cut numerous narrow gullies, 30-50 meters in depth.

On the 21 of April 1921 I came from Mien Chih city walking up the road which leads northwards to Yang-Shao-Tsun. About two li south of this village I had to cross a very big ravine, a veritable miniature canyon which afterwards became a familiar feature in our topographic research. When I had reached the northern side of the ravine, I saw in the wall of a small gullie cut by the road, the following interesting section. At the bottom lies the red Tertiary clay, and overlying it with a sharp angular contact is a kind of ashy soil rich in pottery. It struck me that this might be the culture stratum from which the stone implements were derived. After some few minutes search I found at the very bottom of the culture stratum a small piece of fine red pottery with black painting upon a beautifully polished surface. At

that time I knew nothing about the fine red and black pottery found by the Pumpelly expedition in Anau, and still less about similar polychrome ware which was found in the late Neolithic and Eneolithic sites of Europe, so I considered it impossible that such fine ware could occur together with stone implements. Rather depressed I turned for the next two days to geological work in the surrounding of Yang Shao Tsun, but the third day I returned to the culture deposit and started a careful search of all the extensive exposures found in the road ravines. After a few hours I pulled out from the intact ashy earth a beautiful specimen of the stone adze, which has been described above and which is such a characteristic feature in the furniture of this site. Other interesting finds followed, and it soon became clear that we have in this locality a deposit of unusual extent and very rich, specially in pottery debris of many different types, including the fine polished polychrome ware mentioned above.

In the autumn of the same year I obtained the authorization of the Government to undertake excavations in Yang-Shao-Tsun, and the most effective support was extented to this enterprise not only by my colleagues in the Geological Survey and by H. E. the Minister of Agriculture and Commerce, but also by the Provincial Government in Kaifeng and by Mr. Yeh, the Magistrate of Mien Chih Hsien. The excavation period lasted from the 27 of October to the 1 of December, and I was aided in the work by my five private Chinese assistants who are well trained in excavation work.

Dr. Black visited us during three days in the midst of November and his presence contributed very effectively to the success of our search for human skeletons. Unfortunately he was forced to return to Peking when a veritable graveyard had just come to light, and Dr. Zdansky, my very able palaeontological collaborator, who had already volunteered as leader of an excavating party, took in hand the continued excavation of the graveyard which had been uncovered by him and Dr. Black. The work was carried out by him with the greatest skill and a most careful determination of the exact position of every find.

The Yang Shao site extends from the southern end of the village for a distance of 960 meters southwards to the junction of the two big ravines Hsi Kou and Tung Kou, which form a frame around the site. In E-W direction the extent of the site is 480 meters. In the northern part of this field there are extensive barren areas, but in the southern half or more, nearly every

square meter is occupied by a culture deposit with a thickness of 1-5 meters (average about three meters).

The whole culture area and its immediate surroundings, comprising the big ravines, were most carefully surveyed by Mr. P. L. Yuan on the scale 1:4.000 with five meter contour lines. Mr. Yuan also was in charge of the business transactions of the exploration party and of the negotiations with the local authorities and the villagers. All these duties were performed with persistence, skill and tact, which saved us from several threatening frictions. Here in Peking Mr. Yuan has been untiring in searching Chinese antiquarian works for information bearing upon our problems. It gives me special pleasure to express to Mr. Yuan my thanks for all the help he has so readily accorded.

In order to give a better idea of the imposing dimensions of the Yang Shao site, it may be proper to present a few comparative figures. The kitchen-middens of Denmark are famous not only for their remarkable early Neolithic furniture but also for the unusual volume of the accumulations. They are (according to Hoernes) 100-300 meters in length and 50-150 meters broad with a thickness of the 1-3 meters.

The kurgans of Russian Turkestan which have been so admirably surveyed by Pumpelly's expedition, are hills of human debris of rounded or elliptical plan. The length of the northern Anau kurgan is 100 meters. The height of the refuse-heaps is 10-15 meters, but this great thickness becomes less startling when we learn that it represents a sequence of successive cultures ranging from Neolithic (?) to the Iron Age.

The Yang Shao site represents a single culture epoch of relatively brief duration to judge from the fact that the same furniture is found everywhere within the deposit. When we recall from the above statements that the site has a length of more than 600 meters and a width of 480 m. with an average thickness of three meters of culture soil full of pottery and other human refuse, it becomes evident that this place formed a village of considerable size at the time of the ancient habitation.

Apart from small occasional test pits, our excavations were confined to 17 places carefully marked in Mr. Yuan's map. I have not yet had time to make exact volumetric estimates, but a rough calculation shows that the volume excavated by our party amounts to only a thousandth of the whole site.

I have already said that the big eastern and western ravines form a frame round the deposit, and for a long time I held the idea that the ravines have

formed a natural bulwark which, with its nearly inaccessible cliffs, must have added much to the safety of the ancient village.

But already at my first visit in April, I had made an observation which seemed to point to another, much more startling conclusion. During an excursion with Dr. Black and Dr. Zdansky it became evident that this new idea was well founded and later I worked it out in much detail, to the effect that now there is no doubt that the ravines, 40 meters deep, did not exist at the time when the Yang Shao site was being formed.

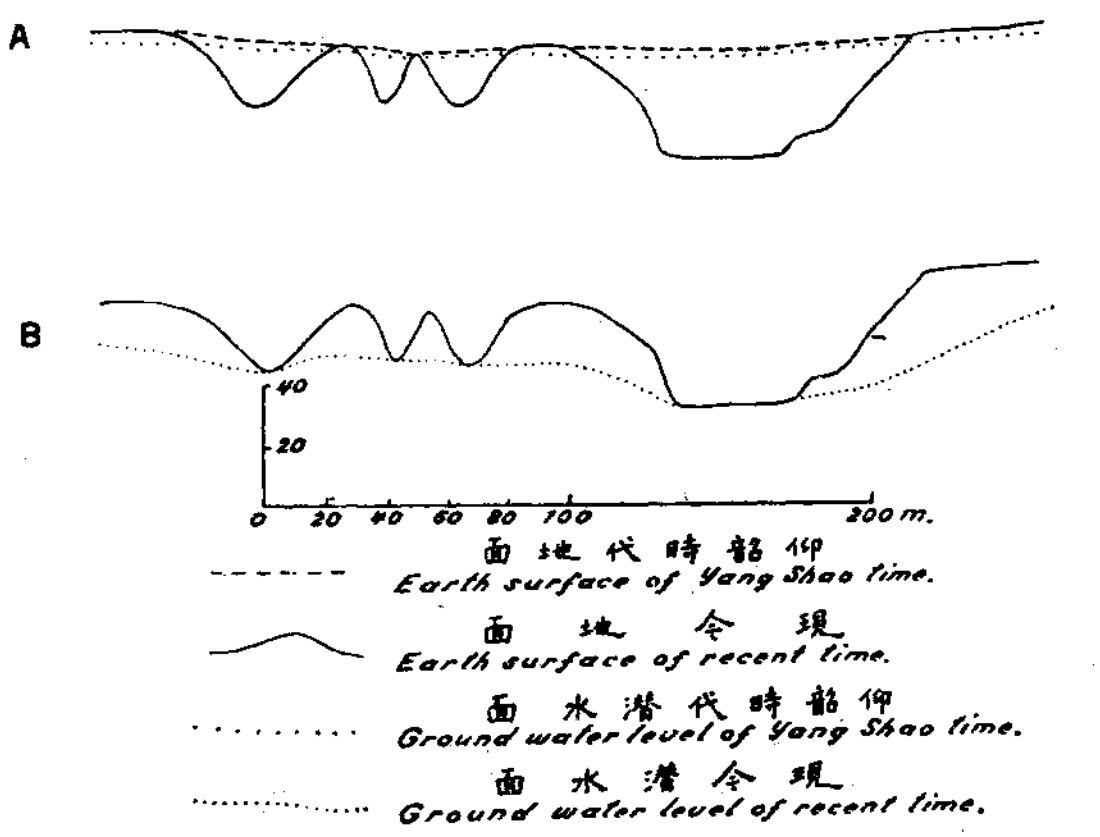

Fig. 4. Section through the southern part of the Yang Shao site to show the post-Yang Shao vertical erosion.

A. The Yang Shao time.

B. Recent time.

第四圖 仰韶古代遺址南端之剖面
表明冲刷作用及潛水面之降落之關係

In many places all along the ravines the culture deposit forms isolated pillars which are difficult of access and which are evidently only isolated remnants of an earlier more continuous deposit.

In the southernmost part of the site there is such a pillar-like remnant left by erosion, which consists, not of the primary ashy earth, but of sand and interstratified gravel rich in pottery and other artifacts which show that at the time the site was formed, a river flowed at the level of the plateau, 40 meters above the present stream at the bottom of the ravine (fig. 4).

This observation, that the ancient site was formed upon a land surface entirely different from the present one, is certainly not of local nature, but can probably be applied to large parts of Northern China. If so, it will have far reaching consequences for the understanding of the topographic background to Chinese history.

There is another feature in the Yang Shao deposit which I want to mention before turning to the description of the artifacts. In fig. 5 is shown one of several existing road sections which immensely facilitate the study of the internal structure of the culture stratum. The lower part is red clay and the upper is the ashy culture earth. The contact between the two sediments is exceedingly distinct and it exhibits a very remarkable feature, namely a number of pockets, which are 1.9-2.8 meters in diameter, circular in plan and 0.5-1.9 meters deep.

These pockets cannot be graves, as no human skeletal remains were ever found in them. They are filled with the usual ashy earth, characteristic of the whole site, but the pottery and artifacts found in the pockets are mostly in a very broken state.

Another reasonable suggestion is that the pockets represent the foundations of the huts in which the ancient people lived. Such circular hut foundations have been noticed in Europe in sites of approximately the same age.

But in our case there are very serious objections to this explanation. The ancient Yang Shao dwellers evidently had a very rich, varied and bulky furniture, indicated by the many and partly large-sized types of pottery. It seems difficult to think that a people with so rich a furniture could have used such narrow huts.

The most probable parallels which I can find in the Western World to these pockets of Yang Shao Tsun are the "Kellergruben" (cellar-pits) described by Forrer from the Neolithic sites of Achenheim and Stützheim in Elsass.

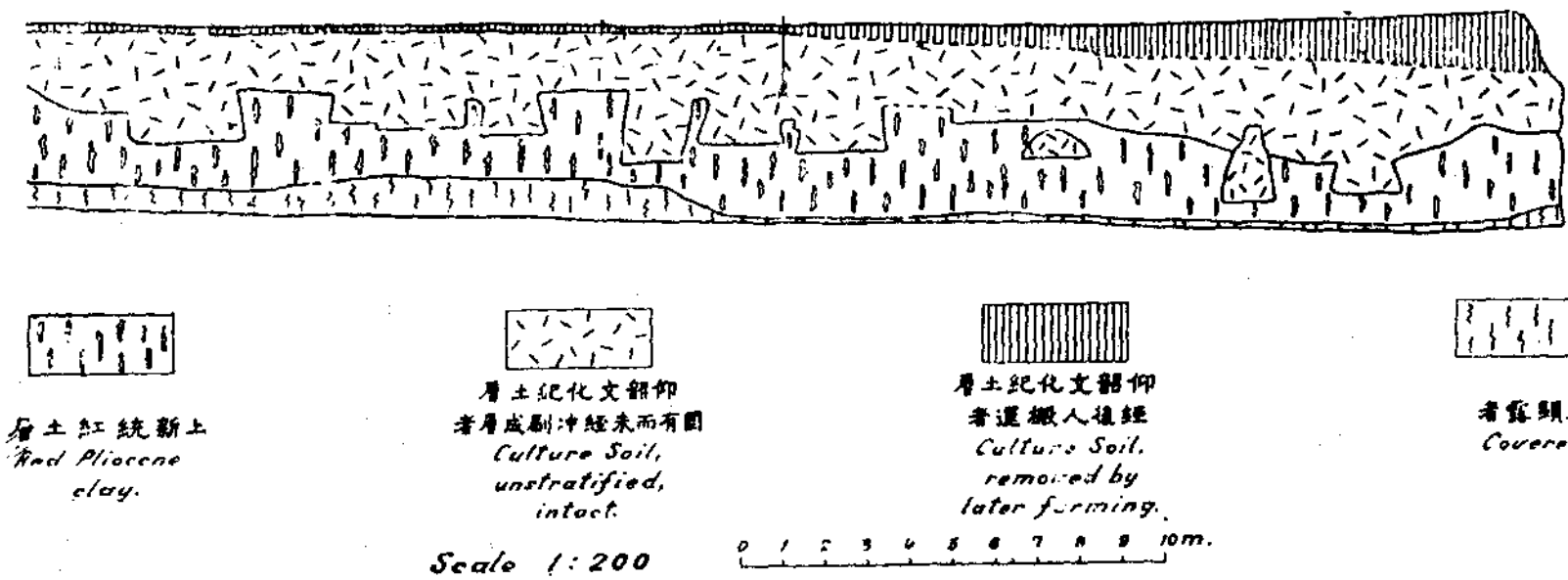

Fig. 5. Road-section through part of the Yang Shao site (to show the "pockets")

第五圖 仰韶古代遺址道旁露出土層(表明袋形窟穴)

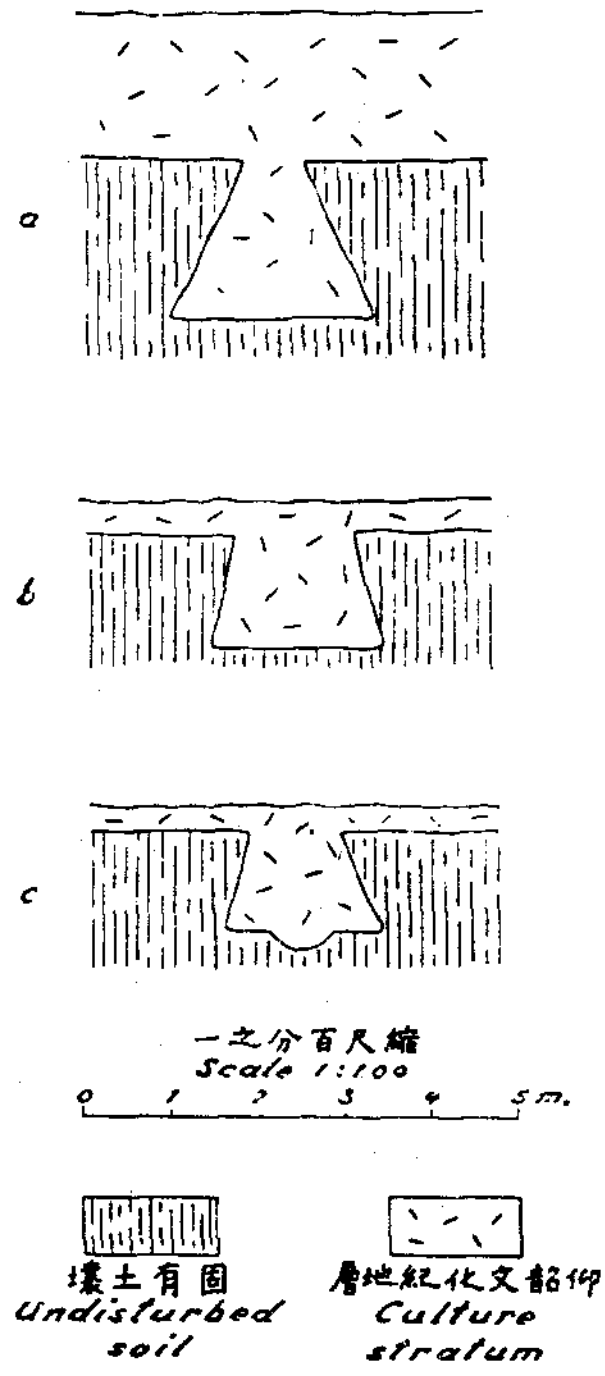

Fig. 6.

(a) *Pocket of the Yang Shao site, Honan.* **河南仰韶古代遺址之袋狀土穴**

(b), (c) *Pockets (Kellergruben) B & P of the Achenheim site, Elsass, (after Forrer).* **愛爾塞司之阿施亥姆之袋狀土穴**

(Forrer: Reallexikon, articles Achenheim, Kellergruben, Stützheim, Wohngruben). I give in fig. 6 representations of "Kellergruben" B and P at Achenheim and one of the Yang Shao Tsun pockets. The figures are all drawn upon approximately the same scale and the likeness is striking also with reference to the conical section of these pits.

The "Kellergruben" are interpreted as a kind of cellars or underground store rooms. It seems from Forrer's descriptions as there may be transitions between "Kellergruben" and "Wohngruben", storage pits and pits where the people lived.

At present we have to leave the "pockets" as one of the unsolved riddles of this site. During this first excavation we were forced to concentrate upon the topographic and stratigraphic problems, but I hope at a later occasion to be able to go into the problem of the "pockets" by means of special detailed excavations in some selected areas of the site.

It now remains for us to review the furniture of implements and pottery found in this site.

A large number of stone axes have been collected, representing several types and very varied sizes. They are all unperforated, having evidently been hafted in a hole in a wooden or bone handle (Pl. VI, fig. 14-17). There are also numerous assymetric adzes and chisels of the type described above in connection with the modern iron Pen (Pl. IV, fig. 1). The larger of these assymetric stone chisels have probably been hafted as adzes. The very small specimens may have been used as the chisel of some kind of planing instruments.

The biggest stone implements in this collection are, to judge from their shape, hoes or mattocks which offer special interest as an indication that the old Yang Shao dwellers were to some extent agriculturists. In the same direction points also the rather common occurrence of small perforated discs of stone or clay which certainly were used as spinning whorls (Pl, VI, fig. 2) and which suggest the cultivation of some textile plant.

The string and cloth patterns which are clearly visible on the surface of many clay vessels form another indication of the use of a textile plant, probably hemp.

There are many fragments and also one very beautiful perfect specimen of the rectangular knife which here is developed in a local (Honan) variety with a single hole situated low down near the edge (Pl. I, fig. I).

A small number of pestle- or muller-shaped stones may have served for grinding some substance.

There are at Yang Shao Tsun very few broad flat stone rings of the kind which was so well represented in the Fengtien cave (Pl. VI, fig. 7). But we find very numerous rings made of stone or clay with triangular cross-section, most of which were probaby used as armlets (Pl. VI, fig. 3-6).

Arrow-heads made of slate are common in various shapes (Pl. VI, fig. 8-11) but there are other arrow points made of bone or even such peculiar material as mussel shells. There is a surprising variety of shapes among these arrow heads and it is to be hoped that the closer study of them will throw some interesting light upon this culture.

In this connection it deserves to be mentioned that we have obtained two clay objects of peculiar shape, for which Dr. Zdansky has offered the very interesting explanation that they served for the protection of the archer's finger.

There are very numerous instruments, mostly pointed, and made of bone and horn. Some of them are small graceful sewing needles (Pl. VI, fig. 12-13) with a neatly cut hole. When we first found these sewing needles, I took them for a proof of a rather advanced culture, but later I noticed that sewing needles, very much like those we found, were already used in the Solutrean and Magdalenian of the Young Palaeolithic §.

Other bone implements may have served as awls or for other purposes, not yet well defined.

Special mention deserve a couple of fragments of axes made of deer antlers and very much resembling examples from the kitchen middens of Denmark §§.

The pottery is by far the dominant component in the furniture of the Yang Shao site. The amount of pot-herds is simply enormous, the whole site

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§. *Déchelette*. Manuel d'archéologie. I. Page 145 and 161-162. *Sollas*. Ancient Hunters. P. 433 and 460-461.

§§. Affaldsdynger fra Stenalderen i Danmark. Kjöbenhavn 1900. Page 58.

is filled with this kind of refuse. Complete specimens are extremely rare and the place offers no attraction to the collector of curios. But a patient study of the large volume of ceramic fragments brought home by our party will certainly bring us in much closer touch with the old Yang Shao dwellers than the examination of all the other artefacts.

The study of this pottery has hardly begun and for the present I shall have to be satisfied with a general description.

The material can for the matter of convenience be classified under two headings:

1. Coarse, mostly gray-coloured pottery with impressed or incised ornaments (Pl. VII, fig. 5-7). Most of these vessels are hand-made and of crude workmanship. But some pots, or at any rate parts of them, were turned *upon the potter's wheel*. There are also small, exceedingly thin, wheel-made vessels, the perfect make of which is a surprise to the student.

The hand-made vessels are often formed upon a bed of cloth, matting or basket work, the impressions of which are still distinctly visible as a constructional pattern, though this has in many cases been obliterated and replaced by a later decorative pattern.

2. The second class of pottery is of much finer ware, mostly of red color produced by strong oxidizing burning. Most of these vessels have black and sometimes white painting in very characteristic patterns and the surface is often beautifully polished.

I shall in a later part of this article have an opportunity to describe some of the numerous ceramic forms.

I believe there is no question connected with this ancient site which is more in need of a definite answer than this: *What is its age?* From the time when the first consignment of stone implements from Yang Shao Tsun reached me to this very day I have struggled with this problem, and I am sorry to confess that I have not so far been able to reach a fully satisfactory solution. The evidence is to some extent conflicting as will be seen from the following rapid review.

In its general composition the Yang Shao site gives the impression of a complete late Neolithic culture. If we compare the material which we obtained

from the Honan site with the collections from the famous Neolithic stations of of Europe, we will find that all the essential elements of the latter are present in the Honan site, viz: stone axes, adzes, and knives, stone and bone arrow points for the men, the hunters and fighters, stone armelets serving as adornment for the women and neat little needles for their hand-work.

A people which had easy access to metal would never have taken the trouble to shape all these tools of inferiour materials. During our five weeks of extensive and careful excavations we never met with a single metal object *in situ*. One of our last days at this site a mischievous village-boy pretended to have found a bronze arrow point at one of our excavation places, and I was inclined to accept his statement with some reservation. But Mr. Yuan went into the matter with more determination and soon found out that the arrow point had been brought from a place N. of Yang Shao Tsun, probably from some Han tomb, and that the little fraud had been attempted in the hope of gaining a few more coppers for the metal object by saying that it had come from our beloved "ashy earth", the characteristic soil of the culture stratum.

There is a remarkable feature in the deposit which at first sight might be looked upon as a proof of metallurgical process, namely the very common occurrence of a green light porous slag. Pieces of this slag are met with almost everywhere within the site, often in the shape of tiny elongated drops showing its ready fluidity. It seemed to me probable from the very outset that this slag had some connection with the manufacture of the pottery, and one day we obtained proof of this in the shape of a specimen, one end of which was pottery with the shape fairly well preserved whereas the other end was typical shapeless porous slag.

A topographic feature which favours a comparatively high age of the deposit is the fact that the deep ravines were cut after the site was abandoned.

This ravine-cutting constitutes such a radical change in the character of the landscape that the geologist is *a priori* little inclined to consider it as having taken place in historic times.

Another feature in favour of a high, probably prehistoric age of the deposit is the entire absence of writing from the hundreds of objects collected by us. We know from the "oracle-bones" of An-Yang in Honan, that the

beginning of Chinese writing was already well advanced during the semi-mythological Shang Dynasty (1766-1122 B. C.).

These are the facts which point to a Neolithic age of the Honan culture stratum. But there are others which indicate that the age might be more recent. As will be shown in the following pages, there occurs amongst the pottery a tripod of very characteristic shape, a type which is proved by historical records to have been known in the Chou Dynasty.

It is then near at hand to consider this tripod as an index fossil of the Chou period and the proof that the Yang Shao site might be the trace left by some barbarian tribe which lived in Honan in the Chou period.

However, I find it very difficult to go so far, as we know that the Chou Dynasty already represented a late stage of the Chinese Bronze Age, and it seems improbable that a barbarian tribe could carry on a pure and unmixed stone culture in the open Honan plain at a place close to the old Chinese highway from Loyang westwards. I feel more inclined to interpret the Yang Shao site as belonging to the transition period from the stone to the metal ages, a stage which has been named in Mediteranean archæology *the Æneolithic period* (The copper-stone Age). There is also another reason for considering the site as probably post-neolithic, namely the existence of wheel-made pottery.

The early history of the potter's wheel as far as it was known in 1907 has been summed up by Forrer in his "Reallexikon der prähistorischen, klassischen und frühchristlichen Altertümer", page 832 as follows:

The potter's wheel was invented in the near Orient where it has been in use since the Neolithic time. Egyptian Neolithic clay vessels are wheel-made.

From Egypt the use of the potter's wheel spread in the third millenium to Greece, in the first millenium to Italy and from there into Gallia and Germania in the La Tène period (second period of the Iron Age).

A somewhat different summary of the conditions in Egypt is given by Hœrnes 1917 in "Kultur der Urzeit" II (The Bronze Age) p. 13-14. He points out that in Egypt the beginning of the metal ages, the so called Copper-Stone Age or The Æneolithic Period took place very early and embraced the period 5000 to 3000 B. C. Copper implements are found together with polished stone axes, flint tools and pottery that is not turned upon the potter's wheel.

Unfortunately I have here no access to the special works, principally by Flinders Petrie, on the prehistoric sites of Egypt. But the above given quotations, somewhat conflicting as they are, suffice to show that, at any rate in a limited area of the easternmost Mediteranean, the potter's wheel might have been in use already in Neolithic time. In most other parts of the Western World the introduction of the potter's wheel is much more recent.

It also deserves to be mentioned that according to the report of the Pumpelly expedition, the two earlier Anau cultures, I and II, both have handmade pottery and that the potter's wheel was introduced only in Anau III*

When these facts are taken into consideration, I think it reasonable at the present imperfect stage of our knowledge, to consider the existence of wheel-made pottery in the Yang Shao site as an argument against its Neolithic age. It is quite possible that future research will prove that the potter's wheel as manifested in the prehistoric sites in the Far East is an early autochtonous type, but such a conclusion is at present entirely premature, especially as there are other features in the Yang Shao furniture which point to a comparatively modern age.

From this point of view we cannot at present put the Yang Shao site earlier than the Æneolithic period.

There is no doubt that much more extensive and profound researh is needed for the solution of this problem. In the meantime it is evident that the sites studied by us represent a stage of civilization rich enough and sufficiently well-defined to deserve a special name. I propose that we coin a local

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* With reference to the age of the Anau cultures there is some divergence of opinion between Pumpelly and his archaeologist Dr. Hubert Schmidt.

In the monographic work "Explorations in Turkestan" "Vol. I, 1908, Pumpelly considers Anau I as belonging to the Æneolithic period, but at the same time he assigns to it a startlingly high absolute age, the beginning of this culture being supposed to have taken place in the IX millenium B. C. This apparent overestimate of the age of the earliest Anau culture was based principally upon an assumed proximate uniformity of stratigraphic growth of city mounds.

In the two charming volumes "My Reminiscences" which the aged explorer published many years later (1918) he gives in two appendices his revised views of the Anau exploration. Here Anau I is referred to the Neolithic period but the absolute age is somewhat reduced, the beginning of this culture being supposed to have taken place in the "sixth millenium or earlier" (Reminiscenees Vol. II. page 813).

Hubert Schimdt made a much more conservative estimate of the age of the Anau cultures: "For the oldest culture (I) 2000 B. C. as a rough date will certainly not be too high. We have to imagine the beginnings of the settlement of Anau as having taken place in the III millenium B. C." Explorations in Turkestan, Vol. I, page 186.

term and name it from the type locality *The Yang Shao culture*. I already know some other sites of this culture in Honan, and we have tried above to prove that the Sha Kou T'un cave deposit in distant Fengtien falls under the same heading.

The moment is now come to turn to the last and supreme query: Was the Yang Shao culture Early Chinese or Barbarian ?

In southern China the Barbarians are the Lolos, the Miaotze, etc., all the local aboriginal tribes; in the north the barbarians are Mongols of different subtribes. Consequently we have reduced the problem for the Yang Shao culture to the alternatives, Mongol or Chinese ?

It is easy to reply that the facies of this ancient culture is decidedly Chinese. The only fact I can mention against this statement is the custom of burying the dead with the head in most cases towards the SE. The skeletons excavated by Dr. Zdansky in most cases lie in this direction, but other positions are also recorded. I understand that the modern Chinese mostly bury their dead with the head to the north, but also here the custom is not strictly established.

In all other features the Yang Shao culture seems to respond well to the denomination of Early Chinese.

It was a settled village, where most probably agriculture was carried out to some extent.

Nearly all the animal bones found in the Yang Shao site belong to a single mammal species: the pig. The abundance of pig-bones is simply astounding, and the tusks have been used for the manufacture of arrow points and pendants. The species is not yet identified, but the immense abundance of the remains makes it more probable that it is a domestic pig, not the wild boar. Pork is a staple food of the Chinese, but is practically unknown among the Mongols.

In the excavations at Yang Shao Tsun we often found fragments of big coarse cooking pots which under the earth still carried a coating of soot from the last camp fire. We also succeeded in obtaining a couple of nearly complete pots (Pl. VII, fig. 5) of this type, and it is apparent that they show a striking likeness to a cooking pot of clay such as one can buy to-day for a few coppers in the Peking streets.

We have also brought home from Yang Shao Tsun a pottery tumbler (Pl. VII, fig. 4) which is remarkably like a bronze tumbler of the Han Dynasty that can be seen in the Art Museum in the Forbidden City.

Most remarkable is a tripod with wide hollow legs which is a very common feature in the Yang Shao deposit. We now are in possession of some few nearly complete specimens (Pl. VII, fig. 6-7 and Pl. VIII, fig. 1) which confirm the idea first worked out by my collaborator Miss Rosenius upon a small fragment from Yang Shao Tsun, namely that these clay tripods in every essential are like some tripods of bronze from the Chou dynasty exhibited in the Art Museum (Pl. VIII, fig. 2-3). The Honan clay specimens are higher, more slender and have a lug, but otherwise the similarity is most striking.

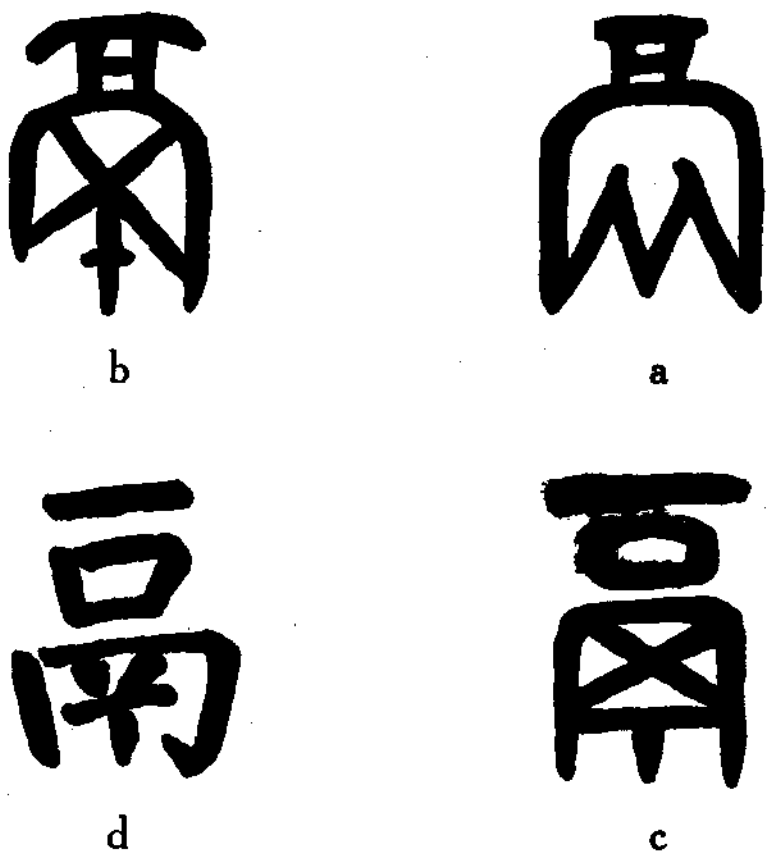

Fig. 7. *Development of the character* Li (鬲)
(a) from Shuo Wên Ku Chou Pu (說文古籀補) Chapter 3. Inscription on a Li (鬲) of the early Chou dynasty.
(b) Ditto, ditto.
(c) from Shuo Wên Ku Chou Pu. Chapter. 3.
(d) modern type of the character.

Mr. Yuan has called my attention to an archaic form of the character Li which means an earthenware pot (Fig. 7). This remarkable pictogram which is explained to represent a clay pot used in the Chou Dynasty is also a true illustration of the bronze Li in the Art museum. Nobody can doubt that there is some kind of close relationship between the bronze tripod Li of the Peking Art Museum and the clay tripods of the Yang Shao culture. The connection can be sought in two widely different ways. Either the Li is an index fossil of the Chou dynasty, and the Yang Shao culture is a barbarian stone culture facies of that time, or the Yang Shao culture is the earliest Chinese civilization so far recorded, and the clay cooking pot, the tumbler and the Li are types which survived from this early culture to the Chou period much in the same manner as we have shown above, that some other types have survived from very early times to the present day.

I consider it necessary to wait for further research, especially the description of the human skeletal remains by Dr. Black, before a definite statement can be made about the ethnological affinities of this culture. My personal impression, at this stage of our work, is that we have here met with the ancestors of the modern Chinese or at any rate a race closely related to the complex anthropological agglomerate which is designated by the little understood term "Chinese." To carry my personal interpretation of available facts a step further, I would assume that these early Chinese of Yang Shao lived at a time slightly preceding the dawn of recorded Chinese history.

Even if I am wrong in this interpretation, and the Yang Shao site represents a barbarian colony of the Chou period, it nevertheless is marked by such strong Chinese features, assimilated from the Chinese population of that time, that I still feel justified in choosing as a title for this paper "An early Chinese Culture".

There remains to be mentioned another group of Yang Shao pottery which possibly points to cultural relations of a different kind, namely with the Western World, Russian Turkestan and even Europe. The polychrome polished pottery which is found sparcely everywhere in the Yang Shao site, even

in the deepest part of the culture stratum, is preserved only in broken fragments, not a single complete vessel being at my disposal. But the fragments are so characteristic that we can form from them a fairly good idea of the nature of this pottery (Pl. IX-XIV).[1]

The vessels were evidently of moderate size and simple shape, mostly bowls. The earthen-ware is much finer than the rest of the pottery; the vessels are thin and gracefully worked; the surface is often polished and covered with black (and occasionally white) paintings in many patterns.

Polychrome polished pottery, more or less like that from Yang Shao Tsun is known from the late Neolithic and Æneolithic cultures of Europe, as for example from Sicily and from Northern Greece (Chæronea ware), from Galicia, and from Tripolje, near the city of Kiew in SW Russia.

A very interesting collection of such painted polished ware has been described and beautifully illustrated by the Pumpelly expedition from Anau near Askabad in Russian Turkestan.[2]

All these local wares have their own characteristics which distinguish them from the other groups, but a comparison between Honan and the western groups, specially Anau, and in the second line Tripolje and the Chæronean-Sicilian groups, reveal striking likenesses in certain designs (Pl. XIII). It is true, they are mostly simple patterns which might have been brought forward by parallelism in development. However, the general aspect of the Honan and the Anau painted ware is so strikingly similar and the instances of common ornamental elements so considerable in number that we are justified to ask whether there is not the *possibility* ~~of a migration~~ of art designs.

The distance from Honan to Anau is very great (fig. 8), but the two regions are connected by a highway of migrations which extends between the Tibetan highlands in the south and the Siberian taiga in the north. These vast expands of steppe and desert which form a nearly continuous belt from

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1.) For details on the polychrome pottery see the descriptive index of these plates.

2.) Explorations in Turkestan, Expedition of 1904. Vol. I.

the Pacific to the Black Sea have, according to the researches of Pumpelly and Huntington, during certain periods enjoyed a climate much more genial than the present.

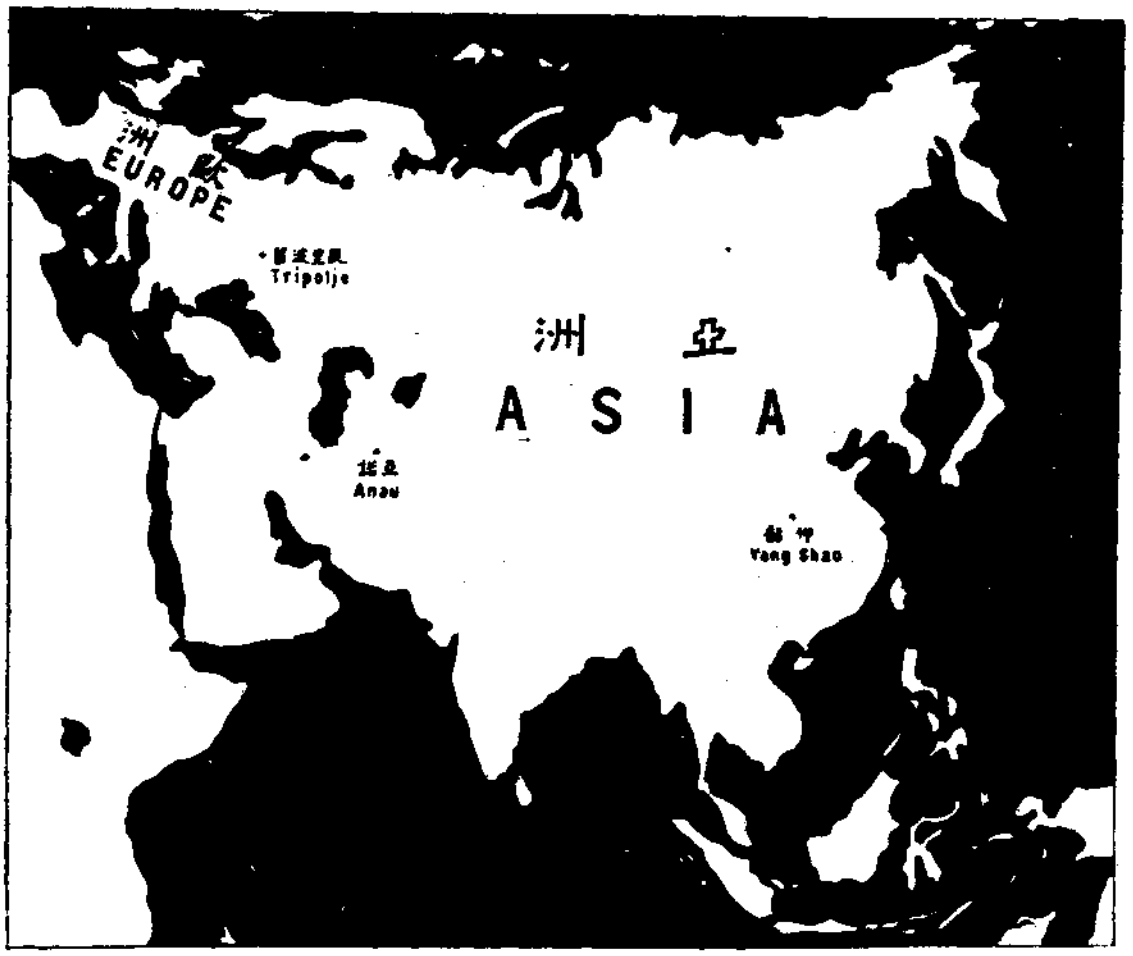

Fig. 8. Map showing the position of Yang Shao, Anau, and Tripolje.

We can also actually record several successive migrations along this zone of least resistance.

Already in Pleistocene time, long before man became a dominant factor in these regions, the Asiatic Ostrich, the eggs of which are known to science under the name *Struthiolithus chersonensis* moved freely from the Shantung Peninsula to the steppes N. of the Black Sea.

From the transition period between the Stone and the Metal ages we can note, as a possible instance of migrations, the just reported similarity between the polychrome potteries of Honan in the Far East and Anau, Tripolje and Sicily as representatives of the Western World.

The Chinese history gives abundant records, from the Han Dynasty onward of intercourse between the Chinese and western nations in peaceful trade and during expeditions of conquest.

The researches carried out by Salomon Reinach, Laufer and Minns have proved a considerable interchange during early historic times of art ideas between the Chinese on one side and Scythian and Turkish peoples on the other.

Lastly, it deserves mentioning that during my journey in Inner Mongolia in 1920 I was able to prove the existence near the northern border of Chihli province, of these strange stone effigies which occur all over the arid belt of Asia, westwards to the shore of the Caspian Sea, and which are interpreted as remains of a little known, probably Turkish people.

My report on the Yang Shao site has now come to an end. I have described only the topographic features and the artifacts. The most important of all our material, the human skeletal remains, has hardly been mentioned. We collected about twenty good, partly perfectly complete skeletons, which are now in the hands of Dr. Davidson Black who has kindly undertaken the scientific description of this material. When his report is at hand we will certainly know much more about the racial affinities of the ancient Yang Shao dwellers.

The above text was in every essential completed in January 1922 when it was read before the "Wen-Yü Hui". At that time my suggestion concerning a possible connection between the polychrome ceramics of the Yang Shao site and similar ware in the Western World was supported only by some few comparisons, principally with Hubert Schmidt's excellent plates and descriptions of the Anau I polychrome ware, in the report of the Pumpelly expedition.

In order to get the opinion of experienced archæologists on this fundamental problem, I sent to His Royal Highness The Crownprince of Sweden,

Chairman of my Swedish Research Committee, and himself an enthusiastic archaeologist of wide experience, the comparative table, plate XIII, together with a small number of duplicate specimens of the Yang Shao polychrome ware.

When His Royal Highness visited London in May 1922 he graciously took the material in question with him and showed it to Mr. R. L. Hobson, the British Museum expert on Chinese ceramics. Mr. Hobson consulted a number of British archæologists about this new Chinese ware and after these consultations presented to His Royal Highness a statement which has been forwarded to me and is here reproduced as far as the polychrome pottery is concerned:

> "Red pottery with black ornaments.
>
> Clearly the same family of design as on the æneolithic pottery found on many sites in the Near East.
>
> e.g. (a) In Babylonia where it is definitely stated by Dr. H. R. Hall to be pre-Sumerian, i. e. before 3500 B. C.
>
> (b) On the eastern borders of Persia.
>
> (c) In Asia-Minor where it would appear to date about 2500-2000 B. C.
>
> (d) Anau and Tripoli.§
>
> (e) Somewhat similar pottery found in Thessaly with objects dating 2000-1200 B. C.

It will be seen that the dating of this pottery has a very wide range from say 4000 to 1500 B. C. It belongs to a neolithic civilisation and, as it is spread all over the Near East of Asia and in Russian Turkestan, it is likely enough to have found its way across Asia via Chinese Turkestan into China. Probably links will be found in Chinese Turkestan.

What is its date in China? One would say that it originated in the Babylonian district and radiated from there; and, as China would be an extreme eastern radiation, it may well have taken a long time to reach there.

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§. Apparently Tripolje in SW. Russia.

On the other hand, the absence of metal work with the finds in China, would indicate an early date, say not later than 1500 to 2000 B. C. Bronze must have been very widely used in China in the Hsia Dynasty 2205 to 1818 B. C.

The use of the wheel on some of this pottery is very interesting, but not surprising as its use can be inferred from litterary sources in the Shang Dynasty 1766-1154 (See T'ao Shuo, Bushell's translation, p. 33)."

I take this occasion to express to H. R. H. The Crownprince of Sweden and to Mr. Hobson my respectful thanks for the encouraging support which they have rendered to my work by this statement, which throws interesting light upon problems of immense interest which I could only imperfectly elucidate in my lecture in January.

I had also sent my comparative table together with a letter explaining the main facts to Prof. Dr. Hubert Schmidt of Museum für Völkerkunde in Berlin, the famous archæologist who directed the excavations in Anau and described the archæological material in the report of the Pumpelly expedition. Dr. Schmidt has kindly sent me two letters in reply to my communications, and his opinion can be summed up as follows:

The patterns common to the two regions as shown by my comparative table (Pl. XIII) are few and the similarities are far from convincing.

Apart form the patterns, the comparisons must also be extended to the technique of the ware, the pigments used and the polish of the surface.

Comparison can hardly be made at the same time with Anau I and with Tripolje, as was done by me, because these two cultures are not of the same age.

Before the question of possible relationship of the Honan polychrome ware with such of the Western World can be successfully attacked, the age of the Honan sites must be known, not only in relationship to younger Chinese culture stages but also with reference to the western sites which contain polychrome wares.

"Ich möchte nochmals betonen, dass es immer gefährlich ist, mit einzelnen Mustern der Ornamentik zu operieren; man muss die keramischen Gruppen im Ganzen als Ausdruck eines bestimmten Kunstgeistes nehmen. Beziehung kultureller und geschichtlicher Art sind erst dann erwiesen, wenn

die Gleichzeitigkeit auseinander liegender Kulturgruppen sich aus allgemeinen oder besonderen Verhältnissen ergibt. Die Ornamentmuster reichen natürlich nicht aus, auf Gleichzeitigkeit zu schliessen, wenn nicht andere Umstände, bes. stratigraphischer Art oder einwandfreie Importstücke vorliegen".

It will be seen from a comparison between the statement given by Mr. Hobson and that forwarded by Dr. Schmidt that the British experts take a more positive view in considering it evident that the Yang Shao polychrome ware is "clearly the same family of design as on the æneolithic pottery found on many sites in the near east". In the same way as I have done in my January lecture, Mr. Hobson traces the migration of this art design across Chinese Turkestan into China.

Dr. Schmidt is much more reserved, but admits the *possibility* of such a connection across Asia and emphazises the importance of the find, provided that such a connection is confirmed by continued investigations.

The difference in opinion of the two scientists may be due partly to the fact that Mr. Hobson had access to a small number of specimens, whereas Dr. Schmidt so far had only my comparative table and written explanation to form his opinion upon. I personally feel that Dr. Schmidt's critical remarks carry much weight and hope to be able, with his kind assistance, to continue the research along the lines indicated by him.

The expressions of opinion received from Mr. Hobson and from Dr. Schmidt have served as a powerful encouragement to carry on our investigations on the Yang Shao sites. It may be safe to say that the possibility of a connection between the polychrome ware of Yang Shao Tsun and those of the Near East must now be recognized as a working hypothesis to guide our future work.

This new development raises issues of far reaching consequences. The problem to which Terrien de Lacouperie devoted so much untiring but partly ill-fated zeal, the question of western influences in the early Chinese civilization, are again brought into the lime-light.§ I understand that very much of his immense scientific fabric, as for instance the fundamental thesis of the

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§. Terrien de Lacouperie. Western Origin of the Early Chinese Chivilization. 1894.

"Bak Sings", is entirely discarded by modern science. However, it is possible that aided by modern philological resources a nucleus of permanent value will emerge from a critical resurvey of the immense store of facts accumulated by Terrien de Lacouperie and also by the more recent writer C. J. Ball.[1])

The early legends of the Chinese point to repeated migrations from the west of "barbarian" tribes which were gradually assimilated by the Chinese race.

It is interesting to note that we can indicate by aid of already existing archaeological facts that more likely the supposed migration of the polychrome pottery technique went from west to east and not in the opposite direction.

According to Mr. Hobson's statement it has been proved by H. R. Hall that polychrome ware was in existence in Babylonia in pre-Sumerian time, i. e. before 3500 B. C.

Because of the close similarity of the Yang Shao clay tripods to bronze tripods of early dynasties and also the evidence of the potter's wheel, I feel inclined to believe that the Yang Shao culture was in existence at a time coinciding with or only slightly preceding the dawn of Chinese history, that is the third millenium B. C. This is a very uncertain conjecture, but is serves to indicate that polychrome pottery probably existed earlier in the West than in the East.

If future research will prove that the technique of polychrome pottery was introduced from the West, then it becomes most likely that also other cultural and possibly also racial traits were carried by the same waves of migration. In this connection I cannot forbear to quote a statement made by the famous anthropologist Dr. Ales Hrdlička at the occasion of his visit to China in 1920. In a lecture before the Joint Conference of the China Medical Missionary Association and the National Medical Association of China he expressed himeslf as follows:

"The Chinese remain essentially a yellow-brown people; but there are indications that they also carry a more or less considerable old admixture of

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) C. J. Ball. Chinese and Sumerian. 1913.

white blood of unknown derivation, together with a little of more modern mixture."

The old question of western influences in the early Chinese civilization is again actualized by the discovery of the Yang Shao polychrome pottery. The definite solution of this complex problem is probably still very distant, and the only possible way leads through cooperation of archæologists, anthropologists and philologists under careful sifting of facts and unbiassed correlation of results. It is specially desirable that Chinese scholars, who alone can elucidate the question from within, will take an active interest in this research.

Peking, September 1922.

EXPLANATION TO THE PLATES.

Plate I.

Semilunar and Rectangular Stone knives.

All the objects on this plate are reduced to half of natural size.

Fig. 1. Rectangular knife of dense red limestone, with a single hole deep down near the cutting edge. Yang Shao Tsun, Mien Chih Hsien, Honan (河南澠池縣仰韶村).

Fig. 2. Semilunar knife without hole. "Greenstone". The back of the knife is unusually broad, 14 millimeters. Because of the absence of holes and the simple semilunar shape this specimen is in some respect the most primitive of all the stone knives at my disposal. Chihli, Hsuan Hua Hsien, Pai Miao. (直隸宣化縣白廟).

Fig. 3. Rectangular knife with a single central hole. Grey sandstone.

Fig. 4. Knife with single central hole; in shape forming a transition between the semilunar and the rectangular types. Red ferruginous sandstone. Chihli, Lung Kuan Hsien, P'an Tao Tsun (直隸龍關縣潘道村).

Fig. 5. Semilunar knife with somewhat thickened back; in shape reminding of Fig. 2 but with two big holes. Greenstone. Joho, Sui Tung Hsien, Ch'ing Yün Ssu (熱河綏東縣慶雲寺).

Plate II.

Rectangular, trapezoidal and semilunar iron knives (鋌 鐮).

All the objects are reduced to half of natural size.

Fig. 1. Trapezoidal with indentate sides. Leather back and strap for the thumb. Chihli, Huai Lai Hsien, Chan Chia Yao. (直隸懷來縣詹家窯).

Fig. 2. High trapezoidal shape. Back and strap of cloth. Same locality as fig. 1.

Fig. 3. Trapezoidal shape. Back inside cloth, outside leather. Strap of leather: Same locality as fig. 1.

Fig. 4. Semilunar shape. Chihli, Wan P'ing Hsien, Kuan Tsu (直隸宛平縣官子).

Fig. 5. Rectangular shape. Joho, Fêng Ning Hsien, T'ou Tao Kou Men (熱河豐寧縣頭道溝).

Fig. 6. Trapezoidal shape. Chihli, Huai Lai Hsien, Hsin Pao An (直隸懷來縣新保安).

It will the noted that the three specimens in the lower row (4-6) have, like those in the upper one, been provided with cloth-or leather-cover and thumb strap. These have been removed to show the two holes which are hidden but existant in the case of the specimens fig. 1-3.

It will be noted that all these specimens are obtained from northern Chihli and Joho, the area of the kaoliang, and they are in the text referred to as kaoliang cutters.

This is also the area of strong Mongol influence during many stages of Chinese history, but overwhelmingly during the Yuan dynasty. It is interesting to quote in this connection that Mr. H. C. Chang in his work Lapidarium Sinicum, pages 151-152, has advanced the opinion that this iron kaoliang cutting knife is not a Chinese, but a Mongol type which was comparatively recently introduced into China, and Mr. Chang has forwarded evidence that the character (粟 墅) indicating this iron tool was not known before the Ming dynasty.

I can give no opinion about the validity of the evidence brought forward by Mr. Chang, but there seems to be several facts indicating that this type of knife is widely spread in China and consequently can be expected to be an ancient type. In addition to the kaoliang cutter here described I have noted in Nanking a rectangular iron knife without hole, and in Honan a very large rectangular iron knife with two holes. These two localities are outside the area of strong Mongol influence, and besides, it has not, as far as I know, been proved that such a knife as the kaoliang cutter exists or earlier existed among the Mongols.

If I am right in my interpretation of the Yang Shao culture as a culture of the early Chinese, we find in the specimens figured Pl. I that the type, then made in stone, did exist amongst the proto-Chinese already in prehistoric times.

Plate III.

Carpenter tools and the knife sharpener's sounding instrument, used at the present day in Peking.

Fig. 1-5 are reduced to 1/10 of natural size; fig. 4 and fig. 5 to 1:6.

Fig. 1. Big carpenter Pen.

Fig. 2. Big carpenter Pen.

Fig. 3. Small carpenter Pen.

Fig. 4. Carpenter's drill.

Fig. 5. Knife sharpener's sounding instrument.

Plate IV.

Development of the Pen.

All the objects are reduced to half of natural size.

Fig. 1. Asymmetric greenstone chisel. Honan, Mien Chih Hsien, Yang Shao Tsun. (河南澠池縣仰韶村).

Fig. 2. Asymmetric socketed bronze celt. Joho, Luan P'ing Hsien, Shang Pan Ch'êng (熱河灤平縣上半城).

This specimen belongs to a grave find which through purchase has come into my possession.

It consists of three celts of somewhat different shapes, a dagger, some razors, horse and dog figures, very numerous buttons and several other objects. It will be described in detail at another occasion. For the present it will suffice to state that there are indications to prove that this grave find dates from a comparatively late time, certainly more recent than the true Bronze age.

Fig. 3. Iron Pen of the modern Peking carpenter.

Plate V.

Development of the Ko[1].

The objects are reduced to ¼ of natural size. For figure 2 which is derived from the Chin Shih So, the reduction is only approximate.

Fig. 1. Ko[1] made of a green finegrained, probably metamorphic rock. Chihli, Lung Kuan Hsien, Tang Chih K'ou. (直隸龍關縣湯池口).

Fig. 2. Ko[1] of copper or Bronze, figured in the Chin Shih So (金石索) page 11 (商 舟 戈). Stated to date from the Shang Dynasty.

Fig. 3. Ko[1] of bronze figured by Shetelig, loc. cit. fig. 2.

Fig. 4. Ko[1] of bronze. Specimen with beautiful patina and strong incrustations. Found in grave in Honan, Hsin An Hsien, An Lo Tsun (河南新安縣安樂村) together with a socketed celt.

Fig. 5 and 6. Bronze Ko[1] bought from curio dealers in Peking. As many objects offered for sale in the curio shops of the big cities these specimens have to be accepted with much caution. Specially fig. 5 is a doubtful specimen. At any rate they are undoubtedly useful for the present purpose, as there can be little doubt that they closely imitate the shape of genuine specimens.

The typological series which has been brought together in this plate is to be considered only as a tentative experiment in arranging a number of specimens in what seems to be a probable typological sequence. But the real proof, the exact dating of the specimens, showing that the supposed development in shape coincides with the progress in time, is entirely missing and will remain so until a sufficient material obtained through systematic excavations has been made accessible to scientific research.

It ought to be pointed out that, as long as the stone Ko[1] figured in Pl. V fig. 1 remains a unique specimen, the evidence furnished by it is not without doubt. It could possibly be said that this beautiful and singular stone object might be simply an imitation in stone of an early type of bronze Ko[1], such as figure 2 of the same plate. However it is at once apparent that the stone Ko[1] is more primitive in type than any known bronze Ko[1], such as for instance figure 2 of the said plate. It is much broader and fuller in shape as required by stone, when compared with metal. It is fully symmetrical, and, last but not least, the tang of the stone Ko[1] is not narrowed in lateral view, as is the case with the tang of all the bronze Ko[1]. On the contrary, the tang is broader than the dagger blade and connected with it by means of two

shoulders, apparently for the purpose of tying the stone weapon to its handle, as shown by textfigure 2 A. If this interpretation of the shoulders is correct, it is interesting to note how this feature remained for some time in the bronze Ko[1] but became gradually replaced by a number of holes intended for the purpose of inserting the tying strings. This gradual transition from stone technique to metal technique takes place together with the development of the part of the later metal Ko[1] which is called Hu (胡) and is a projection downwards along the handle, evidently for the purpose of strengthening the connection between the metal dagger and the wooden handle.

If we can take these features into consideration, we are able to characterize the probable development of the Ko[1], as expressed in Plate V, in the following way:

Fig. 1. Stone. Side view fully symmetrical. Shoulders. Tang of same width as the shoulders.

Fig. 2. Bronze. Side view slightly asymmetrical. Shoulders. Tang narrower than the shoulders. No hole.

Fig. 3. Side view more asymmetrical. Shoulders. Tang narrower than the shoulders. One hole.

Fig. 4. Side view markedly asymmetrical. Beginning development of the Hu. Shoulders less pronounced. Two holes.

Fig. 5. Hu strongly developed. Upper shoulder disappeared. Four holes.

Fig. 6. Hu in length nearly equal to the dagger blade. No upper shoulder. Five holes.

These are only some few principal stages in the development of the Ko[1]. There are many interesting varieties in addition to those here figured, and a detailed typological study of this remarkable weapon will become very interesting when once a reliably dated material is available.

Plate VI.

Artifacts of the Yang Shao Culture.

All the objects are reproduced in half of natural size.

They are all derived from the Yang Shao Tsun site with the exception of the two needles fig. 12 and 13 which have come from the Pu Chao Chai

(不招寨) site, which is situated 10 li W of Yang Shao Tsun and which contains much the same furniture, showing that it also belongs to the Yang Shao Culture. Needles like those in fig. 12 and 13 have also been found in Yang Shao Tsun.

Fig. 1. Sling-stone of hardened (burnt ?) clay.

Fig. 2. Spinning whorl of red limestone.

Fig. 3. Armlet ? ring of clay; outer contour with incised decoration.

Fig. 4. Small ring of bone.

Fig. 5. Ring of burnt clay.

Fig. 6. and 7. Stone rings.

Fig. 8. Stone lance head.

Fig. 9-11. Arrow heads of slate.

Fig. 12-13. Bone needles.

Fig. 14. Broad short greenstone-axe, slightly asymmetrical.

Fig. 15. Asymmetrical chisel of white marble.

Fig. 16 and 17. Greenstone axes.

Plate VII.

Monochrome Pottery of the Yang Shao Culture.

All the specimens are from Yang Shao Tsun, except fig. 6 & 7 which are from Pu Chao Chai.

All the figures are reduced to 1/5 of natural size.

Fig. 1. Two fragments of light brickred ware. It is by far not certain that these two pieces belong to the same specimen, as they were selected from a considerable number of similar fragments which evidently represent a type of vessel with conical bottom.

Fig. 9. Profile of mouth of VII:1. ½.

Thickness of the wall 5-8 mm.

The mouth has a projecting rim, but the aperture is much narrowed (fig. 9), diameter of the rim 88 mm., that of the aperture 42 mm.

The mouth-piece is on both in- and outside covered with regular concentric striæ indicating wheel-work, but the larger part of the vessel is evidently hand-made.

The outer surface of the bottom-piece is covered with string impressions radiating from the apex. The top-piece is below the rim decorated with two systems of impressed string lines intersected under an angle of 47°

Fig. 2. Bowl of brown-grey ware, coarse with fairly big quartz-sand grains. Thickness 5-7 mm. On the inside there are at the margin concentric regular lines suggesting wheel-technique, but otherwise the vessel gives impression of being hand-made. The vessel is provided with a set-off foot, irregularly decorated with finger-impressions. Surface rough. Inside blackened.

Height 64 mm.; diameter at the mouth 179 mm.; diam. of foot 64 mm.

Fig. 3 Bowl without set-off foot. Ware dark brownish-grey, finer than the vessel fig. 2, no visible quartz grains. Margin inwards thickened as shown by fig. 10. On the outside, near the margin, numerous regular concentric lines

Fig. 10. Marginal profile of VII:2. ½.

indicating wheel-technique, but the irregular bottom and the rest of the surface rather point to hand-work. On the outside the vessel is smoothened by scraping and near the margin polished to produce that dark shiny surface which I have described from the vessel X:3 of the Fengtien cave and which has been compared with the appearance of blackened leather. Wall very thin, 3-4 mm. Height 94-97 mm.; diameter at the mouth 204 mm.; diam. of foot 75 mm.

Fig. 4. Tumbler. Light grey ware. Thickness 4 mm. Bottom and outside indicate wheel-technique, inside rough and irregular. Outside at the bottom with four irregular incised furrows (too regularly drawn on the figure). Outside surface smoothened and burnished.

Fig. 5. Tripod of the type Ting (鼎). Ash-grey coarse warse. 5-6 mm. thick. No sign of wheel-work. Outer surface covered with basketwork impression over which there is attached a very irregular equatorial ribbon of clay. Two small lugs, each with two finger-impressions.

The three legs are nearly rectangular in shape with a medium longitudinal supporting ridge which is continued upwards 30 mm until it merges into the wall of the vessel. (Fig. 11).

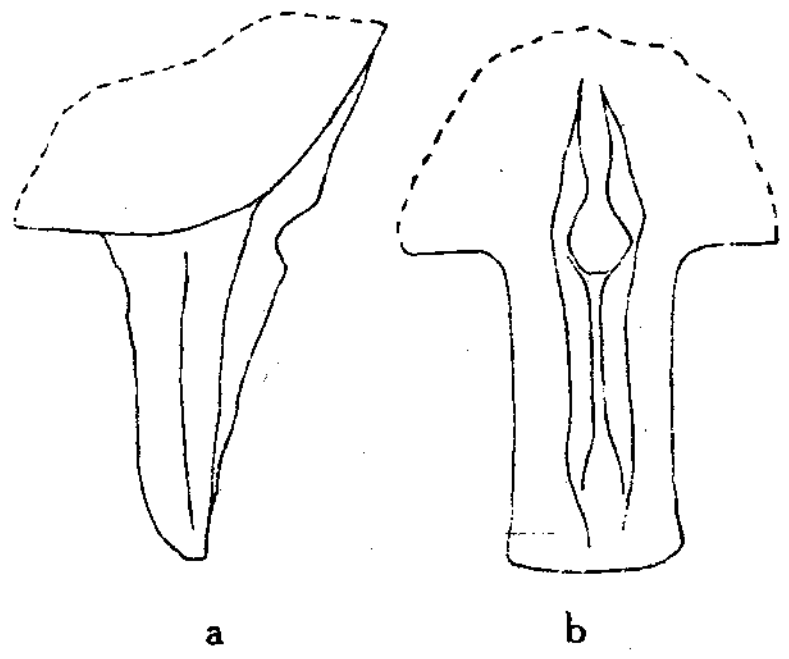

Fig. 11. a lateral, and b frontal view of leg of Ting tripod VII:5. ½.

Diameter at the mouth 214 mm.; diam. of flat bottom 131 mm.; height of body 149 mm.; height of legs 74 mm., making a total height of 223 mm.

Fig. 6. Tripod of the type Li (鬲). Color of ware dark grey-brown. Thickness in leg very variable, 3-7 mm. Hand-work. Legs and body covered with mat-impression pattern. Also on the inside of legs and body there is mat-impression, but less distinct than on the outside. Collar and lug without

pattern, but surface rough and irregular. Collar set off from body by a distinct grove.

Color of surface blackish-grey to nearly black. Inside of the collar secondarily partly blackened by fire.

Diameter of the somewhat irregular mouth 96-99 mm. Total height 166 mm. Height to base of collar 124 mm.; height of collar 45 mm. Length of lug 75 mm. width of lug 35 mm.

Fig. 7. Li of same type as fig. 6, only much bigger. Ware light brown, with a thin black layer on the inside and another, less developed, on the outside. Thickness of collar 5-9 mm., thickness of leg 4-7 mm.

Legs and body on both out- and inside covered with mat-impression which is however everywhere rather obliterated. Collar smooth, not set-off from body. Color of surface grey, in certain parts brownish.

Diameter of mouth 137 mm.; Total height 263 mm.; height of collar 47 mm. Length of lug 106 mm.; width of lug in lower, narrower part 32 mm., in upper part 40 mm.

Plate VIII.

Tripod Li of clay (fig. 1) and bronze (fig. 2-3).

Reduction approximately 1/3.

Fig. 1. Clay tripod of the type Li from Pu Chao Chai.

Ware red brown. Surface of the belly and legs covered with mat-impression. Collar smooth except numerous regularly concentrical lines. These striæ may be interpreted as indicating wheel technique, but a careful examination will reveal under these striæ slight remains of nearly obliterated mat-impression lines.

Outer surface of the whole vessel nearly black.

Only a small part of the lug left. Opposite the lug a round clay dot at the base of the collar.

Height of the whole vessel 224 mm. Height of collar 35 mm. Diameter of the mouth 132 mm.

Fig. 2 & 3. Two bronze Li stated to date from the Chou Dynasty.

Belonging to the Art Museum in the Forbidden city of Peking and reproduced by courtesy of the Directorate of that Museum.*

Fig. 2. Height of the vessel 155 mm; diam. of mouth 157 mm.

Fig. 3. Height of the vessel (to margin) 140 mm; diam. of mouth 140 mm.

Plates IX-XII.

Painted pottery from the Yang Shao site. Half of natural size.

Black means black except in X:4, X:8 and XI:14 where it indicates red painting.

Dotted means brickred surface of the ware (or eventually red colorslip) except in X:4, X:8 and XI·14 where it means the grey surface of the ware.

White means white.

These four plates contain a selection out of a very great number of polychrome fragments from Yang Shao Tsun. No single complete vessel of this type was ever found. XI:14 represents nearly the half of a semispherical bowl. Another instance of a fragment from Yang Shao sufficiently large to allow a reconstruction of the whole vessel is XIV:4, a vessel decorated ly with a narrow black line at the margin.

It is not necessary to describe here in detail everyone of the 38 specimens figured in these plates, but a general analysis of the material will be given under the main headings: ware, wheel-technique, shape, patterns of decoration and colors.

Ware. The clay used for the making of these painted vessels is much more carefully washed and of finer and more uniform grain than is the case with the material used for the big bulk of the monochrome pottery. In most instances it is strongly burnt to a brick-red color (Andersson: The cave-deposit at Sha Kuo T'un Pl. XII, fig. 1 gives an approximate idea of the color of this pottery, but there is somewhat too much yellow in that reproduction). Some of the thick-walled specimens such as IX:2 are not oxidized all through; in this case there is in the midst of the wall a layer showing the original grey color of the clay.

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* I am much indebted to Mr. Kungpah T. King for helping me to obtain this favour from the Museum authorities.

In some few specimens the ware is not brick-red but of a grey color, apparently due to non-oxidizing burning. An exceedingly interesting specimen is XI:14. In nearly the whole vessel the ware is grey, but in the marginal part down to the lowest of the three horizontal bands, the substance is brickred. In the fractures it is easy to see that this red color is due to burning. Close by the margin the wall is red all through; lower down it passes gradually into a zone with a grey core in the centre and still lower the wall is grey all through out to the surface. There is no doubt that this oxidizing burning of the marginal zone is intentional and for the purpose of creating a very handsome effect.*

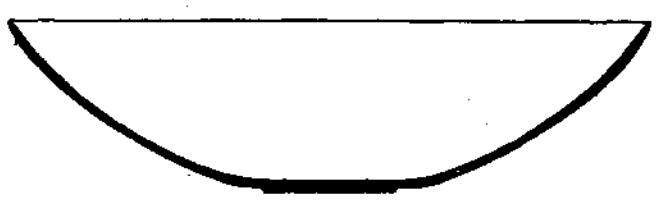


Fig. 12. Grey vessel with red marginal belt. ¼.

XI:12 and another specimen, not figured, consist of a nearly white, slightly yellowish ware.

Technique of shaping the vessels. It is safe to say that the overwhelming majority of the painted vessels are turned upon the potter's wheel. Some few show such irregularities in shape as would indicate hand-work. However, in many other cases the scraping and burnishing to smoothen the surface has evidently obliterated the traces of the wheel with few doubtful exceptions I would mark down this group as wheel-made.

Shape. The painted vessels of Yang Shao Tsun are all small or of moderate size and the shape is simple. Most common are fragments indicating small semispherical bowls possibly with a flattened bottom. A somewhat more elaborate form is the specimen XIV:4. To this latter type belong also I.. 4, IX:6, X:3 and probably also XII:1.

There are also a number of margin fragments with flaring rims, such as IX:4, X:5, X:7. X:8, X:9, XI:11, XII:2, and XII:3. We have not from

* For comparison it is pertinent to mention in this connection that we possess from a newly discovered site of the Yang Shao culture a monochrome, thinwalled, gracefully shaped vessel (fig. 12) of grey ware with a red marginal belt, 12-15 mm. broad, and fading into the grey below. A study of the fractures shows that the red color is due to oxidizing burning, though it is possible that some red pigment has been applied to add to the effect. The vessel is one of the most beautiful in our collection.

Yang Shao Tsun sufficiently complete material to outline the lower part of these vessels but it is probable that most of them were like XIV:1; X:7 and X:9 have more likeness with XIV:5.

IX:5 represents a vessel with strongly profiled, indrawn rim, and there are three more fragments of this type.

XI:13 is a small fragment of a vessel which apparently must have been of flattened globular shape (compare XIV:3) with strongly contracted mouth. There is also a marginal fragment of such a vessel with a low, vertically standing rim.

Patterns of painting. The patterns used for decorating these ceramics are exceedingly varied. It seems as if the ancient Yang Shao artists were but little bound to conventional designs or that they possessed a creative power of developing the inherited patterns into endless individual variations. This flexibility of the designs makes it difficult to afford an adequate description. The following classification may give some idea about the main groups of patterns:

1: *Bowls* (of comparatively big size) *decorated only with a black band round the rim.* XIV:4 is a vessel with a narrow band, only 8 mm. broad. IX:1 has a band 44 mm. broad. Another fragment, not figured, has a marginal band of not less than 56 mm. width. Another specimen of this group differs from the rest in that the band is not black, but of violet-red color.

2. *Bowls with richer decoration in many varied patterns.*

IX:2 is a bowl, undecorated excepted a marginal band consisting of triangles between two horizontal lines.

The trichrome vessel XII:1 is probably of an allied pattern, but too little is left of the lower part to prove that this was undecorated. The marginal band is in this case more complicate, consisting of regularly repeated groups of a triangle, a curved line and a dot.

XI:12 is a small fragment, the main feature of which is two triangles in juxtaposition. This element of design is interesting because it is exceedingly common in the painted pottery of Susa (W. Persia), both of the first and second period. (Compare De Morgan's monographic work, Tome XIII, plates VI, VII, VIII, XXVII, and XXXI).

XI:14 is a bowl of interesting design. At the margin is a band of trellis-work cross-lines bordered below by a straight horizontal line with three parallel lines underneath. Lower down there are groups, each consisting of three long parallel S-shaped lines. At the bottom there is a circular line with superposed wave-lines.

Trellis pattern was also used in vertical bands bordered by parallel lines as shown in XI:7. There is striking similarity between this specimen and XI:9, only with the difference that the vertical band with trellis pattern in XI:7 is left empty in XI:9. XI:1 is also related to the two just mentioned specimens.

Another application of trellis pattern is shown in XI:8.

An interesting group of small bowls of high polish, are XI:2-5. The paintings of two of them at least, XI:3 & 4 might very well have been derived from flower designs.

In addition to the groups already mentioned there are several isolated types such as XII:4,6 & 8 which are little known because of the imperfectness of the material at hand.

3: *Vessels with flaring rim.* Decoration sometimes very simple, as in the case of XII:3. Often it is more complicate, consisting of curved bands, triangles and round dots. (IX:4, X:5). A pattern often met with upon the vessels with flaring rim is a horizontal band with trellis cross-lines between two horizontal bordering lines. That design is also common upon vessels with flaring rim from other localities such as XIV:1, XIV:2, XIV:5. However, it must be noted that horizontal trellis bands occur also upon simple semi-globular bowls such as XI:14. In a general way it can be said that certain patterns preferably go with certain types of vessels; but there are considerable exceptions from such a rule.

Colors. An exhaustive survey of the colors of the painted Yang Shao pottery can be given only after far more detailed investigation, including mineralogical and chemical research for the purpose of identifying the pigments used for producing these paintings which with wonderful resistance stand out after milleniums of burial as if they were a production of yesterday. The brief account given below will indicate simply some main features.

The painting is in most cases applied directly upon the polished surface of the brick-red, grey or in very rare instances white ware. In a lesser number of instances a thin color-slip has been applied as substratum of the painting. (Andersson: The cave-deposit at Sha Kuo T'un, Pl. XII, fig. 2 gives a fairly good idea of the red color-slip of these vessels.)

In the following description the polished surface of the vessel, resp. the color-slip, is counted as a color. Consequently a vessel with black painting upon brickred bottom is bichrome, a vessel with paintings in black and white upon red bottom trichrome etc.

Black painting upon brick-red bottom is by far the most common type. All the figures of Pl. IX are of this color-scheme. So is also the case with most of the figures of Pl. X, except fig. 4 with red painting upon grey bottom and fig. 8 with brownish-red painting upon red-grey bottom. Pl. XI fig. 1-9 have black paintings upon a red bottom which seems to be in most cases a color-slip. XI: 10, a vessel of red ware, has a white slip with black painting. In XI:11 and XI: 13 the painting is so faded that its original color can no more be ascertained, and it stands out only a corroded lines. XI:12 is painted in black upon the white ware,

The artistic effect obtained in the case of XI:14 by oxidizing burning of the marginal part, the rest of the vessel remaining grey, has already been described. The design is painted in a deeper red than the red burnt margin.

XII:1 is a trichrome vessel. The marginal part is covered with a white slip upon which the design is painted in black. Below this marginal band a small part of the brickred lower part of the vessel is seen.

XII:7 & 9 are of the same color-scheme: the upper part is covered with a white slip, and this part is bordered by a black line against the lower part which shows the brickred of the ware.

XII:2, 4, 6 & 8 have black painting upon a white slip covering the brickred ware.

XII:3 shows the brickred ware in a narrow belt underneath the rim which is provided with a black band. Below the red band is another of black color, and the rest of the fragment is white.

XII:5 is painted black upon the brown ware.

In addition to the figured specimens there are some fragments which deserve mentioning. One is a small fragment of white ware with black painting in the shape of a six (?)-rayed star. In the centre of this "star" there is a big roung dot of a red substance much resembling red sealing wax..

Another strange piece is the fragment of a bowl of grey-brown ware decorated only with two big round dots surrounded by a narrow white border of nearly perlaceous lustre.

Plate XIII.

Comparison of painted patterns, Yang Shao, Anau and Tripolje.

All figures are in one third of nat. size, except fig. 15 which is more reduced.

This plate is prepared to show the similarity between certain pattern elements of the Yang Shao painted pottery on one side and the polychrome wares of Anau and Tripolje on the other.

Of the eight Honan specimens No. 1, 2, 4 and 7 are from Yang Shao Tsun, the rest have come from new localities, which will be described in Palæontologia Sinica.

Fig. 1 of this plate is the same specimen as IX:3., fig. 4 is the same as XI:7, and fig. 7 is the same as X:3.

Figures 1-4 and fig. 7 are all painted in black upon the brickred polished surface of the ware or in the case of fig. 4 probably upon a red slip.

Fig. 5, 6 and 8 are to the larger part covered with a cream white slip upon which the design is painted in black with some few lines and dots of red.

The figures of the Anau pottery are all taken from Hubert Schmidt's monograph in volume 1 of the Pumpelly expedition report "Explorations in Turkestan". Fig. 9 is Schmidt's Pl. 23:5, fig. 10 is Pl. 23:1, fig. 11 is Pl. 22:1, fig. 12 is Pl. 24:5, fig. 13 is Pl. 27:2 and fig. 14 is Pl. 30:2. All these specimens are painted in dark color upon wares varying from yellownish white to deep red.

The specimen from Tripolje (fig. 15) is derived from Minns, Scythians and Greeks, fig. 30, page 136. The colors are cream and dark brown.

In the course of 1922 much new material of the Yang Shao culture was brought to light or made better known through excavation or preparation and reconstruction. This continued work lead to a much fuller understanding of the rich variety of ceramics, The increasing manifestation of the relationship of the painted pottery to polychrome wares of the Near East and SE Europe made it probable that also other groups of vessels, when better known, will exhibit relationship to western forms.

In this way it became imperative not to wait for the completion of the definite monographs on the several sites, and for this reason four plates (XIV-XVII) have been added to give a preliminary representation of some of the more conspicuous ceramic types.

Plate XIV.

Painted vessels.

All the figures reduced to 1/4 of nat. size.

Fig. 4 is from Yang Shao Tsun, all the rest from new localities.

Fig. 1. Restoration made from two specimens evidently representing exactly the same shape as well as decoration.

Outer part of the ware red, inner grey. Thickness 3-6 mm.

The vessel has a narrow flaring rim.

Black painting upon the red polished surface of the ware. Beneath the rim there is a trellis band bordered below by two horizontal lines. 2.5 cm lower down there is another band consisting of three lines which are connected with the upper band by vertical lines in groups of three. 5 cm. further down there is a single horizontal line below which the vessel is undecorated. Between this line and the three higher lines there are figures of curved lines, X- and ϖ-shaped.

Fig. 2. Ware and color of surface same as fig. 1. Thickness 5 mm.

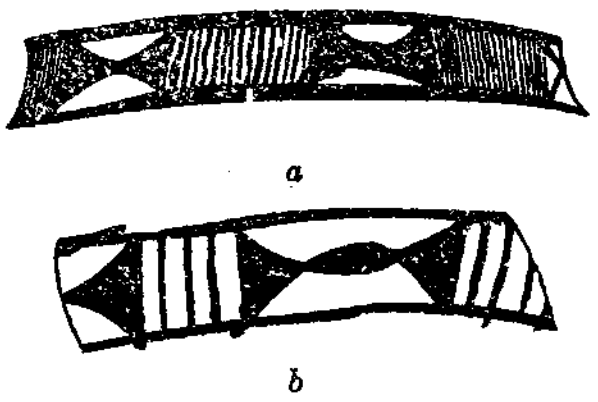
A little below the widest part of the vessel there are two lugs with finger impressions.

Black painting upon the brickred polished surface of the ware. Decoration same as fig. 1, but altogether restricted to the upper part of the vessel. There is also no horizontal line below the X- and ϖ-shaped figures.

This is one of our biggest painted vessels; diam. of mouth 288 mm. The actual height of the bottomless fragment is only 330 mm., so the height of the complete vessel, figured to be 370 mm., is merely a conjecture.

Fig. 3. This is a restoration from a very interesting fragment which shows the mouth but not the bottom. The ware is red on the outside and grey in the interior. The red surface of the ware is shown in a narrow belt along the margin and on the whole lower part of the vessel. The rest of the surface, which carries the design, is covered with a white slip upon which the painting is applied in black and red. Most of the design is black, but the middle one of the three equatorial lines is violet-red and so is also every second of the vertical lines in the upper group and two dots on each side of the "eye".

I am not able to give a definite opinion about the origin of the seemingly naturalistic design which is here named "eye" like. But I want to call attention to the pattern in the lower row which consists of vertical lines and triangles in juxtaposition. This pattern is noticeable because of its striking likeness to a detail of the decoration upon a vessel found in Susa, as, shown by fig. 13.



a

b

Fig. 13. a. Detail of decoration upon painted vessel from Susa. Mémoires de la Délégation en Perse. Tome XIII, Pl. XXIV.
b. Detail from painted vessel (XIV:3) of the Yang Shao Culture. ½.

There are also other pattern elements, such as horizontal lines connected by groups of vertical lines, which are common to the pottery of the second period of Susa and that of the Yang Shao culture. Only after the larger part

of this article was printed, did I receive De Morgan's magnificent monographic work on the excavations in Susa (Mémoires de la Délégation en Perse). I seize this occasion to call attention to this remarkable similarity between the Yang Shao painted pottery and that of the second period of Susa, a likeness which undoubtedly much strengthens the probability of a common origin of the Æneolithic painted ceramics of the Near and the Far East.

Fig. 4. Reconstruction from a fragment of a vessel to which reference has been made several times in the description of plates IX-XII. The ware is all through red burnt. Thickness 5-7 mm. Very distinct wheel-work. Decoration only a black, 8 mm. broad line along the margin.

Fig. 5. This is the only complete painted vessel so far found. It was broken in several pieces during the excavation.

The ware is of a very light reddish-yellow brick color, burnt uniformly all through. Thickness 3-4 mm. The shape is rather irregular, but at the rim there are concentric striæ indicating wheel-work. The painting is in violet-red which gives a very artistic effect upon the reddish-yellow ware. The decoration is a trellis-band underneath the rim, horizontal lines, and, across the interspace between these lines, two groups of vertical lines and two groups of narrow, high wave-lines. The design is very irregularly drawn.

Diameter of rim 135-139 mm.; diameter of bottom 71-72 mm., height 103 mm.

Fig. 6. Broad shallow bowl. Ware dark grey. Thickness 3-5 mm. Inside with irregular scratchings, outside well polished. Painting in red, consisting of two lines along the margin and two others at the bottom. In the interspace three spirals attached to the lower of the margin lines.

Diameter of mouth 170 mm., diam. of bottom 72 mm; height 57-62 mm.

Plate XV.

Monochrome pottery.

All figures 1/4 of natural size.

All the specimens are from Yang Shao Tsun, except fig. 1 & 6 which are from Pu Chao Chai.

Fig. 1. Ware brownish grey. Thickness 5-6 mm. The bottom densely perforated with holes, 7-8 mm. in diam. A row of holes also in the base of

the side-wall as shown by the figure. Lower two-thirds of the vessel covered with vertical basket pattern which is obliterated in the upper one third, the surface of which together with the collar is smooth with fine concentric lines indicating wheel work. The vessel has one (probably originally two) lugs, rectangular-oval in basal-plan, triangular in vertical section, with two deep notches on the upper side, but smooth below.

Height 295 mm., diam. of mouth 208 mm.

At first I interpreted this perforated vessel as a kind of colander made for the purpose of straining off some kind of fluid. But an observation made upon this specimen took my toughts in an entirely new direction. The bottom is on the underside and also the outside of the basal part of the side-wall, as far as the holes extend, covered with a crust of carbonate of lime of the characteristic kind known from vessels in which boiling and evaporation of water has been carried on for a long time. This made me believe that the vessel was used for steaming some kind of food, and that it during this procedure was placed upon some steam-raising vessel. It is even possible that we have found a specimen of this latter vessel in the tripod of the type Li which is reproduced in fig. 6 of the same plate. It will be noted that this Li differs from the common form in having on the inside a horizontal ring attached to the base of the collar. This ring was apparently for the purpose of placing some other vessel standing upon the Li, and then it is near at hand to suggest that this last named vessel was of the type shown by fig. 1.

I am fully aware that this hypothesis might seem very uncertain, specially as the Li looks much too unstable and weak to support such a high and heavy vessel. But it is interesting that, when in the spring of 1922 I had an opportunity to show some of my collections to Mr. Hua Shih Fu (華石斧) a noted scholar residing in Tientsin, he told me that there was such a combined vessel intended for steaming food known under the character Hsien (甗) and that an ancient form of this character shows a high vessel standing upon a Li tripod.

It might also be questioned whether this combined utensil is not related to a type of early bronzes figured for instance in Tao Chia Chi Chin Hsu Lu (匋齋吉金續錄) Vol. I. pp. 1, 2, 4.

These figures show a nearly cylindrical pot standing upon a Li tripod. If future more detailed research will prove that we have here a new instance of similarity between pottery of the Yang Shao culture on one side and archaic characters and early bronzes on the other, then this new instance of relationship between the said culture and early phases of Chinese history is the more remarkable as it is in this case the question of a very complicate and striking device.*

Fig. 2. Ware brown, fine. Thickness 3.5-6 mm. Highfooted piece, with the hollow foot supporting a basin-shaped vessel. The foot is perforated by seven holes, 20-23 mm. in diam. The upper basin-shaped part is on the outside decorated with a horizontal keeled ridge. The inside of the basin is set off in two parts, a marginal, gently sloping zone and a central deeper, bowl-shaped part. Surface scraped smooth. No distinct sign of wheel-work.

Height 215 mm., Diam. of basin-shaped upper part 202 mm.

Fig. 3. Mug with very big handle. Crude and irregular handwork. Height 57 mm., diam. of mouth 59 mm.

Fig. 4. Red-brown ware. Thickness 3-6 mm. Pot with flaring rim. The outer surface is covered with nearly obliterated oblique basket pattern upon which are superposed three horizontal keeled lines. The whole vessel, including these lines, is irregular and apparently handmade, but some kind of wheel-technique seems to have been applied for shaping the rim, the upper side of which is covered with fine regular striæ.

Height 113 mm; diam. of rim 117 mm.

The specimen, which was collected in five fragments, is interesting because two of the fragments are black, whereas the three others are brick-brown. After the pieces were put together, the two colors stand out in striking contrast, which can be explained only so that some of the fragments were affected by fire after the vessel was broken.

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* These bronzes are named with the character Hsien (鬳) which has been mentioned above. Mr. P. L. Yuan has kindly called my attention to the interesting fact that the right half of the character is the radical Wa (瓦) which means earthenware. This seems to indicate that these bronzes were derived from an earthenware prototype, as suggested by our archæological observations.

Fig. 5. Brown ware. Hand-made mug with an ear which is comparatively much smaller than that of fig. 3.

Height 68 mm., diam. of mouth 110 mm.

Fig. 6. Fragment of a Li-tripod of peculiar shape, so far unique in our collection. The legs are more inflated than those of the typical Li. On the inside there is at the base of the collar a horizontal ring as shown by the figure.

An explanation of the probable use of this device is given in the description of fig. 1 of this plate.

The whole outside of the vessel, including the collar, covered with deep mat-impression, over which there is upon the collar some incised horizontal lines. Surface dark.

Fig. 7. Narrow-necked vase. Ware brownish brickred. Surface yellowish brown. Handwork. The lower half or a little more of the outer surface with nearly obliterated basket-pattern, The upper part scraped smooth.

Height 306 mm.; diam of the mouth 117 mm; diam of bottom 88 mm.

Plate XVI.

Monochrome pottery.

All figures 1/4 of nat. size.

All the specimens are from Yang Shao Tsun, except fig. 1 & 8 which are from Pu Chao Chai and fig. 5 which is from a new locality.

Fig. 1. Ware light grey. This large vessel is of an exceedingly fragile build, the ware being only 2-4 mm in thickness. The specimen was collected in a large number of fragments and the bottom was missing. However, at the same place were found several equally thinwalled bottoms of the same ware and surface pattern, and to judge from those it seems probable that the vessel had a flat bottom with the side-wall smooth nearest to the bottom. The larger part of the outside of the sidewall is covered with vertical basket pattern, over which there run four horizontal incised lines below the equator and six others half way from the equator to the base of the collar. Between the uppermost of these lines and the collar is a smooth belt, where the basket pattern is entirely obliterated. In this smooth belt there are three incised lines. Also

the collar is smooth, both on the in- and outside, with fine striæ indicating wheel-technique. The inside of the vessel is irregular and pitted. Apparently the vessel was formed by hand (inside a frame of basket-work?) and only the collar and the uppermost smooth part of the outside was given its final shape by means of the wheel.

Equalorial diam. 270 mm.; diam of mouth 172 mm.; height of complete vessel approximately 360 mm.

Fig. 2. Ware greenish grey, very coarse. Thickness 7-8 mm. Small basin upon three rectangular legs. On the outside indication of two ridges similar to those of XV:4. Marginal part on the inside profiled, as shown by the figure. This part shows mark of wheel-work, otherwise the vessel is of rough making.

Height 109 mm.; diam. of mouth 224 mm.

Fig. 3. Ware fine, grey-brown. Small basin with both in- and outside scraped and slightly polished. Foot set off, and a slightly keeled ridge upon the lower part of the outside.

Height 69 mm.; diam of mouth 202 mm.

Fig. 4. Ware fine, reddish-brown. Thickness 4 mm. The shape of the vessel very clearly shown by the figure, except that there is a flat bottom, about 80 mm. in diam. The surface of the vessel is very peculiar. It is scraped smooth, burnished and blackened, so that it has a shiny appearance like black leather.

Height 112 mm., diam. of the widest part 242 mm., diam. of the vertical rim 204 mm.

Fig. 5. Ware coarse, brown. Pot, decorated with a wave-line ridge. Inner surface rough, outer surface dark, slightly shiny.

Height 183 mm.; diam. of widest part 223 mm.; diam. of mouth 176 mm.

Fig 6. Ware dark grey, surface of both in- and outside smooth. A miniature Li consisting of very short legs and an enormous collar, provided with a big lug which extends low down one of the legs.

Height 96 mm.; diam. of mouth 101 mm.

Fig. 7. Ware red-brown. Fragment of a small pot, characterized by deep and distinct mat-impression covering the whole outside except the collar and a narrow zone at the bottom which are both smooth.

Height 120 mm.

Fig. 8. Fragment of a pot with a big single lug. Ware grey. Inner surface exceedingly rugged. Outer surface covered with a rhomboid network of ridges. The outer surface sootish black. Flaring rim smooth, with fine regular striæ indicating wheel-technique.

Plate XVII.

Monochrome pottery.

All figures 1/5 of natural size.

Fig. 1. is from Pu Chao Chai, fig. 2-3 from Yang Shao Tsun and fig. 4 from one of the new localities.

Fig. 1. A big vessel of unique type.

The ware is light grey, with abundant sand intermixture. Thickness of wall 6-10 mm.

The outside has undergone a series of treatments before it obtained the final decoration. Originally is was all over covered with mat-impression, which is still very distinctly visible in the lower part. A broad zone below the rim is nearly entirely smooth, but even here numerous traces of the obliterated mat-impression can still be seen.

In a broad equatorial zone there is a rhomboid pattern impressed over the largely obliterated mat-impression. This rhomboid pattern ends abruptly at the lower border of the uppermost smooth zone, but below it merges into the bottom zone where the mat-impression still prevails.

The latest feature of the decoration is nine (or ten, counting a less distinct band at the bottom) horizontal smooth bands which in their way have obliterated both the previous patterns. These nine bands run in approximately equal interspaces, the uppermost one at the border between the rhomboid pattern zone and the uppermost smooth belt.

The rim is on the outside decorated with faint low vertical ridges.

The lowest part of the side-wall is pierced by six holes in groups of two, and 20-25 mm. in diam. These holes are close below the bottom which is attached to the sidewall about 5 cm above its base.

This huge vessel seems to have been altogether handmade.

Height approx. 560 mm.; diam. of mouth 360 mm.; diam. at base of side-wall 203 mm.

Fig. 2. Grey ware. Fragment of coarsely made broad vessel with pointed bottom. The inner surface is very rough indicating coarse handwork. The outer surface is covered with oblique basket pattern which is smoothened out and obliterated at the apex. The shape of the mouth remains unknown.

Ware grey, thickness 7 mm. at the apex, 3 mm. in the higher part.

Fig. 3. This is a fragment of a vessel of conspicuous and complicate shape.

The ware is grey, 5-7 mm. thick.

In the upper part the vessel is a simple pot, the bottom of which was probably slightly rounded as indicated by the figure. From the side of this pot an outer wall extends downwards in vertical direction. At the very joint-line of these two walls, the outer one is pierced by oval big holes, probably six in number. Round these holes the walls are sootish black, what has made me believe that the vessel was a kind of cooking stove, where the holes served for the escape of the smoke. The lower part of the vessel, with a supposed opening for the admittance of the fuel, is a mere construction.

Fig. 4. This is certainly one of the most remarkable types among the ceramics of the Yang Shao culture: a very large vessel with conical bottom and surprisingly delicate build.

The ware is brickred, the vessel is very thinwalled, 3-4 mm.

The shape is fully shown by the figure. The mouth is unknown.

Inner surface rather irregular with shallow pits. Outer surface everywhere uniformly covered with very fine and exceedingly sharply impressed stringlines which radiate from the apex of the vessel. These lines lie so regularly and closely together, that it becomes probable that they are not

formed as single string impressions but rather are the impression of a very fine cloth which covered the whole vessel.

The two lugs are rather carelessly superposed upon this cloth-impression.

Length of the vessel in its present fragmentary state about 570 mm.; Diam. of widest part 246 mm.

From the same locality we have numerous fragments of another specimen, sufficient to reconstruct the shape of the vessel except the unknown mouth. This specimen, which is shown in textfigure 14, differs from XVII:4 in the

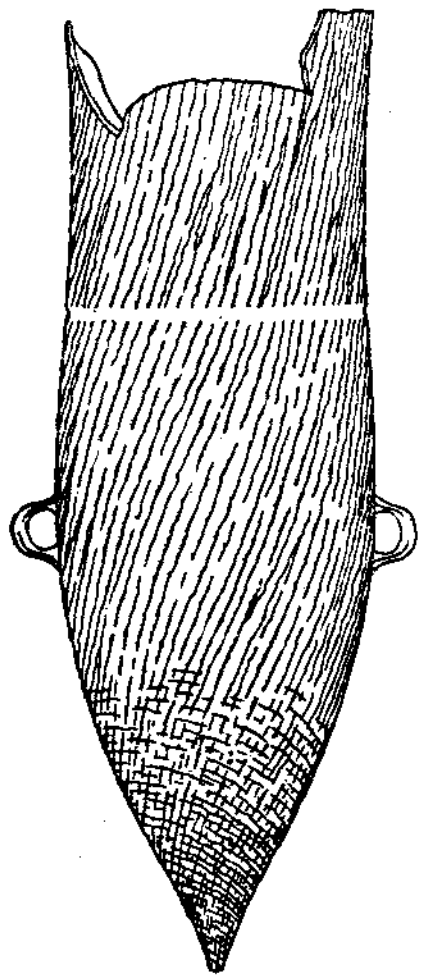


Fig. 14. Reconstruction of large vessel with pointed bottom. 1/6.

following points: the wall is thicker, 5-7 mm., the stringline- or cloth-pattern is much coarser, near the apex there are two intersecting systems of lines, the shape of the vessel is more slender, the apex more sharply pointed and the lugs attached a little below the widest part of the vessel.

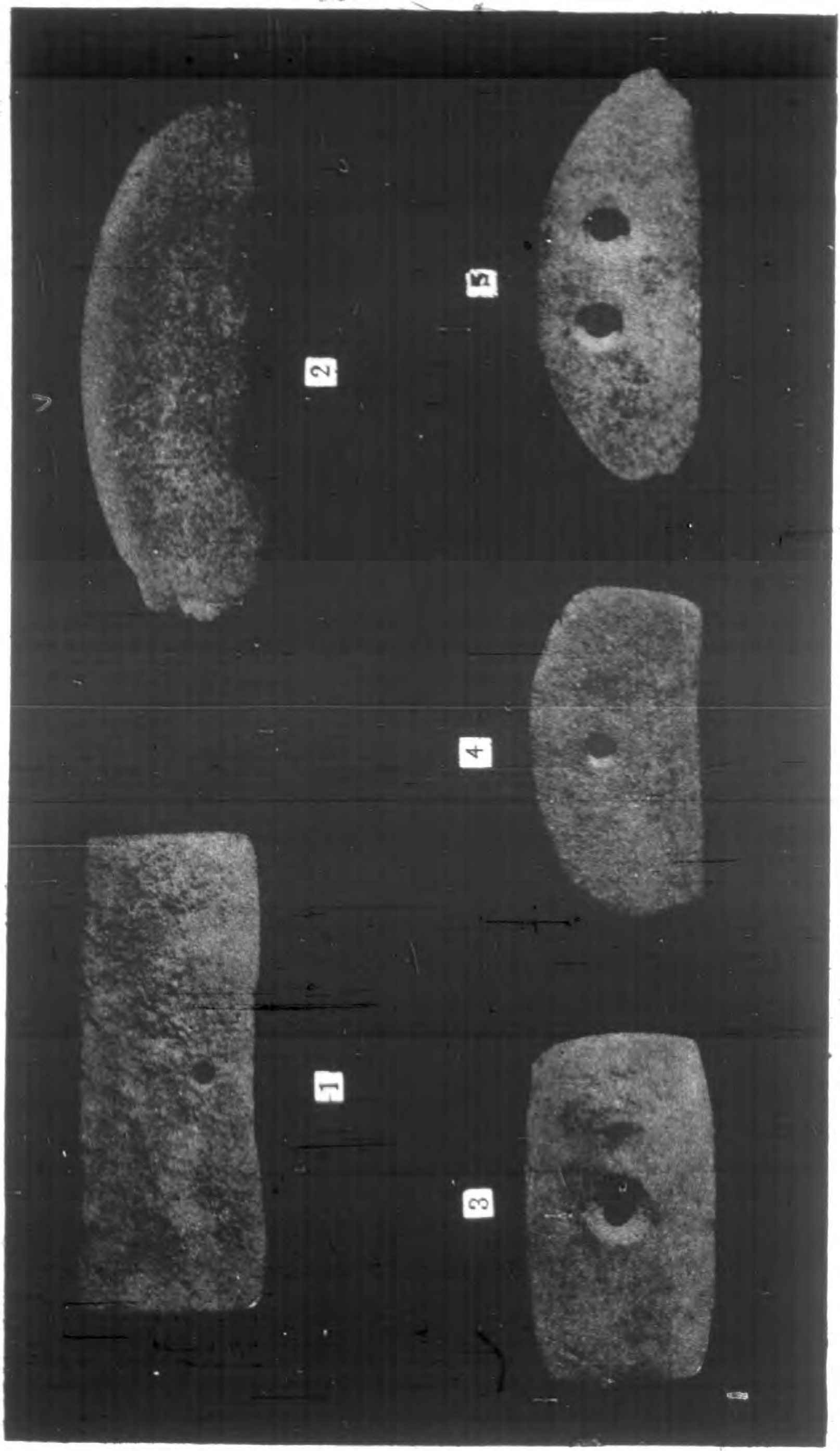
It will be noted that we have described from the Yang Shao sites three types of vessels with pointed bottoms. One is the form just described, a very big thinwalled vessel of brickred ware and covered with fine cloth pattern. Another is the type figured in Pl. VII:1, a smaller pointed vessel, also of brickred ware, decorated with string lines and with contracted neck. A third coarser type is XVII:2, a broad vessel with basket-impression and made of grey ware.

In this connection it is interesting to mention that clay vessels with pointed bottom are still to some extent in use in China. Textfig. 15 shows a

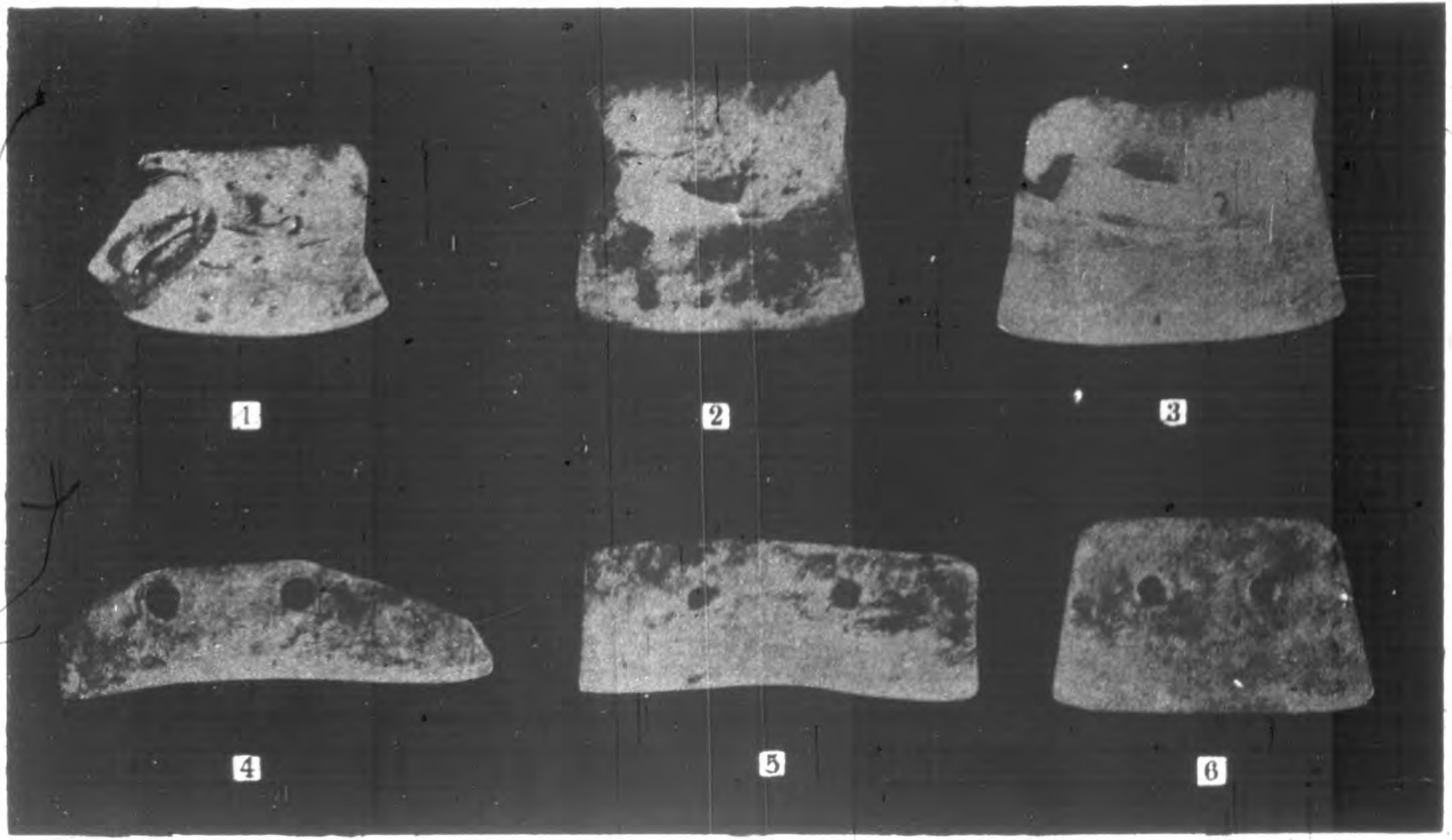
Fig. 15. Modern vessel with pointed bottom. 1/6.

small vessel of this kind which I found on board a river boat, with which I travelled on the Yellow river from Yuan Chü Hsien down to the bridge of the Kin-Han railway. It has a yellow to brownish red glaze and is entirely undecorated. Such vessels are said to be manufactured at K'uang K'o in Hsin An Hsien at the Yellow river.

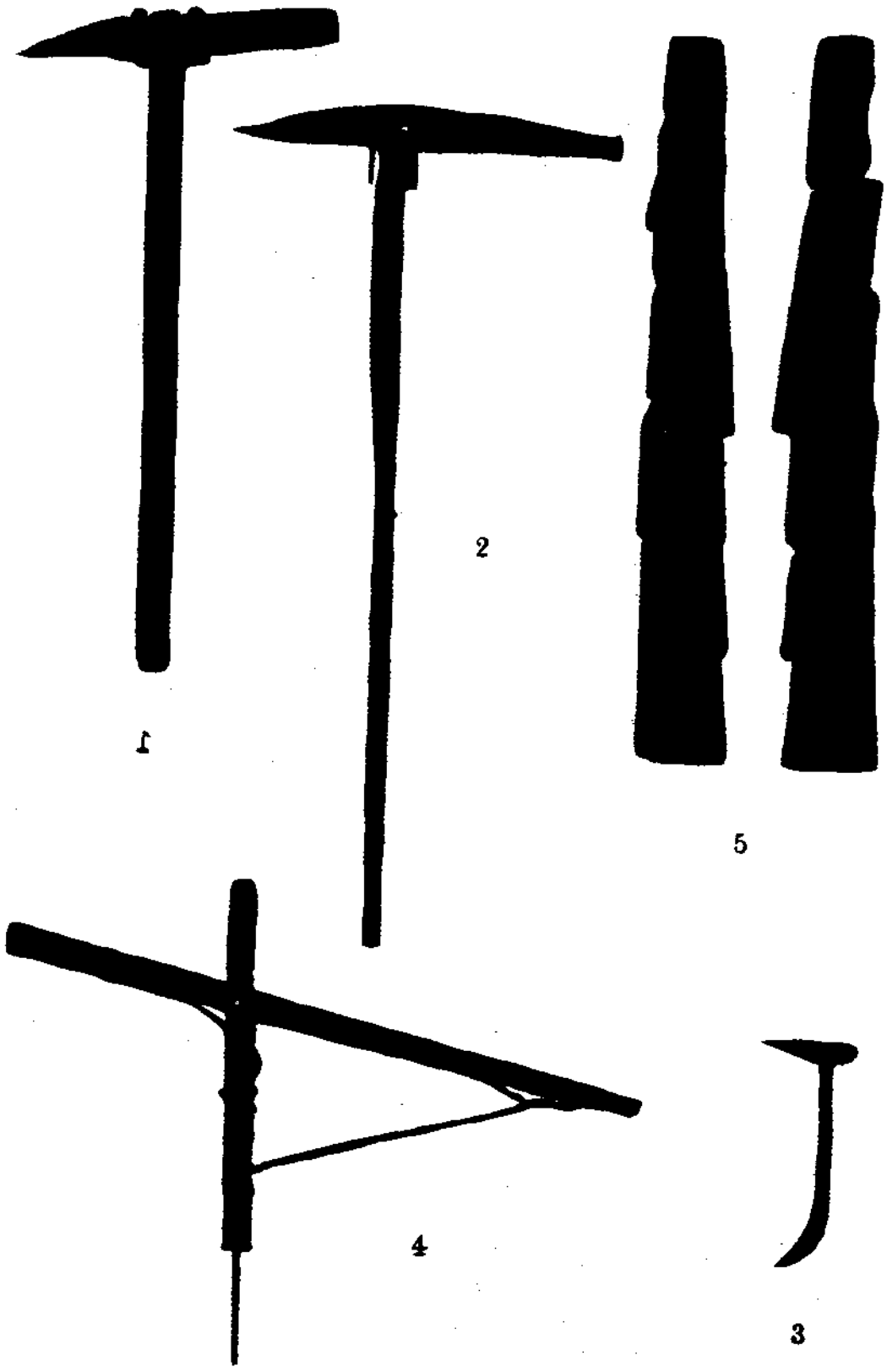
Clay vessels with conical bottom were common in the early Neolithic of Scandinavia, but those pots are of a much cruder make than the vessels of the Yang Shao culture. Gracefully shaped conical vessels are known from early Egyptian dynasties and from other areas of the eastern Mediterranean, but I have at present too little of the literature on those areas to be able to make any comparisons.



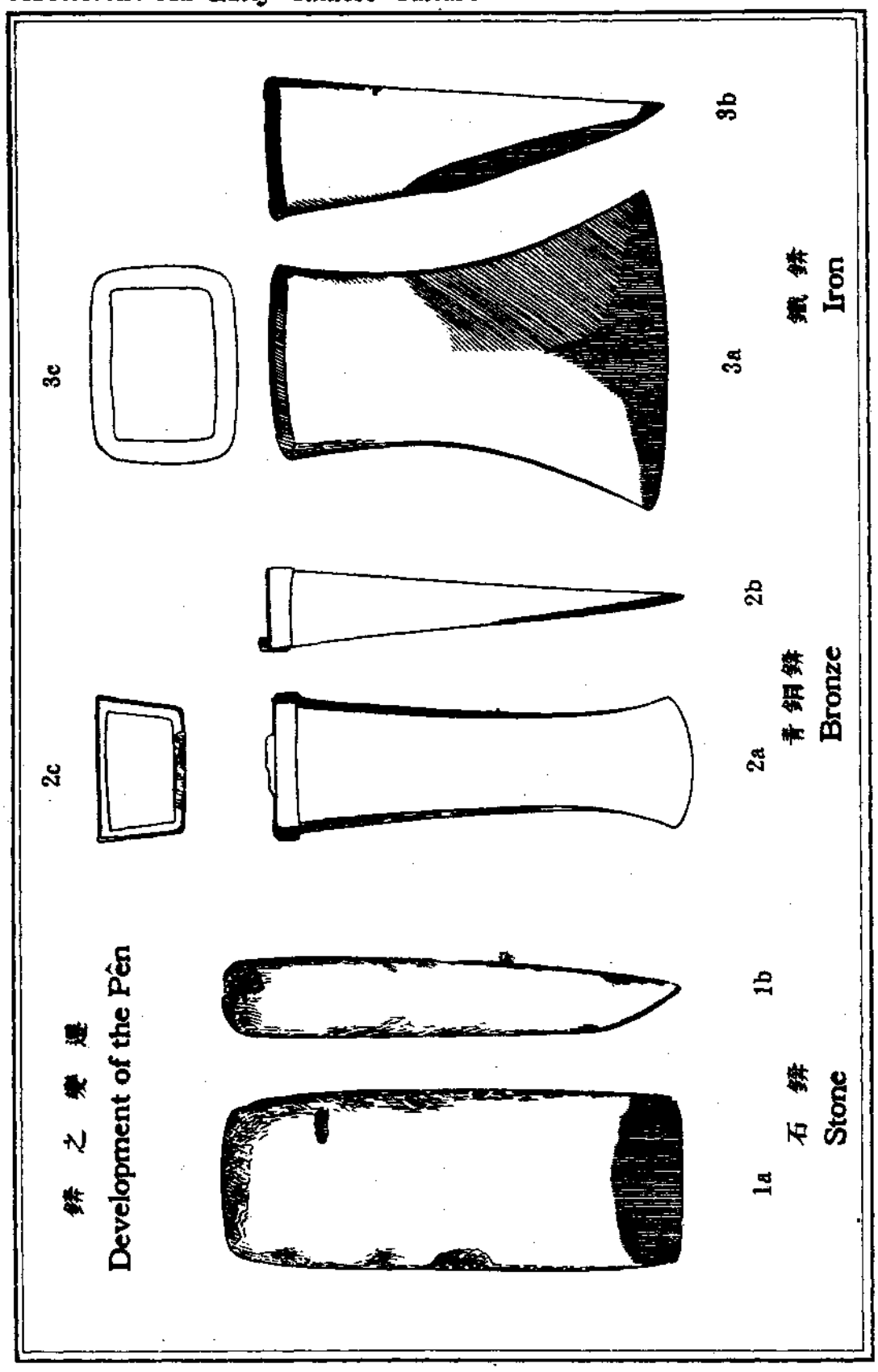
Rectangular and semilunar stone knives. 鏃石式月牛及式方長



Rectangular, trapezoidal and semilunar iron knives. 鎌鐵式月牛及式方梯式方長



arpenter tools (1—4) and the knife sharpener's sounding instrument (5)
(五圖)(圭金之謂諧行)速滑鐵匠刀磨及(四至一圖)械器匠木


鏟之演進
Development of the Pên
石鏟
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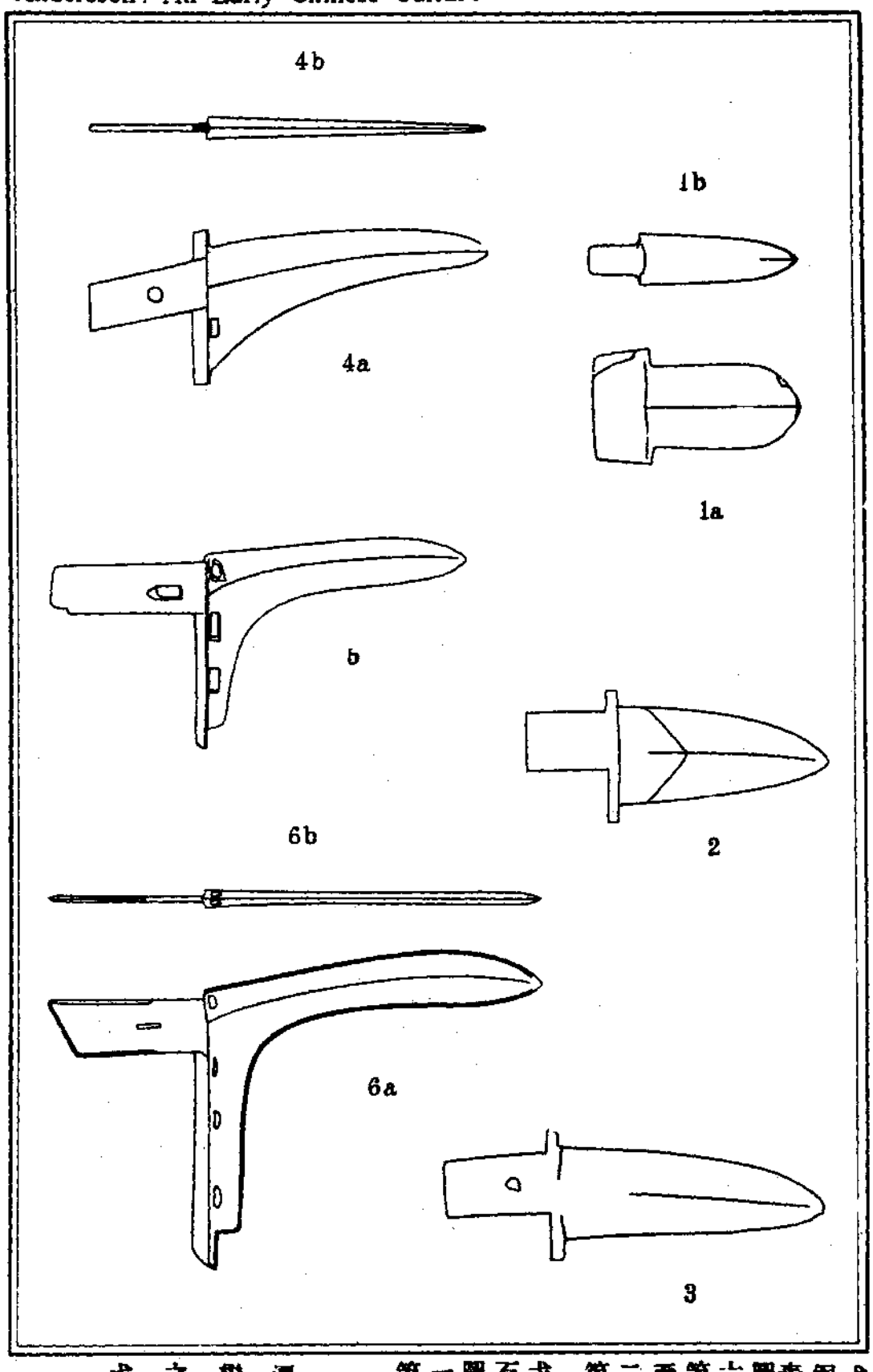
1b
青銅鏟
Bronze
2a
2b
2c
鐵鏟
Iron
3a
3b
3c



戈之變遷　　第一圖石戈　第二至第六圖青銅戈

Development of the Ko. (Fig 1. Stone; Fig 2-6 Bronze.)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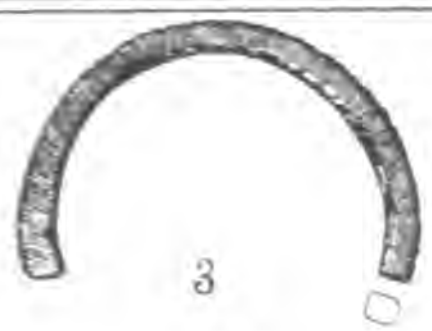
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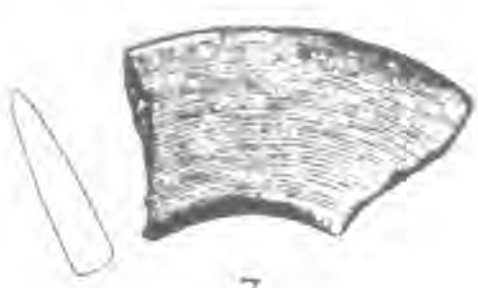
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Artifacts of the Yang Shao Culture.

仰韶文化遺物

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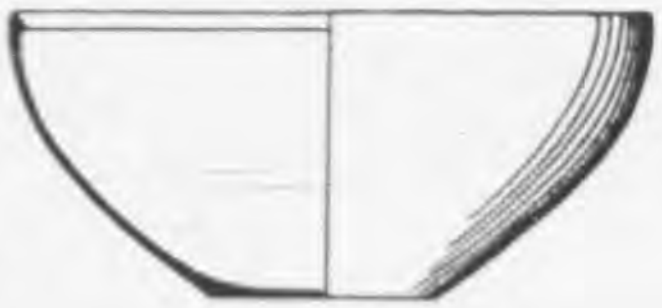

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Monochrome Pottery of the Yang Shao Culture.

仰韶石器文化之單色陶器

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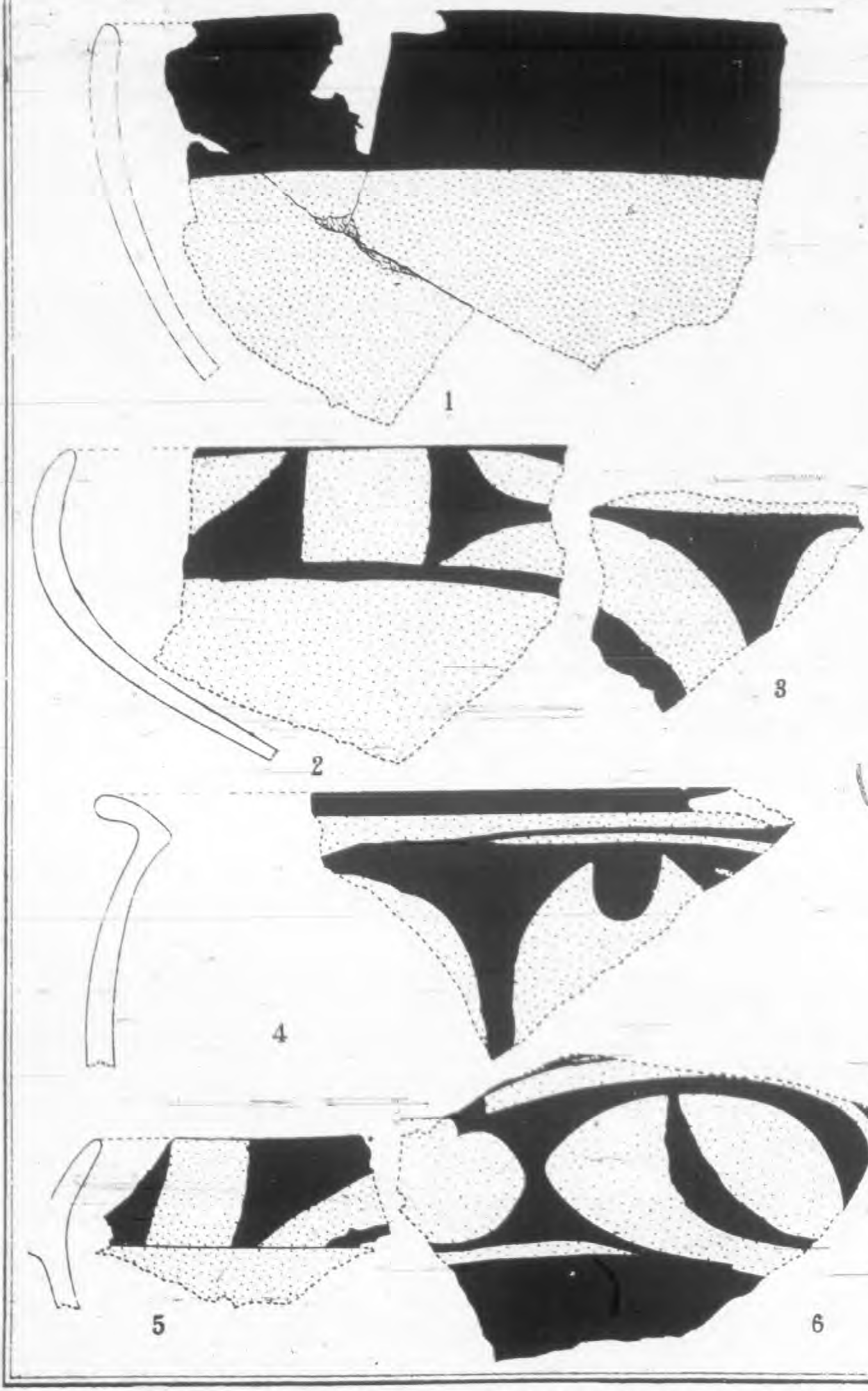
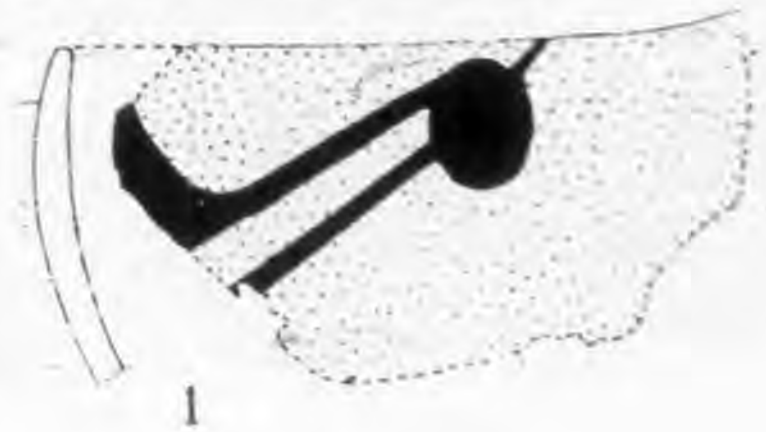
Fig. 1. Clay Li of the Yang Shao Culture. Fig. 2 & 3. Bronze Li of Chou Dynasty. (三至二圖)周銅鬲(一圖)齊陶之紀化文仰



Painted pottery. Yang Shao Tsun. Half of nat. size. 半之小大物厲表村韶仰器陶色彩



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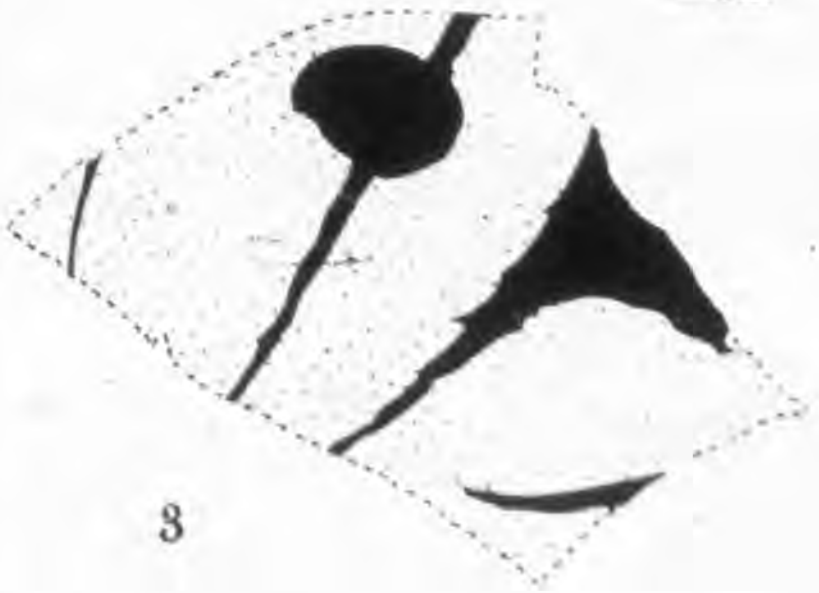

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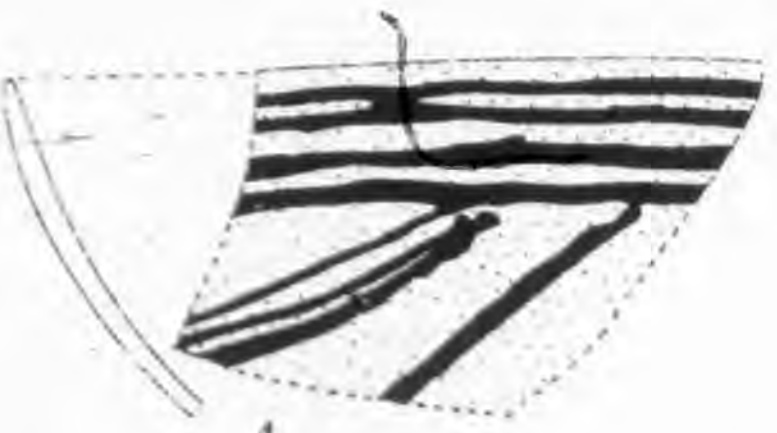

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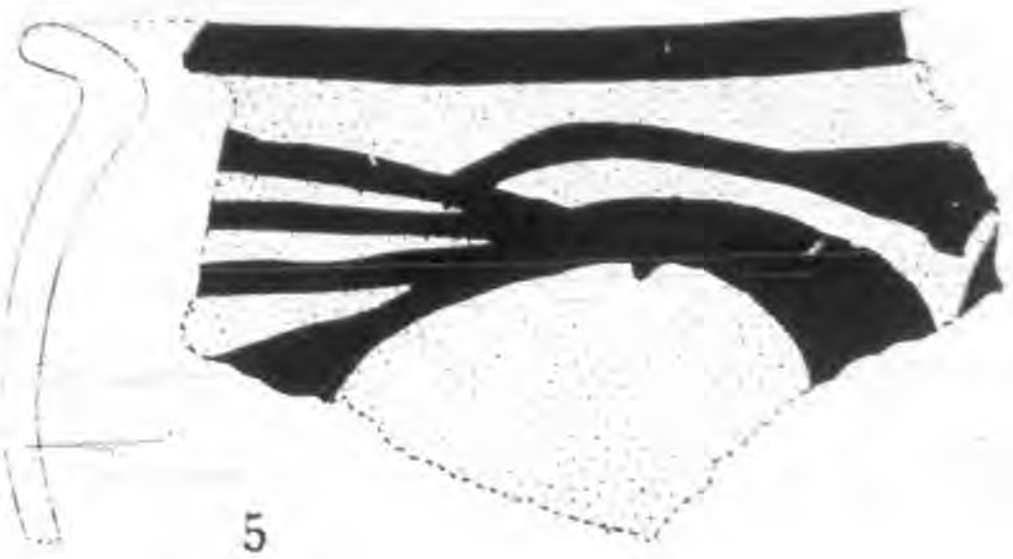

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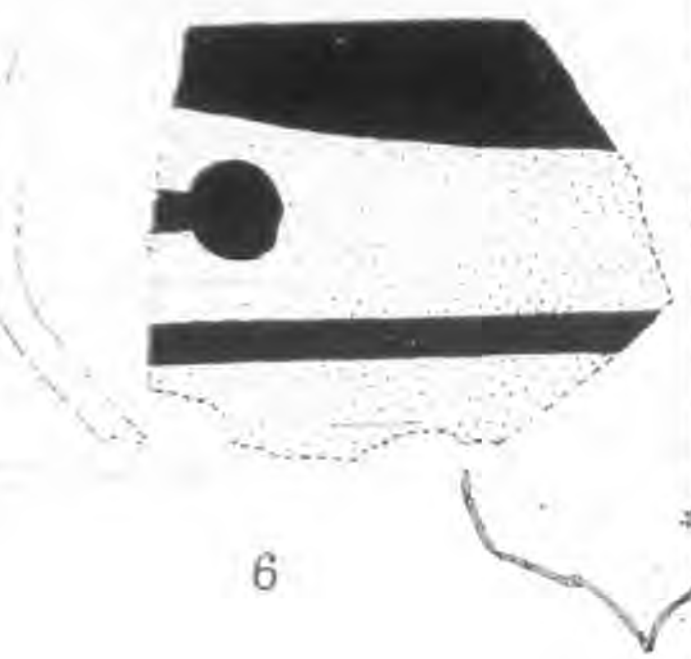

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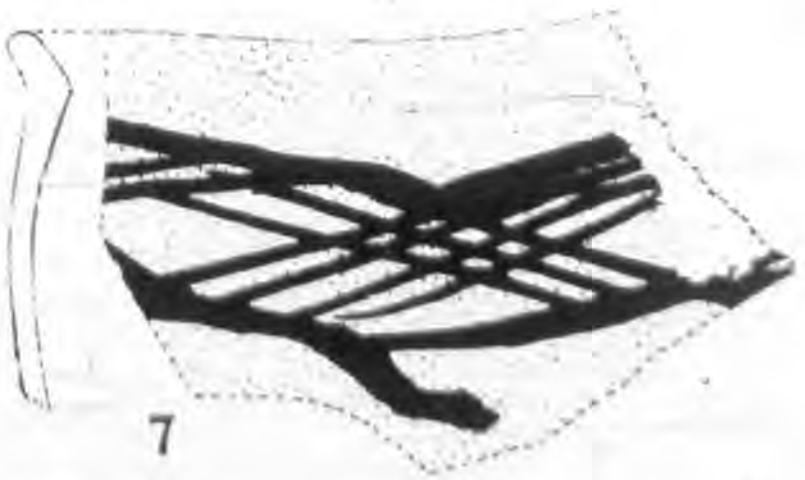

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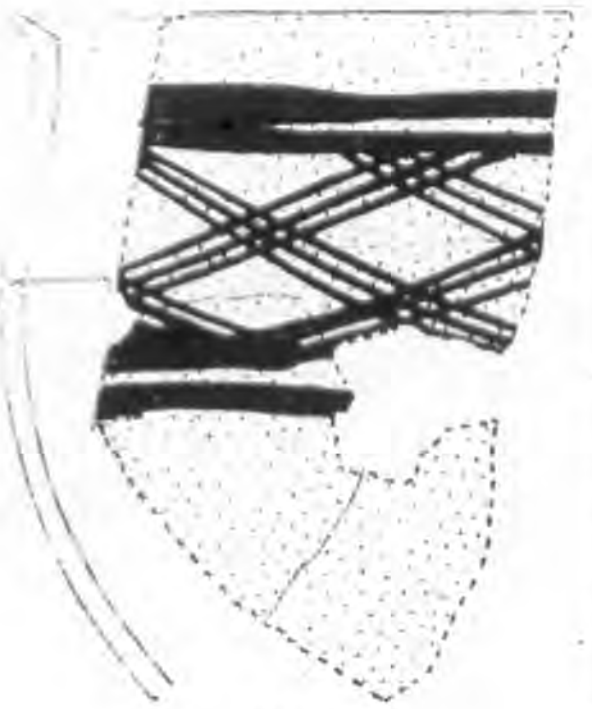

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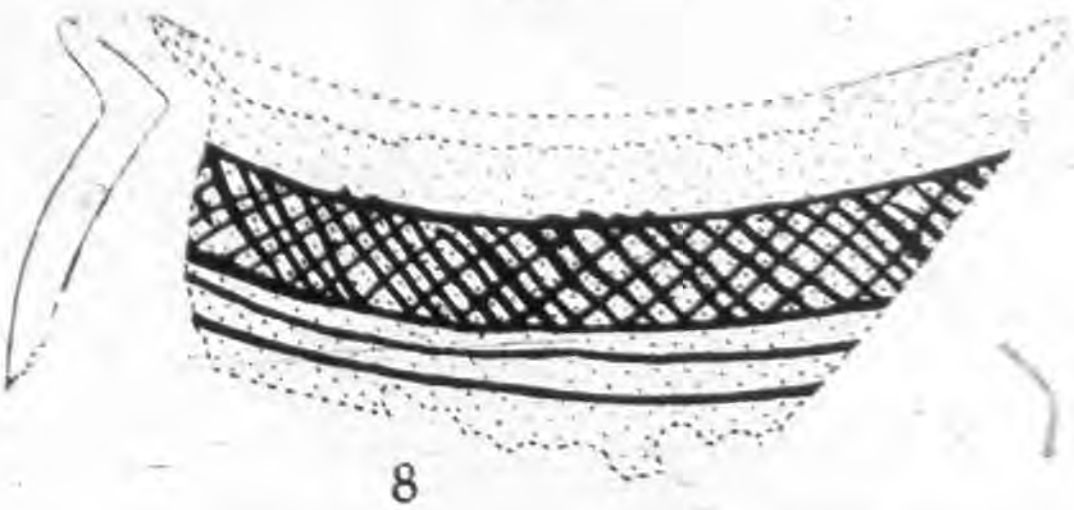

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Paintadpottery. Yang Shao Tsun. Half of nat. size. 半 之 小 大 物 原 表 村 韶 仰 器 陶 色 彩


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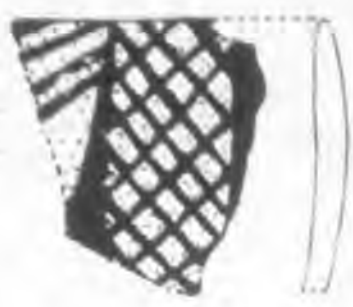
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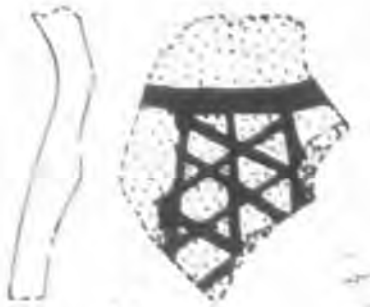
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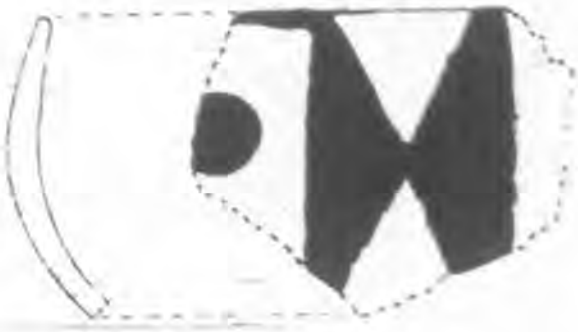
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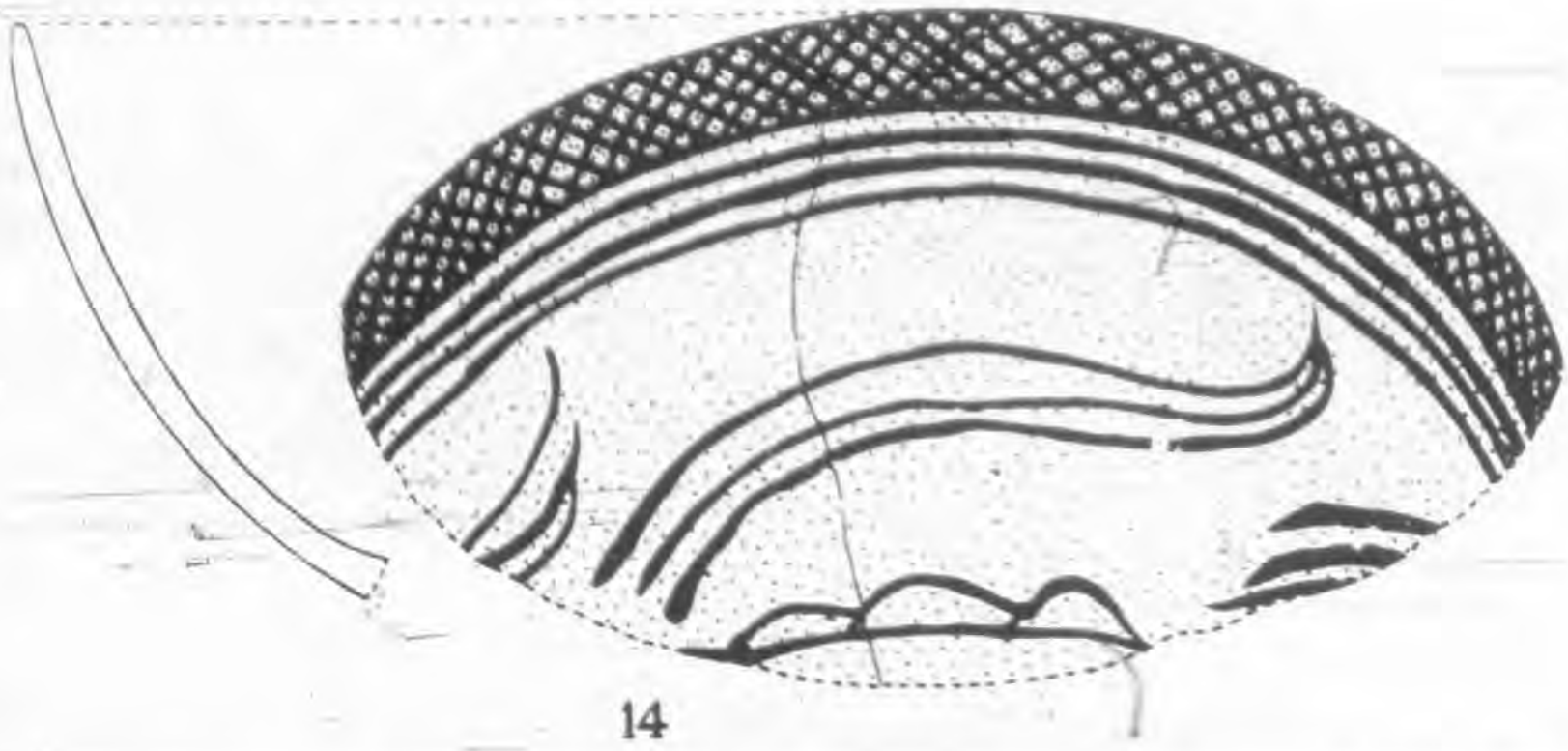
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Painted pottery. Yang Shao Tsun. Half of nat. size. 半之小大物原表村紹仰彩陶色彩

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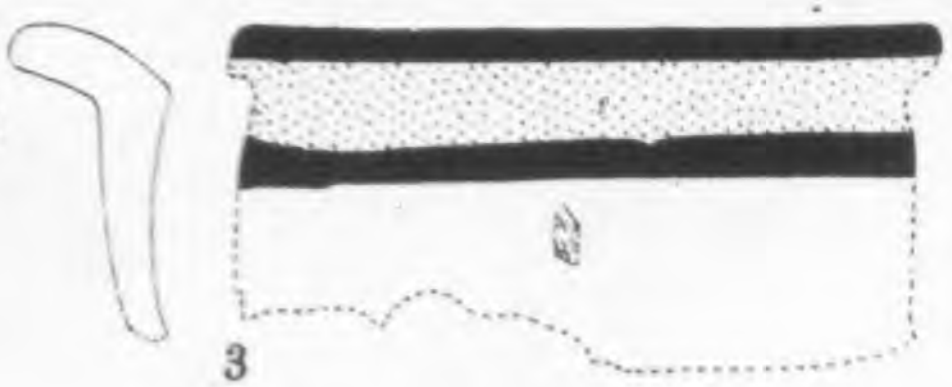

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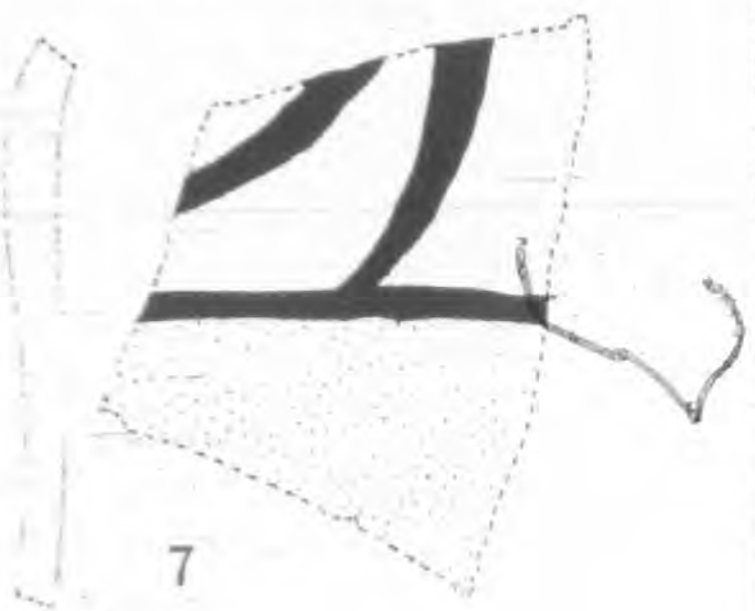

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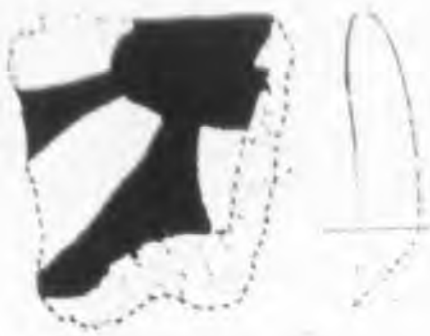

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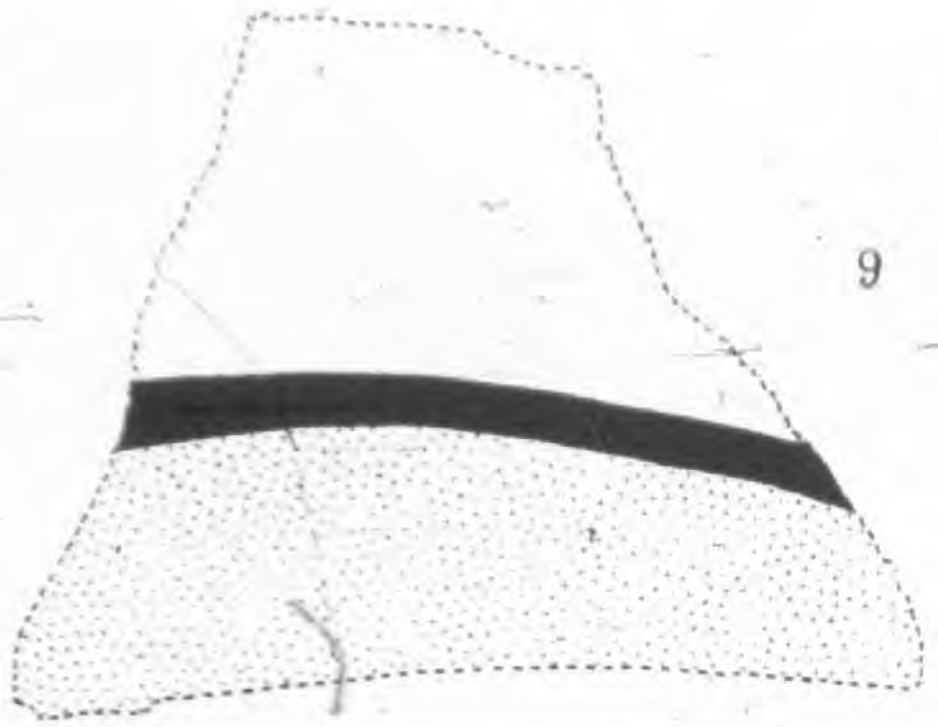

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Painted pottery. Yang Shao Tsun. Half of nat. size. 半 之 小 大 物 原 表 村 韶 仰 器 陶 色 彩

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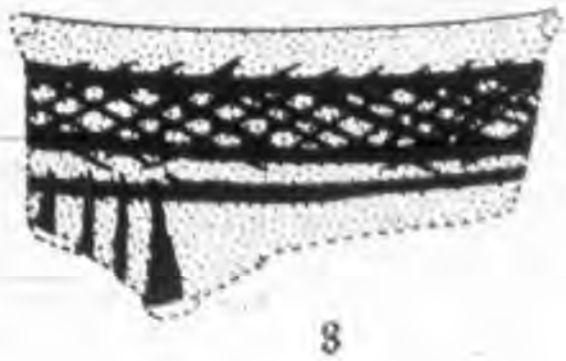

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代時化文(基羅其堡)諾亞
ANAU. CULTURE I.

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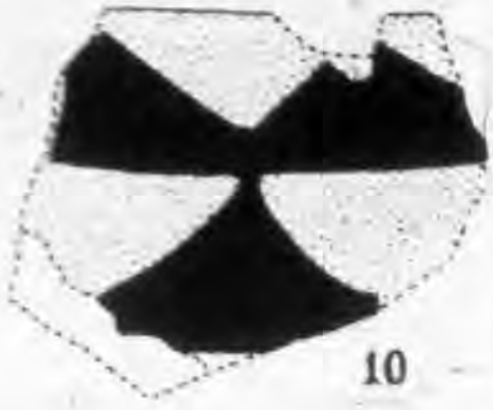

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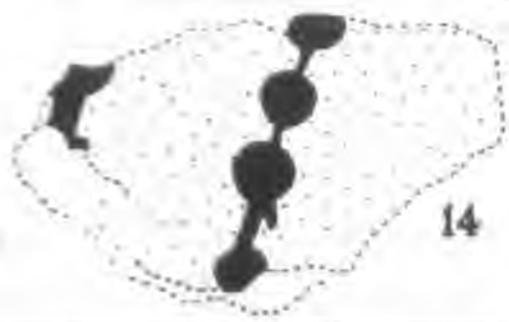

14

代時化文(塔鼎營)留波里脫
TRIPOLJE CULTURE A.

15

Comparison between painted pottery of Honan, Anau & Tripolje

圖較比之器陶色着底三留波里脫諾亞南河

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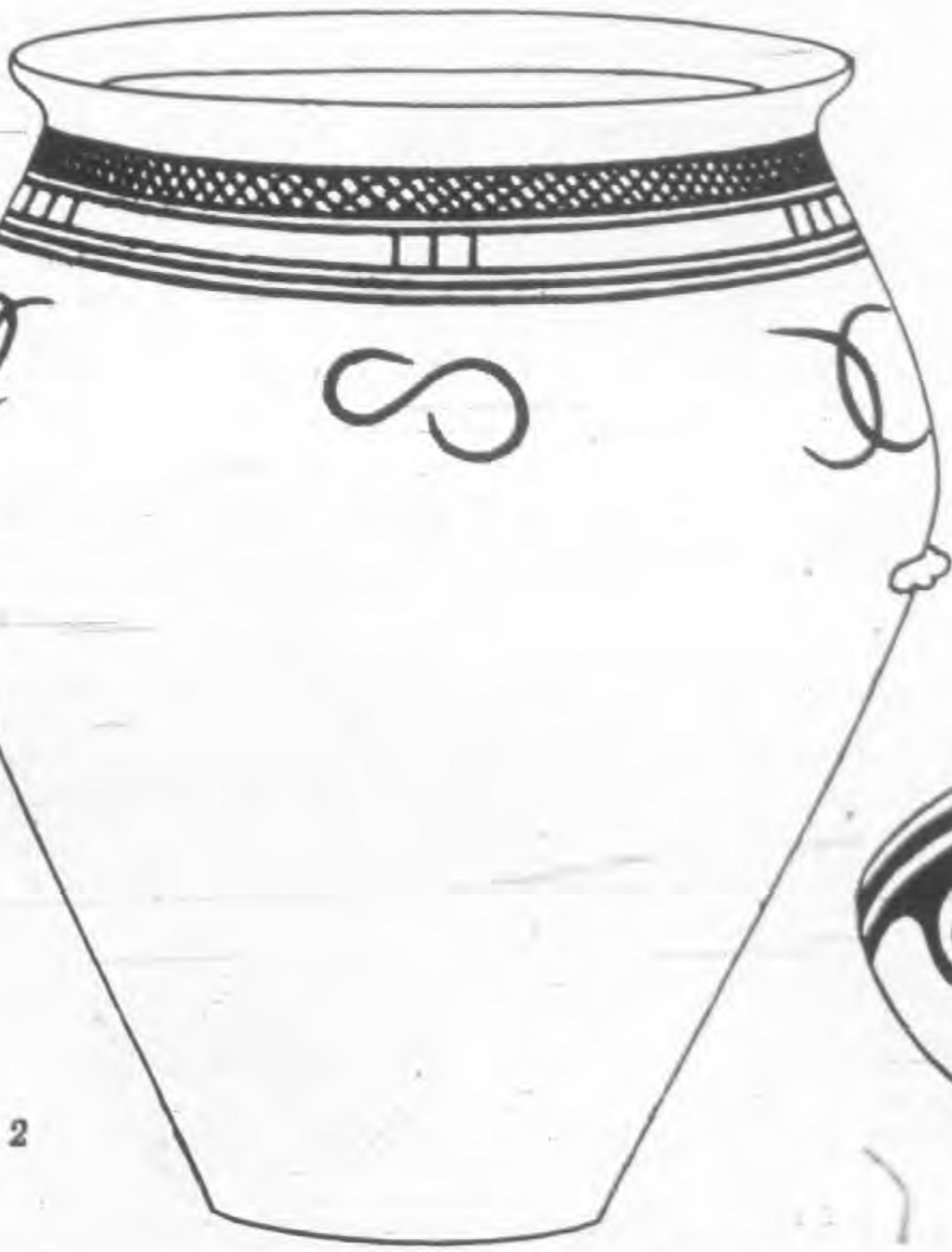

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Selected Monochrome Pottery of the Yang Shao Culture. 1/4 of natural size

一之分四小大物原表當相者產所村韶仰與器陶色單之美完最

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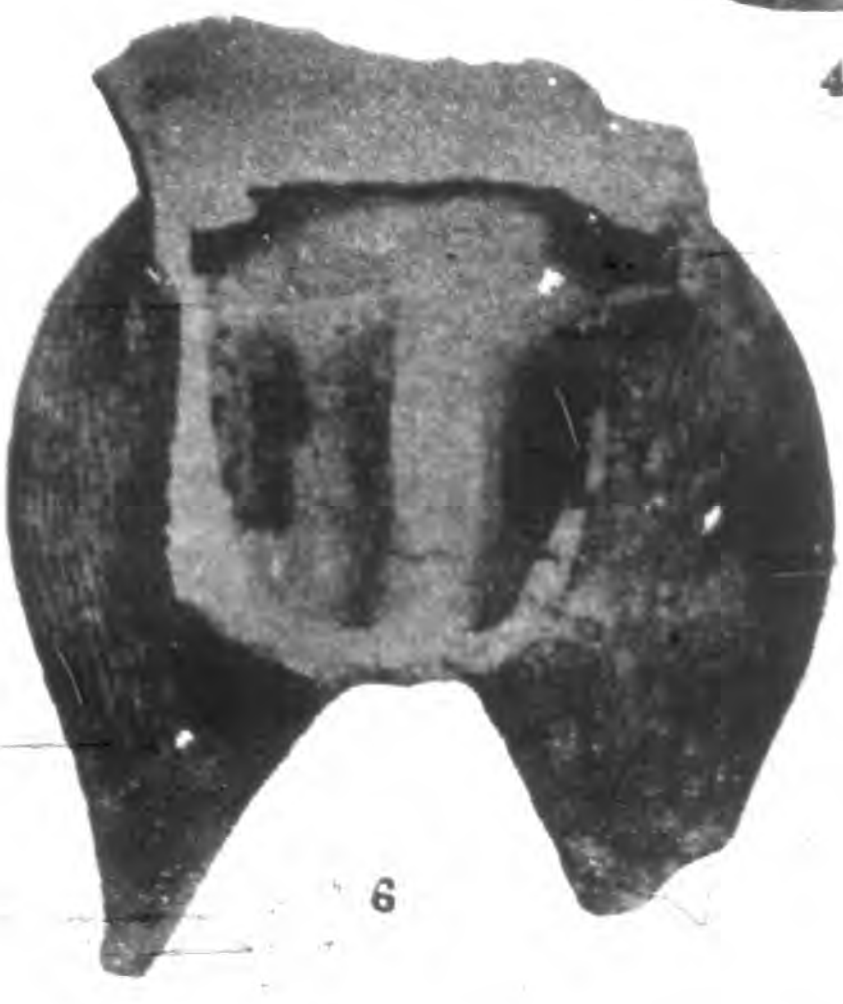

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Selected Monochrome Pottery of the Yang Shao Culture. 1/4 of natural size.

一之分四小大物原表當相者產所村韶仰與器陶色單之美完最

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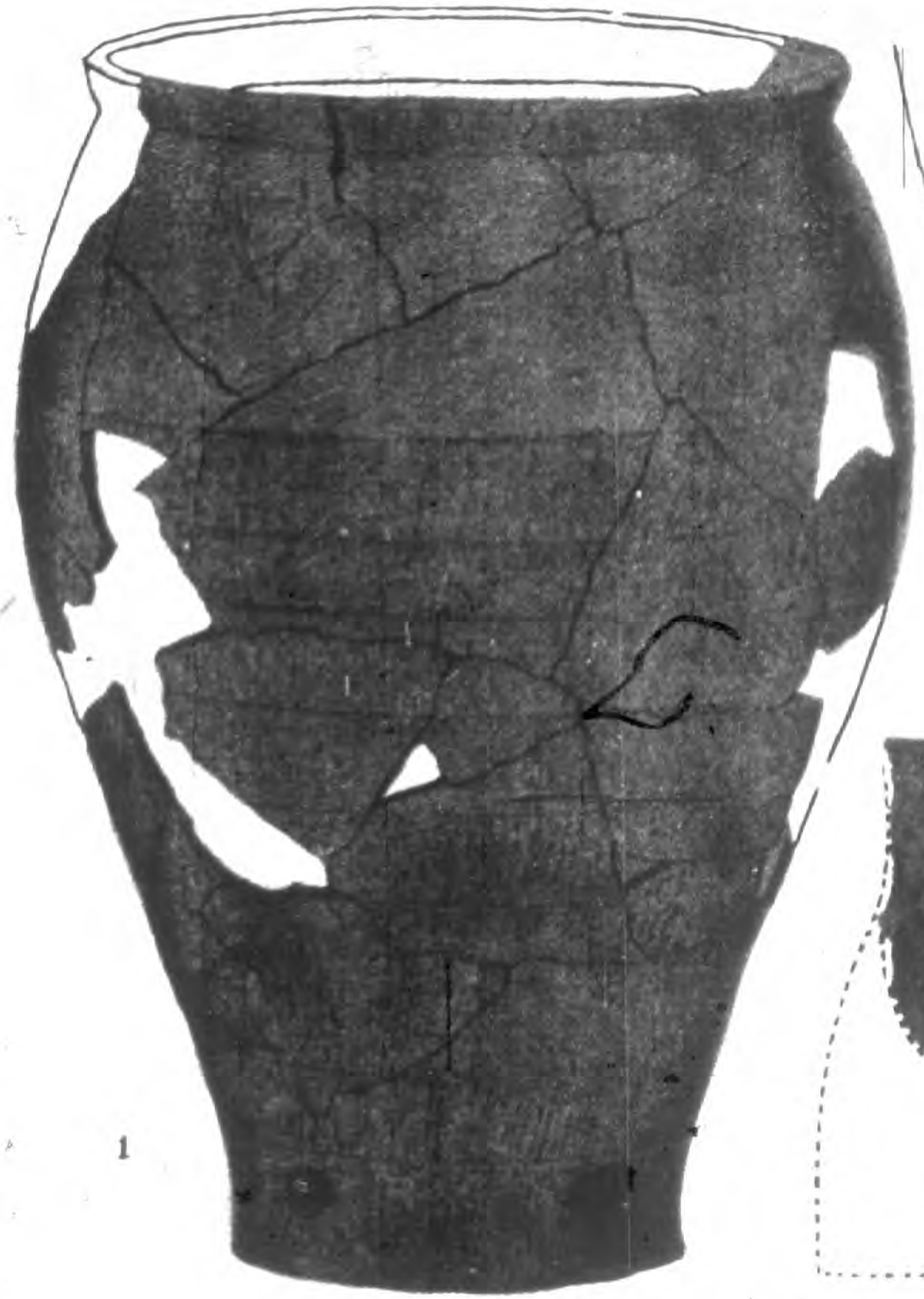
Selected Monochrome Pottery of the Yang Shao Culture. 1/4 of natural size.
一之分四小大物原表當相者產所村韶仰與器陶色單之美完最



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Selected Monochrome Pottery of the Yang Shao Culture. 1/5 of natural size.

一之分五小大物原表當相者產所村韶仰與器陶色單之美完最

FUNDORTE DER HIPPARION-FAUNA UM PAO-TE-HSIEN IN NW-SHANSI.

Von

O. Zdansky.

TOPOGRAPHIE.

Im nordwestlichen Shansi, im Gebiete von Pao-Te-Hsien, liegt eines der Zentren für den Handel mit fossilen Knochen im nördlichen China. Pao-Te-Hsien selbst liegt 8 Tagereisen nord-westlich von der Provinzhauptstadt Tai-Yuan-Fu, am Gelben Flusse. Das zu besprechende Gebiet liegt im Nordosten von Pao-Te-Hsien und hat seinen Mittelpunkt ungefähr in Chi-Chia-Kou, etwa 13 km nordöstlich der Stadt.

Das Land ist ein vom Westen, vom Gelben Flusse, nach Osten allmählich ansteigendes Plateau, das aber von zahlreichen Schluchten und Gräben zerschnitten wird, so dass der Eindruck zunächst der eines Hügellandes ist, bis ein Blick aus grösserer Entfernung die Gleichmässigkeit des Ansteigens zeigt.

Die beigefügte Karte zeigt die Topographie und Geologie der Gegend. Wie man sieht, gehen fast alle Täler bis auf das Karbon hinab, in welches das Wasser oft 10-15 m tiefe, enge Schluchten eingeschnitten hat. Fast überall tritt Kohle zutage, die in zahlreichen Gruben abgebaut wird, meistens freilich nur für den Hausbedarf. Im Grossen und Ganzen liegt das Karbon horizontal, wenn die Schichten auch örtlich schwach geneigt sein können. An der Grenzfläche zwischen Karbon und dem überlagernden Hipparionlehm treten häufig kleine Quellen zu Tage.

LU TZU-KOU—SERIE.

Auf einem ganz kleinen Gebiet (teilweise in der Nordwestecke der Karte zu sehen) folgen über dem Karbon Schichten, deren genaues Alter sich wohl nach erfolgter Bestimmung der gefundenen Fossilien bestimmen lassen dürfte. Einstweilen sei dafür der Name Lu-Tzu-Kou-Serie, nach dem Hauptfundorte, vorgeschlagen. Die räumliche Erstreckung dieser Sedimente beschränkt sich auf das Tal, in dem das Dorf Chung-Lu-Tzu-Kou gelegen ist, mit

seinen Seitentälern, sowie auf das im Norden folgende Paralleltal. Weder im Norden, noch im Süden, noch im Osten ist etwas davon zu sehen, doch sah der Verf. während einer Reise nach Nan-Sha-Wa etwa 30 km nördl. von Chi-Chia-Kou zwischen Karbon und Hipparionlehm eine etwa 30 cm starke Schichte von Quarzrollsteinen, die wahrscheinlich einen Teil der Lu-Tzu-Kou-Serie darstellt. Nach Westen zu schliesslich reichen diese Schichten bis fast an den Gelben Fluss heran.

Bei Chung-Lu-Tzu-Kou erreicht die in Frage stehende Schichtfolge an einzelnen Punkten eine maximale Mächtigkeit von 25-30 m, jedoch kommen in nächster Nähe auch geringere Mächtigkeiten vor. Die Serie beginnt über dem Karbon regelmässig mit einer Schichte Quarzgerölles (auch ein Stück Jadeit wurde darunter gefunden), dessen Zwischenräume durch gelbe und grüne Quarzsande ausgefüllt sind. Stellenweise kann durch festere Bindung eine Konglomeratbank gebildet werden (s. Fig. 1). Als Einschlüsse können Linsen feinen Sandes sowie Brocken grünen Mergels mit *Fischresten* vor handen sein. Diese Geröllschichte enthält spärlich abgerollte *Knochensplitter* und *Zähne* grösserer *Säuger*. Gefunden wurden je ein Zahn eines *Equiden*, eines *Rhinoceriden* und eines *Nagers*. Über dem Gerölle folgen dann grüngelbe Mergel und Mergelkalke mit *Süsswassermollusken* und *Pflanzenabdrücken*. Darüber können feine gelbe Sande mit Kreuzschichtung auftreten. In diesen wurde ein *Rhinocerosunterkiefer* gefunden. Ein bemerkenswerter Horizont wird von grünlichweissen, geschichteten Kalkmergeln gebildet, die stellenweise von Fischresten ganz erfüllt sind. Daneben kommen *Mollusken* in geringer Anzahl vor, doch kann es sich an manchen Stellen innerhalb desselben Horizontes gerade umgekehrt verhalten. Soweit sich bisher feststellen liess, sind die Mollusken durch je 2 Arten von *Gastropoden* und *Lamellibranchiaten* vertreten.

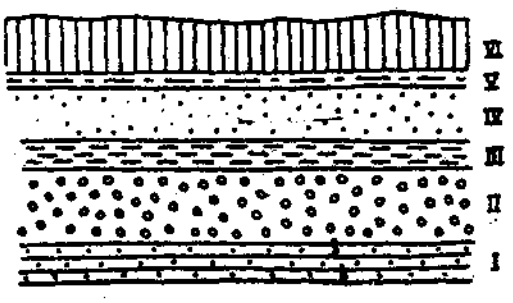

Fig. 1. Profil durch die Lu Tzu Kou Schichten des Sang T'a-Kou.

Das zwar nicht mächtigste, aber, was das Vorhandensein der verschiedenen Komponenten betrifft, vollständigste Profil sei hier wiedergegeben. Es stammt vom Osthange des Sang-T'a-Kou, das sich südöstlich von Chung-Lu-Tzu-Kou in das Haupttal öffnet und ist auf Fig. 1. und Taf. I, Fig. 1. zu sehen.

VI mehr als 4 m rötliches, lössartiges Material mit Knochensplittern und *Rhinoceros* zahnfragmenten in einer Schichte von Kalkkonkretionen an der Basis.

V 1.3 m grünlichweisse, geschichtete Kalkmergel mit zahlreichen Knochensplittern grösserer *Säuger* und *Mollusken*.

IV 4.5 m feine gelbe Sande mit Kreuzschichtung. *Rhinoceros* unterkiefer.

III 2.3 m grüngelbe Mergel und Mergelkalke mit *Fischresten* und *Mollusken*.

II 6.5 m Quarzgerölle, die Zwischenräume von gelben und grünen Sanden erfüllt. Stellenweise eisenschüssig und erhärtet. Zuweilen Linsen grünen Sandes und Mergelbrocken einschliessend. Enthält abgerollte Knochensplitter und Zähne von *Säugern*.

I Karbon.

Während dieses Profil die Frage nach der Beziehung der Lu-Tzu-Kou-Serie zum Hipparionlehm nicht in zufriedenstellender Weise beantwortet, da das nach oben zu abschliessende rote Sediment, wie so häufig, weder vom Löss, noch vom Hipparionlehm mit Sicherheit zu unterscheiden ist, so wird diese Frage völlig klar durch ein Profil aus dem Ch'i-Tzu-Kou, dem nördl. Paralleltale des Lu-Tzu-Kou, das auf Taf. I, Fig. 2. zu sehen ist. Die verlassene Wohnhöhle, deren zwei Öffnungen zu sehen sind, liegt noch in den in Betrachtung stehenden Ablagerungen, die gerade dort eine härtere Mergelbank bilden und reich an *Fischresten* sind, darüber aber folgt mit scharfer Grenze der Hipparionlehm, der sich dort nicht nur durch seine deutlich ausgeprägte petrographische Natur, sondern auch durch Fossilführung mit Sicherheit als solcher zu erkennen gibt.

Im Lun-Ch'üh-Kou (auf der Karte sichtbar) tritt eine Schichte grünlichen Kalkmergels reich an *Gastropoden* und mit einigen *Fischresten* in einem roten Lehm auf, der dem Hipparionlehm äusserst ähnlich sieht.

Bis zur Bearbeitung des Fossilmateriales ist auf Grund seiner vorläufigen Sichtung und aus geologischen Erwägungen heraus für die Lu-Tzu-Kou-Serie miozänes Alter anzunehmen. Die Lagerung ist schwebend.

HIPPARIONLEHM.

Die eben besprochenen Ablagerungen fehlen aber in dem weitaus überwiegenden Teil des untersuchten Gebietes und das Karbon wird vom Hipparionlehm überlagert, teilweise direkt, meistens aber unter Einschaltung einer Konglomeratbank von wechselnder Mächtigkeit, die bis auf 4 m steigen kann. Rollsteine sowie Bindemittel sind Kalk. Die Lagerung ist schwebend. Die Bildung der Schicht ist jedenfalls derjenigen des Hipparionlehmes unmittelbar vorangegangen. Fossilien finden sich darin nicht. Topographisch tritt das Konglomerat dadurch hervor, dass es, zwischen den obersten, mergelschieferartigen Gliedern des Karbon und den roten Lehmen eingelagert, härter als beide, in den Schluchten eine, meist unterhöhlte, Steilstufe bildet. Zu bemerken ist, dass sein kalkiges Bindemittel grau ist, während die Geröllbänke, die im Hipparionlehm auftreten, durch den roten Lehm gebunden sind.

Darüber folgt der schon wiederholt genannte Hipparionlehm, roter Lehm, der dem von Pikermi in jeder Hinsicht gleicht. Die grösste beobachtete Mächtigkeit beträgt etwa 65 m. Eine Unterteilung in verschiedene Horizonte lässt sich a priori nicht durchführen, da die häufig vorkommenden Geröllbänke nicht konstant genug sind. Diese lassen jedoch erkennen, dass schwebende Lagerung vorliegt. Spärlich kommen Lagen von Kalkkonkretionen vor. In diesem Lehme nun befindet sich in etwa 1150 m ü. d. M. (vergl. die Karte) ein fossilführender Horizont, der von der Bevölkerung ausgebeutet wird. Die Reste der durch *Hipparion Richthofeni* Schl. charakterisierten Fauna kommen in Nestern vor, welche in meist geringem Raum (½-2 kbm ist das Normale) eine grosse Menge von Knochen der verschiedensten Formen durcheinandergemengt enthalten. Ganze Skelette wurden nicht gefunden, doch kommen zuweilen mehr oder weniger vollständige Extremitäten und Teile von Wirbelsäulen zum Vorschein. Desgleichen sind Raubtierschädel gewöhnlich noch mit dem Unterkiefer vereinigt, dasselbe ist bei Rhinoceriden der Fall. Die Reste sind ziemlich stark mineralisiert,

die Markhöhlen gewöhnlich mit Kalkspatkristallen ausgekleidet, die Oberfläche gewöhnlich rein weiss. Der Lehm ist in der unmittelbaren Umgebung der Fossilnester kalkig infiltriert und erhärtet. Zuweilen sind kleine Sandlinsen eingeschaltet, die dann meist auch kleine Knochensplitter enthalten. Manchmal ist auch innerhalb der Knochenanhäufungen eine gewisse Schichtung zu erkennen. Der Lehm enthält auch ausserhalb der Geröllager einzelne Rollsteine geringer Grösse.

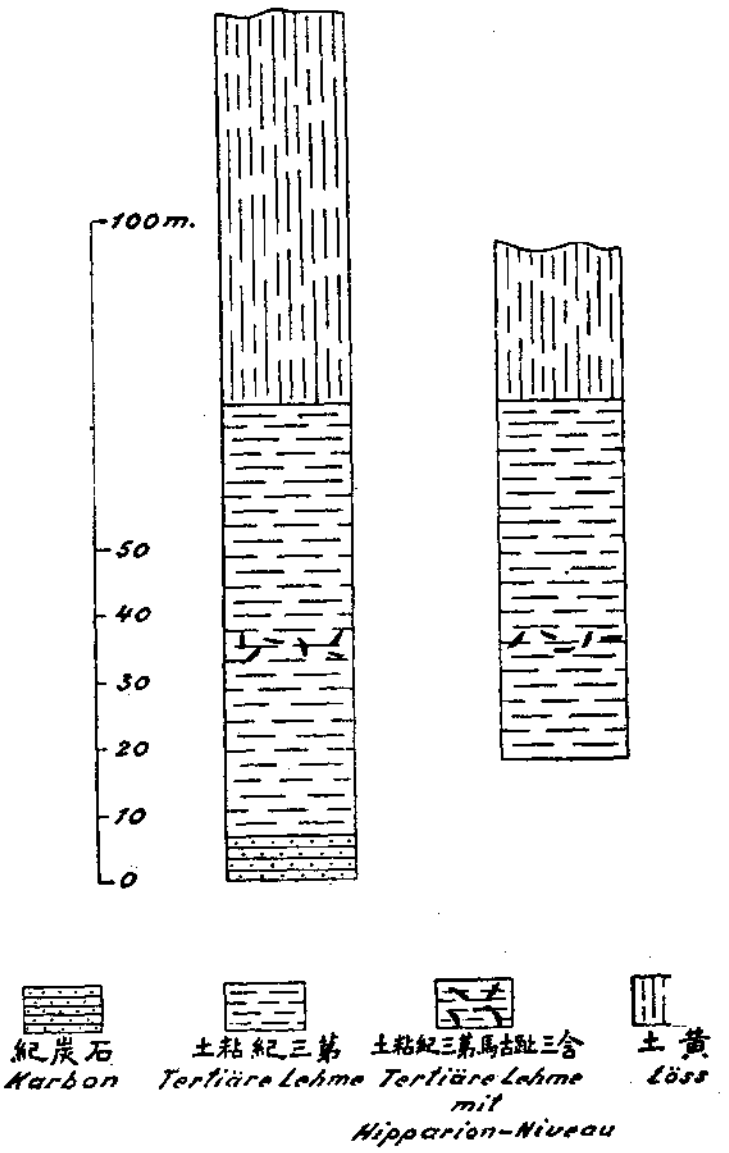

Fig. 2. Generelle Profile durch die Hipparion Ablagerungen.
A. Chi Chia Kou und Nan Sha Wa.
B. Wu Lan Kou.

Wie schon gesagt, liegen die Fossilanhäufungen sämmtlich in einem Niveau, jedoch kommen Abweichungen von ungefähr 5 m vor, ja es können zwei Nester mit 1 m Zwischenraum unmittelbar übereinanderliegen. Von der Gesammtmächtigkeit des Hipparionlehmes liegen somit 25 m unter und 35 m über dem fossilführenden Niveau, s. Fig. 2. Was den Fossilinhalt der Nester betrifft, so ist derselbe überall der gleiche, d. h. es gibt keine Formen, die wesentlich auf eine bestimmte Lokalität beschränkt wären. Jedoch ist anzumerken, dass speziell Lok. 30* bei Tai-Chia-Kou fast ausschliesslich grössere *Ruminantier* und *Carnivoren* liefert, neben *Rhinoceriden*, die überall gleich gewöhnlich sind. Im Yang-Mu-Kou, Lok 49, wurde einmal eine Fossilanhäufung angefahren, die ungewöhnlich reich an Raubtierresten war, ein anderes Mal fanden sich ebendort auf kleinstem Raume die Reste von wenigstens 4 Schweinen, die sonst ziemlich selten sind. Die west-östliche Erstreckung des Gebietes beträgt 5,5 km, die nord-südliche 5 km. Über dem Hipparionlehm folgt dann der Löss, der eine ganz beträchtliche Mächtigkeit erreichen kann. Einst bedeckte er das ganze Gebiet, doch im Laufe der Zeit schnitten sich die nachtertiären Wasserläufe wieder ein, so dass die Topographie in grossen Zügen unverändert blieb, s. Profil A-B. Als Argument für diese Anschauung ist der Umstand anzuführen, dass in den Seitentälern, die natürlich neueren Datums sind, die Kontaktfläche zwischen Hipparionlehm und Löss immer gleichsinnig mit der jetzigen Oberfläche fällt. Fossilfunde im Löss sind aus diesem Gebiete nicht bekannt. Die Höhen der Hügel schliesslich sind zum grossen Teile mit Flugsand bedeckt, was durch die Nähe der Wüste Ordos zu erklären ist.

ENTSTEHUNGSWEISE DER FOSSILANHÄUFUNGEN.

Die Frage nach der Entstehungsweise der Knochenablagerungen im Hipparionlehm ist schwierig zu beantworten. Zunächst ist im Auge zu behalten, dass die Fundstellen in einem Horizonte liegen, wobei Höhenunterschiede von etwa 5 m auftreten können. Das weist darauf hin, dass die Oberfläche des Gebietes zur Zeit der Ablagerung nahezu horizontal war. Aus dem Vorhandensein von Fossilanhäufungen, die durch fossilleere Zwischenräume getrennt sind, im Verein mit dem Vorkommen von kleinen Sandlinsen

* Die Nummern der Lokale entstammen einer laufenden Nummerierung.

sowie Schichten von Knochensplittern geht hervor, dass die Ablagerung durch fliessendes Wasser bewirkt wurde. Der vollkommene Erhaltungszustand der Reste verbietet die Annahme eines Transportes über grössere Entfernungen. Und nun hat der Verf. für die Anregungen Dr. J. G. ANDERSSON'S zu danken, der ihn auf Grund seiner Beobachtungen in der mongolischen Steppe darauf aufmerksam machte, wie wechselnd dort der Verlauf der (temporären) Wasserläufe heutzutage ist. Es ist also ganz gut möglich, dass in dem zur Zeit der Ablagerung der Fossilien nahezu ebenen Gebiete damals ähnliche Verhältnisse herrschten, so dass die Fossilnester von den im Laufe der Jahre, vielleicht sogar einer Niederschlagsperiode, das Bett wechselnden Wasserläufen aus der nächsten Umgebung zusammengeschwemmt worden sind. Dann könnten nicht alle Anhäufungen absolut kontemporär sein, womit aber die schon erwähnten Höhenunterschiede, sowie das Auftreten zweier Nester übereinander sehr wohl übereinstimmt. Was schliesslich die Beschränkung der Fossilführung nur auf einen Bruchteil der Gesammtmächtigkeit der roten Lehme betrifft, so möchte sich der Verf. auch hier Dr. ANDERSSON'S mündlich geäusserter Ansicht anschliessen, dass zu einer gewissen Zeit durch die Vereinigung günstiger topographischer und klimatischer Verhältnisse ein beschränktes Gebiet in der Steppe eine besonders üppige Vegetation tragen kann, die dann natürlich eine Konzentration des Tierlebens in diesem Gebiete veranlassen wird. Wir hätten also in der Umgebung von Chi-Chia-Kou die Reste einer derartigen Oase vor uns. Von der Annahme einer Katastrophe, wie sie z. B. von Prof. O. ABEL für die Ablagerungen von Pikermi wahrscheinlich gemacht wurde, glaubt der Verf. mit Rücksicht auf das Fehlen von Frakturen und auf die damalige Bodengestaltung absehen zu müssen. Desgleichen dürfte es sich nicht um die Ablagerungen eines grösseren Wasserlaufes handeln, denn wenn auch die angeführte Tatsache von Lok. 30 dafür zu sprechen scheint, so lässt sich doch die regellose Verteilung der Fundorte, sowie die Tatsache, dass in den einzelnen Gruben keine kontinuierlichen Fossillager anzutreffen sind, mit einer solchen Annahme nicht in Einklang bringen.

CHARAKTERISTIK DER FAUNA.

Anschliessend sei der Versuch gemacht, die Fauna soweit zu charakterisieren, als es vor der Präparation der Sammlungen möglich ist. Dabei soll

auch das Material berücksichtigt werden, das von den chinesischen Sammlern Dr. ANDERSSON'S in früheren Jahren gesammelt wurde. Die *Perissodaktylen* sind vertreten durch das schon erwähnte *Hipparion Richthofeni*, das ziemlich häufig ist, *Anchitherium*, sowie durch *Rhinoceriden*, die nach Prof. WIMAN'S brieflicher Mitteilung 6 Arten angehören. Davon sind zuzurechnen: 4 dem Genus *Teleoceras*, eine dem Genus *Aceratherium*, und schliesslich als interessanteste Form *Sinotherium Lagrelii*, Ringström. Die Rhinoceriden sind durch ihre Grösse und Häufigkeit das weitaus hervorstechendste Element der Fauna. Die *Artiodaktylen* sind reich vertreten was Arten und Individuenzahl betrifft. Es finden sich *Cervicornier* verschiedener Grösse, wenn auch nicht gerade häufig, eine ganze Reihe von *Antilopen* in grosser Anzahl, von *Pellicorniern* eine Form, die von Prof. WIMAN *Chilinotherium Tingii* benannt worden ist. Die *Bunodontier* sind durch zwei Arten von *Schweinen* vertreten, eine von der Grösse des *Sus erymanthius* von Pikermi, die andere wesentlich kleiner. Die Zahl der *Raubtiere* ist ganz bedeutend. Am häufigsten ist eine riesige *Hyäne*. *Viverriden* sind nicht allzuselten. Auch *Feliden* kommen vor, sowie als Seltenheit *Machairodus*. Ein Schädel, welcher vorliegt, gehört *Hyænarctos* oder *Arctocyon* an. *Musteliden* sind in wenigstens zwei Arten gefunden worden. Schliesslich wäre auch ein Dachsartiger Schädel zu erwähnen. Von Elephantiden sind *Mastodon*, *Stegodon* und *Elephas* vertreten. Von *Nagern* liegen nur zwei Arten vor: ein *Biber*-ähnlicher Unterkiefer sowie ein Schädel von Sciurus-Grösse.

Von *Vogelresten* ist nur das Becken eines *Struthioniden* bekannt, der den lebenden afrikanischen Strauss an Grösse beträchtlich übertraf.

Von *Reptilien* finden sich *Schildkröten* in wenigstens zwei Arten, eine Testudinide und eine Emydide.

GEWINNUNGSWEISE DER FOSSILIEN.

Die Gewinnung der Fossilien zu medizinischen Zwecken bildet einen Erwerbszweig der Bevölkerung. Seit wie lange, ist schwer zu bestimmen, doch lautete eine Angabe auf 60-70 Jahre. Wenn man aber die grosse Zahl der verlassenen Gruben und die Länge mancher noch bearbeiteten in Betracht zieht, so erscheint auch ein höheres Alter des Betriebes denkbar. Der Abbau erfolgt derart, dass dort, wo es aussichtsreich erscheint, wo z. B. Fossilreste an

der Oberfläche erscheinen, ein Stollen von etwa 90 cm Breite und ebensolcher Höhe in horizontaler Richtung vorgetrieben wird. Wo eine grössere Fossilanhäufung angetroffen wird, kann der Stollen kammerartig erweitert werden. Wenn das Nest, das zum Beginn des Betriebes Anlass gab, oder, im späteren Betriebe, dasjenige welches eben abgebaut wurde, erschöpft ist, so wird nach Gutdünken in irgend einer Richtung fortgesetzt, wobei nur die manchmal vorhandene Verhärtung des Lehmes in der Nähe der Fossilien zuweilen über die einzuschlagende Richtung Aufschluss geben kann. Von der Horizontalen wird im Allgemeinen nie abgegangen, wenn man von geringen Abweichungen absieht. So graben die Leute oft 4-5 Tage, eine Woche, bis wieder eine Fossilanhäufung angetroffen wird. Aus dieser Arbeitsweise erklärt sich die regellos gewundene Form der Stollen und ihre reiche Verzweigung, s. Taf. III und IV. Die verwendeten Geräte sind

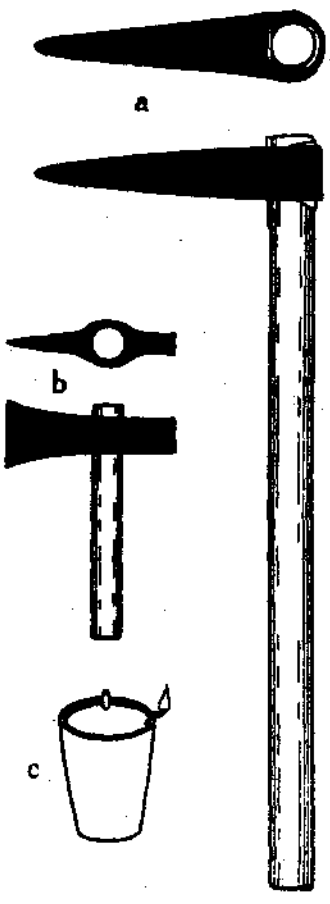

Fig. 3. Geräte, die in den Knochengruben verwendet werden. (Verkleinerung 1/6).
a. Spitzhaue,
b. Kleines Beil,
c. Öllampe.

überaus einfach (siehe Fig. 3). Eine ziemlich schwere Spitzhaue mit kurzem Stiel ist das Universalinstrument vor Ort. Daneben wird am Tag ein kleines Beil zum Herausschlagen der Reste aus der Matrix und der Zähne aus den Kiefern verwendet. Zum Transport des Materiales dient ein kleiner hölzerner Wagen auf 4 kleinen hölzernen Scheibenrädern. Länge 1.3 m, Breite 60 cm, Höhe 35 cm. Ein darauf liegender flacher Korb fasst das Material. Besonders darin geübte Leute ziehen, auf allen Vieren gehend, die Karren an einer Seilschlinge, die zwischen den Beinen durch und über eine Schulter läuft. Zur Beleuchtung dienen die ortsüblichen Öllampen, in einer eigens ausgehauenen Nische oder auf einem passend geformten Eisenspiesse stehend, der in den Lehm getrieben wird. Im Frühjahr kommen dann die Einkäufer der chinesischen Droguenhandlungen und kaufen die vorhandenen Vorräte auf, wobei für 1 catty Knochen 6 cash, für 1 catty Zähne 6-8 Kupfercents gezahlt werden. Während der Sommerszeit pflegt der Betrieb wegen der Beschäftigung mit dem Ackerbau zu ruhen.

ANDERE FUNDORTE.

Im Verlaufe seiner Reise besuchte der Verf. auch den Ort Nan-Sha-Wa im Gebiete von Ho-Ch'ü-Hsien, 140 li nördl. von Chi-Chia-Kou, wo gleichfalls die Reste der Hipparionfauna von der Bevölkerung gegraben werden. Die Nester scheinen dort erheblich grösseren Kubikinhalt zu besitzen und gleichzeitig nicht so dicht von Knochen erfüllt zu sein, doch ist die Zahl der Gruben zu gering–drei, von denen nur zwei unmittelbar nebeneinander liegende in Betrieb stehen–um daraus Schlüsse von irgendwelcher Tragweite zu ziehen. Die Matrix ist dort mehr sandig und auch in der nächsten Nähe der Knochen nur selten kalkig infiltriert. Wie bei Chi-Chia-Kou liegen die Stollen 25 m über dem Karbon und werden von etwa 30 m fossilfreien Lehmes überlagert, s. Abb. 2. Sie sind ungefähr 1½ m hoch und bis zu 3 m breit. Die Gründe dafür liegen teils in der grösseren Weichheit des Materials, teils in der mehr schütteren Verteilung der Fossilien. Die verwendete Haue ist keilförmig, mit kurzer, querer Schneide. Zur Förderung dient ein Schubkarren mit kleinem, hölzernen Rad, auf welchem ein runder Korb festgebunden wird.

Ein weiteres Gebiet, das im Verlaufe der Reise besucht wurde, ist Wu-Lan-Kou im Gebiete von Fu-Ku-Hsien in Shensi, 110 li westl. von

Pao-Te-Hsien. Dort befindet sich eine ganze Reihe von Stollen, die alle auf kleinstem Raume in einer Seitenschlucht liegen. Deshalb wäre die Tatsache, dass sie sämmtlich in gleicher Höhe liegen ohne die gleiche Beobachtung von Chi-Chia-Kou an sich ohne weitere Bedeutung. Das Material ist auch dort sandig-lehmig, die Knochen daher etwas zerbrechlicher als in Chi- Chia-Kou. Über dem Fossilhorizonte liegen etwa 35 m fossilfreien Lehmes, die Höhe über dem Karbon liess sich dort nicht konstatieren. Es hat somit den Anschein, dass die Gesammtmächtigkeit des Hipparionlehmes in allen drei Gebieten dieselbe, sowie dass die Lage des Fossilhorizontes in allen Fällen die gleiche ist. Die dort angewendeten Arbeitsmethoden sind dieselben wie in Chi-Chia-Kou.

ZUSAMMENFASSUNG.

Es sei nun noch kurz zusammengefasst. Das Ausbreitungsgebiet des Hipparionlehmes erstreckt sich im Osten bis an die kambro-ordovicischen Kalkhügel, im Westen über den Gelben Fluss hinaus nach Shensi hinein, wie das Profil, Fig. 4, zeigt. Nach Norden und Süden zu ist der Verf. nicht über den Bereich des Hipparionlehmes hinausgekommen, doch genügen die gemachten Beobachtungen und Funde, die aufgestellte Behauptung zu stützen, dass es sich bei den fossilführenden Gebieten um Oasen handelt, die durch fossilleere Zwischenräume voneinander getrennt sind. Das weitaus Bedeutendste Gebiet der Fossilführung liegt bei Chi-Chia-Kou, im Norden davon das von Nan-Sha-Wa, im Westen das von Wu-Lan-Kou und im Süden das von Kung-Lung-Yen,* halbwegs zwischen Pao-Te-Hsien und Lin-Chia-Yü, s. Fig. 5. In Anbetracht der ganz bedeutenden gegenseitigen Entfernungen, von Chi-Chia-Kou aus gerechnet, nach Nan-Sha-Wa 145 li, nach Wu-Lan-Kou 135 li, nach Kung.Lung Yen 60 li, dürfte die Betrachtungsweise derselben als Oasen nicht ungerechtfertigt sein.

BEMERKUNGEN ZU DEN PLÄNEN DER FOSSILGRUBEN UM CHI-CHIA-KOU, TAF. III UND IV.

Die gestrichelten Teile sind alte Gänge und nicht mehr befahrbar.

FF—Stellen, an welchen zur Zeit der Vermessung Fossilien zu sehen waren.

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* Wurde nicht besucht.

Lok 110.—Die Stollen liegen unmittelbar unter einer Geröllbank.

Lok 44. a.) Linse von Sand und Knochensplittern 12 cm stark.—b.) Linse von Sand und Knochensplittern. c.) d.) und e.) Sandlinsen.

Lok 30. a.) Knochen in einer Schichte angeordnet.—b.) Unter den Knochen eine gewisse Schichtung erkennbar.

Lok 43. a.) Zwei je 2 cm starke Schichten von kleinen Knochen, dazwischen andere unregelmässig verteilt.

Lok 109. a.) Schichten von Hanfkorngrossen Knochensplittern.

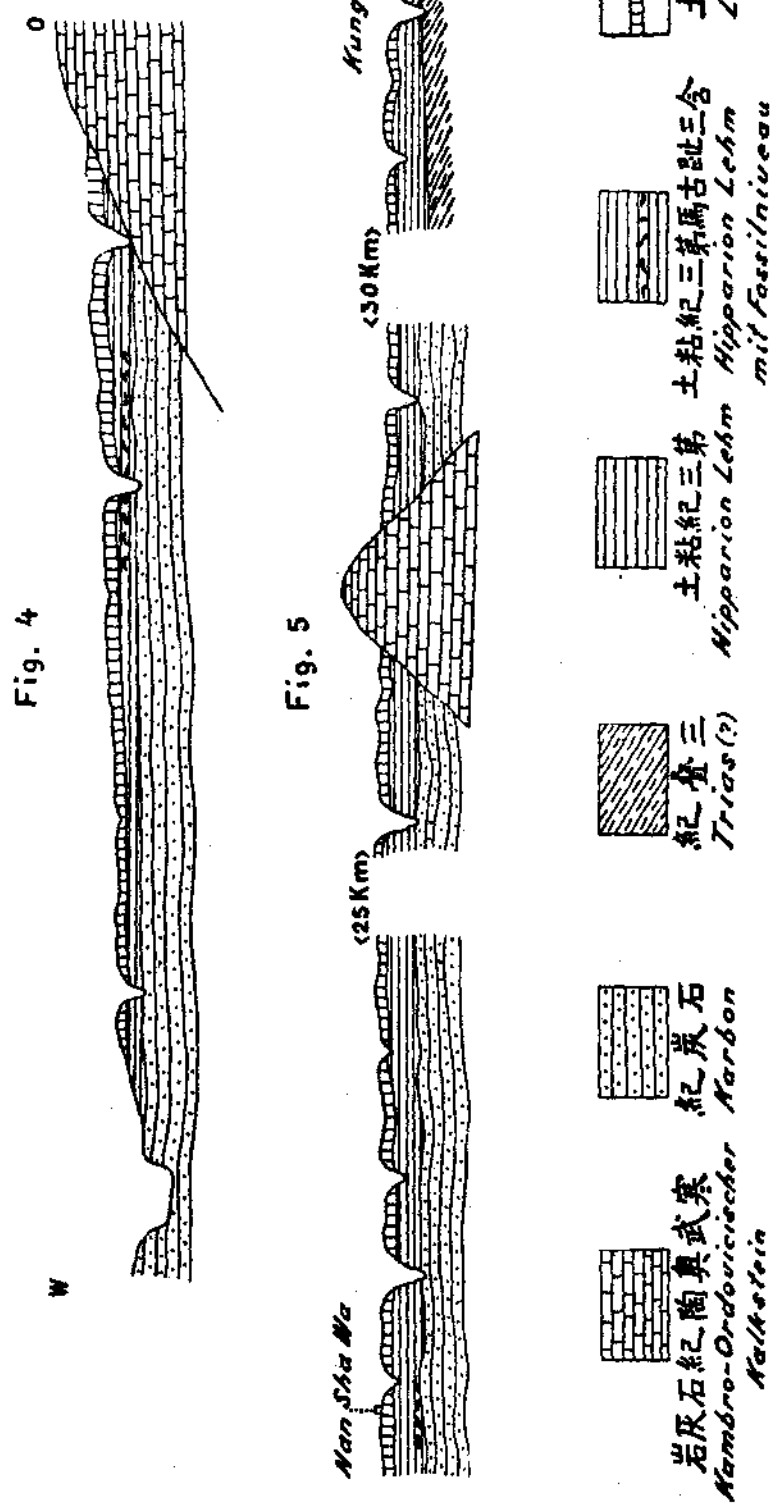


Fig. 4 & 5. Generelle Profile. 1: 100.000. 4 fach überhöht.
Fig. 4. W-O durch die Umgebung von Chi-Chia Kou.
Fig. 5. Längs des Huang Ho, ungefähr N S.

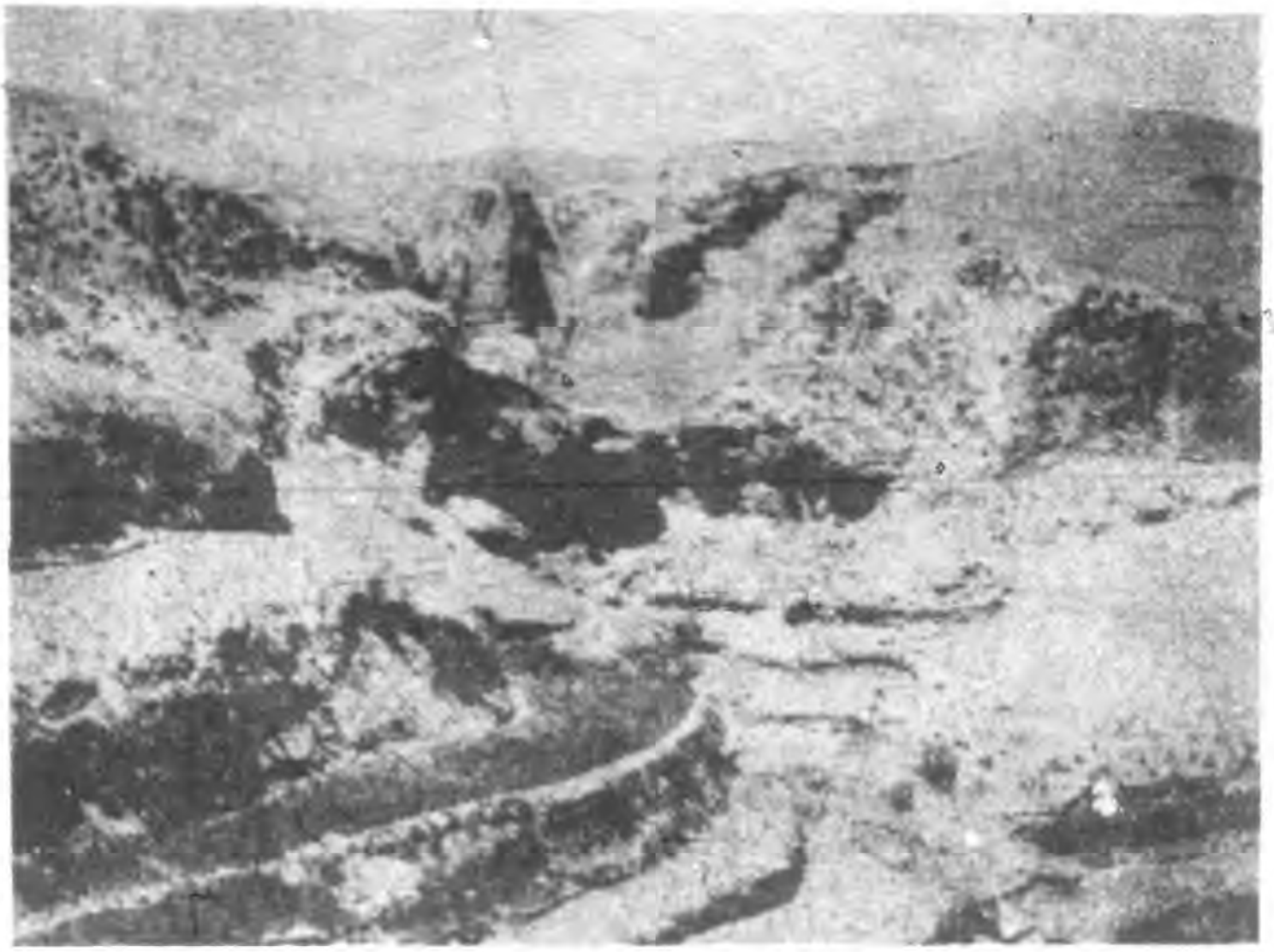


Fig. 1.

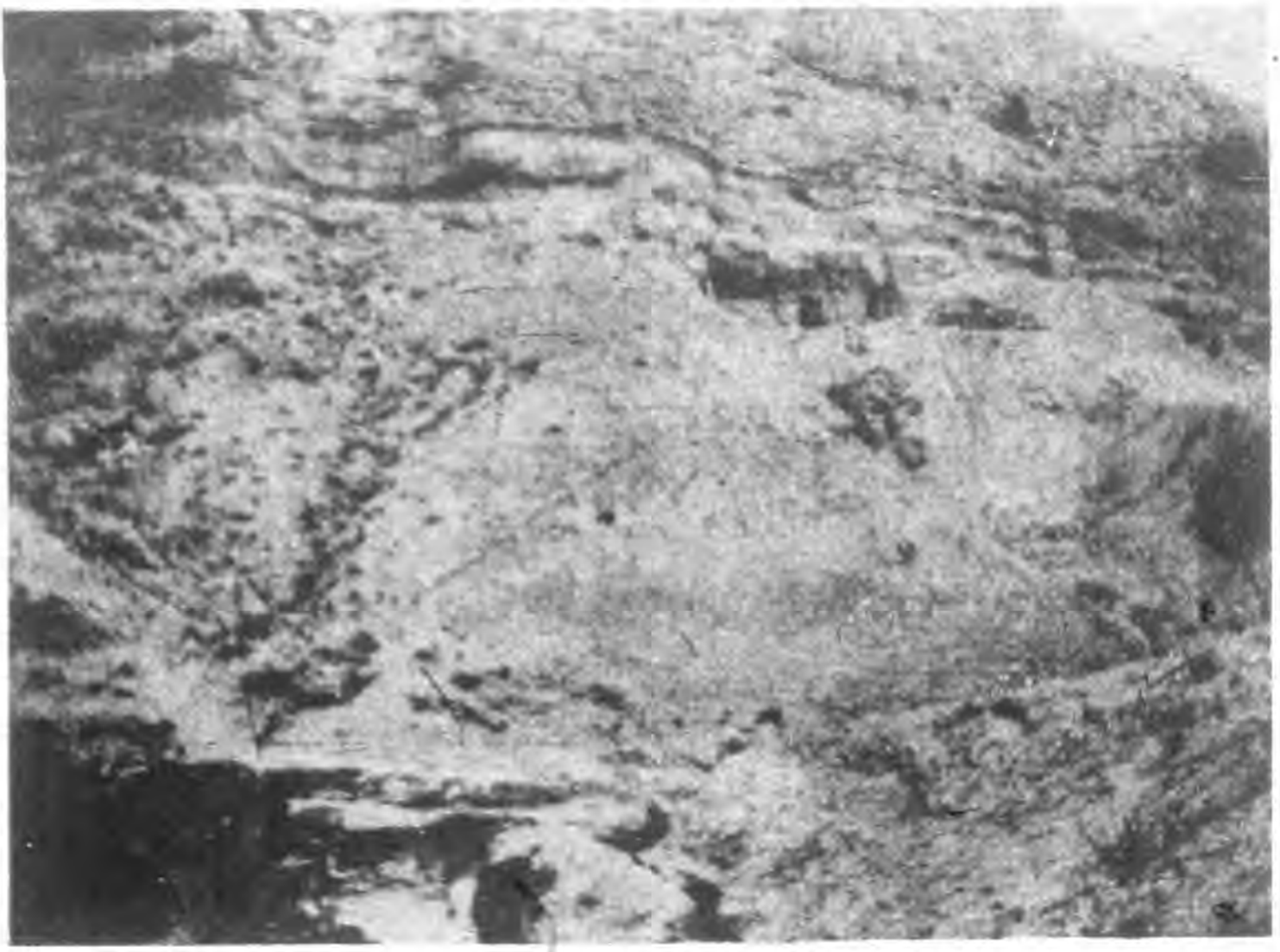
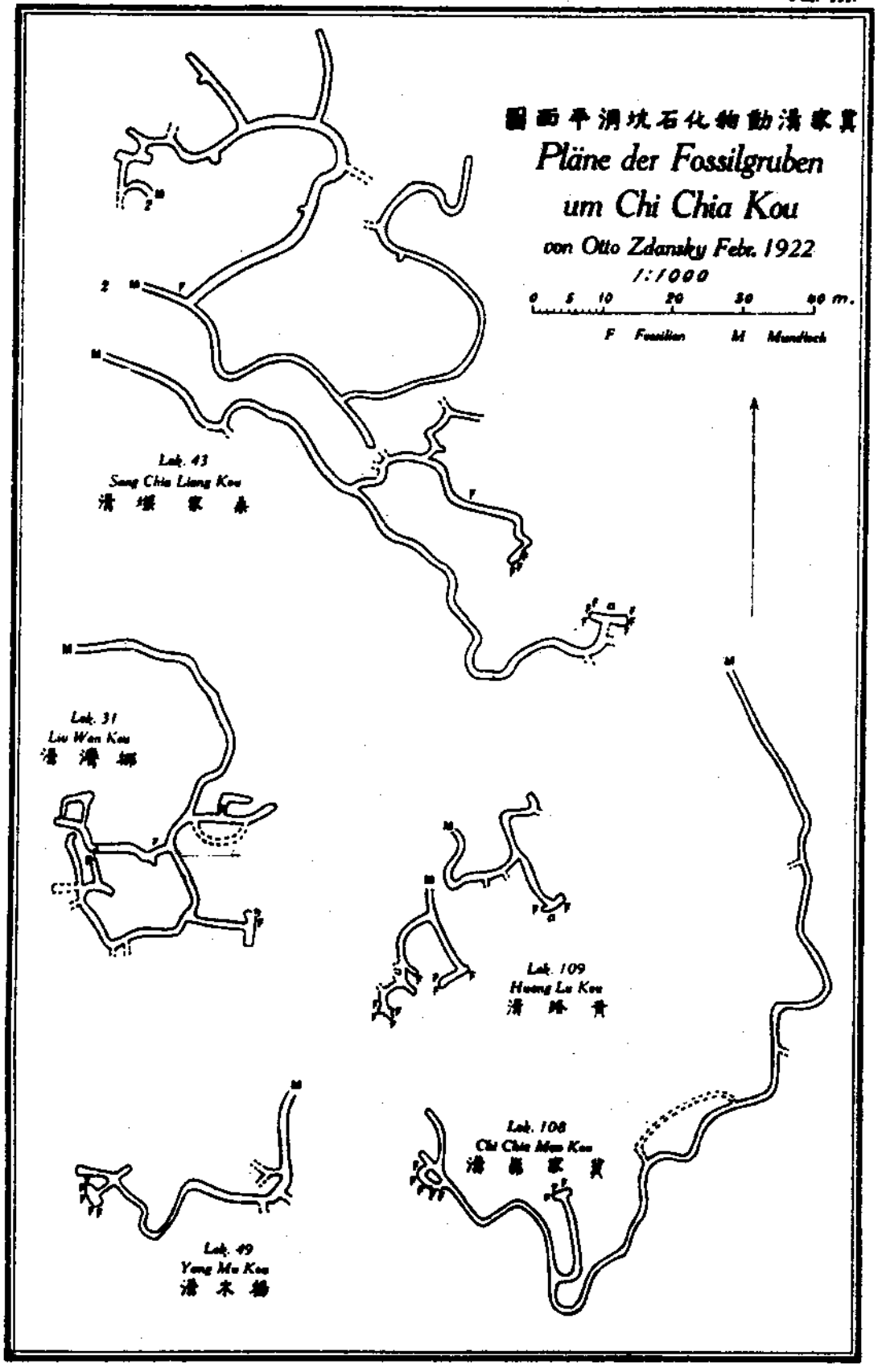
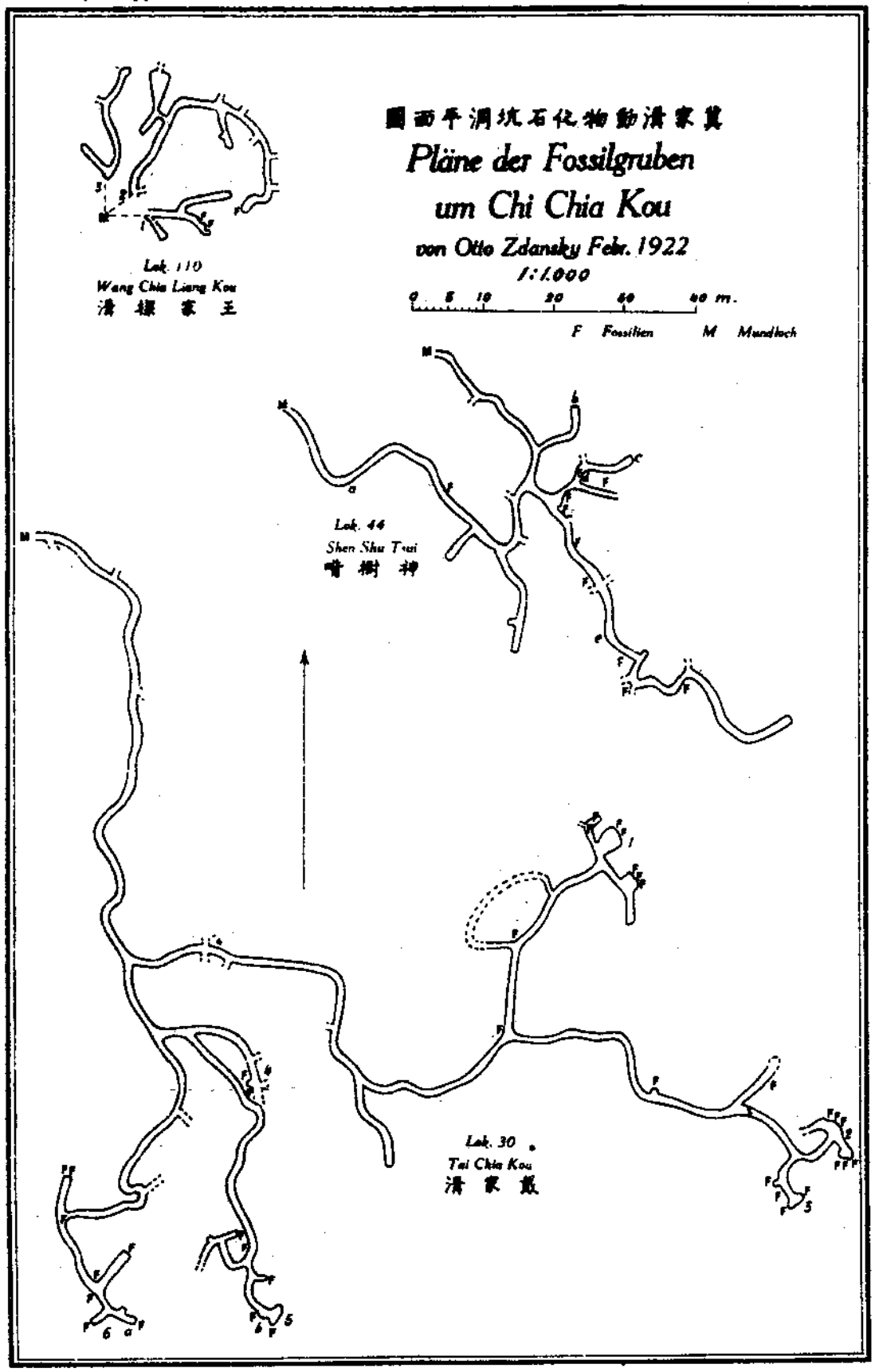


Fig. 2.

Fig. 1.

Fig. 2.


Pläne der Fossilgruben
um Chi Chia Kou
von Otto Zdansky Febr. 1922
1:1000
0 5 10 20 50 60 m.
F Fossilien M Mundloch
Lok. 43
Sung Chia Liang Kou
Lok. 31
Liu Wan Kou
Lok. 109
Huang Lu Kou
Lok. 108
Chi Chia Mao Kou
Lok. 49
Yang Mu Kou


周口店西平洞坑石化物動滑家賞
Pläne der Fossilgruben
um Chi Chia Kou
von Otto Zdansky Febr. 1922
1:1.000
0 5 10 20 40 60 m.
F Fossilien M Mundloch
Lok. 110
Wang Chia Liang Kou
滑 樑 家 王
Lok. 44
Shen Shu Tsui
嗜 樹 神
Lok. 30
Tai Chia Kou
滑 家 戴

山西保德縣冀家溝三趾古馬化石位置圖
DIE FUNDORTE DER HIPPARION FAUNA VON CHI CHIA KOU PAO TE HSIEN SHANSI.

測量者邱昇司
aufgenommen von O. Zdansky 1922.

一之分萬二尺縮
Scala 1 : 20.000

0 500 1000 m

等高線距離二十五米達
Schichtenlinien von 25 m zu 25 m.

北

A

B

PU FANG YEN

TZU KOU

CHI CHIA KOU

SHEN SHU TSUI

HSING YUNG YEN TSUM

YU CHUANG

CHUNG LU TZU KOU

紀炭石 Karbon

呂梁子層 Lu Tzu Kou Schichten

土豬馬古趾三含 Hipparion Lehm

黃土及沙礫層 Löss, Flugsand, Ackerkrume

Die Meereshöhe des Trigonometers wurde mit 1290 Meter angenommen.
假定高度標點約千二百米達

Höhen- und Längenmassstab 1:20.000 平直面縮尺二萬分之一

中盧子溝
CHUNG LU TZU KOU

Höhenmassstab 1:10,000 Längenmassstab 1:20,000 直面縮尺萬分之一 平面縮尺二萬分之一

化石坑 Fossilgrube
莊村 Dorf
塔 Turm
寺廟 Tempel
高度標點 Trigonometer
路道 Weg
點高 Kote
碑 Grabstele
闊葉樹 Laubbaum
松林 Nadelbaum

ÜBER EIN SÄUGERKNOCHENLAGER IN CHOU-K'OU-TIEN, PROVINZ CHIHLI.

Von

Otto Zdansky

Als ich in Dr. J. G. Andersson's Auftrag in den letzten Tagen des Juli 1921 in Chou-K'ou-Tien weilte, um eine bereits bekannte Fundstelle zu besuchen, fand dieser, als er mit Dr. W. Granger, dem Paläontologen der 3. asiatischen Expedition des Am. Mus. Nat. Hist. in New York zu dem Zwecke hinkam, um Letzterem diese Lokalität zu zeigen, an Hand von Angaben der Bevölkerung eine neue Fundstelle, die sich von solchem Interesse erwies, dass ich mein Arbeitsfeld sogleich dorthin verlegte und im Verlaufe von 3 Wochen ein recht umfangreiches Material zusammenbrachte, sowie auch imstande bin, einige Informationen über die lokalen Verhältnisse zu geben, wie ich an Hand der beifolgenden Kartenskizze auseinandersetzen werde.

Chou-K'ou-Tien liegt an einem Seitenzweige der Kin-Han-Eisenbahn und besitzt als Verladestation für Kohle und gebrannten Kalk lokale Bedeutung. Etwa 250 m. von der Station talaufwärts (nördl.) kreuzt die Bahnlinie eine Strasse, die in das Lao-Niu-Kou genannte Tal hineinführt, das sich gegen Westen erstreckt und auf seiner Südseite von dem Wo-Hu-Shan genannten Hügelzug aus ordovicischem Kalkstein, auf seiner Nordseite von dem als Shi-Mou-Ping bezeichneten Hügelkomplex aus karbonischen Schichten begrenzt wird, die einige kleine Kohlenvorkommnisse enthalten.* Der südl. Abhang ist bedeckt mit in Betrieb befindlichen und bereits verlassenen Kalksteinbrüchen, in denen der Kalk gleich an Ort und Stelle gebrannt wird. Die neue Fundstelle liegt in dem am weitesten östl. gelegenen Steinbruche, der zurzeit nicht in Betrieb steht und den man erreicht, wenn man sich gleich nach dem letzten Hause zur Linken an der taleinwärts führenden Strasse nach Südwesten wendet. Nach wenigen Metern aufwärts steht man in dem Steinbruche, der östl. von einer Höhle mit doppeltem Portal flankiert wird.

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* Die Geologie dieser Gegend wurde von L. F. Yih in seiner Arbeit: The Geology of Hsi-Shan or the Western Hills of Peking; Mem. Geol. Survey of China. Ser. A. Number 1, 1920 behandelt, woselbst Chou-K'ou-Tien im südlichsten Teile der dort gegebenen geologischen Karte zu sehen ist.

In der Mitte des Steinbruches erblickt man eine etwa 42° gegen Norden fallende, glatte Kalksteinwand, über der sich in etwas mehr als 6 m Höhe, nur mittels Leitern zugänglich, der Fundplatz befindet. Dieser stellt sich dar als die Ausfüllungsmasse einer im Kalkstein befindlichen Höhle, genau so wie an dem als Chi-Ku-Shan ("chicken-bone-hill") bekannten Fundorte in der nächsten Nachbarschaft, nur mit dem Unterschiede, dass erstere Höhle bedeutend grösser war und der Charakter der darin enthaltenen Fauna ein ganz anderer ist. Wie aus der beifolgenden Abbildung zu ersehen, setzt sich die Felswand unter demselben Neigungswinkel nach oben fort, verrät jedoch ihren geänderten petrographischen Charakter sofort durch die Farbe und das Auftreten einer spärlichen Vegetation. In 11-12 m über dem Erdboden folgt dann eine abschüssige begrünte Terasse, die nach Westen auf den natürlichen Abfall des Hügels hinausführt und über der sich wieder der Kalkstein aufbaut. Wir haben eine Höhle im Kalkstein vor uns, die mit Sedimenten ausgefüllt und dann im Verlaufe der Steinbrucharbeiten angefahren wurde. Ihre relativ grosse Erstreckung- die west-östliche Länge, die zutage gelegt ist, misst gegen 15 m-dürfte den Grund zur Einstellung des Betriebes gebildet haben. Von der östlichen, unteren Ecke des sichtbaren Teiles der Ausfüllungsmasse erstreckt sich ein 1 m breiter Streifen des Sedimentes bis zum Fuss der Felswand herunter, der zuerst als die Ausfüllung eines Schachtes angesehen wurde, der sich aus dem Hauptraume der Höhle in die Tiefe erstreckte, wie ein solcher auch in kleinerem Masstabe an der Westseite der Höhle vorhanden war. Im Verlaufe der Arbeiten liess sich jedoch feststellen, dass die sichtbare Grenze zwischen Kalkstein und Höhlensediment nicht die Lage der ehemaligen Höhlensohle darstelle, sondern dass diese tiefer liege und der Steinbruch verlassen wurde, bevor auch die tieferen Partien freigelegt wurden. Die tatsächliche Lage der Sohle liess sich ohne grosse Kosten nicht feststellen, da Probebohrungen durch Steinbrucharbeiter den anstehenden Kalkstein nicht erreichten. Ich bin geneigt anzunehmen, dass die Schachtartige Partie am Ostrande auch die Tiefe des Hauptraumes anzeigt. Dieser Schacht, der von einem gelblichen, sehr festen Sandstein mit eingeschlossenen Kalksteinblöcken erfüllt ist, war es, wo durch die Bevölkerung die Fossilfunde gemacht wurden, die zur Aufsuchung der Stelle Anlass gaben.

Es lag natürlich nahe, sich nicht auf die Ausfüllungsmasse des Schachtes zu beschränken, sondern auch den Hauptraum der ehemaligen Höhle zu untersuchen. Mit Hilfe von Leitern wurde ein Zugang geschaffen und von diesem aus beginnend im östlichen Teile der Höhle, der sich als der fossilreichere erwies, in einer Länge von etwa 8,5 m ungefähr 2,5 m tief in den Berg vorgedrungen, nachdem die mit dem Absturze drohenden Felsmassen entfernt worden waren.

Bevor ich eine Übersicht über das dabei gefundene Fossilmaterial gebe, soweit sich das prima vista und ohne gründliche Präparation tun lässt, will ich die Schichtenfolge in 2 Profilen beschreiben, wie sie sich im Zuge der Arbeiten ergeben hat. Die Schichten der Höhlenfüllung fallen im Durchschnitt 7° gegen N 18° O. Da die Schichtflächen nicht eben sind, lässt sich nur diese Durchschnittsneigung angeben.

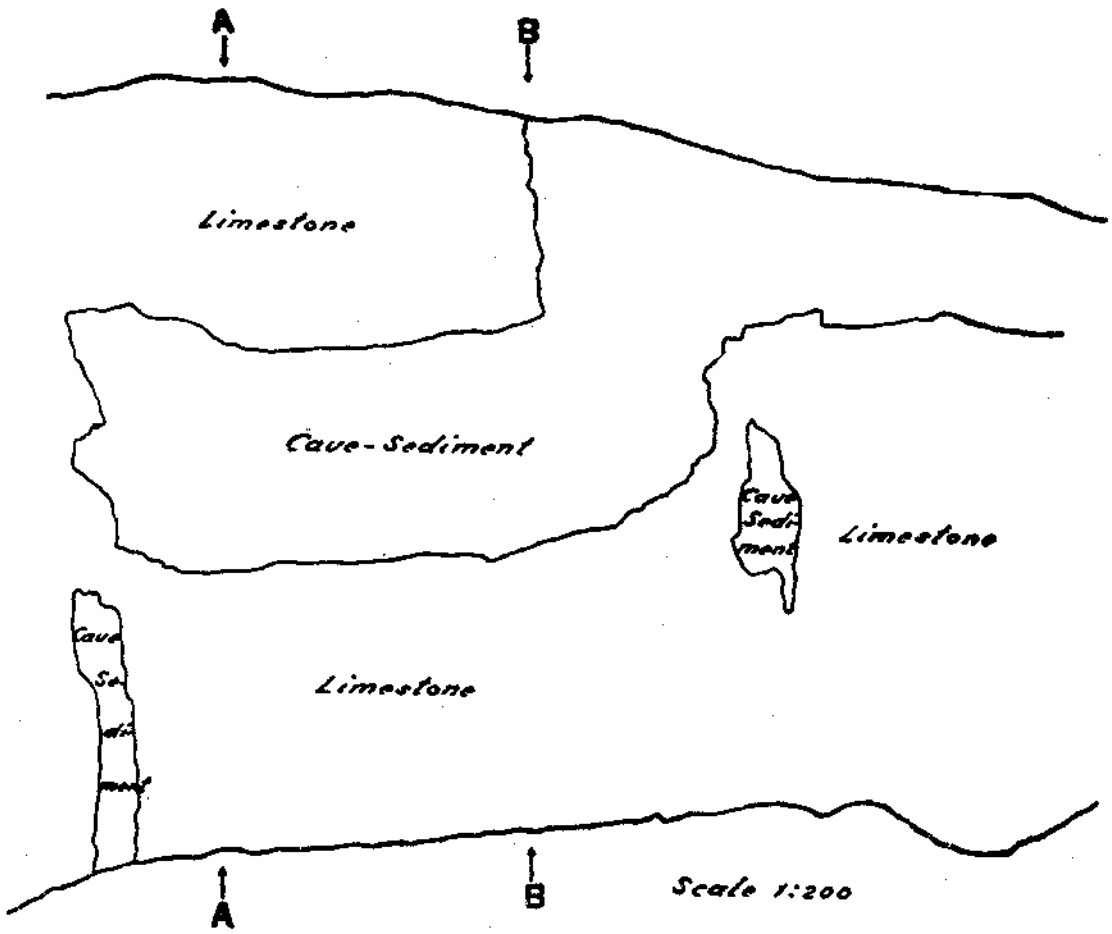


Fig. 1. Schematisches Bild von dem Knochen-Verkommen bei Chou-K'ou-Tien.
Knochen Ablagerung—Cave-Deposit.
A - A und B - B Profillinien.

Schichtenfolge von oben nach unten in:

Profil A

8. Breccie aus kantigen Kalksteintrümmern ohne Schichtung. Bindemittel kalkig-sandig. Enthält Landschnecken und Knochenreste.

7. 80 cm mächtige grellrote, lehmige Sande mit Sandstein-Zwischenlagen. Landschnecken. Nach oben übergehend in 8.

6. 33 cm mächtiger brauner Lehm, schwach braun gebändert. Grenze gegen 7 nicht ganz scharf.

5. 21 cm mächtiger schwarzbraun gebänderter, fetter Lehm.

4. 6,5 cm starke Lage lichtgelben Lehmes.

3. 4,5 cm starke Lage schwarzbraunen fetten Lehmes. Knochen und selbst Zähne sehr stark zerstört. Enthält kantige Quarzstücke.

2. 15 cm mächtiger lichtgelber, sandiger Lehm mit reichlichen Knochenresten Enthält kantige Quarzstücke.

1. Gelblicher Sandstein von unbekannter Mächtigkeit. Enthält reichlich Knochenreste, Kalksteintrümmer und Tropfsteinbruchstücke. Hohlräume mit Kalkspatkristallen ausgekleidet.

Profil B

9. Wie bei A No 8.

8. 80 cm mächtige rote Sande' geschichtet und gebändert.

7. 16 cm starke Lehmschichte, unten gelb, oben bräunlich.

6. 15 cm starke Bank von rotem Sandstein.

5. 30 cm starke Lage roten, gebänderten, teilweise verfestigten Sandes.

4. 6 cm starke Schicht lichtgelben Lehmes.

3. Wie bei A No 3.

2. 17 cm mächtiger lichtgelber, sandiger Lehm mit reichlichen Knochenresten. Enthält kantige Quarzstücke.

1. Wie bei A No. 1.

Um nun auf die Fossilreste überzugehen, so ist zunächst zu bemerken, dass es nach Dr. J. G. Andersson's Feststellungen, das erste Mal ist, dass in

China in denselben Schichten eine Makro- und eine Mikrofauna zusammen gefunden wurde. In der Hipparionfauna kennen wir von Reston kleiner Formen (Nager, Insektivoren, usw) so gut wie nichts, aus Ertemte in der Mongolei dagegen mit seltenen Ausnahmen wieder nur solches Material. Dieser neue Fund gibt uns also zum ersten Mal ein Mittel in die Hand, uns ein Bild von der Lebensgemeinschaft im oberen Tertiär Chinas zu machen. Allerdings deutet Alles darauf hin, dass wir es mit einer etwas jüngeren als der Hipparionfauna zu tun haben, vielleicht Oberpliocän. Die Fossilien kommen mit Ausnahme der Mikrofauna, die bis in die Breccie an der oberen Grenze der Schichtfolge hinaufgeht, nur in den oben mit 1, 2, und 3 bezeichneten Schichten vor. Im Allgemeinen handelt es sich um Unterkiefer und isolierte Zähne, vereinzelte grosse Extremitätenknochen, Wirbel, Geweihstücke von Cervicorniern und Unmengen von Knochensplittern, doch ist nur ein Schädel gefunden worden und Oberkiefer sind recht selten. Die Reste der bereits mehrfach erwähnten Mikrofauna bestehen aus Tausenden von Extemitätenknochen, hauptsächlich 2 kleiner Nager (? Arvicolide & ? Muride), deren Unterkiefer ebenfalls in grosser Zahl gefunden werden, ferner findet sich als recht seltenes Element Talpa, von dem einige der charakteristischen Humeri und ein Kiefer vorliegen, ein kleiner Insektivore von Sorex-Grösse und Reste kleiner Vögel. Wie gesagt, gehen diese Faunenelemente durch die ganze Ablagerung hindurch. Die folgenden Genera bleiben aber auf die Schichten 1-3 beschränkt. Da ist zuerst ein Equide und zwar kein Hipparion, sondern ein richtiger Equus; nur vereinzelte Zähne des Ober-und Unterkiefers. Von Perissodaktylen findet sich weiter ein Rhinoceride in einer Anzahl loser Zähne. Die Artiodaktylen sind beiweitem reicher vertreten. Zunächst durch ein grosses Schwein, das mit keiner der von Schlosser beschriebenen Formen identisch sein dürfte. Von Ruminantiern sei zuerst ein Cervide erwähnt, der durch eine ganze Anzahl mehr oder weniger kompletter Unterkiefer vertreten ist; auch die vorhandenen Geweihe möchte ich ihm zuschreiben. Der horizontale Ast dieser Unterkiefer fällt durch seinen abgerundeten Querschnitt und seine ganz auffallende Verdickung in der Gegend des dritten Molaren auf. Während diese Form infolge ihres guten Erhaltungszustandes leicht unterschieden wird, lassen sich die übrigen Ruminantia, die durch Hunderte von einzelnen Zähnen, seltener durch

Kieferbruchstücke repräsentiert werden, ohne vorhergehende Präparation und gründliches Studium nicht mit genügender Sicherheit auseinanderhalten, so dass es möglich wäre, ihre Zahl anzugeben. Ein grosser Bovine lässt sich durch seine grossen prismatischen Zähne leicht unterscheiden. Von Carnivoren fand sich ein Machairodus, der dem Schlosser' schen M. horribilis sehr ähnlich ist, eine Hyäne, ein ziemlich kleiner Bär in einem vollständigen Unterkiefer und einigen losen Zähnen sowie ein kleiner Carnivore von Fuchs-Grösse, dessen Schädel erhalten, aber nur im Querbruch zu sehen ist, so dass sich über seine systematische Stellung vorläufig nichts aussagen lässt.

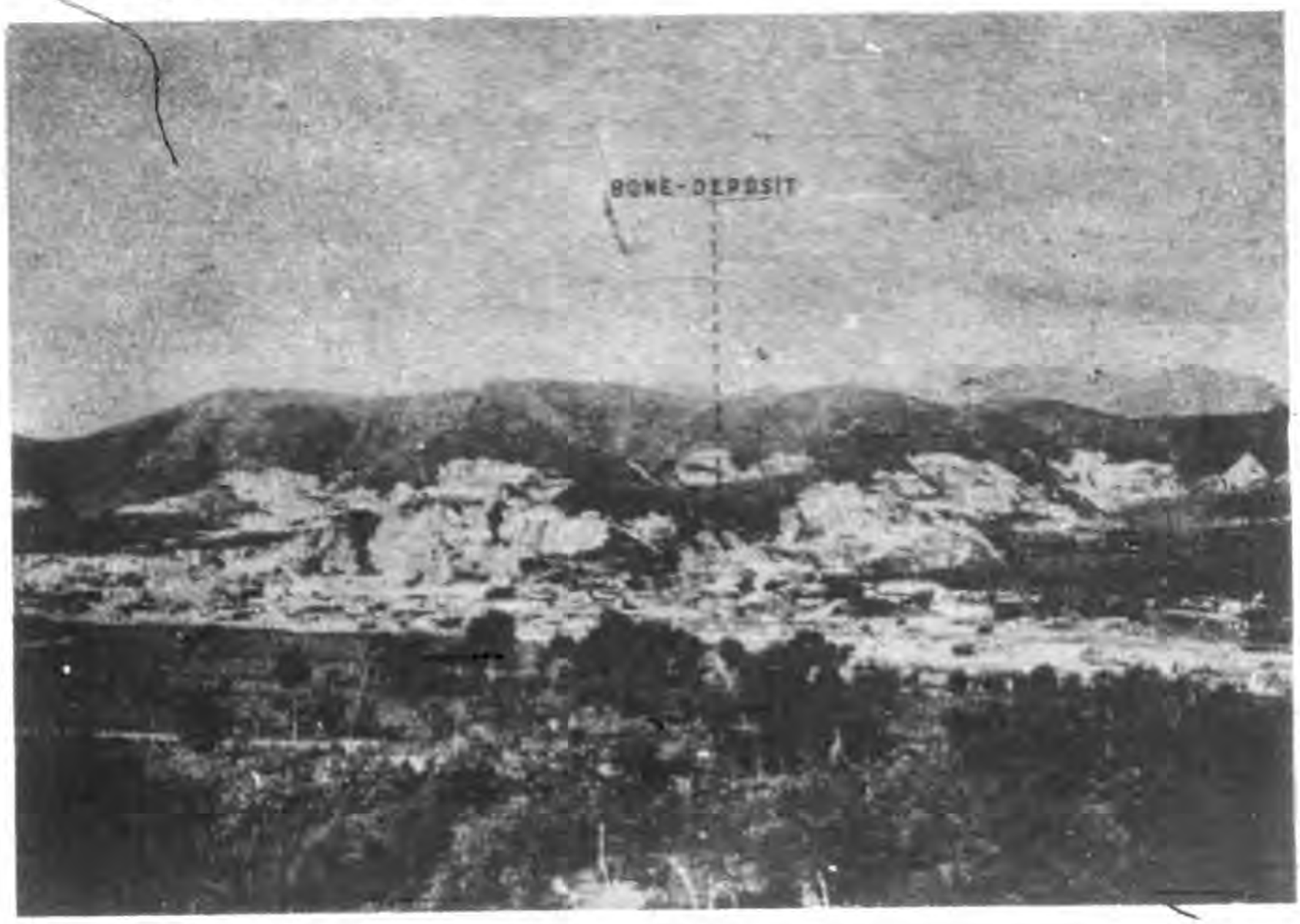
Von Evertebraten fanden sich in den roten Sanden und den nach oben folgenden Breccien zwei Landschnecken, von denen die eine sehr häufig ist und mit einer noch an Ort und Stelle lebenden Art identisch zu sein scheint.

Was nun die Entstehungsweise der Ablagerungen anbelangt, möchte ich Folgendes bemerken. Die Höhle war ursprünglich eine Tropfsteinhöhle, Bruchstücke von Stalaktiten bis zu 15 cm Durchmesser sowie bis 18 cm starke Tropfsteinüberzüge auf Kalksteintrümmern wurden in den Schichten No 1 beobachtet. Wie fast alle der recht zahlreichen Grotten, besass auch diese eine mehr oder weniger vertikale Erstreckung, d. h. der Eingang befand sich an der oberen Seite. Das Vorkommen der Reste der grösseren Tiere ist wohl so zu erklären, dass die Höhle von grossen Raubtieren bewohnt war, die ihre Beute in die Höhle schleppten. Damit im Einklang steht die Seltenheit intakter Röhrenknochen und die grosse Masse von Knochensplittern, wie auch der Umstand, dass die bedeutendsten Anhäufungen von Knochen unmittelbar an der alten Höhlenwand gefunden wurden. Für die Nager und vielleicht auch für die Vögel müssen wir annehmen, dass sie in der Höhle selbst gelebt haben, während das spärliche Vorkommen von Talpa vielleicht nur ein zufälliges ist.

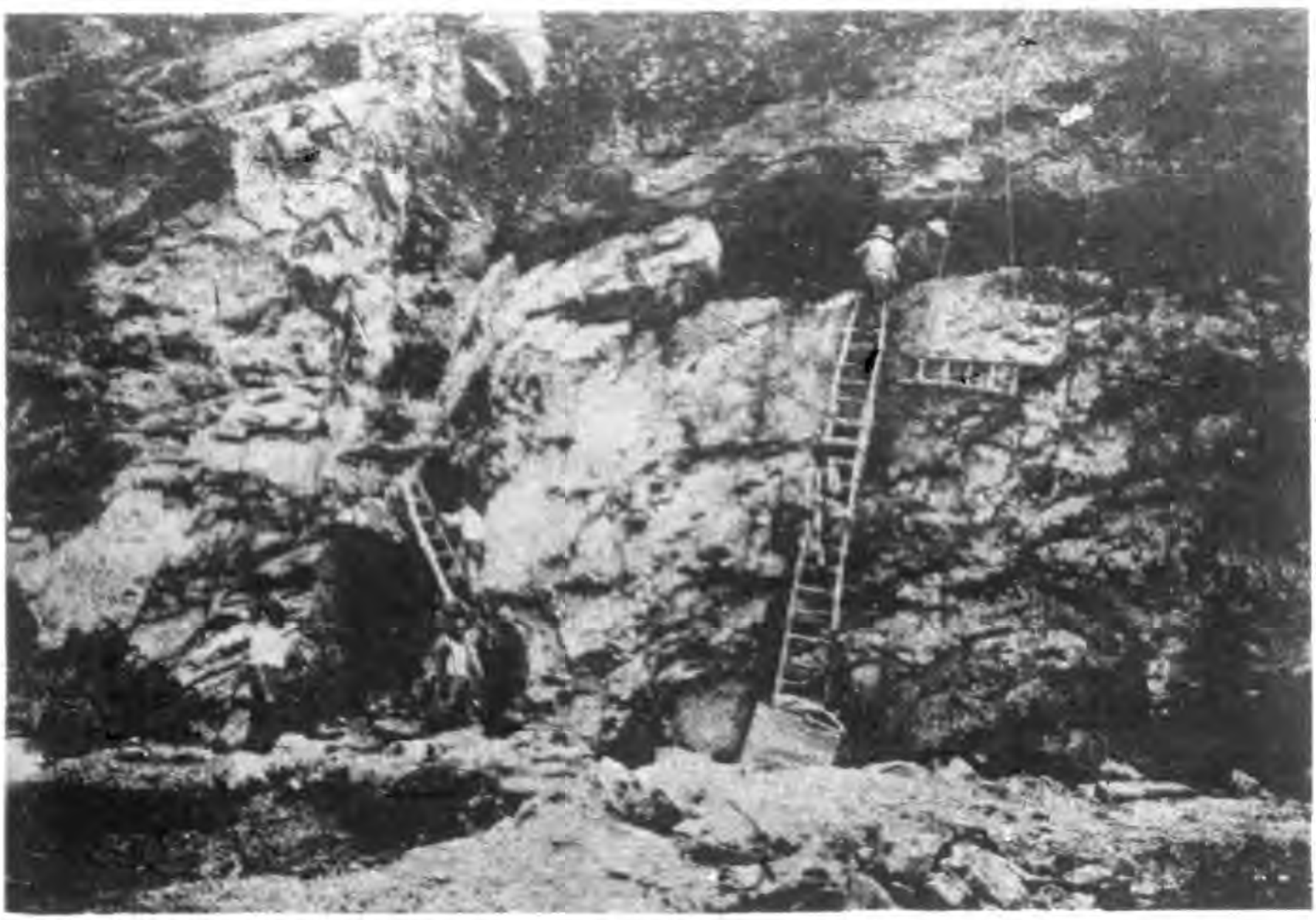
Dass es sich nicht um eine Sedimentation aus dem Wasser handelt, geht für die Glieder der Ablagerung, die unter den roten Sanden liegen, hervor aus dem wechselnden Neigungswinkel der Schichten und daraus, dass diese trotz der geringen horizontalen Abmessungen nicht über die ganze Bodenfläche ausgebreitet sind, schliesslich spricht dagegen die Erscheinung, dass speziell in den schwarzbraunen Schichten, da die Bänderung dort besonders fein ist,

deutlich zu sehen ist, wie Steine und Knochen von den sich bildenden Schichten schalenartig umlagert wurden, ein Effekt, den allenfalls beim Absatz aus tiefem Wasser, keinesfalls aber dann zustande kommen konnte, wenn die Fossilreste zugleich mit dem Sediment eingeschwemmt worden wären. Die genannten schwarzbraunen Schichten stellen vielleicht eine humöse Ablagerung dar, in welchem Falle sich die hochgradige Zerstörung der darin enthaltenen Fossilreste durch die Humussäuren erklären liesse. Das Vorhandensein von pflanzlicher Substanz lässt sich bei der relativen Grösse des Höhleneinganges und seiner Lage in der Decke begreifen. Das Auftreten der Kaksteintrümmer und Tropfsteinstücke im Sediment ist auf Rechnung von Deckeneinstürzen zu setzen. Für die höheren Glieder der Schichtfolge ist die Art der Sedimentation durch das zahlreiche Vorkommen der Landschnecken ausser Zweifel gesetzt.

Zdansky: Chou-K'ou-Tien



Gesammtansicht.



Fundort.

京西周口店骨層周圍圖

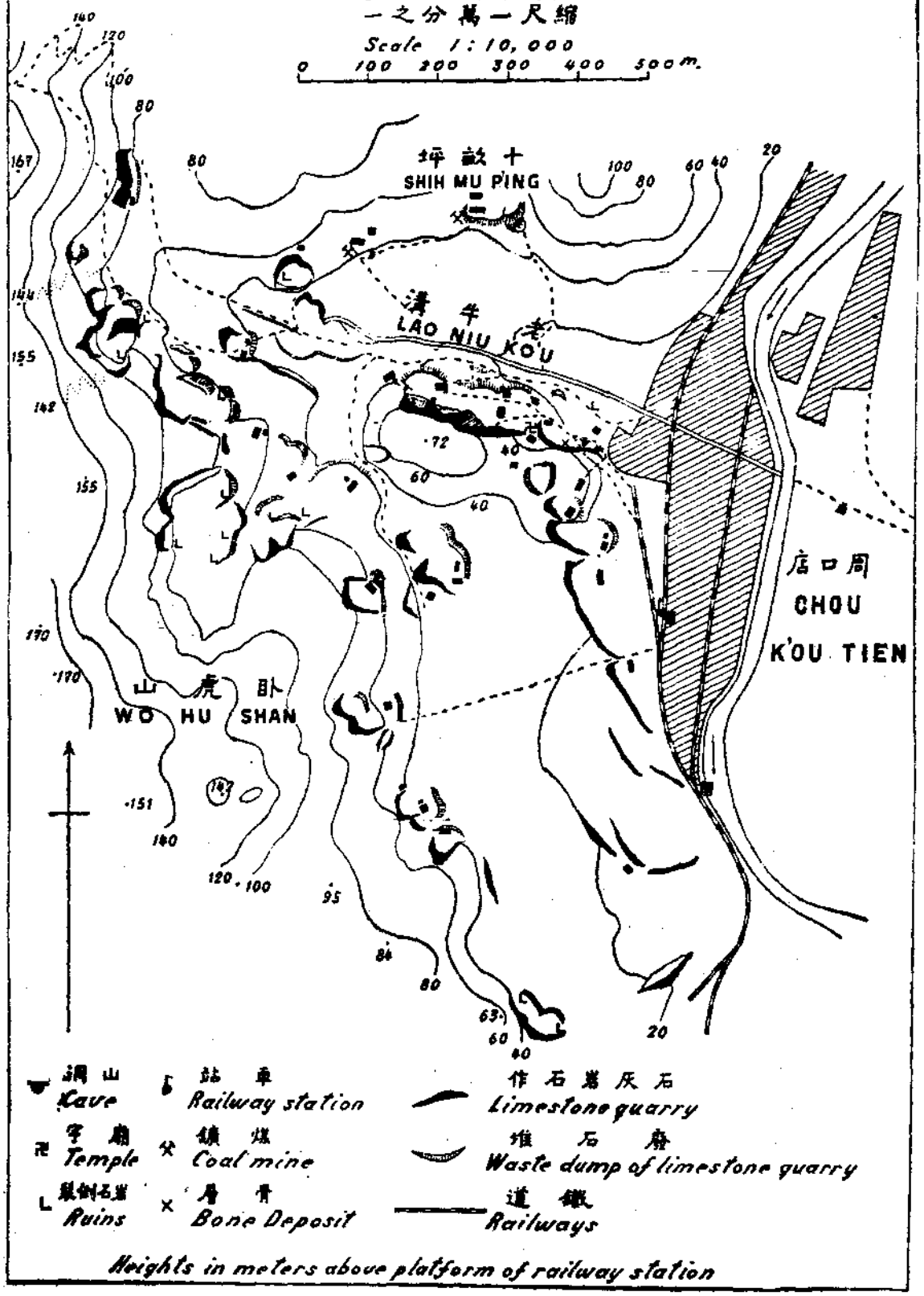
THE SURROUNDINGS OF THE CHOU-K'OU-TIEN BONE DEPOSIT.

BY O. ZDANSKY

一之分萬一尺縮

Scale 1 : 10,000

0 100 200 300 400 500 m.



Heights in meters above platform of railway station

SINOTHERIUM LAGRELII RINGSTRÖM.
A NEW FOSSIL RHINOCEROTID FROM SHANSI, CHINA.

By

T. J. Ringström, Uppsala.

In 1917 the undersigned commenced, in coöperation with the Geological Survey of China, a systematic search for fossil mammals, and already in the following year the work had met with so much success that he could, together with Dr. V. K. Ting, the Director of the Geological Survey, work out a definite plan for the continuation of the work.

We secured the able coöperation of Professor C. Wiman of the University of Uppsala, Sweden, for the scientific preparation and description of the rapidly growing material, and the necessary funds for an extensive collecting campaign were obtained partly from contributions by private Swedish donators (who have been awarded special honors by the Chinese Government) and partly by a Swedish Government grant.

It has been arranged between Dr. Ting and the Swedish authorities that the material will be divided between the Palæontological Museum of Uppsala and the Geological Museum in Peking. All the material will be described in the publications of the Geological Survey of China, small preliminary papers in the Bulletin, larger geological papers like my "Essays on the Cenozoic of Northern China" in the Memoirs and the full palæontological monographs in the *Palæontologia Sinica*.

Among the material thus collected, there are a number of new types which have considerable morphological interest.

The first of these new types, recognized as such by Professor Wiman, was a remarkable member of the *Giraffidæ* which has been named by him *Chilinotherium*, the name being derived from the Chinese allegorical animal the *Chilin*, which according to the recent researches of Mr. H. T. Chang is probably an anatomical composition with the giraffe as a model.

The *Chilinotherium* has been given the specific name *Ch. tingi* in honour of Dr. V. K. Ting, the Director of the Geological Survey, who has not only supported our fossil collecting campaign most actively, but has also planned and brought into being the *Palæontologia Sinica*, which is intended to contain, as far as possible, descriptions of all the fossils of China.

We hope soon to receive from Professor Wiman for publication a preliminary description of the *Chilinotherium tingi*.

In the meantime one of Dr. Wiman's pupils, Mr. T. J. Ringström, has sent us the following interesting note on a new member of the Rhinocerotidæ. this form presenting interesting relationships to the isolated and remarkable *Elasmotherium*. This new Rhinocerotid has been named *Sinotherium* by Mr. Ringström with the specific name *S. lagrelii* in honour of Mr. A. Lagrelius of Stockholm, who with tireless enthusiasm has financially supported our collecting campaign from its inception.

Peking in May 1922.

J. G. Andersson

Among the fossil mammals, that have been collected in China during the last few years by Dr. J. G. Andersson, there has lately been found a Rhinoceros tooth of gigantic dimensions, belonging to a new form, which I propose to name *Sinotherium lagrelii* Ringström. The specimen consists of the third molar from the left maxilla, and is about half worn down. It is somewhat damaged, the roots and the upper part of the protocone being broken off. The length of the tooth, measured along the ectoloph, is 10.5 cm., the height of the crown on the outer side is about 9 cm., and the greatest width 6 cm. It must thus have belonged to an animal of unusual dimensions, closely comparable with *Elasmotherium*§ · though probably larger than that animal. The most conspicuous characteristic of the tooth is the sinuous folding of the enamel, and the filling up with cement. The outsides too, are covered by a thin layer of cement. In the middle of the grinding surface the cement is less strongly developed, whereby a triangular shallow cavity arises. Otherwise the tooth is built according to the typical pattern of the *Rhinocerotides*.

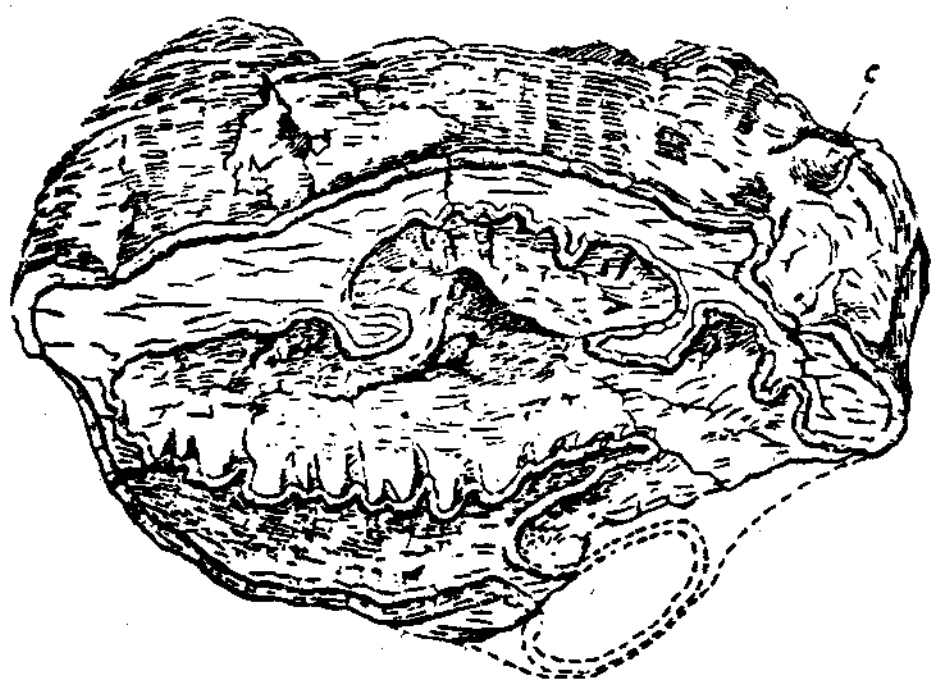


Fig. 1. *Sinotherium lagrelii*.
Third molar of left maxilla. Nat. size. c. Rest of cingulum.

The ectoloph is nearly straight, with no trace of the parastyle, 'crista', 'crochet' and 'antecrochet' are well developed; the protocone is large, and strongly

§ Brandt, J. F., "Mittheilungen über die Gattung *Elasmotherium*, besonders den Schädelbau derselben." *Mem. Ac. Imp. Sci. St. Petersbourg, Ser.* VII; Vol. XXVI 1878.

constricted off. The cingulum has completely disappeared with the exception of a small residuum (c in the figure) between the ectoloph and metaloph, which has the shape of a conic style. As already mentioned, *Elasmotherium* and *Sinotherium* occupy, with regard to size, a special position within the family RHINOCEROTIDÆ, and it seems likely that in *Sinotherium lagrelii* we may have found a less specialized form, belonging to the same phylum as *Elasmotherium*. One further resemblance to *Elasmotherium* is found in the characteristic folding of the enamel. In *Sinotherium* the folds are confined to the protoloph and the middle part of the ectoloph, while in *Elasmotherium* the enamel of the entire tooth is folded. This is however, only a difference in degree, which agrees well with the geological succession of these two animals; *Elasmotherium* lived during the Pleistocene, while the tooth in question comes from the early Pliocene or late Miocene deposits in Pao-Te-Chou, in the province of Shansi, a deposit which contains a typical *steppe fauna* e. g. hipparions, giraffes and antelopes. Further resemblances to *Elasmotherium* are seen in the facts, that the 'fossettes' are filled with cement, and that the protocone is strongly constricted and prominent. Contrary to what is seen in *Elasmotherium*, this tooth, although strongly specialized, still retains the typical appearance of a Rhinoceros molar, and has, like that, distinct roots. Supported by the above-mentioned resemblances, I do not hesitate to place *Sinotherium lagrelii* within the subfamily ELASMOTHERIINÆ, which formerly included only two species, both from the Quaternary period. I consider it premature, with the material in hand, to attempt to solve the riddle of the origin of *Elasmotherium*, or to connect the ELASMOTHERIINÆ, with any of the other six Rhinoceros phyla, arranged by Osborn[1]. Still, certain details in the tooth do remind one of the 'Teleocerine' rhinoceroses and of some aceratheres. Osborn[2] has shown that *Aceratherium incisivum* has a frontal horn, and suggests that *Elasmotherium* may possibly originate from that or some similar form. I do not consider that the tooth here described supports such a conclusion, for it shows that the members of the ELASMOTHERIINÆ were strongly specialized, and had already reached a huge size during the early Pliocene. It seems thus more probable that both these Rhinoceros phyla originated from some common ancestral type of the early Tertiary period, rather than that the ELASMOTHERIINÆ represent a side-branch of the ACERATHERIINÆ.

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1) Osborn, H. F., Phylogeny of the Rhinoceroses of Europe. *Bull. Am. Mus. Nat. Hist.* Vol. XIII. 1900.

2) Osborn, H. F., Frontal Horn on *Aceratherium incisivum*. Relation of the Type to *Elasmotherium*. SCIENCE, n. s. Vol. IX. Feb. 1899.

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山東中生代及舊第三紀地層

譚錫疇

引言

山東地質、久經學者考察、至爲清晰。往往他處地層疑不能決者、率以山東地質爲標準而比較之。惟以前研究、於古生代爲獨詳。古生代以後之地層、學者尙未詳細考究。致多數地層時期不能確定、即各層界限、仍多模稜耳。考察山東地質者、以李希提霍芬勞林芝威利斯爲最知名。梭爾格博士服務地質調查所時亦有所研究。四氏之中惟威梭二氏於較新地層稍爲注意。威氏調查新泰一帶地質時、於古生代以後地層僅分爲新泰系及汶河礫岩層。梭氏於查勘淄川博山煤田地質之役、則觀察較詳、分古生代以後地層爲下崑崙上崑崙及三台諸系。但地層位置之高下、各層界限之分劃、尙有懷疑、必待重加考正。近年安特生博士於技術任務之外、頗致力於純粹科學研究、特於久未經人注意之新生代地層詳加考察、於脊椎動物之化石尤盡力採集。其結果於古生代以後地層、多所闡發。中國地質得李希提霍芬而基礎立、得威利斯而古生代地層始大明、得安特生博士而新生代之歷史行將啓發無遺、三氏之大有造於中國地質者、已成鼎足之勢矣。

六年前德國礦師白哈蓋爾以一種大恐龍脊椎骨標本贈送調查所所長丁先生、並謂標本得自山東蒙陰縣。自是丁所長蓄意採訪恐龍產地。民國六年作者適有山東之行、道經蒙陰、遍地尋訪、費時頗久、而竟無所得、擱置已逾五載。至十一年夏、有重勘恐龍產地之提議。先是民國十年、博士發見山西垣曲縣始新統地層、曾詢作者山東較新地層有無與垣曲始新統地層相似者。作者當以山東確有較新地層、其時期因未得化石、不能確定、但舉或與垣曲地層有相當者以告。有此種種原因、博士遂邀同作者於十一年十一月二十八日再赴山東、

十二月二十一日歸京。雖調查之期、僅及三週、結果所得、不第產恐龍之較新地層得以發見、除恐龍外、尙於中生代地層採集魚類龜類蠑蚌類、於始新統地層採得腹足類及哺乳類化石。於是中生代及新生代之地層分劃及次第從此分明、地層既明、於地質構造上亦得相當之校正焉。惟調查範圍太狹、只限於蒙陰新泰萊蕪等處。安博士歸自山東、卽提議大舉調查山東他部。故十二年春師丹斯基博士赴新泰一帶繼續採集、作者則獨赴山東東部從事探勘、是役於中生代地層更有所發見焉。

先是安博士自魯歸來、擬於山東一役有所記述、刋載地質彙報、卒以甘肅之行在卽、諸待拼擋、未克脫稿、乃以編述之務屬諸師博士及作者、並囑將春季旅行所獲一併編入。但師博士回京不久、卽赴房山縣周口店研究洞穴塡充地層、於是所長翁文灝博士以五期彙報出版在卽、責成作者獨任編輯、並提議如將山東所有古生代以後地層悉行列入、則此編之作、或更可爲他處同時地層比較之標準。惟山東較新地層未得化石者尙有數層、作者誠恐僅以岩石性質、分別層序、不免錯誤、未敢自信。雖然中國古生代以後之地層、向欠詳細研究、此次山東東西兩部既各有所發見、則彼此關係所在、亦宜就實地所見敘述而討論之、以期於中生代及新生代前半期之歷史、能得系統的觀念、故應翁博士之命而作此報告。

斯基博士關於脊椎動物化石以切要之點相告。葛利普博士及周贊衡君於化石鑒定、竭誠相助、並有最有價值之記述。章鴻釗先生於報告文字曾詳賜校閱、並由李瑞生君擔任繪圖。均附記於此以誌謝忱。

斯編之作多承諸師友指教襄助。安特生博士於赴甘以前、預將關係資料廣爲搜集、移交作者、意尤可感。師丹

山東低平之區、每屬古生代以後地層、故本編所述、大抵非谿谷廣野、卽山嶺邊緣。山東西部低平區域、每爲中生代以前地層組成之山嶺所分隔、而東部低平原野、則率爲山嶺所環繞也。嶧縣煤田及費縣谿谷之間、山嶺蜿蜒、最高之峯達七百米突。聳立於費縣蒙陰萊蕪兩谷之間者、爲蒙山山脈。盤亘於蒙陰萊蕪兩谷之間者、爲新甫山山脈。最著名之泰山山脈、分隔萊蕪谿谷及淄博章邱煤田。沂水谿谷、東與莒縣谿谷、西與蒙陰谿谷、亦均以山嶺隔限之。而低平廣原位於東部者、四周山脈環峙、西爲沂山山脈、南有馬耳山山脈、東南爲勞山山脈、北有荆山及崮山山脈。與低原隔荆山山脈而不相連屬者、則萊陽谿谷也。

蒙陰谿谷、包有汶河沂河流域。汶河一支蜿蜒於西、出谷西流、沂水一支流貫於東。出谷東南行、谷之北、岡陵起伏、多由始新統地層組成。谷之南小嶺連亘、大部爲紅色砂岩層以下地層。谷之中部有一帶小嶺、蒙陰系發育於此、呈模範痔地狀。谷之西部冲積層遍地顯露、始新統地層、似隱匿於其下也。谷之生成由於地層變動斷折下沉所致、其後河流成立、剝蝕作用日盛、乃成今日之狀態。此谷現似仍在壯年期、將來受侵削作用不已、至兩河上游一旦聯絡、則其間分水小嶺卽將泯沒矣。

萊蕪谿谷、爲汶河流域、主幹西流、折而西南至大汶口、一支自蒙陰谿谷西流來會。谷之北有一帶小嶺、半爲太古地層、半爲始新統地層。谷之南岡阜蜿蜒、古生代地層觸處發育、間有閃長岩踪跡。谷之中部鑛山孤立。山以東平嶺連亘、山以西地勢以次低落、至萊蕪泰安交境、遂成原野。此谷之成立、與蒙陰谿谷同一原因、其正在壯年期而仍被侵削不絕亦相類。惟谷之大部除一二小山聳立外、不見岡巒起伏之狀、爲稍異耳。

費縣谿谷形長而闊、兩端與平原連接、無顯著分界。谷長逾二百里、浚河泗河流貫東西、中有岡嶺爲兩河分水

界。始新統地層著於谷之北、古生代地層帶於谷之南、谷之東部有中生近生兩代地層、谷之西部惟始新統地層最發育。至谷之成因、與蒙陰萊蕪兩谷相同、但受侵削作用較劇、一部似已至老年期矣。

泰山山脈北緣、淄博章邱煤田在焉。其低平區域、大半爲古生代以後地層、包有侵入岩、常成孤立小山、最高者爲長山、高約八百米突。孝婦河流貫煤田低地、由煤田地勢觀察、亦正在侵削作用期內。其成因半由於斷層、半由於拗摺作用。

嶧縣煤田、在山東山地之西南端。紅色砂岩占其北部、北爲斷層阻絕。其生成亦由地層折斷陷落所致。

沂河流域、有較新地層分佈之區二。一在沂水縣之南、成谿谷、沂河流貫之、凝灰礫岩層佈滿各處。一在沂水縣西北沂河上游、成盆地、亦爲凝灰礫岩層暴露之所。谿谷盆地均位於斷層之俯側、且均呈高下起伏之地勢。

莒縣谿谷、沭河所經、北與山東東部低原相接。爲其分界者、爲沭河濰河之分水嶺。谷內較新地層分佈、地勢愈南愈低、至谷之南端、則已夷爲原野矣。

山東東部低原、非第從地形地文上觀察、關係重大、即於地質構造亦關切要。按其地勢、中部爲平原、四周邊際爲低嶺、平原低嶺之間、尙有一帶類似平原。低原河流大別爲二系。一系蜿蜒於西部、北流入萊州灣、濰河爲其主幹。一系屈曲於東部、南流入膠州灣、沽河爲巨流。膠州灣與平度縣之間、地頗平坦、成一平原。至其成因、大抵由剝蝕作用、似非由積累所致也。自即墨縣至荊山南麓、地平坦、間有小嶺突出、幾近平原焉。自膠縣高密以西至諸城莒縣之交、亦爲一類似平原、一面接平原、一面連低嶺、適成中間過渡區域。總之山東東部低原、爲一不完全之盆地、中部有一平原、外爲類似平原、而邊緣則環以低嶺、地勢由四周漸向中央低降、而地層亦由四方

向中央傾斜、侵削作用繼續不已、平原行將擴大、類似平原也。萊陽谿谷、包有五龍河流域。地層抵抗侵蝕之力有差、故地勢亦高下不等。谷之北東兩部、爲含魚地層及凝灰礫岩層所在、地多山嶺。西部爲紅色粘土層分布之區、成一高原、爲無數溝渠所刻劃。谷之一部雖尙在少壯期、但他一部則已至老壯期矣。

地層

山東古生代以後地層、每不連續、故在一地而能獲見全豹者絕鮮。各組地層相互之關係、亦常不甚明瞭、欲集合各地層而確定其次序關係接觸狀態、非用各種方法比較其同異間接推論不爲功。比較之法、自以考證化石爲最有據。從前學者所以未免有誤者、實由所得化石甚少、不足借鏡、甚或一無所得故也。今作者雖迭經發見新化石、而困難仍不能免、惟以含有化石之層序爲基礎、間接推定未得化石地層之位置而已。

中生代地層中、惟濰縣坊子煤系得就歷來所出植物化石、確定爲侏羅紀。民國八年、安特生博士與作者在坊子煤田亦採集植物化石多種、中以 Podozamites, Coniopteris, Asplenium, Baiera 及 Elatides 等爲最常見。山東萊陽所產魚化石、由烏德瓦德博士（A. S. Woodward）鑒定、多屬 Lycoptera sinensis 一種屬、故當承認含魚地層爲侏羅紀之物。但最近由葛利普博士鑒定與魚化石共生之昆虫類葉鰓類及植物化石之結果、則萊陽含魚地層之時代、仍可懷疑。其他中生代地層、雖經諸學者劃分、且各與以專名但其時期率未確定。新生代地層惟李希霍芬及威利斯略有記述、而威氏稱始新統地層之最上部爲汶河礫岩、而以其下部屬諸中生代、則稍誤矣。

近來古生代以後地層、歷經地質學者觀察研究、除不含化石及無顯著特性可供考證者外、其上下位置、時代同異、均較前大爲明瞭。中生代內惟地層之屬於三疊紀上侏羅紀及上白堊紀者、位置似不能確定、其餘率無可懷疑者。新生代內茲篇所述者、僅始新統地層、他如紅土黃土及黃土以後之物、均付闕如。蓋作者於始新統以後地層、尙無暇詳細研究、不能不俟諸異日也。

地層分佈既少連續、發育又不一致、如按地敘述、勢嫌參差、不若依地層大致次序、先後記述、較有統系。茲以梭爾格博士所稱下崑崙系之紅色砂岩層爲中生代開幕之地層、並依次續述其以後各層如左。

(甲)下崑崙系或紅色砂岩層　在記述本系之先、有應行敘及者、爲本系與其下各層之關係是也。本系在山東南北兩部、均直接位於二疊石炭紀煤系以上之石英砂岩層、即所謂層石層之上。但在山東中部則與古生代煤系及奧陶紀灰岩接觸、不見石英砂岩踪跡。石英砂岩在山東中部、是否原未生成、抑或紅色砂岩與奧陶紀灰岩及古生代煤系爲斷層接觸、實一問題。不第紅色砂岩與石英砂岩以前之地層接觸、即紅色砂岩以後地層、亦有與之逼近者。且石英砂岩在山東南北兩部既頗發育、獨中部一域未曾沉積、於理難解、故謂紅色砂岩以斷層與古生代煤系及奧陶紀灰岩接觸、似較可信也。

本系生於山東西部、與古生代煤系分佈有聯帶關係。雖紅色砂岩爲其重要分子、而岩石性質、亦每隨地而異。在淄川博山煤田、本系分佈於孝婦河兩岸、岩石以紅色鬆質砂岩爲主。與石英砂岩層接觸處、有棕色淺黃灰色粘土及泥質頁岩、與淺綠色砂岩相間而生。其接近中生代煤系者、常夾薄層淺黃綠色砂岩。輝長岩之侵入岩塊顯出於本系之上部。在章邱煤田之北、沿長山南麓、本系亦時顯露、每爲安山岩所侵、

一部變化爲石英岩。在萊蕪谿谷、本系沿汶河分佈、位於與石英砂岩相當之一種淺黃白色砂岩之上。但未見兩種砂岩接觸處。岩石以紅色砂岩爲主、呈十字層形、上部爲正長岩坂所侵。在蒙陰谿谷、本系沿汶河一支及沂河旁支東汶河暴露、與奧陶紀灰岩及古生代煤系爲斷層接觸。岩石以紅色砂岩爲主、最上部含礫岩、礫石大半爲石英岩、間有灰岩質者。砂岩亦呈十字層形、質堅而不粗。在費縣谿谷、本系見於浚河及其下游訪河沿岸、露頭斷而不續。下與古生代煤系爲斷層接觸、上爲蒙陰系所覆、下部斷沒不見、存者僅其上部。在費縣城之北古城一帶、岩石爲紅棕色砂岩、與紅色頁岩及礫岩相間而生、礫石大半爲石英岩。費縣臨沂之間、柴埠（讀如卜）莊煤田北緣亦嘗目擊紅色砂岩及礫岩。在嶧縣煤田、本系直位於石英砂岩層之上、北阻於斷層。岩石以紅色粗鬆砂岩爲主、並夾礫岩。嶧縣臨沂之交、紅色砂岩亦有暴露者、惟沖積層四佈、與他層接觸不明。

本系厚度頗不一律、由數十米突以至七百米突、因本系一部爲斷層所斷沒、故厚度相差若是其鉅。僅在淄博煤田及萊蕪谿谷、本系全部可以追尋、估計之約得六百八十米突及七百米突。在章邱煤田、本系因受火成岩之影響、厚度無法估計。在蒙陰費縣嶧縣等處、地層斷落不全。其存留部份、在蒙陰約百十米突、在費縣約二十米突、在嶧縣約百二十米突。

李希霍芬及勞林芝嘗以本系歸入於二疊紀。威利斯置之於新泰系之下部。梭爾格博士於調查淄川博山煤田地質之役、名之爲下崑崙系。因向未得化石、故本系時代迄今未能確定。但就其互相關係之位置觀察、似爲三疊紀之產物也。

(乙)坊子系或中生代煤系　本系在山東坊子、組成重要煤田、故系以坊子名。在坊子一帶、未見本系下之地層、僅於煤田之南、見本系與寒武紀以前地層成斷層接觸、一部已斷折沉沒。其與太古代片麻岩接近處、受火成侵入岩之影響。在昌樂縣五圖高鎮等處、本系與寒武紀地層爲斷層接觸。在坊子煤田、本系岩石露出者、爲白色粘土灰色頁岩白色泥質頁岩、白色硬砂岩、淺黃棕色砂岩及頁岩、白色細粒鬆砂岩。坊子西鑛開鑿豎坑黃土下爲凝灰岩、厚由三十餘尺至四十餘尺、下爲砂岩、厚三四尺、下爲黃色頁岩、厚七八尺、下爲灰色頁岩、厚三十尺至四十尺、下爲煤層、總厚二十二尺八寸、底部夾灰色頁岩八寸、再下爲灰色頁岩。在五圖高鎮等處、本系亦夾煤層、惟露頭頗少。五圖一帶地層可見者、爲黑色泥質頁岩淺紫色薄層砂岩黃色軟質硬質砂岩。高鎮一帶暴露者、惟淺黃綠色砂岩及灰黑色頁岩而已。

本系暴露不全、厚度無從估計。其所存含煤層之一部、似不逾六十米突。本系所含煤層、坊子東西兩礦、所採者只一層、厚度有差。西鑛煤層最厚部份、逾二十尺、平均約十二尺。東礦煤層厚處逾三十尺。五圖煤層其數爲三、最厚者僅二尺五寸、總厚不過四尺、高鎮煤層只一層、厚約五尺。

自泡唐尼（H. Potonié）鑒定由坊子所採植物化石後、本系時代始確定爲侏羅紀。日本地質學者亦在坊子採得侏羅紀植物化石。民國八年安特生博士與作者於調查坊子煤田地質之役、曾採集 Podozamites, Coniopteris, Asplenium, Baiera 及 Elatides 種種植物化石、均可據以確定本系生成之時期者也。

(乙')上崑崙系或中生代煤系　本系發育於淄博煤田之西部、在孝婦河以西、組成小平嶺、位於下崑崙系之

上。岩石以砂岩頁岩爲主、上部間含礫岩。層內包有輝長岩及安山岩侵入體、因受輝長岩灼烙、砂岩一部變爲石英岩、爲博山製造玻璃之主要原料。在變衣舖一帶、地層次序（由下而上）如下。

淺黃綠色硬砂岩、夾黑色頁岩（似含煤層。）

白色粗粒砂岩、時呈赤色。

灰白色粗砂岩、在崑崙山變爲石英岩。

淺黃綠色砂岩、有時質稍堅實。

淺灰黃色砂岩。

淺黃綠色泥質頁岩、及黑色泥質砂岩頁岩。

在西劉庄一帶、本系地層次序如左。

黑棕色淺綠色泥質頁岩、及淺黃綠色砂岩。

綠色砂岩。

黑棕色淺綠色泥質頁岩、時露植物化石痕跡。

綠色砂岩。

白色粗粒砂岩。

礫岩。

綠色粗砂岩。

本系厚度估計約百六十米突。曾經梭爾格博士詳細觀察、名之爲上崑崙系。作者在舊採煤暨坑石澗內、尋得植物化石痕跡、惟形體不具、種屬未能辨識、故本系時代尙未確定。但由岩石性質觀察、一部與坊子系內岩石相似、上崑崙系或即與坊子系相當也。

(丙)三台系或紅綠砂岩系　本系分佈於淄博煤田之西部、位於上崑崙系之上。岩石爲紅綠棕紫淺灰黃各色砂岩、與上崑崙系接近處、變爲礫狀、與安山岩及輝長岩接觸者、變爲石英岩。

本系久經剝蝕、確實厚度無從計算、其存留部份、似不下五百米突。歷來地質學者於本系多未顯著劃分、勞林芝僅稱之爲中生代地層、威利斯歸之於新泰系內、其後梭爾格博士始劃分之、名之爲三台系。因本系化石絕跡、時代未能確定、但按其位置所在、似仍屬於侏羅紀也。

(丁)蒙陰系　由化石考察、本系似與山東東部萊陽層及青山層相當。惟三系地層須分別叙述、不能混爲一談、故以(丁)冠於蒙陰系之上、而以丁一、丁二指示萊陽青山兩層、所以表明萊陽青山兩層爲蒙陰系之分層也。

蒙陰系分佈於山東中部、萊蕪蒙陰費縣谿谷發育尤著、位於下崑崙系之上。在萊蕪谿谷、岩石爲灰色綠色頁狀砂岩、有時呈淺棕色、含多數火成岩侵入體、每成坂狀。有時本系雖含綠色凝灰礫岩、凝灰角礫岩、凝灰岩及岩流等火山之物、並夾侵入岩體、但不見砂岩踪跡。在蒙陰谿谷、岩石以綠色砂岩爲主、凝灰礫岩有時亦占重要位置。在蒙陰縣西北部、本系下部含黃綠色礫狀砂岩、黃色淺綠色砂岩、及頁岩、往往呈十字層形中部爲綠色頁狀砂岩及淺綠色砂質頁岩、上部含綠色砂岩及紫棕色頁岩。在蒙陰縣城一帶、

下部爲灰色淺綠色淺棕色頁狀砂岩、及綠色硬粗砂岩、中部含綠色凝灰礫岩、凝灰岩、與黃灰色砂質頁岩、及綠色頁狀砂岩相間而生、上部爲綠黃棕色頁狀砂岩、與淺紅色黃灰色粘土灰白色鬆砂岩及凝灰礫岩相間而生。在費縣谿谷、本系多被掩於冲積層、未能窺見全豹。在費縣城北古城一帶、岩石爲淺綠色鬆砂岩、與綠色凝灰岩夾雜並生。在費縣城東忠義山一帶、岩石亦爲淺綠色鬆砂岩夾綠色凝灰礫岩、及侵入岩體。

本系厚度不甚一律、在蒙陰縣西北部估計爲八百三十米突、在蒙陰縣城一帶爲千二百四十米突、在費縣谿谷計約千米突、在萊蕪谿谷計約三百六十米突、其含火山物質之部、厚度頗大。

李希霍芬勞林芝及威利斯在萊蕪蒙陰新泰等處、均曾目擊此系。李勞二氏並未特別道及、似僅以之歸入於二疊石炭紀內。威氏考察本系較詳、置之於新泰系之中部。本系所含化石頗多、動物植物俱備。脊椎動物化石曾經師丹斯基博士鑒定、植物化石曾經克利世陶佛維持（P. N. Kryshtofovich）博士及周贊衡君觀察、均謂似屬於白堊紀。故本系時代假定爲白堊紀、當不致全誤、但其一部或已屬於侏羅紀之末期也。

丁一、萊陽層或含魚層　本層在山東東部萊陽即墨膠縣諸城莒縣等處特別發育、與泰山系及五台系均成不整一之接觸。萊陽本層可分爲三部、下部以後棕色黃色灰色頁狀砂岩爲主、夾綠紫紅色泥質頁岩及黃灰色粗砂岩、有時呈礫狀、中部含灰綠色薄層頁岩及黑灰色灰質硬頁岩、夾黃色灰色砂岩、上部爲黃灰綠及淺紅色砂岩、夾綠灰紅色泥質頁岩及黑色頁岩。下部並含火成岩侵入體、或成塊狀、或爲板

形。即墨膠縣諸城莒縣、本層似不夾含魚化石之灰質頁岩、但含石英岩數層。在即墨、岩石爲淺綠色頁狀砂岩、棕紅淺綠灰黃色砂岩、夾石英岩綠色棕色砂岩礫岩及淺灰色石英岩。在膠縣諸城、本層含黃色淺綠色淺棕色硬砂岩、夾灰綠淺棕色泥質頁岩及礫岩。上部砂岩一部、成石英岩質。在莒縣、本層惟分佈於大山一帶、含黃色鬆砂岩、棕色砂岩、綠色粗硬砂岩、夾綠色紫色泥質頁岩。

本層厚度各處均無大差異、在萊陽計約七百米突、在即墨膠縣諸城等處、約九百米突。本層所含魚化石、由烏德瓦德博士鑒定、爲侏羅紀物、但葛利普博士考察作者採得之昆虫類葉鰓類魚類植物化石、則謂大致均屬白堊紀。故本層位置、必須移置於白堊紀、其一部或仍屬於侏羅紀耳。

丁二、青山層或凝灰礫岩層　本層在山東東部發育特著、分佈頗廣、位於各層之上、成不整一不整合或整合之接觸。在萊陽青山、由作者發見爬行類骨骸、故本層以青山名。在萊陽、本層位於萊陽層之上、含棕色凝灰礫岩、綠色紫色淺紅色凝灰岩、與岩流及紅色粘土相間而生。其下部有綠灰紫棕色泥質頁岩、及淺黃紅色砂岩。在山東東部他處、本層含凝灰岩礫岩及火山岩流、間有棕紅色砂岩、包各種火成岩侵入體、但未見粘土。本層除在即墨膠縣諸城及莒縣東部直覆於萊陽層外、在安邱臨朐濰縣沂水莒縣、位於泰山系之上、在安邱東部萊陽南部位於五台系之上、在安邱西南部臨朐南部莒縣昌樂境內位於元古界矽質灰岩及寒武紀地層之上、在臨朐南部沂水北部位於奧陶紀灰岩之上、在莒縣西部位於古生代煤系之上、離縣昌樂境內則位於侏羅紀煤系之上。

本層由莒縣沂水一帶起、愈東愈厚、至諸城膠縣即墨計約千二百米突、至萊陽厚度仍無增減、就所含化

石及與萊陽層關係考察、本層仍當屬於白堊紀也。

(戊)王氏系或紅色粘土層　化石初發見於萊陽王氏村一帶、故系以村名。本系在山東東部分佈甚廣、東部低原萊陽莒縣谿谷、均處處暴露。在萊陽谿谷、本系位於青山層之上、露頭若斷若續。在萊陽谿谷、本系位於青山層之上、與五台系成斷層接觸。含紅色粘土、夾紅色白灰色棕色礫岩及鬆砂岩。中部有黑色粘土數層、礫岩中礫石由石英岩砂岩片麻岩斑岩及火山岩組成。在膠縣諸城及高密一部、本系可分爲三部。下部含紅色粘土、夾紅色灰色砂岩、中部爲紅色粘土夾綠色灰色粘土及礫岩、上部含粗礫岩、夾棕紅色粗硬砂岩。在莒縣谿谷、本系露出不全、所存留者只下部中部。岩石爲紅色粘土、夾紅色鬆砂岩及礫岩。下部有淺綠色頁岩砂岩及淺黃綠色粘土、礫岩所含礫石、爲石英岩灰岩硬頁岩及火山岩居多。在沂水谿谷南部、有紅色粘土、綠色紅色頁岩砂岩露頭數處、似位於青山層之上、乃本系之分層也。

本系頗厚、估計不下二千米突。在本系中部、作者曾發見巨大骨化石多種、師丹斯基博士謂似爲爬行類、而非哺乳類。但大爬行動物、絕非第三紀內所應存在、故師氏之說若能證實、則本系當屬白堊紀、無疑矣。

(己)官莊系或紅色鬆砂岩層　在新泰縣官屯附近、本系內採得腹足類化石及哺乳動物牙齒多種、故即以村名系。本系在蒙陰萊蕪費縣谿谷、特別發育、泰安南部甯陽東北部、均有暴露。以紅色鬆砂岩粘土及礫岩爲主、夾黃灰色砂岩泥灰岩灰岩、間含黑灰色頁岩、似帶炭質。在蒙陰谿谷、本系位於蒙陰系之上。下部爲紅色鬆砂岩及礫岩、其中礫石有紅石英岩、灰岩及正長岩、閃長岩等。中部爲紅色鬆砂岩、黃灰淺綠色砂岩、淺灰色粘土、黑灰色頁岩、白灰色薄層頁岩（層薄如紙）淺灰綠色泥灰岩及灰白色灰岩、夾灰質

結核。泥灰岩及灰岩、均成薄層、厚約由半米突至兩米突。上部含礫岩及紅色鬆砂岩、其中礫石大半爲灰岩及斑岩輝綠岩、較下部所夾礫石爲大。在萊蕪谿谷、本系位於蒙陰系下崖崮系及閃長岩體之上。下部含紅色鬆砂岩及粘土、夾鬆質礫岩、礫石大半由灰岩組成。在萊蕪縣城之北、閃長岩露頭一帶、紅色鬆砂岩含長石細粒並礫岩、其中礫石之一部爲類似侵入體岩石之閃長岩。中部爲紅色鬆砂岩、與黃灰淺綠及白灰色砂岩相間而生、夾淺灰白色灰岩數層。上部爲礫岩、間夾紅色鬆砂岩。沿萊蕪泰安兩縣交境、曾見黃綠砂岩及白色灰岩、亦似屬於本系者。在費縣谿谷、本系或位於蒙陰系之上、或與古生代地層成斷層接觸、大部被覆於冲積層。惟沿谿谷北緣、本系上部礫岩及紅色鬆砂岩、時或暴露。在費縣北境、地層露出者爲中部之白色灰岩、黑灰色淺綠色頁岩及上部之粗礫岩、紅色鬆砂岩。在泗水境內、本系地層爲紅色鬆砂岩、礫岩、灰色粘土、黃色粗鬆砂岩、紅色鬆砂岩內往往含石膏、粘土一部帶炭質、並含薄煤層。在寧陽東北境、有白灰色粘土砂岩及礫岩暴露、粘土亦含煤。在泰安南境、紅色鬆砂岩礫岩及白灰色粘土、夾常目擊、雖未採得化石、大致亦本系之分層也。

本系厚度頗不一律、在蒙陰谿谷由六百米突至千一百米突、在萊蕪谿谷、最厚部份計約千六百七十米突。但費縣谿谷寧陽泰安等處、本系暴露不全、厚度無從估計。由所得哺乳類腹足類等化石考證、本系確爲始新統之產物也。

地層位置之概論　如上所述、地層括爲數組、各發育於不相關連之谿谷或低原內、計共九系。分隸於四紀、屬於三疊紀者一、屬於侏羅紀者三、屬於白堊紀者四、屬於始新統者一。雖各屬時代、由所含化石、岩石性質與

相關位置考證、大致似已確定、或暫假定、但各層同異之關係、位置之高下、亦有研究討論之必要。屬於三疊紀之下崑崙系、在諸地層中爲最古、宜置於柱狀剖面之底部。次於下崑崙系者有三層、上崑崙系及蒙陰系直覆其上、而坊子系下則不見下崑崙系踪跡。但就化石考證、蒙陰系爲白堊紀物、距下崑崙系尙遠、中間似缺少一段地史。坊子系確含侏羅紀化石、由岩石性質觀察、上崑崙系似與坊子系相當、故兩系均當緊接下崑崙系、而置於中下侏羅紀者也。坊子系之上爲青山層、上崑崙系之上爲三台系、青山層與坊子系之間、兩層不相連續、亦顯似缺少一段、而三台系似當繼續坊子上崑崙兩系、而位於中上侏羅紀者也。但三台系是否與蒙陰系同時、抑或時代較古、因在三台系內未得化石、尙有疑義。就岩石性質觀察、三台系以紅砂岩爲主、蒙陰系內綠色岩石占重要位置、故兩系似不相當、三台系較古於蒙陰系、而下崑崙系與蒙陰系間之缺失似當爲上崑崙系及三台系所填充也。繼三台系之後者、蒙陰系或萊陽層適當其選。但於排列位置之前、蒙陰系與萊陽青山兩層當互相比較、並可與美國紐約博物院所派遣之調查隊在蒙古觀察之地層、考證其關係。在蒙陰系中上兩部凝灰礫岩及火山物質有時占重要位置、而青山層幾全爲凝灰礫岩及火山物質。雖兩種凝灰礫岩色澤不同、然至少蒙陰系一部與青山層相當。蒙陰系下部以綠色頁狀砂岩爲其主要分子、而萊陽層亦多夾色性酷似之砂岩、故蒙陰系下部似當與萊陽層一部相當。由化石考察、蒙陰系相當於萊陽青山兩層、愈覺可信。蒙陰系所含動植物化石、由師丹斯基博士及克利世陶佛維持博士鑒定、謂屬白堊紀、萊陽青山兩層所含動植物化石、由葛利普博士及周贊衡君鑒定、亦爲白堊紀之物。並就化石觀察上述三層當與蒙古地層有相當者。蒙陰系及青山層、含恐龍類龜類魚類葉鰓類及植物化石、萊陽層含魚

類昆虫類葉鰓類及植物化石。蒙古地層含恐龍類者、爲渣斗塔層、阿色爾層、昂代塞爾層、及愛嫩達巴蘇層、而昂代塞爾層又含昆虫類魚類及葉足類化石。前三層屬於下白堊紀、後一層屬於上白堊紀。昂代塞爾層之昆虫、大致爲蚊蝶之類、而萊陽層所見、亦有似蚊虫者、萊陽層與昂代塞爾層似有相當之處。要之、山東之蒙陰系萊陽層青山層頗似蒙古之渣斗塔層阿色爾層及昂代塞爾層、故蒙陰系及萊陽青山兩層均可置諸下白堊紀、而後兩層與前一系、位置更當同。但萊陽層之下部甚厚、未獲化石一部或已伸入於上侏羅紀。

青山層之上爲王氏系、含骨化石頗夥、師博士謂爲爬行類骨骸、王氏系當屬白堊紀。蒙古愛嫩達巴蘇層、由美國學者定爲上白堊紀、含恐龍類葉鰓類鱷魚類龜類等化石。王氏系除含恐龍類外、亦有葉鰓類化石、故王氏系或與愛嫩達巴蘇層相當。可置諸上白堊紀內。所述各層內最新者爲官莊系、由化石考證、確爲始新統。下表即示各層所屬之組及其相關之位置。

					王氏系	不整合	青山層
							萊陽層
				不整合	官莊系		
					蒙陰系		
					三台系		
					上崑崙系	不整合	坊子系
第三紀	始新統	白堊紀	上部		下崑崙系		
			中部				
			下部				
中生代		侏羅紀					
		三疊紀					

化石

近年來在山東所採各種化石中、雖有一部尚未鑒定、不能洞悉地層準確時代、而大致對於山東地層之次序及構造之狀態、似有幾許之貢獻。近來山東幾次調查、原爲搜尋化石、已於引言內敘及。本章所述、爲化石產地、

含化石之地層、及化石之種屬。地層含化石者、爲坊子系蒙陰系萊陽層青山層王氏系及官莊系等六系。坊子系僅含植物化石、夾於接近煤層之黑灰色及白灰色頁岩內、在坊子煤田東西兩礦均有之。所知者有Podozamites, Coniopteris, Asplenium, Baiera 及 Elatides 數種。所有標本、均已送往瑞典詳細鑒定、俟將來再行刋佈。蒙陰系內化石頗多、動物植物俱備。植物化石採於蒙陰縣城一帶蒙陰系之中上兩部。在城東北四里之處、植物遺跡尤多、有樹幹及羊齒類葉之遺痕。動物化石爲龜類魚類淡水產軟體動物及恐龍類。龜類魚類化石採於蒙陰縣城西北三十五里窩家溝一帶蒙陰系之中部。淡水產軟體動物亦得於窩家溝及蒙陰縣城一帶蒙陰系之中部。上述動植物化石、均已送往瑞典鑒定。茲當中國內地初次發見恐龍類之際、凡在中國屬境恐龍類之採集、亦當略有所記載。關於黑龍江岸恐龍類產地、第一次科學記錄、刋載於一千九百二十年克利世塔佛維世 (N. J. Kryshtofovich) 所作俄國礦物地質年報。內云、層內所有骨骸、哥薩克土人俱知之、標本送於卜拉高外世陳斯克 (Blagoweshchensk) 博物館陳列、擬諸象骨焉。一千九百十四年克利世陶佛維持 (A. N. Kryshtofovich) 博士於黑龍江旅行之際、哥薩克人告以黑龍江岸中國境內柏林亞河口下有骨化石產地、克博士乃尋獲含恐龍類之礫岩層、夾於鬆砂岩層內。自克博士發見骨化石後、俄京彼德格拉 (Petrograd) 地質調查所曾於一千九百十五年至十七年三夏季組織調查隊往該處從事發掘。掘出之物送往俄京均已由李阿賓尼母 (A. N. Riabinin) 鑒定。多數屬於 Ornithopoda 一類、即爲 Trachodon 及 Saurolophus 兩種、與北美 Trachodontidae 近似。並有與 Albertosaurus 類似之食肉恐龍類 (Theropoda) 牙齒、及大體當屬於 Ceratopsidae 之碎片。一千九百二十二年夏美國調查隊格蘭裘 Granger 博士及伯克 Berkey 博士在蒙古採

集恐龍類頗夥。在渣斗塔層內曾發見一新種恐龍、名之曰 Protoceratopsis andrewsi 在阿色爾層內採得 Camptosaurus 及一種大恐龍之肋骨、在愛嫩達巴 mptosaurus 恐龍及巨體之蜴蜥類、在昂代塞爾層內亦有 C 蘇層內採得兩足恐龍及食肉恐龍兩種、其小者屬於 Ornith ithominus。在中國內地初次發見恐龍類者、爲德國 基督教神父麥純斯 Metreis。彼於十年前在山東蒙陰縣寧家溝附近曾採得一種恐龍骨幹、其一部曾由白 哈蓋爾君贈於丁文江所長。其時恐龍產地未詳。至民國十一年安特生博士與作者不僅尋獲恐龍產地、且復 多所採集。在寧家溝一帶採得恐龍骨骸多種、大抵屬於軀幹部份、獨不得頭部。十二年春季、師博士在寧家溝 附近麥神父採集恐龍之處、從事發掘、得一巨大脊骨、全長幾二十尺、並有破碎頭骨一塊、附有牙齒數枚。上述 恐龍類均夾於蒙陰系之中下兩部。十二年春、作者在山東東部萊陽膠縣等處亦採得骨骸多種、內有少數夾 於青山層下部、餘均得於王氏系之中部。青山層所夾恐龍類、採自萊陽城東北十五里之青山及城北十五里 之馬崖口內有骨骸層境、大約爲臀骨之部份。王氏系所夾骨骸、師博士謂亦屬爬行動物。古生物學泰斗奧斯 朋 Henry Fairfield Osborn 博士於十二年秋到所參觀、就巨大之腿骨肋骨大致觀察、謂當屬於 Iguanodon 或 Camptosaurus。產地在萊陽縣之王氏天橋屯將軍頂及膠縣之張營等處。有腿骨肋骨脊骨臂骨牙齒種種、上述 各種骨骸、均將送往瑞典詳細鑒定。萊陽層內夾動植物化石多種、在萊陽城東北二十里之泊子及城東三十 里之南務採得昆虫類魚類葉齶類及植物化石、均夾於萊陽層之中部。其下部亦有植物化石痕跡。青山層及 王氏系內、除爬行類外、亦有葉齶類及腕足類化石。在萊陽城北約十八里朱家莊青山層之下部、採得葉齶類。 在膠縣張營王氏系之中部、採得葉齶類及腕足類。上述化石均經葛利普博士及周贊衡君鑒定、其記述附後。

在蒙陰萊蕪谿谷之官庄系內、安博士及作者發見化石頗多、均夾於該系中部之淺灰白色灰岩、淺灰白色及淺綠色泥灰岩及砂岩內。產於蒙陰谿谷之新泰官莊一帶及萊蕪谿谷之李家鎮附近者、爲淡水產及陸生軟體動物數種、屬 Trionyx、蜥蜴類及六種屬哺乳類之牙齒顎骨、與其他骨骸。哺乳類由師博士鑒定爲 Phenacodontid 或原始 Hyracotheriine, Anchitheriine, Mesohippus, Anchilophus 及 Greodont 或原始 Canid 昆虫類葉鰓類腕足類及植物化石多數、均已由葛利普博士及周贊衡君分別鑒定、其記述另詳於後篇。

構造

山東全省構造狀態、較爲複雜。不但內部情形須詳加討論、而對外關係、亦應特別注意。但本編所述區域、僅全省一小部份、而各地層又僅包括於中古近古地質史內、故敘述構造狀態只取與本編有關係者爲限。

水陸之變遷（參觀剖面圖）　當古生代之末期、山東除久經剝蝕之東部外、均爲二疊期淺海所淹沒。惟此淺海至古生代之末即已退去陸地沉澱物即得沉積之機。下崑崙系與其下石英砂岩層成整合之接觸、此現象直當繼續至三疊紀之末季。但下崑崙系與其上之地層、又呈不整合之覘。故知當海水退去之際、似全省均成陸地、惟地勢平坦毫無折疊之跡。

在侏羅紀之初、陸地沉積之域、占據山東西北部盆地邊緣、大致在泰安萊蕪沂水安邱之北。他處仍繼續受剝蝕作用。坊子系與上崑崙系均沉積於此時。但當中侏羅紀盆地邊緣漸向西移、前被沉澱積覆之區、如濰縣昌樂臨朐益都等處、均經隆起。而博山淄川章邱歷城及其以北之地均仍繼續沉澱、直至侏羅紀之末、故三台系得直接沉積於上崑崙系之上。就化石及剝蝕之跡考察、下崑崙系與其上蒙陰系之間、及坊子系與其上青山

層之間均顯有缺史。由此可知坊子系與久經昇起之下崑崙系、均曾大受剝蝕。至侏羅期之末、沉積終止、三台系暴露山東全省似又高出沉積地面之上。但不知此時東部已爲沉積物占據否耳。

在白堊期之初、河流沉積又盛、似分兩區。一區由東方侵入、覆蓋於久經剝蝕之東部、當白堊前期、盆地邊緣大抵在臨沂沂水以西。其時臨沂莒縣安邱沂水一部、及臨朐昌樂濰縣、益都博山淄川章邱歷城、並其以北各處、均成高地。其南部分隔兩沉積盆地。當時火成岩似已活動。在東盆地內、萊陽層沉積於泰山系五台系之上、但白堊前期沉積之區向西發展、直越兩水區中間陸地、與西盆地相連。其時西盆地內蒙陰系積覆於下崑崙系之上。繼萊陽層而生成於東盆地者、爲青山層、向西發展、繼續沉積於後侏羅紀以前地層之上、終與蒙陰系上部連接。由此觀之、青山層對於後侏羅紀以前地層、顯成超積

至白堊中期、河流活動終止、山東全部似均脫離沉積範圍。爲時不久、沉積又起於東部、沉積區域邊緣、大抵在臨沂莒縣安邱縣城及諸城高密縣城之間。沉積於此盆地者、爲王氏系。其礫岩之礫石、一部來自青山層之岩流。由此可知青山層與王氏系爲不整合之接觸、蓋白堊中期沉積範圍縮小之後、繼又恢復其原狀也。

在白堊期之末、沉積區域向東遷移、山東全省又起爲陸。至前第三期河流沉積復被於山東西部、盆地邊緣、大抵在臨沂蒙陰萊蕪泰安境內。官莊系即在此盆地產生者。在萊蕪谿谷、其下部夾閃長岩礫石及長石砂粒閃長岩侵入體。大抵與蒙陰系同時、或生成略晚、蓋官庄系含閃長岩礫石、頗可證明。蒙陰系與官庄系之間、確有一不整合、並可信當前第三期之際、沉積區域有一度之前進也。此沉積區域繼續至始新世之末、沉積終止。此

後惟黃土河淤相與營作焉已耳。

地層之折褶（參觀剖面圖）　在始新世之末、山東全省地勢、似已漸次隆起、呈一拗曲之狀、以後繼續發育、至漸新世拗曲發育已臻其極。就地形狀態山嶺高度與地層厚度觀察、拗曲之巔、似在中部泰安境內、高不下五千米突。其拗曲面積之長計約九百里、寬約五百里。在山東山地北緣、地層彎曲之跡、有時尙著。但其他部份均爲褶皺斷層及剝蝕作用所泯沒。始新統地層之上、時有玄武岩流、故拗曲發育之際、火山似已活動。至拗曲發育達其極點、地殼不能抵抗地動勢力、因以破裂、故斷層與褶皺、遂占山東地質構造之重要位置矣。

斷層關係於山東地質構造、較褶皺尤爲重要。斷層所在恒有、而影響於地層者甚著、而褶皺所及率限各局部、關係亦不甚明瞭。當拗曲發育極盛之際、地層似均呈彎曲之觀、但至拗曲破裂以後、彎曲之跡每爲剝蝕作用分割、或阻絕於斷層、只山東山地邊緣、得窺見其踪跡、因之遂若無關全省之構造矣。

本編所述區域內、褶皺不甚發育、惟東部低原及莒縣谿谷、略顯其跡。在安邱境內、青山層傾斜東南或東、斜角由十度至三十度、在諸城境內、萊陽層青山層及王氏系地層大致均向西北、傾斜角度由十八度至四十度、地層作成一寬大淺平之內斜層。在膠縣南部、萊陽層青山層及王氏系地層向西北或西北偏北傾斜、斜角由二十度至四十八度、在膠縣北部、王氏系地層傾斜向南、斜角約十度。此亦可證明東部低原有一廣大淺平之內斜層。其褶曲所成之軸、向西南偏西東北偏東延長。又莒縣谿谷內亦有一內斜層、由青山層及王氏系當其左翼地層、傾斜西北、斜角頗大、右翼地層大致向東南傾斜、斜角約四十度。內斜層之南部較狹、北部較寬、軸向西南東北延長。但莒縣谿谷及東部低原地層本相連屬、兩內斜層似原爲一內斜層、起於莒縣之南部、而終於膠

縣之北部者。除上述區域外、他處地層不顯褶皺之狀態、但淺平彎曲之跡、常於中生代及舊第三紀地層分佈之處得察見之。

抱曲部份甫經破裂、斷層即隨之而生。關係於構造之大斷層、似均成於此時。中生代及第三紀初期地層常當其俯側。大斷層可分爲受斷層之影響、故兩代地層所在、常有大斷層隨之、而中生代及第三紀初期地層所在、常有大斷層隨之而中生代及第三紀初期地層常當其俯側。大斷層可分爲正錯斷層及平推斷層。正錯斷層有時相對排列、發生地塹、而聯爲凹陷斷層（或塹斷層）。費縣蒙陰萊蕪谿谷、均由凹陷斷層而生。而中生代及第三紀初期地層夾於其間。凹陷斷層大致均互相平行、向西北東南兩方延長一部偶成東西方向、其仰側常爲中生代以前地層、俯側常爲古生代以後地層。有時斷層之斷距頗大、不下四千米突。嶧縣煤田北邊、限於一大正錯斷層、仰側爲寒武紀及元古代地層、俯側爲古生代地層及下崑崙系。其斷距視上述凹陷斷層之斷距較小。斷層西部、大致爲東西走向、東部則向東南偏東延長。萊陽谿谷南緣亦爲一東西向之正錯斷層所限。仰側爲五台系、俯側爲萊陽層青山層及王氏系。斷層之斷距計亦不下四千米突。在坊子煤田之南有一大致東西向之正錯斷層、泰山系當其仰側、坊子系青山層當其俯側、斷距較小。莒縣谿谷之西、有一南北向之正錯斷層、仰側爲古生代前期及太古地層、俯側爲青山層王氏系及二疊石炭紀煤系、斷距不大。在高鎮五圖等處、寒武紀地層與坊子系之間、亦均有正錯斷層、惟不甚延長、踪跡亦不明瞭。蒙陰谿谷之西、有一南北向之正錯斷層似阻絕該谿谷凹陷斷層西進之路者。

平推斷層發育於山東北部淄川博山章邱煤田均受其影響。斷層大致爲南北方向與地層大致走向成近於直角之角度。推移距離在十里三十里之間。斷層有二、一爲分割章邱煤田及淄博煤田之斷層、一分爲隔章邱煤田及淄博

煤田之斷層、卽與較新地層有關係者。因斷層右之地層較高於斷層左之地層、似平推之外、兼帶上下移動。左方地層爲下崑崙系上崑崙系及三台系、與右方古生代地層成斷層接觸。

上述各斷層外、在東部低原之北部、似有一大正錯斷層、但踪跡未見、僅由地層之露頭而推測者。在膠縣高密北部、王氏系暴露處、幾成水平層、有時向北傾斜、斜角至大不逾十度、在昌邑南部平度西部、又常見泰山系。在此殊異地層之間、似有一東西向之大斷層、泰山系當其仰側、王氏系當其俯側者。其他小斷層及關係不重要者、均不贅。

至論大斷層之生成時代、威利斯謂起於第三紀之前期。汶河礫岩（卽本編所稱官莊系之最上部）卽在斷層發生時或斷層發生後所生成、其所含物質、均來自大斷層之仰側而積集於其俯側者。威氏在新泰縣一帶、曾觀察汶河礫岩、其『中國地質攷察記』所載、有礫岩在翟家莊之東、覆於震旦系灰岩之上、在新泰縣南五英里、覆於新泰系底部紅砂岩之上、在新泰縣之東、覆於新泰系上部紅色礫狀粘土之上。據此事實、卽得證汶河礫岩與較古地層成不整一之接觸者。此現象又可以新泰以東斷層附近地層構造證明之。紅色礫狀頁岩向斷層傾斜、斜角二十二度、而於距離不及半英里之處礫岩則幾成平層、又在新泰縣之南礫克層內夾軟紅砂岩碎塊、如碎塊係來自新泰系之底部、則可推知紅色地層其時曾受剝蝕、卽可證明礫岩不整一於新泰系之上。以上所述、均爲威氏據以證明礫岩之下、有不整一之迹、亦卽威氏誤定斷層時期之導線也。新泰系生於斷層之前、且曾受其影響、威氏實已知之乃誤認有不整一存在、遂假定汶河礫岩未受斷層影響、而後於斷層生成者。但就作者觀察所得、汶河礫岩實爲官莊系之一部、其下無不整一之迹。在萊蕪新泰蒙陰費縣等處、汶

河礫岩與震旦系灰岩（即寒武奧陶紀灰岩）均爲斷層接觸、初非被覆者可比。新泰系底部之紅色砂岩、即本編之下崑崙系、在蒙陰谿谷內由汶南向西北延長暴露、而翟家莊之南、官莊系大致向東南傾斜、兩系中間之蒙陰系、在蒙陰谿谷西部未嘗目覩、故在谿谷西部官莊系常與下崑崙系成斷層接觸。威氏所見兩系之接觸、或正值兩系以斷層接觸處也。在新泰縣之東、汶河礫岩繼續新泰系而生、未嘗間斷。在蒙陰新泰萊蕪費縣等處、新泰系上部及汶河礫岩傾斜一致、或向斷層、或背斷層、威氏所見兩層傾斜不同之處、或受局部變動之影響。官莊系與蒙陰系之間蒙陰系與下崑崙系之間、各有一不整合、前已敘及。故汶河礫岩（官莊系之一部）實可包含官莊系以前各層之物。礫岩內含新泰系底部紅砂岩之礫石、殊不足以證明汶河礫岩之下有不整一存在也。

以上所述、可證汶河礫岩實爲屬於始新統之官庄系之最上部、而繼續沉積於其上者。官莊系與泰山系成斷層接觸、有時角礫岩介於其間、此角礫岩當即爲斷層所生者。在新泰東北約一里之處、曾目擊此種事實、故屬於官莊系上部之汶河礫岩、應較斷層爲古。官莊系既屬始新世、則斷層大抵生於漸新世或中新世、但不能後於中新世、蓋中國北部上新統之紅色粘土、未曾受斷折褶皺之影響也。至褶皺生成時代、謂爲與斷層同當亦不致全誤。

山東白堊紀之植物化石

周贊衡著

民國十二年、地質調查所譚錫疇氏由山東萊陽縣之南務村附近採回之化石中、其一部份爲植物化石、一經研究並與歐美白堊紀之植物化石圖說比較後、其種屬頗多類似之處、其地質時期當屬下白堊紀。植物化石、大都屬松柏科、間有古公孫樹及蘇鐵之葉。此種化石均保存於黃色薄頁岩中、同時又有魚類及昆蟲化石發見。據譚氏報告、全系厚約七百公尺、含化石層祇限於薄頁中、砂岩中則無之、所有植物化石都凡十一種、茲分錄於左。

一 Brachyphyllum obesum Heer.

樹枝短小、寬僅三至八公厘、葉與葉痕呈鱗狀、且緊附於葉軸之上、成長方或六角形、葉序作螺旋狀、葉均環繞軸上。此種化石曾於葡萄牙之 Almargen & Aptian 地層中發見之、屬白堊紀。(如第一版第二至第八圖)

二 Brachyphyllum magnum Chow (sp. nov.)

樹枝甚稀、葉與葉痕成長方形、在分枝上者較大、有時竟占分枝平面之全部、分枝與大枝成鈍角、葉序亦作螺旋狀、枝之寬者約七公厘、長者約三十公厘。(如第二版第一二圖)

三 Brachyphyllum multiramosum Chow (sp. nov.)

此種化石、僅有一小碎片、爲樹枝之上端、有多數小枝緊生於其上、長自五至二十公厘不等、此或爲一幼小枝、因其分枝之密遂以是名。(如第二版第一三圖)

四 Sphenolepis elegans Chow (sp. nov.)

枝葉甚細、分枝相間而生、與幹適成鈍角、葉小而尖、成三角形、緊附葉軸之上、如瓦鱗然、無花形小葉附於分枝上。（如第二版第八圖）

五　Sphenolepis arborescens Chow（sp nov.）

全枝長約十三公分、枝之最寬處約四公厘、葉小而緊附葉軸上、分枝亦相間而生、有時葉部生種子狀之小顆粒或、似花形顯、與他種稍易。（如第二版第三圖）

六　Pagiophyllum sp.

枝葉密生、成圓椎形、莖較粗、葉密而緊附軸上。（第一版第七圖）

七　Palæocyparis cf. flexuosa Saporta

葉小作三角形、密附軸上、現瓦鱗狀、此種化石、與葡萄牙之下白堊紀地層中之 Palæocyparis flexuosa 比較、其形態頗相似、當屬此種。（如第二版第四圖）

八　Araucarites sp.

屬此類者、有圓椎形之小枝、枝上滿生針形葉、作螺旋狀繞生於葉軸之上、葉之尖端均略向外、有一保存較佳之葉、長約四十公厘、寬約七公厘。

九　Baiera cf. australis M'Coy

此類化石、爲古代公孫樹屬、一葉均分爲四至八不等、但此葉僅分成五、均作狹長形、葉脈不甚清楚、五分葉均聚生於一長約二公分之葉柄上、若與南美洲之 Baiera cf. australis 比較、其形態頗相似。（如第二版第七

圖）

十　Zamites sp.

此種化石、共有兩葉、均不與葉柄連續、其較大之一葉、長約九公分寬七公厘、葉脈平行甚清楚。（見第一版第九圖及第二版第五圖）

十一　Thinnfeldia sp.

葉分四片、下連葉柄、葉之二外緣、成半圓形、葉之中間兩片又分爲二、生有三角形之小羽葉、其葉之大致形態及葉脈、頗似 Thinnfeldia。（如第二版第六圖）

山東之白堊紀化石

葛利普著
趙亞曾節譯

地質調查所譚錫疇君在山東白堊系內所採集之化石多爲隔絕之生物羣。每處與每層各有其特種而不復見於他處與他層。萊陽層內之化石固與雷司氏 Reis 等在西伯利亞川司拜喀爾（Trans-Baikal）紙狀頁岩內所鑑定者極相似、但除 *Estheria middendorfi* 外、亦無一同者。雖然二者之堆積情形相同、而時代或亦相若、則毫無疑意也。氣候乾燥、雨澤稀少、間有大雨、則河挾細泥、流入低窪之區、而瀦爲淺水湖澤、於是生物得所、漸次繁生、及水乾涸、或劇變發生、乃留遺骸於淤泥中、此西伯利亞與山東紙狀頁岩之所以生成也。

西伯利亞紙狀頁岩之時代、久爲討論之的。由侏儸紀以至漸新統各有其主持者。雷司氏始綜其動物羣及植物羣所代表之時代而斷定其屬於下侏儸紀以至上白堊紀。

予以爲前篇周贊衡君所論之萊陽層植物羣確帶有下白堊紀之彩色。亞洲上侏儸系或更老之地層內無一似之者。但歐洲西部之下白堊系或北美東部之波譚馬（Potomac formation）層內之植物則與我等者極相近、即萊陽層內之昆虫亦與產於西伯利亞烏斯巴（Ust Bali Basin）來盆地之侏儸系內者迥異也。

Proterocarabus 之產生尤足爲屬於後侏儸紀之鐵證、蓋以眞正屬 Scarabride 族之化石、向未發見老於始新統之地層中也。至於其肢體之複雜亦可爲時期較新之一證。即令產於上侏儸系內之化石確有屬於此族者。但其肢體之構造簡單多矣。

蒙陰層之時代屬於下白堊紀。德人佛萊士(Frech)曾鑑定若干葉腮類於四川之東部。新近李仲揆教授趙亞曾君等亦曾在湖北歸州層內採集葉腮類多種。佛萊士所鑑定者與新近携歸者均確屬於下白堊系而

與英國之瓦爾登層 (Wealden) 相當。蒙陰層內之化石與四川東部及湖北歸州者均有同種。因此，知三者之堆積時期相皆屬於下白堊紀。

荊山層之下部只有一葉腮類頗帶產於北美拉雷米 (Laramie) 層者之概況，但其時代或仍爲下白堊也。王氏系之屬於上白堊紀毫無疑問，不只由 *Pisidium* 及 *Sphaerium* 狀葉腮類之特別之多可爲明證，即生物羣之極似北美拉哇米層者亦可斷其與後者之時代相當也。

山東白堊系內之化石頗爲豐富。植物化石周贊衡君已發表於前篇。魚類化石則予另有專著載於本所古生物誌中。本篇所及尙有下列諸種。

一　葉腮類

1　*Leptesthes chingshanense* Grabau (148頁，　圖1)

2　*Unio* (*Lampsilis*) *johan-böhmi* Frech (150頁，　圖2)

3　*Unio cf. menkii* Dunker (152頁，　圖3)

4　*Myetopus mengyinense* Grabau (153頁，　圖4及154頁，　圖5)

5　*Cyrena* (*Sphaerium?*) *tani* Grabau (156頁，　圖6a-b)

6　*Cyrena* (*Pisidium?*) *shantungense* Grabau (156頁，　圖6c)

7　*Cyrena* (*Pisidium?*) *wangshiliense* Grabau (156頁，　圖6d-e)

8　*Cyrena* (*Pisidium*) *rekorodense* Grabau (156頁，　圖6f)

9 *Cyrena* (*Pisidium*) *altiformis* Grabau (156頁, 圖6-g)

Unio johan-böhmi Frech 首先發現於四川今則更見於蒙陰。*Mycetopus mengyinense* Grabau 本首先發現於蒙陰今則更見於湖北之歸州。*Unio menkei* Dunker 原爲德國下白堊紀之化石。產於山東蒙陰層者固與德國者稍有差異、但相差無幾而佛萊士亦曾謂其產於四川。是蒙陰之介殼雖欠完整、而二者之相同似無悖於理也。除此數種外、餘均爲新種、只見於山東、而不產於他處。

二 腹足類

1 *Bithinia mengyinense* Grabau (161頁, 圖7a-c)

2 *Valvata suturalis* Grabau (161頁, 圖7e-g)

3 *Limnaeus* ? sp.

4 *Cyclophorus* ? sp.

此數腹足類或爲新種、或太破碎不能加以確實之鑑定。彼等均只產於山東、尙未發現於他處。

三 甲殼類

1 *Estheria middendorfii* R. Jones.

Estheria middendorfii R. Jones. 原產於西伯利亞川司拜喀爾之紙狀頁岩中。長二十二公分、高十四公分。產於萊陽者則最大者方長十公分。是其殼小於西伯利亞者約半倍。但其形狀則與西伯利亞者無異。二者之符合似無疑意。總之、予所能研究之介殼多不完整、將來如有完全介殼之發現、其相同與否不難立辨也。

四　昆蟲類

昆虫化石之發見於亞洲東部者寥寥無幾、今日山東白堊紀內昆虫化石之發現自趣味特濃。當白堊紀時、歐洲大部淹沒於大海之中、造成數千尺之白堊、亞洲則不獨不埋沒於大海、而其面積反較今日者爲尤大。陸地既廣、情形自異。故山東昆虫之迥與他處異者乃當然之結果耳。

亞洲東部之中生代昆虫羣均發現於西伯利亞。其中之最富者發現於葉尼塞(Irkutsk)之烏斯巴來盆地中、由其同生之植物化石、其年代屬於中侏儸紀。在土爾哥河(Turga River)之土爾哥頁岩中。袁司氏曾鑑定昆虫數種。其餘如在威底木河(Witim river)彼亦曾記出數種不能確實鑑定之昆虫。土爾哥河及威底木之堆積似均屬於下白堊紀。

山東之新種

1. *Sinoblatta laiyangensis* Grabau
2. *Laiyangia paradoxiformis* Grabau
3. *Proteroscarabaeus yeni* Grabau
4. *Samarura gregaria* Grabau

目　Blattoidea

屬　*Sinoblatta* Grabau (新屬)

譚君在萊陽頁岩所採集之化石內有一壓扁之 Coak-roach。其腹面全現於外、兩翅僅露少許。則凡僅以

翅之結搆而成立之屬自難定其與吾等者相同與否。其體之形狀、頭之偉大、凡予所能見之書、中無一似之者故予特闢一新屬而名之曰 *Sinoblatta* Sino 寓產於中國之意。

西伯利亞之中生界地層中只有兩個 *Blattoidea* 見於科學著作中。漢黎士 Handlirsch 均以之屬於 *Ophismoblatta*、其一 *O. siberica* 只有一翅可供研究。其二、*O.? maculata* 只有胸腹可供參考。後者之歸於此屬純由於其與前者同生於一處、則其是否屬於此屬尙在不可知之列。*Ophismoblatta* 之成立既大部由於其翅之結搆、而其肢體復過於破碎不足供比較之用、是以萊陽之標本似以不歸於西伯利亞之屬爲佳也。

此屬之特徵在今日與其種者無別。偉大之卵形頭、偉大之眼、心形之前胸及其肢上之長刺可暫爲其屬之特徵。

Sinoblatta laiyangensis Grabau (新種)(插圖一、圖a)

頭大、形精圓、長二公分、寬三公分。兩旁各有一卵形之痕跡即眼是也。其前各生細長之觸角一。此二觸角均爲若干環節所作成、一公分之內約有十節。

前胸頗大、寬於長。前端形圓、後端形如三角。前胸之中間有前肢一對。中胸與後胸相連。生肢兩對、上有銳刺。

翅之保存不全其脈絡之形狀不能定。身長十七公分、如腹部完全時身長或可至二十公分。頭長二公分、寬三公分。前胸長五公分。身寬六公分。餘部相稱。

產於山東萊陽頁岩之魚層中。採集者譚錫疇。

目？

屬 *Laiyangia* Grabau (新屬)

在萊陽魚層中有一極特別之昆虫。彼與其他昆虫之關係頗難證明。予之所以不能歸於任何一目者固一方由於參考書之缺乏。但經詳細考察若干近代昆虫之標準著作後、亦復無其劃分之線索可尋。身體之奇異雖可由於擠壓之結果、但其保存之部分均左右對稱。則只擠壓之力是否能作成此奇異之胸頗屬疑問。因此、予將其各部之形狀詳細敍述之、而將其與他族之關係俟諸異日解決之。

Laiyangia paradoxiformis Grabau (新種)(插圖二一 圖b)

此虫顯然露其腹面。頭形橢圓。觸角及口部皆壓碎、頭與前胸連接之處頗鬆、似有一短頸介其間。前胸較小、形如心狀。前肢失却。前胸與中胸之界限分明、只中間連接。中胸與後胸合而爲一、形如截圓錐、後寬於前者約兩倍、隔一極狹之腰而與腹相接。

中胸與後胸分爲五節、後者較寬。就翅之位置定之、前二節屬於中胸、餘者屬於後胸。胸之中間有一淺而分明之溝、直貫三胸、

第二對肢尙有一保存者。保存最完全之部分爲其小肢、含有五節。每節均生刺毛、終節並成爪形。翅兩對、前翅長於寬者約三倍、後翅則較寬。脈絡簡單、其分配之情形如圖所示。

腹之保存不全。前環節頗狹、形如細腰。後環節忽然變寬。寬於前者約二倍有餘。

產於山東萊陽之魚層中。採集者譚錫疇。

目　鞘翅類

族　Scarabaeidæ

屬　*Proteroscarabaeus* Grabau（新屬）

屬於此新屬之昆虫只有一個可供研究。屬之特徵自與其種者無異。在西伯利亞侏羅系內雖亦有數種視爲屬於此族者、但漢黎士謂其中確有可歸之於他族者、亦有因保存不全可歸之於任何一族者。則譚君在山東下白堊系內採集之昆虫實爲世界上一最老之 Scarabaeidae、而亦在第三紀以前之確知屬於此族之第一昆虫也。

Proteroscarabaeus yeni Grabau（新種）（插圖二，圖a）

頭形如三角兩旁各有一薄板狀之觸手上生葉狀之環節七、散佈如扇狀。

前胸之界線分明、中寬後狹而與中胸相接。前肢之大肢頗寬、邊呈鋸齒狀、但無刺毛

中胸與後胸合爲一、長約與前胸等。翅鞘分明、邊鬱前尖、面上有極多之疱點、排列成曲線狀。鞘下之薄翅未露出。第二對肢位居中胸之肩部、在右面者保存較全。第三對肢較前者稍長。大肢之內邊成鋸齒狀、小肢之前端突出成二長刺。

腹部分爲六節、其末節突出於翅鞘之外。

產於萊陽縣南務北一里之萊陽紙狀頁岩中。採集者譚錫疇。

目　蜻蛉類

屬 *Samarura* Brauer Redtenbacher and Ganglbauer

此屬之成立本特爲產於烏斯巴來盆地中？侏羅系內蜻蛉類之幼虫而設。其最要之特徵爲其後端之三個葉狀尾。在山東萊陽頁岩內此等之幼虫頗爲不少、但保存多不全、而尤以後端爲甚。予手下之標本只能見二個葉狀尾、其第三個之缺欠似由於保存之不全、而非原來之短少、蓋以產於烏斯巴來者亦只見兩個而第三個常被掩也。

Samarura gregaria Grabau（新種）（插圖一、圖b至d）

此種恒較西伯利亞者爲小但較寬。頭小、略成圓形、前生觸鬚二。胸部均被壓、較腹部爲寬。其詳細之形狀不能定。無翅。腹部分爲七節、每節均呈長方形、腹之後端生有二個圓形葉狀尾。在一個標本上、似有第三個葉狀尾之痕跡。如萊陽之蜻蛉類昆虫原來即只有二個葉狀尾、則須另歸之於一他屬。

產於萊陽縣泊子北一里之萊陽紙狀頁岩中。採集者譚錫疇。

五　魚類

1. *Lycoptera sinensis* Woodward.

2. *Lycoptera ferox* Grabau

此二種魚、予均詳細描述之於古生物誌中、茲不重敘於此。

中國北部之白堊紀軟體類化石

葛利普著
趙亞曾節譯

本篇所論之軟體類化石來自下列三處。

一奉天義縣楊柳屯　採集者譚錫疇

二熱河凌源縣　採集者朱庭祐

三山西渾源縣安春　採集者安迪生

凡此三處均在中部中生代山脉之北（燕山山脉即古南口等山脉及秦嶺山脉）而代表當時山內之盆地。產於山西渾源之 *Corbicula andersoni* Grabau 亦見於奉天之義縣、是二處之岩層顯然爲同時之堆積。但中間之熱河則代表一隔絕之區域而其年代亦較前二者爲老。

岩層之次序及時期

熱河　據安迪生、朱庭祐及董常之調查、該處岩層之次序、如下。

上班岩層、即熱河系。岩石多爲頁岩、板岩及砂岩所作成、間夾礫岩。其上部爲薄層之湖沿式停積、內有魚類化石頗夥。……共厚五十至一百公尺。

下班岩層。據董君、在他處此層不見、魚層直接覆於砂質石灰岩及片麻岩之上。

熱河系內之化石以魚類爲最夥、大者名曰 *Lycoptera jehoense* Grabau、小者名曰 *Lycoptera jehoense* var. *minor* Grabau。小魚之化石最爲普通、有時一方英尺之內即有五十至一百頭之多。除此外、尚有數植物化石似屬於 *Czekanowskia*、昆虫及 *Estheria* 之碎片、及 *Corbicular jehoense* Grabau。

此層之年代從前多歸之於侏羅紀。但山東萊陽層內之魚顯然係由熱河魚變來者、則二處岩層自代表同時之停積。萊陽層之年代既由植物昆虫及軟體介諸化石之研究而斷定其屬於下白堊紀，熱河系自亦屬於下白堊紀。

當侏羅紀之將沒、燕山山系隆起、斜貫東西、其位置與現在之南口山系同。在山北之低窪盆地中河流湖沼停積成熱河系。在山南、停積成萊陽層。二處各不相通、以燕山爲其分水嶺。

奉天　義縣位居熱河之東北、二地相距約一三〇英里。據譚錫疇君之報告，該處地層之次序如下。

奉天火山岩系。熔岩、凝灰岩及凝灰礫岩內含凝結岩之侵入體。

不整一

義縣層。

頂部爲灰色砂岩及礫岩、下面漸變爲黃色及灰色砂岩、灰色及淡綠色泥質頁岩。中部稍下爲黃色及灰色薄層砂岩、灰白色及帶綠色泥質頁岩、及深灰色頁岩、內含下面所述之頭足類及葉腮類化石、其內並有煤層及凝結岩之侵入體。……露出之岩層共厚九〇〇公尺。

下面岩層未露出。

在楊柳屯露出之化石層爲一種深灰色厚層之泥質頁岩、內含葉腮類極多而腹足類則頗少。其中最普通之化石爲 *Corbicula andersoni* Grabau。由幼年以至老介皆有其代表。凡此介殼多經壓力壓扁、殼之外面則多保存完全。除此以外、間有一種似 *Pisidium* 之小介、但其保存太壞不足作精確之研究。屬於腹足類者只

有一殼似屬於 *Viviparа* (*Paludina*)，亦以擠壓遇甚不能作精細之鑑定。

此頁岩層中並夾有薄灰質層、厚只數寸、幾全爲淡水腹足類 *Campeloma* 之螺殼所作成。螺殼之排列無一定則該層之生成顯然爲螺死以後方停積於小區域內之淺水中。螺殼雖間受擠壓但均未經削磨。灰質之來源自非由於螺殼之破毀而成於外因、大約爲化學之沈澱作用。藻類之分泌灰質亦可造成泥灰岩。如近代之 *Chara* 泥灰岩、義縣泥灰岩內之包子狀小顆粒或可爲此說之一證。

除最多之 *Campeloma* 外、間亦有與頁岩內同種之葉腮類。本層內之 *Campeloma* 有下列諸種

1. *Campeloma clavilithiformis* Grabau
2. *C. fentieisis* Grabau
3. *C. yihsienensis* Graban
4. *C. tani Grabau*

此四種內以第三種爲最多、餘者較少、彼此之形狀頗相近。

據動物羣之性質觀之、本層之年代屬於上白堊紀。奉天層內之化石頗與北美西部拉哇米層者相近、即令前者之年代不必亦如後者之晚、而其屬於上白堊紀則似無問題。但吾等之化石頗少、下白堊紀甚至上侏羅紀亦未爲不可能之事也。

山東位居奉天義縣之南約二四〇英里、熱河之東南二六〇英里、四川之東北八〇〇英里。山東距奉天及熱河雖近、而上白堊紀之軟體類及下白堊紀之魚化石則無一同者、距四川雖遠、二處則每有同種。其所以

致此之故、蓋由於山東與奉天及熱河之間當時爲燕山山系中隔、交通斷絕、而山東與四川則均在燕山之南、交通較易也。詳見古生物誌魚篇中。

山西　化石層露出於山西北部渾源縣之安春。岩石爲一種密緻之紫灰色頁岩、內含葉腮類化石 *Corbicula anderssoni* Grabau 頗多、但無他種。介殼之保存完全外面色白、間爲鐵質染黃、極爲美觀。

本層內之化石與奉天者屬同種、顯然二處爲同時所停積而均屬於上白堊紀。

本篇所論之軟體類化石有下列諸種

葉腮類

1. *Corbicula anderssoni* Grabau (189頁，圖1a-b)
2. *Corbicula jehoense* Grabau (189頁，圖1c)

腹足類

3. *Campeloma clavithiformis* Grabau (195頁，圖2a-b)
4. *Campeloma fengtienensis* Grabau (195頁，圖2c)
5. *Campeloma yihsienensis* Grabau (695頁，圖2d)
6. *Campeloma tani* Grabau (195頁，圖2e)

香港之下白堊紀菊石

葛利普著
趙亞曾節譯

一九二三年二月、韓雷博士(Dr. C. M. Heanley)函知本所、謂彼在香港採得一菊石。其後、彼詢本所所長之請、慨然以該石化見贈、幷略述該處地層之情形。因此、予得詳細研究之而成是篇。

據韓雪博士、該處地層可分爲三段。

上層爲砂岩及礫岩。礫岩之膠粘物均屬灰質。但此礫岩內更含有一種老礫岩之漂石。其中之石灰岩卵石、據李四光教授之鑑定、含有莖蠅 *Fusulina cf. mansuyi* Deprat 及 *Fusulinella*。則搆成此老礫岩之石灰岩似屬於二疊紀。與中層成不整合。傾斜小於十五度。

中層爲厚層之紅色頁岩、紅色礫岩及紅色砂岩、下與下層相接之處隔以火成岩。下部有極清晰之基底礫岩層、則其與火成岩之關係似爲不整一。傾斜由二十五至四十度。

下層多爲紅色及紫色頁岩與石英岩、間夾白色之礫岩及石英岩薄層。此等礫岩在本系中最爲特別、幾全爲乳白色之圓石英塊及石英砂所作成。產菊石之岩石爲一種細粒的、砂質的、深灰色碎屑岩、內含黃鐵鑛頗多經風化結果每呈赤褐色。傾斜六十度、間至八十度以上。

產於下層之菊石爲下白堊紀時印度太平洋區分佈最廣且最爲普通之 *Hoplites wallichi* Gray。形狀雖大致與產於他處者同、但稍有差異之交、因名之曰 *Hoplites* (*Blanfordia*) *wallichi* Gray var. *hongkongensis* Grabau

此種菊石之產於香港頗爲特別、如謂其係由喜馬拉亞大向斜東經緬甸、中國南部而抵香港、則中國南

部向未發現白堊紀之海成層。因此、當時情形、似有一大向斜與中國東南海岸平行、其西隔以晚侏羅紀時所成之山系與內地不相通。由山上冲下之沙石等物因作成白堊紀至第三紀之陸成層。山之東麓則可間爲海浸故香港有菊石之發現也。

中層內礫岩之卵石有由下層內之岩石所作成者且二者中間復有一不整一、則前者自較後者爲新或者屬於上白堊紀。

上層較中層尤新、其時代似屬第三紀。

如上述之時代無誤、則該處最後之摺曲作用似起於中新統及其後、而與喜馬拉雅山及四川紅盆地之大變動爲同時。

中國中部歸州層內之白堊紀化石

葛利普著
趙亞曾節譯

維理士（Willis）等統名巫山石灰岩以上之含煤頁岩系及砂岩與頁岩系曰歸州層。其先屬辟利（Pumpelly）及李希霍芬（Richthofen）曾在此含煤系內採集有植物化石、據牛伯瑞(Newberry)及謝克(Schenk)之鑑定、其時代屬於侏羅紀。其後懷底氏（David White）則證明其確屬於 Rhaetic 即上三疊系之最上層。新近北京大學李四光教授名此含煤頁岩曰香溪系而以歸州系專代表含煤層以上之砂岩頁岩等。在歸州系之下部靠近香溪之處、趙亞曾君曾採有化石頗多、王恒升君亦得有數種。此層顯然與李希霍芬在四川湖北交界處所發現者爲同層而均屬於下白堊紀、即英國之瓦爾登層（Wealden）。據佛萊士（Frech）之鑑定、李希霍芬所採集之化石含有下列諸種

1. *Unio cremeri* Frech
2. *Unio johan-böhmi* Frech
3. *Cyrena (miodon) cf. kiliani* Frech

此次在香溪附近歸州層內所採集之化石含有下列諸種

1. *Unio cremeri* Frech
2. *Unio chaoi* Grabau
3. *Unio (Lamprilis) johan-böhmi* Frech
4. *Mycetopus mengyinensis* Grabau

5. *Cyrena kweichowensis* Grabau

6. *Cyrena hupehensis* Grabau

六種之中、三及四均曾發見於山東之蒙陰層、二、四及五則均爲新種。據李四光教授、歸州層共厚約有二二〇〇公尺。但化石之產生則似只限於其下部、

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NEW RESEARCH ON THE MESOZOIC AND EARLY TERTIARY GEOLOGY IN SHANTUNG

BY

H. C. T'AN.

INTRODUCTION

The geology of Shantung has been surveyed and studied by several well-known geologists, v. Richthofen, Th. Lorenz, B. Willis etc. and appears comparatively clear. But the post-Palaeozoic formations have not been thoroughly studied. The age of most of these formations remained unsettled and the demarkation lines between them remained mostly obscure. B. Willis distinguished the Sint'ai series and the Wenho conglomerate among the post-Palaeozoic strata, in the Mêng Yin valley. Dr. F. Solgar has left in the Geological Survey a geological map of the Tzŭ-Ch'uan and Po-Shan coal field(1) in which he distinguished among the Post-Palaeozoic sediments Hsiak'unlun formation, Shangk'unlun formation and Sant'ai formation. No definite age however was assigned to these formations. Since the last few years, instead of confining himself to the purely technical work, Dr. J. G. Andersson devoted his attention to the research on the Cenozoic deposits of China which have long been neglected by earlier geologists. He conducted under the auspices of the Geological Survey a systematic campaign of fossil collections, especially reptiles and mammals. Preliminary reports have recently been published under the title of "Essays on the Cenozoic of North China",(2)

Some six years ago a German mining engineer W. Behagel presented to Dr. V. K. Ting a big sandstone block containing three vertebrae of a fairly large-sized Dinosaur. He states that the specimen originated from the Mêng Yin district in Shantung. It has long been kept in Dr. Ting's mind to locate the point where this remarkable specimen was found, and finally, in 1917, the writer acting upon his instruction, undertook a systematic search for it in the Mêng Yin district. But the search was in vain, though

(1) This field has been resurveyed both topographically and geologically by the auther of this paper and a report with the map has been published in Bull. N° 4.

(2) Mem. Geol. Surv. China N° 3.

much time was spent in tracing the Dinosaur bearing formation, and in making inquiries among the natives after the so-called dragon-bone producing localities. In the summer of 1922, when we rearranged our museum the specimen referred to, again came up for consideration; and Dr. Andersson decided to take a trip to Shantung for the purpose of locating the place in which that specimen was found.

There was also another reason for a journey in Shantung. In 1921 Dr. Andersson surveyed the Eocene area of the Yüan Ch'ü district in S. Shansi. The survey of the Yüan Ch'ü area proved the existence of a series of Eocene beds preserved in a sunken block limited by faults with downthrow of something like ten thousand feet. On his return from Shansi Dr. Andersson approached the writer, asking him whether there is any possibility of finding in Shantung young sediments of the type of the Yüan Ch'ü Eocene. The writer then pointed out the existence within several areas of Shantung of several young formations which he has surveyed in the preparation of the Shantung geological map, but the age remained unsettled because of the apparent lack of fossils.

These were the reasons for Dr. Andersson's and the writer's joint journey in Shantung from November 28 to December 21, 1922, a trip which, in spite of its short duration seemed to have thrown much light not only upon the younger formations in question including the Dinosaur bed, but also upon the tectonic development of the area. In addition to the Dinosaurs, fishes, turtles and mussels, found in the Mesozoic beds, we also obtained Mammals and Gastropods from the Eocene beds.

This was the first time that animal fossils of continental Mesozoic deposits were found in China proper.(1)

The area surveyed in the mentioned trip was limited to the Mêng Yin and Lai Wu valleys. On returning from Shantung Dr. Andersson proposed that further research should be made in other parts of that province. So in the spring of the present year Dr. O. Zdansky went to central Shantung, especially to the Lai Wu, Mêng Yin and Fei Hsien valleys to

(1) A preliminary report has been communicated to the Geological Society of China see Bull. Geol. Soc. China Vol II pp. 29- 3.

undertake more collecting work, and the writer went to Eastern Shantung, especially to the Lai Yang, Chiao Hsien and Chu Ch'eng districts, for the purpose of finding the fossiliferous beds in the young formations. Success at last crowned both efforts and several new faunas were discovered.

On returning from Shantung Dr. Andersson decided to write a joint paper with the writer on the results of the above mentioned trips to be printed in the Bulletin of the Geological Survey. As, however, his time was so fully occupied with preparation for his Kansu journey, he did not find the opportunity to complete the paper and left that task to Dr. Zdansky and the writer, who were thus enabled to insert in the paper the results of their new researches made during the latest trip.

A short time after his return to Peking Dr. Zdansky undertook the study of the cave deposits at Chou K'ou Tien where he was obliged to remain for several weeks occupied with excavation work. Thus Dr. W. H. Wong entrusted to the writer alone the preparation of this paper which is intended to record the field observations for which the writer is mainly responsible.

Moreover, it is also Dr. Wong's suggestion that all the observations on the post-Palaeozoic formations in Shantung, which were made by the writer on previous occasions should be brought together here, so that this paper might become of use in correlating all the post-Palaeozoic formations of Shantung.

As, however, some formations have not yielded any fossils, the writer is compelled in such cases to base the correlation solely upon stratigraphic relation or lithic characters.

A general account of all the post-Palaeozoic formations in Shantung may, however, be given and their mutual relations discussed, and so, in accordance with Dr. Wong's suggestion, the writer proposes to extend this paper so as to include the Mesozoic and Eocene formations which occur in other parts of Shantung, as well as those in the Mêng Yin, Lai Wu, Fei Hsien and Lai Yang valleys and in the Chiao Hsien and Chu Ch'êng districts.

It gives the writer great pleasure to express his thanks to the many gentlemen who have assisted him in this undertaking. To Dr. Andersson he is under particular obligations for his experienced guidance in the fossil collections, his kindness of entrusting to the writer the preparation of this paper and much help also in the interpretation of the structural facts. Dr. Zdansky has kindly furnished him the valuable palaeontological data concerning the vertebrate fossils, and Dr. Grabau has undertaken the study of invertebrate fossils and has by his enthusiasm for scientific research very much encouraged the author to write this paper. Mr. Chow kindly undertook the description of the plant fossils.

TOPOGRAPHY.

The areas here in question almost entirely occupy comparative lowlands, either in the valleys and basins or on the margins of the mountainous regions. For in Shantung most of the lowlands are composed of the young formations which will be described below (see Plate I).

The regions which were touched in the later trips are in the Mêng Yin, Lai Wu, Lai Yang, and Fei Hsien valleys and in the Chiao Hsien and the Chu Ch'êng districts. The other places where the post-Palaeozoic formations occur were visited in previous journeys.

In western Shantung the lowlands that are composed of the post-Palaeozoic formations are mostly separated by the mountain ranges which are chiefly made of the Archean gneiss, whereas in eastern Shantung the lowlands of the young formations are generally surrounded by the mountain ranges of the Archean and Palaeozoic formations, though in some places the mountains project from them. In the Yi Hsien, Tzŭ Ch'uan, Po Shan and Chang Ch'iu coal fields as well as in the Mêng Yin, Lai Wu and Fei Hsien valleys there occur the post-Palaeozoic formations. Between the Yi Hsien basin and the Fei Hsien valley lies a mountainous region which contains different sets of elongated mountain ranges and isolated hills which all consist of pre-Mesozoic formations. The mountains are not very high, the highest peak among them attains an elevation of not more than 700 meters. Between the Fei Hsien valley and Mêng Yin valley there lies an extended mountain range called the Mêng Shan Range, the summit of which rises to more than

1000 meters above sea level. The Mêng Yin and the Lai Wu valleys are separated by the Hsin Fu Shan Range, the highest peak of which is more than 900 meters above sea level. The Tai Shan Range which is famous by the height of its main peak at about 1500 m. lies between the Lai Wu valley and the Tzŭ Po and Chang Ch'iu coal fields. The Yi Shui valley is separated by mountain ranges from the Mêng Yin valley on the western side and from the Chü Hsien valley on the eastern side. The lowlands in Ch'ang Lo, Wei Hsien, An Ch'iu, Chu Ch'êng, Chiao Hsien, P'ing Tu and Chi Mo are all composed of the post-Palaeozoic formations and are surrounded by the Yi Shan Range on the west the Ma Erh Shan Zange on the south and the Lao Shan Range on the southeast, Ku Shan Range in P'ing Tu and Ching Shan range in Lai Yang. These lowlands may be called the lowland of Eastern Shantung. The Lai Yang valley is separated from the lowland of Eastern Shantung by the Ching Shan Range. The mountain ranges which separate and surround the lowlands are all made of the pre-Mesozoic formations. The topographical features of the valleys, basins and lowlands which are composed of the younger formations will be separately stated as follows:

The Mêng Yin valley includes the regions through which the tributaries of the rivers Wenho and Yiho with their subsidiary streams pass. The tributary of Wenho also called Wenho has its course in the western part of the valley and the tributary of Yiho called Tung Wenho finds its way in the eastern part. The former flows out from the valley westward and the latter southeastward. In front of the Hsin Fu Shan Range standing on the north of the valley and extending southeastward there are many hills which constitute the northern margin of the valley and are mostly made of the Eocene beds. Along the northern foot of the Mêng Shan Range there stand also many hills which form the southern margin of the valley and are composed largely of the red sandstone and its underlying formations. In the middle part of the valley lies a low ridge which commences on the north of Wennan and terminates at the northern bank of Tung Wenho, southeast of Mêng Yin city; it is only made of the so called Mêngyin series and exhibits apparently the feature of the typical bad lands. Most of the western part of the valley is covered by the alluvium underneath which the Eocene beds seem

to hide here and there. The valley was formed after the strata had been partly sunken down by the faulting which affected the tectonic features of the whole province. Subsequently the rivers Wenho and Tung Wenho became established and found their way in opposite directions. The valley is in the sub-mature age but is still undergoing peneplanation. Between the two rivers lie only some low hills which form their watershed; when one river will have been captured by another, the hills will be dissected or swept away.

The Lai Wu valley is dissected by another tributary of the Wenho with its subsidiary streams. The main river flows westward, turns to the southwest after leaving the valley and unites at Ta Wen K'ou with the river running from the Meng Yin valley. Along the northern margin of the valley lies a series of hills, these being composed of Archean on the northern slope and of the upper part of the Eocene beds on the southern slope. In the central part of the valley stands a conspicuous hill which is named K'uang Shan and is made of diorite, and in the eastern part there are many flat low hills which consist mostly of post-Carboniferous formations and some igneous bodies. Westward from K'uang Shan the land which comprises mostly the Eocene beds becomes lower and lower; it forms only the flat and elongated hills and becomes a plain on reaching the boundary between Lai Wu and T'ai An districts. Along the northern foot of the Hsin Fu Shan Range there are many hills which form the southern margin of the valley and are composed of the Palaeozoic formations and of diorite intrusion. Most of the land along the streams is covered by alluvium. As it has originated the Mêng Yin valley, the faulting also caused the formation of the Lai Wu valley which sunk down as the downthrow-side of the trough faults. The Lai Wu valley as well as the Mêng Yin valley, is in a sub-mature stage and is being peneplained. Most of the valley region does not show high relief, though somewhere rocks still retain the conspicuous form owing to their considerable resistance.

The Fei Hsien valley is much longer and broader than the two above stated. The two ends of the valley are both open and immediately connected with the plains without any remarkable divide between them. Only the middle part of the valley was visited by Dr. Zdansky in his later trip, but

most has been covered by the writer's tracks in former journeys. The valley is more than 200 li long and composed of the regions through which the rivers Tzun Ho and Ssŭ Ho pass. The former with its tributaries runs southeastward and the latter westward, and between them lie some low hills which form their watershed. Along the northern margin of the valley there are flat low hills, most of which comprise the upper part of the Eocene series. The Palæozoic formations compose the southern margin forming the transi tion between the mountainous region and the valley. The constituents of the eastern part of the valley are both the Mesozoic and Cenozoic formations, but in the western part only the Eocene series predominates and the Mesozoic strata are missing. Most parts of the valley contain flat low lands which appear to be in the latest mature stage and even in more advanced stage in the eastern part. Contemporaneously with the above mentioned valleys the Fei Hsien valley was established as soon as the central part of Shantung was subjected to breaks by the faulting. But it seems to have been undergoing greater peneplanation, so that the stage which it attains at present is more or less older than the Mêng Yin and Lai Wu valleys.

On the northern margin of the T'ai Shan Range are situated the Tzu Po and Chang Ch'iu coal fields, the lowlands of which are partly formed of the post-Palæozoic formations. The younger formations were invaded by many igneous intrusions which form isolated hills rising from the lowlands. A big mountain Ch'ang Shan is of this type, but the igneous body composing this mountain, very much affected the younger formations. The river Hsiao Fu Ho with its tributaries passes through the Tzu Po field and one part of the Chang Ch'iu field. According to the relief these lowlands are being peneplained. The establishment of the lowlands is due partly to warping and partly to faulting.

The Yi Hsien basin is situated at the southwestern end of the mountainous region of Shantung. It contains Palæozoic coal series, quartzose sandstone and red sandstone. The latter is regarded as the early Mesozoic formation and spread only in the northern part of the basin. The formation of the basin is also due to the faulting.

Along the river Yi Ho there are two areas which consist of the younger formation and cover the lowlands. One, on the south of the Yi Shui district forms a valley which may be named the Yi Shui valley, another situated across the upper course of Yi Ho forms a basin that may be called the Yi Ho basin. In the valley and the basin the predominant constituent is the tuff-conglomerate which causes them to exhibit some low relief. The valley and the basin all occur on the down-throw side of the faults that were concerned in their origination.

The Chü Hsien valley includes the places through which the river Shu Ho passes. It is connected with the lowlands of Eastern Shantung on the northern side, the watershed between Shu Ho of the Chü Hsien valley and Wei Ho flowing in the lowlands may be regarded as their demarkation. The valley contains many low hills which are composed of the young formation and appear still in mature stage. The relief becomes lower and lower southward and descends to the plains on reaching the southern end of the valley.

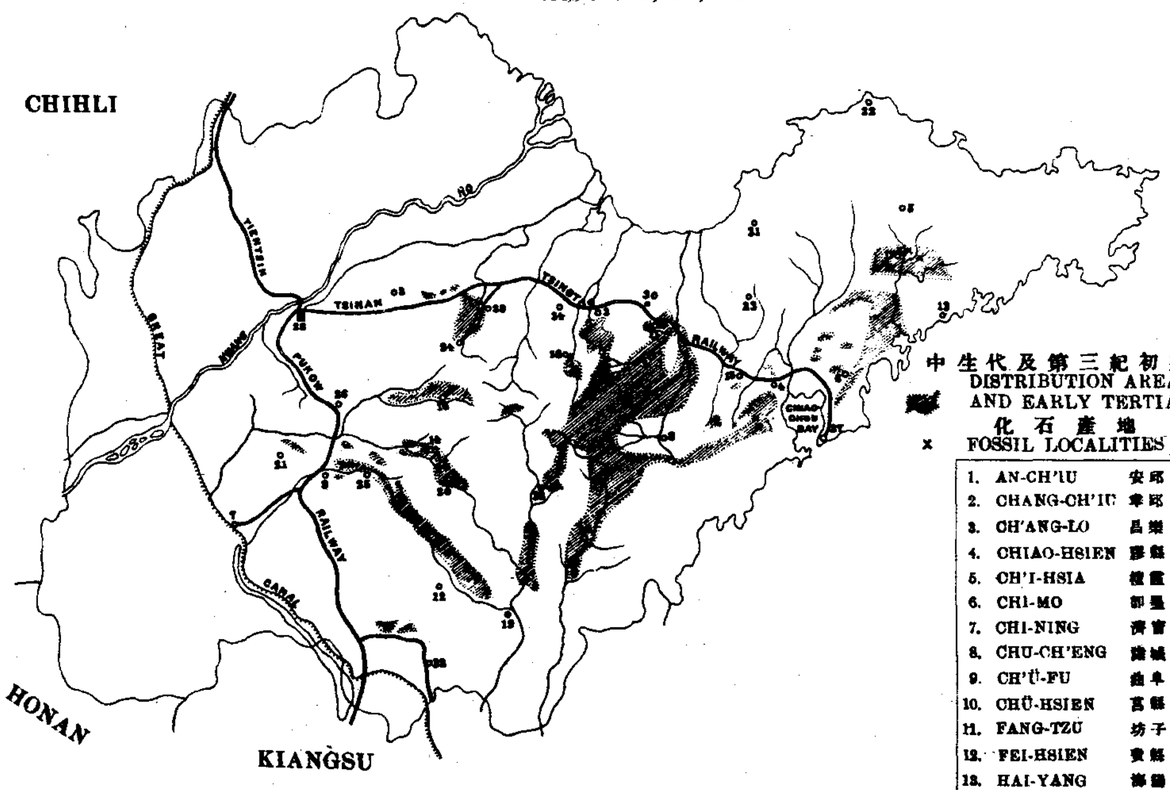
The lowlands of eastern Shantung are of great interest not only from the topographical and physiographical point of view but also because they show features of structural importance. They may be divided into plain, peneplains and low hills. In some cases, however, the relief attains such a height that the peaks at least are not less than 600 meters above the sea. This uplifted hill, however, occupies only one portion, and the general elevation of the whole region including the lowlands is much less than that of the surrounding mountain ranges. The rivers may, in general, be divided into two groups, one including the rivers which meander in the western part of the region comprising the lowlands and northward pour into the gulf of Lai Chou, an inlet of Po Hai, the river Wei Ho being the chief and largest; the other including those which flow in the eastern part of the region and run southward into Chiao Chou Bay, the biggest of these being the Ku Ho. Between the Chiao Chou Bay and the P'ing Tu city the land is so smooth that it forms really a plain. Regarding the origin of this plain, the writer supposes that it is referable to the plains of denudation rather than to those of accumulation and seems to be a result from the formation of a peneplain. From the Chi Mo city to the southern foot of the Ching Shan Range in Lai

山東中生代及第三紀初期地層分佈畧圖

MAP
SHOWING
THE DISTRIBUTION OF MESOZOIC AND EARLY TERTIARY SEDIMENTS IN SHANTUNG

一之分萬八十百三尺縣

Scale 1:3,180,000



中生代及第三紀初期地層分佈區域
DISTRIBUTION AREAS OF MESOZOIC AND EARLY TERTIARY SEDIMENTS

化石產地
× FOSSIL LOCALITIES

1.	AN-CH'IU	安邱	18	LIN-CH'Ü	臨朐
2.	CHANG-CH'IU	章邱	19.	LIN-YI	臨沂
3.	CH'ANG-LO	昌樂	20.	MENG-YIN	蒙陰
4.	CHIAO-HSIEN	膠縣	21.	NING-YANG	寧陽
5.	CH'I-HSIA	歷下	22.	P'ENG-LAI	蓬萊
6.	CHI-MO	即墨	23.	P'ING-TU	平度
7.	CHI-NING	濟寧	24.	PO-SHAN	博山
8.	CHU-CH'ENG	諸城	25.	SSU-SHUI	泗水
9.	CH'Ü-FU	曲阜	26.	T'AI-AN	泰安
10.	CHÜ-HSIEN	莒縣	27.	TSINGTAO	青島
11.	FANG-TZU	坊子	28.	TSINAN	濟南
12.	FEI-HSIEN	費縣	29.	TZÜ-CH'UAN	淄川
13.	HAI-YANG	海陽	30.	WEI-HSIEN	維縣
14.	HSIN-T'AI	新泰	31.	YEH-HSIEN	掖縣
15.	KAO-MI	高密	32.	YI-HSIEN	嶧縣
16.	LAI-WU	萊蕪	33.	YI-SHUI	沂水
17.	LAI-YANG	萊陽	34.	YI-TU	益都

Yang the land exhibits the characters of the peneplain. It has a flat surface from which occasionally low isolated hills arise. This peneplain is connected with the above mentioned plain on the western side and with the foot hills of the Lao Shan Range and the Ching Shan Range on the other three sides. The land from Chiao Hsien and Kao Mi cities westward to the boundary between Chu Ch'êng and Chü Hsien also bears the features of a peneplain. On the eastern side this peneplain descends to the plain, and on the other three sides it ascends to the hills. Generally speaking, the lowlands of Eastern Shantung form an incomplete basin, in the central part of which lies a plain followed on both sides by peneplains, on the margins of which stand many sets of hills. In the same manner as the relief descends from the periphery towards the middle of the basin, the inclination of the strata here in question is generally from all sides down towards the centre. It may be predicted that the plain will become larger and larger as the peneplains will gradually lose their relief, the lands comprising the hills will through continuous peneplanation become lower and lower and eventually form other belts of peneplains.

The Lai Yang valley is adjacent to the lowlands of Eastern Shantung and separated from the latter only by the Ching Shan Range which consists of the Archean and Algonkian formations. The river Wu Lung Ho with its tributaries passes through the valley. Owing to the differential resistance the erosion and weathering of the rocks contained in the formations, the relief is variable. In the northern and eastern parts of the valley where the fish beds and the tuff-conglomerate occur, the land is more hilly, and especially in the area where the tuff-conglomerate is formed even conspicuous hills stand here and there, either isolated or in groups. In the western part which is composed of the red clay the land forms nearly a plateau dissected by small ravines. One part of the valley still remains in a state of comparatively early maturity, though the other part has been peneplained to a stage of quite late maturity.

STRATIGRAPHY

In Shantung the post-Palæozoic formations are seldom represented in continuous and complete section. In no place did the writer find a section showing all the post-Palæozoic formations developed in Shantung. And, one occurrence of the formations does not always show the same characters as, nor does it bear any apparent similarity to another outcrop of the same formations. Thus the stratigraphic correlation is a some what difficult task and had to be done by different methods. Of course, the method by fossil evidence is the most reliable one of all by which different formations may be correlated. The ambiguity and errors of differentiation and correlation of the younger formations by the earlier geologists who have been in Shantung were really due to the fact that they did not obtain sufficient fossil evidence, if they got any at all from the formations in question. It is hoped that the fossils obtained on our recent trips will help us this time to better understand the stratigraphy, although one great drawback remains, namely that the fossils were not found in all the post-Palæozoic formations. Owing to the lack of fossils the age of some of the formations still remains unsettled. The writer will, however, try to correlate non-fossiliferous formations by other means and to place them in their proper relation to the determined ones, so as to show the general chronological sequence of the post-Palæozoic formations.

Among the Mesozoic formations only the Jurassic coal series of Fang-tzu, Wei Hsien, was accurately determined by the former geologists who found some plant fossils belonging to this period. The fossils collected by Dr. J. G. Andersson and the writer during the survey of the Fang-tzŭ coal field in 1919, fully confirm their determination. The prevailing types of the plant fossils consist of Podozamites, Coniopteris, Asplenium, Baiera and Elatides.

Almost all the geologists including the writer, who studied the fish-beds of Lai Yang, Shantung, thought them to be referrable to the Jurassic age owing to the fact that the fishes obtained from Lai Yang were determined as *Lycoptera sinensis* by A. S. Woodward[1], and referred by him to Jurassic. But according to the determination by Dr. A. W. Grabau, of the other fossils

(1) Fossil fishes found by H. M. Becher, determined by A. S. Woodward.

including pelecypoda and plants collected by the writer from the fish-beds of Lai Yang, the jurassic age of the these fish-beds appears questionable, or even entirely wrong.

The horizons of other Mesozoic formations have not been precisely settled by the former geologists, though some of them separated the Mesozoic strata into groups and applied special names to the divisions.

The Cenozoic strata were only briefly mentioned by von Richthofen[1] and Bailey Willis[2]. The latter named the uppermost part of the Eocene beds the Wenho conglomerate but mistakenly conceived the lower part as belonging to the Mesozoic.

So far as they have been observed and studied by other geologists and by the present writer in later years, the stratigraphic relation and time correspondence of the post-Palæozoic formations have become clearer than ever before except in the case of some divisions which are quite free from fossils and bear no apparent characters for correlation by other means. In the Mesozoic three formations are referred with some uncertainty to the Triassic, late Jurassic and late Cretaceous, though the age of the rest are probably settled. In regard to the Cenozoic the writer would like to note here only the consolidated sediments which belong unquestionably to the Eocene. The supperficial sediments, such as red clay, loess and post-loess deposits, will be discussed at other occasions, since the writer has only a slight acquaintance with them and has not obtained any mateiral from them, which could prove of either palæontological or geological importance.

On account of the discontinuous distribution and diverse developments of the formations, the stratigraphical relations can hardly be treated valley by valley. It will be more systematic to describe these various formations according to their general chronological sequence, after which the correlation and subdivisions of the formations may be considered. The formation which the writer regards as the initial one of the Mesozoic is the red sandstone named the Hsiak'un-lun Formation by Dr. F. Solgar[3].

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(1) V. Richthofen, China. II, pp. 193 and 228.

(2) Bailey Willis, Research in China, volume I, part 1, p. 57.

(3) The geological map of the Tzŭ-ch'uan and Po-shan coal field by Dr. F. Solgar.

The writer would like to retain this name, since this formation is quite fully developed and has clear contacts with the underlying and overlying formations in the Tzŭ Po coal field where Dr. Solgar first observed it.

A. HSIA-K'UN-LUN SERIES (下崑崙系) OR RED SANDSTONE:

This formation directly follows the quartzose sandstone overlying the Permo-Carboniferous coal measures which are exposed both in the southern and the northern parts of Shantung. But in central Shantung this formation is mostly in direct contact with the Palæozoic coal series or even with the Ordovician limestone, while the quartzose sandstone is missing. It is questionable whether there is a big unconformity below the red sandstone in central Shantung or the red sandstone is in fault contact with the Ordovician and Permo-Carboniferous formations. The latter case is assumed by the writer on the ground that not only the red sandstone is in contact with the pre-quartzose sandstone formations but the post-red-sandstone formations also touch them, and that the presence of the quartzose sandstone in central Shantung is to be expected to join those portions found in northern and southern Shantung.

This formation occurs in western Shantung especially in connection with the Palæozoic coal fields. The petrological characters are variable in different places, though the red sandstone is predominent wherever this formation exists. In the Tzŭ-Ch'uan Po-Shan coal field this formation occurs along the river Hsiao Fu Ho and is largely composed of deep red loose textured sandstone, the lowest part in cantact with the underlying quartzose sandstone including brown and yellowish-gray clay and clayey shale interbedded with greenish sandstone, and the upper part near the overlying Mesozoic coal series frequently comprising thin yellow-greenish sandstone. The gabbro intrusion forms laccolith in the upper part. In the southern part of Chang Ch'iu Hsien and the western part of Tzŭ Ch'uan Hsien it is exposed on the north of the Chang Ch'iu coal field and along the southern foot of the mountain Ch'ang Shan, being dislocated and converted into quartzite through metamorphism by the andesite of Ch'ang Shan. In the Lai Wu valley this sandstone formation is mostly exposed along one tributary of the river Wenho and rests upon a yellowish-white coarse sandstone which may correspond to

the quartzose sandstone overlying the Palæozoic coal series in other parts of Shantung. The real contact between these two sandstones was not clearly observed. This formation consists of cross-bedded red sandstone, the upper part being invaded by syenite dykes. In the Mêng Yin valley this formation occurs along another tributary of the Wenho and Tung Wenho, the branch stream of Yi Ho, being in fault contact with the Ordovician limestone and the Palæozoic coal series. It is composed chiefly of red sandstones and of conglomerate in the uppermost part; the pebbles contained in the latter consisting mostly of quartzite and occasionally of limestone. Here, too, the sandstone is cross-bedded, compact and not coarse. In the Fei Hsien valley this formation is discontinuously exposed along the river Tsun Ho, the lower course of which is also called Fang Ho running into the river Yi Ho. It is in fault contact with the Palæozoic coal series below and covered by the Mêng-yin series above. Apparently only the upper part of this formation remaines and the lower part having been faulted downwards. At Ku Ch'êng, about 20 li north of Fei Hsien city, it consists of red and brown sandstone interbedded with red shale and conglomerate, the pebbles of which are mostly made of quartzite. The red sandstones and conglomerates also occur along the northern margin of the Ch'ai Pu Chuang coal field situated between Fei Hsien and Lin Yi cities. In the Yi Hsien coal field this formation rests directly upon the quartzose sandstone and is interrupted by the faults on the northern side. It comprises red coarse and loose sandstone with conglomerate. The red sandstone formation was also met with along the border between Yi Hsien and Lin Yi. But the contact relation to other formation is obscure owing to the presence of the alluvial deposits surrounding its exposure.

The observed thickness of this formation in the different areas is very variable, ranging from some tens of meter to about 700 meters. This great difference is due to the subsidence of parts of this formation affected by the faults. Only in the Tzŭ Po coal field and in the Lai Wu valley can the whole series be traced and the total thickness estimated, this being about 680 and 700 meters respectively. In Chang Ch'iu coal field the thickness is difficult to estimate owing to the disturbance caused by the igneous bodies. In the Mêng Yin and Fei Hsien valleys and Yi Hsien coal basin this

formation is incomplete, so that the thickness estimated can not represent that of the whole series. The existing part of this series amounts to about 110 meters in the Mêng Yin valley; about 20 meters in the Fei Hsien valley; and about 120 meters in the Yi Hsien coal basin.

This series was placed by v. Richthofen[1] and Th. Lorenz[2] in the Permian, and by Bailey Willis[3] in the lower part of the Sint'ai formation which he regarded as Permo-Mesozoic. Dr. F. Solgar, while studying the geology of the Tzŭ Ch'uan Po-Shan coal field, applied to this red sandstone the name Hsia-k'un-lun series which is still retained in this paper.

In regard to the age of this series the writer like former explorers also finds himself in the dark. No fossils were found to indicate the age. But because of its tratigraphic position this series may be regarded as probably Triassic.

B. FANG-TZU-SERIES (坊子系) OR MESOZOIC COAL SERIES:

Because of the fact that this is the only important productive Mesozoic coal field in the vicinity of Fang Tzŭ in Shantung, this coal series is called Fang Tzŭ Series in this paper. But the underlying formation of this series so far has not yet been observed. On the south of the Fang Tzŭ coal field this series is in fault contact with the pre-Cambrian formations, and one part was faultted to sink down to invisible depth. The part in contact with the Archean gneiss is affected by igneous intrusions. At Wu T'u and Kao Chên in Ch'ang Lo district it also occurs and is in fault contact with the Cambrian strata. This series is free from marine deposits but yet variable in petrographic characters. In Fang Tzŭ coal field the strata exposed are white clay and gray shale; white clayey shale and white hard sandstone; white clay, yellowish-brown sandstone and shale, and white fine-grained loose sandstone. According to the section through the shaft of western coal mine (Japanese) of Fang Tzŭ, the petrographic sequence is as follows:

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(1) v. Richthofen, China. II, p. 227.

(2) Th. Lorenz, Beiträge zur Geologie und Palæontologie von Ostasien, I Teil, p. 18 and plates.

(3) B. Willis, Research in China, vol. I, part 1, pp. 53-56.

Loess

Tuff (one part of the Tuff-conglomerate) from more than 30 ft. to more than 40 ft. thick.

Sandstone 3-4 ft. thick.

Yellow shale 7-8 ft. thick.

Gray shale 30-40 ft. thick.

Coal seam 22.8 ft. thick, containing .8 ft. of gray shale in lower part.

Gray shale.

At Wu T'u and Kao Chên this series also contains coal seams, but is rarely exposed. At Wu T'u the strata observed are black clayey shale, violet thin sandstone, yellow-compact and loose sandstone, black clayey shale and yellow sandstone. At Kao Chên only yellowish green sandstone and gray-black shale were found.

Owing to the incomplete exposure of this series, the thickness can not be estimated. The part which contains coal seams appears to be not much more than 60 meters thick. The thickness of the coal seams contained in this series may also be taken into account. In Fang Tzŭ coal field only one seam is being worked, this being of variable thickness At West Mine the thickest part is more than 20 ft. while the average is about 12 ft ; at East Mine the seam is somewhere more than 30 ft. thick. At Wu T'u the coal seams which were worked are three in number, the thickest one is noly 2.5 ft., the total thickness is not much more than 4 ft. At Kao Chen there is also one seam amounting to about 5 ft. in thickness.

After the determination of the plant fossils from the Fang Tzŭ coal field by H. Potonié[1] this series was known to be of Jurassic age. Japanese geologists also collected some Jurassic flora from the Fang Tzŭ coal field. In 1919 Dr. J. G. Andersson and the writer took a short trip in the Fang Tzu coal field and there made a collection of plant fossils, of which *Podozamites*, *Coniopteris*, *Asplenium*, *Baiera* and *Elatides* are the prevailing types. This flora can be cited to confirm the jurassic age of this series.

(1) Futterer, Durch Asien III. 1, 1903.

B'. SHANG-K'UN-LUN SERIES (上崑崙系) OR MESOZOIC COAL SERIES:

This series occurs in the western part of the Tzŭ-Ch'uan Po-Shan coal field and forms small flat hills on the west of Hsiao Fu Ho. It overlies the Hsia-k'un-lun series and consists mostly of sandstones and shales and occasionally of conglomerate in the upper part. It was invaded by gabbro and by andesite intrusions. and was partly converted through metamorphism by the gabbro into pure quartzite, which is utilized in the glass work at Po Shan. In the vicinity of Pien-yi-p'u the petrographic sequence is given as follows:

Yellowish-green clayey shale, dark clayey sandstone and shale.

Grayish-yellow sandstone.

Yellowish-green sandstone, somepart compact.

Graywhite coarse sandstone inverted into quarzite at K'un-Lun Shan.

White coarse sandstone somepart reddish.

Yellowish-green hard sandstone containing black shale (with coal seam?)

In the environs of Hsi-liu-chuang the sequence is the following:

Green coarse sandstone.

Conglomerate.

White coarse sandstone.

Green sandstone.

Dark-brown and greenish. clayey shale with the trace of plant fossils.

Green sandstone.

Dark-brown and greenish clayey shale and yellowish-green sandstone.

The thickness of this series is estimated at about 160 meters. This series was studied in detail by the writer[1] and named the Shang-k'un-lun series following the example of Dr. F. Solgar[2]. The age, however, ie still questionable, trace of plant fossils was found in the rock heaps near the old

(1) Bulletin of the Geological Survey of China, No. 4 p. 83.

(2) F. Solgar, the geological map of the Tzŭ-ch'uan Po-shan coal field.

pits from which the natives formerly got bad coal but stopped the work owing to absence of valuable seam. From its lithic characters however this series may be provisorily correlated with the Fang-Tzŭ series.

C. SAN-T'AI SERIES (三台系) OR RED AND GREEN SANDSTONE:

This series occurs only in the western part of the Tzŭ-ch'uan Po-shan coal field, in which stands conspicuously the San T'ai Shan, a hill from the name of which that of this series is derived. It rests upon the Shang-k'un-lun series and is the last member of the consolidated sedimentary formations occurring in this coal field. It is composed of red, green, brown, violet and grayish-yellow sandstione, becoming conglomeratic in the part in contact with the underlying series and metamorphosed into quartzite along the contact with the andesite and gabbro intrusions.

One part of this series was eroded away, so that the real thickness can not be estimated. But the part which remains seems to be not less than 500 meters in thickness.

Earlier geologists did not subdivide this series, Th. Lorenz[1] termed it simply the Mesozoic strata, and Bailey Willis[2] grouped it as the Sint'ai series. It was first separated from its underlying series by Dr. F. Solgar[3] who applied to it the name Sant'ai series. Since fossils were not found in this series, the age is still underterminable, but according to its superposition. this series may still be of Jurassic age.

D. MÜNG-YIN SERIES (蒙陰系)

The Mêng-yin series occurs in Central Shantung, especially in the Lai Wu, Mêng Yin and Fei Hsien valleys and rests upon the Hsia-k'un-lun series. In the Lai Wu valley this series is composed of gray and green shaly sandstone, sometimes brownish, including numerous igneous intrusions, of which the dyke is the prevailing form. But in some places it comprises only volcanic material, such as green tuff-conglomerate, tuff-breccia, tuff and lava

(1) Th. Lorenz, Beiträge zur Geologie und Paläontologie von Ostasien, 1 Teil, p. 19 and plates.
(2) B. Willis, Research in China, vol. I, part 1, pp. 56 and 57.
(3) F. Solgar, the geological map of the Tzŭ-ch'uan Po-shan coal field.

flow, with some intrusive bodies but without any sandstone. In the Mêng Yin valley this series is largely composed of green sandstone, and in many places tuff-conglomerate plays an important role in its composition. This sandstone is a peculiar shaly sandstone which easily crumbles down to very small angular fragments. In the northwestern part of the Mêng Yin district the lower part of this series comprises yellow and green conglomeratic sandstone, yellow and greenish sandstone and shale, in some places cross-bedded. The middle part contains green shaly sandstone and greenish sandy shale The upper part embraces green sandstone and violet and brown shale. In the vicinity of the Mêng Yin city the lower part consists of gray, greenish and brownish shaly sandstone, and green, hard, coarse sandstone. The middle part contains green tuff-conglomerate and tuff interbedded with yellow, gray sandy shale and green shaly sandstone. The upper part includes green, yellow and violet shaly sandstone interbedded with reddish, yellow, gray clay, gray-white loose sandstone, and tuff-conglomerate. In the Fei Hsien valley this series is mostly covered by alluvial deposits and there is no good section to show its successive members. In the envirnos of Ku Ch'êng, about 20 li north of the Fei Hsien city, above the Hsia-k'un-lun series is a greenish loose sandstone interbedded with green tuff. In the vicinity of Chung Yi Shan, about 25 li east of the Fei Hsien city, occurs also a greenish loose sandstone with green tuff-conglomerate and intrusive bodies. All these belong to this series.

The thickness of this series is variable. It is estimated at 830 meters in the northwestern part of the Mêng Yin district; 1240 meters in the vicinity of the Mêng Yin city. In Fei Hsien valley this series is, by estimate, about 1000 meters thick. In the Lai Wu valley it amounts to 360 meters, but that part which contains volcanic materials has a considerable thickness.

This series was observed by v. Richthofen[1], Th. Lorenz[2] and Bailey Willis[3] in the Lai Wu valley as well as in the Mêng Yin valley. The former two gentlemen have not made distinct statement about this series

(1) v. Richthofen, China, II, pp 191 and 227.
(2) Th. Lorenz, Beiträge zur Geologie und Palæontologie von Ostasien, p, 18 and plates.
(3) B. Willis, Research in China, Vol. I, past 1, pp. 54-56.

though they seem to group it in the Permian. Bailey Willis made comparatively detailed observations on this series and put it in the middle part of the Sint'ai Series established by him. This series bears an abundance of fossils, both animals and plants. The former were examined by Dr. O. Zdansky and the latter by Mr. Chow and later confirmed by Dr. A. N. Kryshtofovich. These palæontologists denoted that the fossils may be assumed to belong to the Cretaceous rather than to the Jurassic. Thus it is nearly certain that this series can be referred to the Cretaceous though one part may extend down to the late Jurassic.

In Eastern Shantung no typical Mêng-yin series has been observed bearing the same characters as above described. But there are two formations respectively called by the writer the Laiyang and Ch'ingshan formations which seem to be equivalent to the Mêng-yin series of Central Shantung. They are, however, so distinct in occurrence that they should not be united with each other to constitute one series but will be separately described under the following arrangement, D Mêng-yin series followed by d_1. Laiyang Formation and d_2. Ch'ingshan Formation. This arrangement shows that the latter two formations are the sub-divisions of the former series.

d_1 LAIYANG FORMATION (萊陽層) OR FISH BEDS:

This formation is well developed in Eastern Shantung, especially in Lai Yang, Chi Mo, Chiao Hsien, Chu Ch'êng and Chü Hsien districts. It unconformably rests either upon the T'ai Shan complex or upon the Wu T'ai System. In Lai Yang it may be divided into three parts; the lower part consisting chiefly of brownish, yellow and gray shaly sandstone with green, violet and red clayey shale, and of yellow and gray coarse sandstone, in some places conglomeratic; the middle part comprising gray and green thin-bedded shale and dark-gray hard calcareous shale with yellow and gray sandstone; the upper part containing yellow, gray, green and reddish sandstone with green, gray and red clayey shale and dark shale. The lower part also includes some intrusive bodies being either in dykes or laccoliths. In Chi Mo, Chiao Hsien, Chu Ch'êng and Chü Hsien this formation seems to exclude the calcareous shale which contains the fossil-fishes, but includes many beds of quartzite. In Chi Mo, it is composed of greenish shaly sandstone, brown,

red, greenish, gray and yellow sandstone with quartzite, green and borwn sandstone and conglomerate, and grayish quartzite. In Chiao Hsien and Chu Ch'êng it comprises yellow, greenish and brownish hard sandstone with gray, green and brownish clayey shale and conglomerate, in the upper part the sandstone is partly quartzitic. In Chü Hsien it occurs only in the vicinity of Ta Shan and consists largely of yellow loose sandstone, brown sandstone and green coarse and hard sandstone with green and violet clayey shale.

The thickness of this formation is not as variable as that of the Mêng-yin series. It is estimated at about 700 meters in Lai Yang and about 900 meters in Chi Mo, Chiao Hsien and Chu Ch'êng.

Formerly, according to the determination of the fossil-fish by A. S. Woodward[1], this formation was regarded as Jurassic. But Dr. A. W. Grabau pointed out that the fossils including insects, fishes, pelecypods and plants, collected by the writer may be of Cretaceous age. So the position of this formation should be moved upward in the chronological column, and this formation may be referred to the Cretaceous though part of it may still belong to the Jurassic.

d_2 CH'INGSHAN FORMATION (青山層) OR TUFF-CONGLOMERATE:

This formation is widespread in the eastern part of Shantung and rests upon different formations either in unconformable, disconformable or in conformable contact. The fossiliferous members of this formation in Shantung were first found at Ch'ing Shan in Lai Yang district. This is the reason why the name Ch'ingshan formation is adopted. In Lai Yang it overlies the Laiyang formation and consists of brown tuff-conglomerate, green, violet and reddish tuff interbedded with volcanic lavas and red clay, and green, gray, violet, brown clayey shale and yellow-reddish sandstone in lower part. But in other parts of eastern Shantung this formation comprises tuff, conglomerate and volcanic lavas, and occasionally brown-red sandstone, including various igneous intrusions, the clays have not been met with. Aside from overlying the Lai-yang formation in Chi Mo, Chiao Hsien, Chu

(1) Fossil fishes found by H. M. Becher, determined by A. S. woodward.

Ch'êng and the eastern part of Chü Hsien, this formation rests upon the T'ai Shan complex in An Chiu, Lin Ch'ü, Wei Hsien. Yi Shui and Chü Hsien; upon the Wu T'ai system in the eastern part of An Ch'iu and southwestern part of Lai Yang; upon the siliceous limestone and Cambrian formations in the southwestern part of An Ch'iu, southern part of Lin Ch'ü and some parts of Chü Hsien and Ch'ang Lo; upon the Ordovician limestone in the southern part of Lin Ch'ü and northern part of Yi Shui; upon the Palæozoic coal series in the western part of Chü Hsien; and upon the Jurassic coal series in Wei Hsien and Ch'ang Lo.

This formation gradually increases in thickness from Chü Hsien and Yi Shui eastward, the thickness is estimated ot about 1200 meters in Chu Ch'êng, Chiao Hsien and Cai Mo, and remains constant as tar as the Lai Yang district. According to the fossil-contents and the relation to the Lai-yang formation, this formation may be of Cretaceous age.

E. WANGSHIH SERIES (王氏系) OR RED CLAY:

The name of this series is derived from the name of a small village in Lai Yang, in the vicinity of which the fossils were discovered by the writer. This series is so widely distributed that the lowlands of eastern Shantung, the Lai Yang and Chü Hsien valleys are mostly composed of it or its members, though in some places it is often concealed beneath the superficial deposits. In the Lai Yang valley it follows the Ch'ing-shan formation and is in fault contact with the Wu T'ai system, consisting chiefly of red clay with red, white-gray and brown conglomerate and sands and many seams of dark clay in the middle part, the pebbles of the conglomerate are made of quartzite, sandstone, gneiss, porphyry and volcanic rocks. In Chiao Hsien, Chu Ch'êng and one part of Kao Mi this series may be divided into three parts; the lower part comprising red clay with red and gray sandstone; the middle containing largely red clay with green and gray clay and conglomerate; the upper including mostly coarse conglomerate with brown-red coarse and hard sandstone. In the Chü Hsien valley this series is incomplete, only the members belonging to the lower and middle parts exist and the upper part seems to be missing. It is composed largely of red clay with red sands and conglomerate, containing greenish shale and sandstone and yellowish-green

clay in the lower part, the pebbles of the conglomerate are formed of quartzite, limestone, some hard shale and volcanic rocks. In the southern part of the Yi Shui valley there are some outcrops of red clay, green and red shale and sandstone which seem to overlie, though without apparent contact, the Ch'ingshan formation. They may be the members of this series.

This series has a considerable thickness estimated at not less than 2000 meters in the Lai Yang valley as well as in the Chiao Hsien, and Chu Ch'eng districts. The age of this series is assumed to be Cretaceous by Dr. Zdansky. In the middle part of this series the writer found an abundance of large fossil bones. Dr. Zdansky regarded them all belonging to reptiles. As no such large and specialized reptiles can have existed in the Tertiary, this series must be referred to the Cretaceous, if Dr. Zdansky's assumption proves to be correct.

F. KUAN-CHUANG SERIES (官莊系) OR RED SANDS:

In the vicinity of the village Kuan-chuang in the Hsin T'ai district, this series furnished numerous gastropods as well as several kinds of mammal-teeth, so that the writer proposes to apply to it the name of that village. This series is well developed in the Mêng Yin, Lai Wu and Fei Hsien valleys, and occurs also in the southern part of the T'ai An district and the northeastern part of the Ning Yang district. It is chiefly composed of red sands, clay and conglomerate, containing yellow, gray sandstone, marl and limestone, occasionally with dark gray shale which seems to be carbonaceous. In the Mêng Yin valley this series rests upon the Mêng-yin series. The lower part of it consists of red sands and loose conglomerate, the pebbles of which are formed of red quartzite, limestone and igneous rocks, such as syenite and diorite. The middle part comprisee red sands, yellow, gray and greenish sandstone, grayish clay, dark gray shale white-gray paper shale, gray-greenish marl and gray-white limestone, including an abundance of calcareous concretions. The marl and limestone are represented in several beds which are from less than half a meter to about two meters in thickness. The upper part contains conglomerate and red sands, the pebbles of the former being mostly of limestone and of igneous rocks such as porphyry and diabase, and mostly larger than those included in the lower part. In the Lai Wu valley

this series overlies the Mêng-yin series, and also the Hsia-k'un-lun formation and the diorite body. The lower part consists of red sands and clay with loose conglomerate beds, the pebbles of which are mostly made of limestone. In the vicinity of the diorite body, north of the Lai Wu city, the red sands contain an abundance of felspar grains, and the pebbles of the conglomerate beds are partly composed of diorite which also constitutes the main intrusive body. The middle part comprises red sands interbedded with yellow, gray, greenish and white gray sandstone, including numerous beds of grayish-white limestone. The upper part is a conglomerate, occasionally with red sands. Along the border between the Lai Wu and T'ai An districts we met with some outcrops of yellow, green sandstone and white limestone which may also be referred to this series. In the Fei Hsien valley this series either follows the Mêng-yin series or is in fault contact with the Palæozoic formations. The larger part of this series is covered by the superficial deposits, but along the northern margin of the valley the upper part, including the conglomerate and red sands, frequently occurs. In the northern part of the Fei Hsien district the members exposed are white limestone dark-gray and greenish shale which belong to the middle part, and the coarse conglomerate and red sands which are of the upper part of this series. In the Szu Shui district the members of this series are red sands, conglomerate, gray clay and yellow loose and coarse sandstone. In some places the red sands contain gypsum, and the clay is partly carbonaceous and known by the natives to include poor coal. In the northeastern part of Ning Yang there occur the white-gray clay with sandstone, and the conglomerate; the clay is also known to contain coal. In the southern part of T'ai An there are many outcrops of red snads, conglomerate and white-gray clay,which may also belong to this series, though no fossil was found.

The thickness of this series is variable, from 600 to 1100 meters in the Mêng Yin valley, in the Lai Wu valley the thickest part is estimated at 1670 meters. But in the Fei Hsien valley and in Ning Yang and T'ai An districts, owing to the incomplete exposure of this series, the estimate of the thickness can not be made. According to the determination of the fossils which include mammals, gastropods, reptiles and fish-bone, this series is unquestionably of Eocene age.

Brief Summary of the stratigraphic Position of the Formations described.

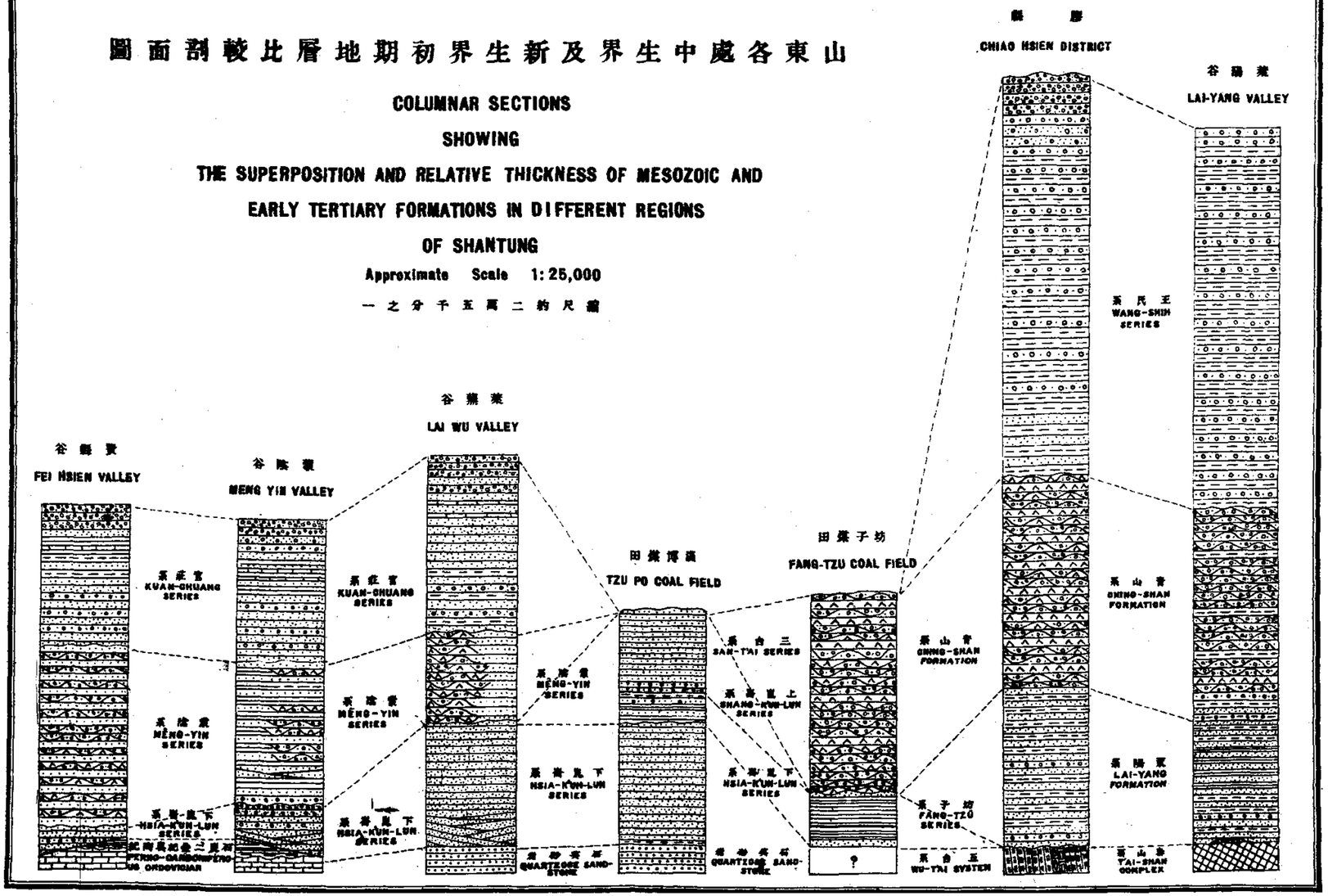
As indicated in the preceding paragraphs the formations are separately included in several independent groups and restricted in disconnected valleys or lowlands. There are nine formations belonging to four periods, one of the formations being regarded as Triassic, three referred to the Jurassic, four to the Cretaceous, and one being of Eocene time. But, though the age of these formations has been generally settled or assumed to be settled either according to the fossil-contents or to the lithic characters and the superposition, the mutual relations between them and the stratigraphic position should also be considered. Among them the Hsia-k'un-lun series which is assumed to be of the Triassic age, is the oldest one and must be put at the base of the column. There are three series which follow next upon the basal member. The Shang-k'un-lun series and the Mêng-yin series directly overlie it, whereas the Fang-tzŭ series has no contact with it. But according to the fossil-contents the Mêng-yin series is probably Cretaceous age its stratigraphic position thus being separated widely from the Hsia-k'un-lun series; between them there certainly exists a gap. The Fang-tzŭ series which contains undoubtedly Jurassic plant-fossils should follow the basal series though no direct contact has been observed. According to its lithic characters, the Shang-k'un-lun series may be correlated with the Fang-Tzŭ series. Thus both are the successors of the Hsia-k'un-lun series and may be tentatively placed in the Lower and Middle Jurassic. Overlying the Fang-tzŭ series and the Shang-k'un-lun series are the Ch'ing-shan formation and the Sant'ai series in Eastern and central Shantung respectively. The Ch'ing-shan formation is not a close successor of the Fang-tzŭ series owing apparently to the existence of a gap between them, so that the Sant'ai series seems to be the only formation which may be placed immediately above both the Shang-k'un-lun series and the Fang-tzŭ series, though it has not actually been observed between the latter and the Ch'ing-shan formation, and is put ther eto fill the blank of middle and upper Jurassic suecession. But it is questionable whether the Sant'ai series may correspond to the Mêng-yin series or belong prior to it. No fossils were found in the former. The lithic characters of the one are very different from those of the other, the Sant'ai

圖面剖較比層地期初界生新及界生中處各東山

COLUMNAR SECTIONS
SHOWING
THE SUPERPOSITION AND RELATIVE THICKNESS OF MESOZOIC AND EARLY TERTIARY FORMATIONS IN DIFFERENT REGIONS OF SHANTUNG

Approximate Scale 1: 25,000

一之分千五萬二約尺縮



series containing predominantly red sandstone, while the members of the Mêng-yin series are mostly green rocks. For this reason the writer *assumes* that the Sant'ai series is older than the Mêng-yin series, and the Sant'ai series and the Shang-k'un-lun series may be placed to occupy the hiatus between the latter and the Hsia-k'un-lun series. Next to the Sant'ai series comes either the Mêng-yin series or the Lai-yang formation. Let us now consider first the relative position of the Mêng-yin series, the Laiyang and the Ch'ingshan formations as correlated with each other and compared with those formations in Mongolia observed by the members of the recent American Expedition. In the Mêng-yin series especially in the middle and upper parts, the tuff-conglomerate and other volcanic material are dominant members in some places, and the Ch'ing-shan formation nearly entirely comprises the tuff-conglomerate and volcanic material. So the middle and upper parts of the Mêng-yin series or at least one of these two parts may be correlated with the Ch'ing-shan formation, though the two tuff-conglomerates are different in colour. In the lower part of the Mêng-yin series the green shaly sandstone is the essentical constituent, and the Lai-yang formation contains plenty of the sandstone which has the same colour and character as that just mentioned. Therefore the lower part of the Mêng-yin series may correspond to the Lai-yang formation or to at least one part of it. Moreover, from the palæontological point of view the assumption that the Mêng-yin series is the correlative of the Lai-yang and Chingshan formations seems more tenable. The fossils including animals and plants obtained from the former series were examined by Dr. O. Zdansky, Mr. Chow and Dr. A. N. Kryshtofovich, and the animal and plant fossils collected from the latter two formations were examined by Dr. A. W. Grabau and Mr. T. C. Chow. In both cases the palæontologists agree to refer the fossils of the Mêng-yin series to the Cretaceous rather than to the Jurassic as was also done with the fossils of the Lai-yang and Ch'ing-shan formations. According to the fossil contents the three formations above mentioned may correspond to some of the formations in Mongolia. The Mêng-yin series and the Chingshan formation contain Dinosaurs, turtles, fishes, pelecypods and plants, and the Lai-yang formation includes fishes,

insects, pelecypods and plants. In Mongolia there are four formations[1], namely the Dja-doch-ta formation, the Ashile formation, the Ondai Sair formation and the Iren Dabasu formation, all of which contain Dinosaurs, while in the Ondai Sair formation are found also insects, fishes and some phyllopods The first three formations are referred to the lower Cretaceous and the last to the Upper Cretaceous. The insects of the Ondai Sair formation are represented by mosquitoes and butterflies In the Laiyang formation insects resembling mosquitoes were also found. Thus it is probable that the Laiyang formation of Shantung may be the correlative of the Ondai Sair formation of Mongolia, and generally speaking, the Mêngyin series, the Laiyang formation and the Ch'ingshan formation of Shantung may be corresponding to the Dja-doch-ta formation, the Ashile formation and the Ondai Sair formation of Mongolia, or parts of the former ones to parts of the latter ones. Thus the Mêng-yin series with the Laiyang and Ch'ingshan formations may be put in the Lower Cretaceous space, and the last two will be placed in the same horizon as the first one. But the lower part of the Lai-yang formation is barren and is very thick. Perhaps one part of it may extend into the late Jurassic. The Ch'ingshan formation is followed by the Wang-shih series which contains an abundance of big fossil-bones. According to Dr. Zdansky's opinion these fossil-bones may belong to the reptiles, so that the Wang-shih series should be put in the Cretaceous. The Iren Dabasu formation of Mongolia, which has been put by American explorers in Upper Cretaceous, includes Dinosaurs[2], pelecypods,[2], crocodiles[2] and turtles[2] In the Wang-shih series pelecypods were also found besides Dinosaurs. Thus the Wang-shih series may correspond to the Iren Dabasu formation and may occupy the Upper Cretaceous blank. Among the consolidated formations the Kuang-chuang series is the last one. According to the fossil contents this series or at least one part of it is certainly of Eocene age and placed in that epoch. The geological column showing the groups of the formations mentioned and their relative position is given in the following table.

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(1) American Museum Novitates, No. 77, May 25, 1923.

(2) American Museum Novitates, No. 42, p. 3.

TERTIARY	EOCENE		Kuan-chuang Series			
			Disconformity			
MESOZOIC	CRETACEOUS	Upper			Wang-shih-Series	
					Disconformity	
		Lower	Mêng-yin Series		Ching-shan Formation	
	JURASSIC	Upper		San-t'ai Series		Lai-yang Formation
		Middle			Disconformity	
		Lower		Shang-k'un-lun Series	Fang-Tzu Series	
	TRIASSIC		Disconformity			
			Hsia-k'un-lun Series			

FOSSILS.

The fossils which were collected in the later trips seem to throw much light on the geology of Shantung, both on the stratigraphy and both on the structure, though some of them have not been determined and we can not state precisely the age of the formations in which they are included. It has been mentioned in the introduction that the trips were taken in Shantung largely for the purpose of finding fossils. In this chapter will be shown where and in what formations the fossils were found and to what genera or species the fossils belong. The fossiliferous formations here in question are the Fang-tzŭ series, Mêng-yin series, Lai-yang formation, Ch'ing-shan formation, Wang-shih series and Kuan-chuang series. In the Fang-tzŭ series the plant fossils were found. They are contained in the dark-gray and white-gray shale near the coal seam and were collected at the east mine and west mine in the Fang-tzŭ coal field. So far as we know, amongst them the prevailing types are *Podozamites*, *Coniopteris*, *Asplenium*, *Baiera* and *Elatides*. But as all the specimens collected have been sent to Sweden for precise examination and determination, the descriptions will be published in future. The Mêng-yin series contains an abundance of fossils, both animals and plants. The plant fossils were obtanied from the middle and uppe parts of this series in the vicinity of Mêng Yin city. The beds are especially rich in fossil plants at a locality about 4 li N. E. from the city. These are represented by fossil wood and impressions of ferns. The animals include turtles, fishes, fresh water mollusks and remains of Dinosaurs. The turtles and fishes were obtained mostly from the middle part of this series in the neighbourhood of Ning Chia Kou, a small village 35 li N. W. from Mêng Yin city. The mollusks occur in the vicinities of Ning Chia Kou and Mêng Yin city and are also contained in the middle part. Both the plant and the animal remains mentioned have been sent to Sweden for determination. On this occasion when the first find in Chnia proper of a member of the Dinosauria is recorded in this paper it may be proper first to make a brief record of other finds of Dinosauria within Chinese territory. The first scientific note[1] on the occurrence on the Amur of vertebrate remains which later proved to belong to Dinosaurs was published

(1) Communicated by Dr. A. N. Kryshtofovich.

in "Annuaire de minéralogie et géologie de la Russie" par N. J. Krischtafovitsch in 1902, where it is stated that bones from these beds were known to the local cossacks and that some specimens were brought to the museum of Blagoweshchensk as "bones of mammoth". In 1914 Dr. A. N, Krysht-ofovich when travelling along the Amur river was informed by a cossack about the existence of fossil bones on the Chinese side of the Amur river below the mouth of the Burreya river. Dr. Kryshtofovich there found the Dinosaur bed which is a layer of conglomerate intercalated in a series of sand and loose sandstone. The important discovery made by Dr. Kryshtofovich led to a series of organized campaigns in the three summers of 1915-1917 when expeditions from the Geological Commitee of Petrograd visited the place and made extensive excavations. The large material brought to Petrograd from these excavations has been examined by A. N. Riabinim(1). Most common are remains belonging to the group Ornithopoda and related to the North American Trachodontidæ. These are referred to the genera Trachodon and Saurolophus. There are also teeth and other remains of carnivorous Dinosauria (Theropoda), related to *Albertosaurus*, as well as some fragments possibly belonging to the Ceratopsidæ. In the summer of 1922 Dr. W. Granger and Dr. C. P. Berkey of the American expedition made very rich and varied finds of Dinosaurs in Mongolia. In the Dja-doch-ta formation an entirely new form of Dinosaur was found and described under the name *Protoceratops andrewsi*(2). In the Ashile formation were found a dinosaur of *Camptosaurus*(3) type and a sauropod of very large size. In the Ondai Sair formation a dinosaur of *Camptosaurus*(4) type and a rib of a large dinosaur were obtained. In the Iren Dabasu formation were found predentate Dinosaurs(5) probably of the bipedal type. and carnivorous dinosaurs of at least two genera, the smaller one being of the *Ornithomimus*(6) type. In regard to the finds of Dinosauria in China proper the man who discovered the first specimen of a Dinosaur in Mêng Yin, Shantung,

(1) Communicated by Dr. A. N. Kryshtofovich.
(2) American Museum Novitates, No. 77, p. 11.
(3) American Museum Novitates, No. 77, p. 11.
(4) American Museum Novitates, No. 77, p. 7.
(5) American Museum Novitates, No. 42, p. 3.

will first be mentioned. About 10 years ago a Catholic pater named Metrens collected in the vicinity of Ning Chia Kou of Mêng Yin a nearly complete skeleton of the Dinosaur, one part of which was presented to Dr. Ting by Mr. Behagel. But then we did not know the locality whence the Dinosaur was derived In the winter of 1922 Dr. Andersson and the writer not only identified the place where the Dinosaur in question had been found, but also collected more material of this Mesozoic reptile. In the vicinity of Ning Chia Kou we found several parts of the Dinosaur, most of them belong to the body, the portions of the skull were not obtained. In the sping of 1923 Dr. Zdansky made excavations in the environs of Ning Chia Kou. At the locality where pater Metrens collected the big specimen, Dr. Zdansky also obtained large vertebrate column, the whole length of which is nearly 20 feet, and a broken skull with several teeth. The bones of the Dinosaur are contained in the lower and middle parts of the Mêng-yin series. In the same seasen the writer made a large collection of fossil-bones in eastern Shantung, especially in the Lai Yang valley and the Chiao Hsien district. Some of them were found in the lower part of the Ch'ing-shan formation, the remainder in the middle part of the Wang-shih series. The bones contained in the former formation, occurring at Ch'ing Shan and at Ma Yai K'ou about 15 li N. E. and N. from the Lai Yang city respectively, belong to the Dinosaur, two pieces of them seem to be the parts of the pelvis. The fossil-bones included in the Wang-shih series belong, according to Dr. Zdansky's decision, to reptiles. They were found at Wang Shih, T'ien Ch'iao T'un and Chiang Chün Ting in the Lai Yang valley and at Chang Ying in the Chiao Hsien district, and are represented by leg-bones, rib-bones, vertebræ, pelvis and tooth. All the fossil-bones collected from different localities will be sent to Sweden for precise examination and determination. The Lai-yang formation contains many kinds of fossils, both plants and animals. At P'o Tzŭ and Nan Wu about 20 li N. E. and about 30 li E. from the Lai Yang city respectively were found insects, fishes, pelecypods and plants. They are contained in the middle part of this formation, and some poor plant fossils were also met with in the lower part. In the Ch'ing-shan formation and the Wang-shih series aside from the reptiles were also found the pelecypods and brachiopods. At Chu Chia Chuang about 18 li N. of the Lai Yang city the pelecypods were obtained

from the lower part of the Ch'ing-shan formation. And at Chang Ying in Chiao Hsien the pelecypods and brachiopods were collected from the middle part of the Wang-shih series. Preliminary descriptions of the above mentioned fossils, by Dr. Grabau and Mr. Chow, will be given below. In the Kuan-chuang series occurring in the Mêng Yin and Lai Wu valleys Dr. Andersson and the writer discovered an abundance of fossils. They are contained in the grayish white limestone, grayish white and greenish marl and sandstone in the middle part of this series, and were found in the vicinities of Hsiu T'ai and Kuan Chuang in the Mêng Yin valley and in the neighbourhood of Li Chia Chên in the Lai Wu valley. The fossils are represented by several species of freshwater and probably also of landmollusks, remains of Trionyx, teeth of lizards and teeth, jaws and isolated bones of at least six species of mammals, including, according to determinations made by Dr. Zdansky, a Phenacodontid or primitive Hyracotheriine, an Anchitheriine, possibly Mesohippus, Anchilophus, a Creodont or primitive Canid.

Besides the fossils sent to Sweden, many others including insects, pelecypods, and plants, have been examined and determined by Dr. Grabau and Mr. Chow, from the successive horizons and will be described in succeeding pages of this Bulletin.

A Fossils from the Lai Yang Formation (Loc. 218)

PLANTÆ

1 *Brachyphyllum obesum* Heer
2 *Brachyphyllum magnum* Chow
3 *Brachyphyllum multiramosum* Chow
4 *Sphenolepis elegans* Chow
5 *Sphenolepis arborescens* Chow
6 *Pagiophyllum* sp.
7 *Palæocyparis* cf. *flexuosa* Sap.
8 *Araucarites* sp.
9 *Baiera* cf. *australis* M'Coy.
10 *Zamites* sp.
11 *Thinfeldia* sp.

PHYLLOPODA

12 *Estheria middendorfi* R. Jones

INSECTA

13 *Sinoblatta laiyangense* Grabau

14 *Laiyangia paradoxiforme* Grabau

15 *Proteroscarabæus yenni* Grabau

16 *Samarura (?) gregaria* Grabau

PISCES

17 *Lycopters sinensis* Woodw

18 *Lycoptera* sp.

B Fossils from the Lower Chingshan formation (Loc. 219)

PELECYPOD:

1 *Leptesthes chingshanense* Grabau

PLANTÆ

2 Indeterminable plant remains

C *Fossils from the Mengyin Series at Ning Chia-Kou*

(Received from Pater Alfred Kaschel)

PELECYPODA

1 *Unio (Lampsila?) johan-böhmi* Frech

2 *Unio* cf. *menkii* Dunker

3 *Mycetopus mengynense* Grabau

GASTROPODA

4 *Bithinia mengyinense* Grabau

5 *Valvate suturalis* Grabau

D *Fossils from the Wangshieh series*

Chiao Hsien Shantung (Loc. 220)

PELECYPODA

1 *Cyrena (Sphærium?) tani* Grabau

2 *Cyrena (Pisidium?) shantungense* Grabau

3 *Cyrena (Pisidium?) wangshiense* Grabau

4 *Cyrena (Pisidium) retrorostrum* Grabau

5 *Cyrena (Pisidium) altiformis* Grabau

GASTROPODA

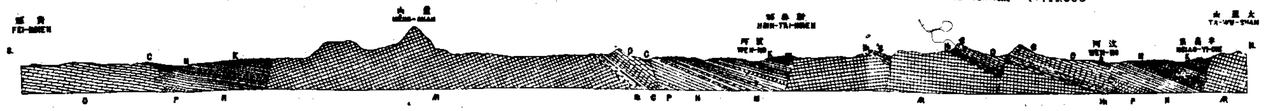
6 *Limnaeus?* sp,

7 *Cyclophorus?* sp.

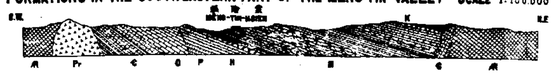
山東中生代及第三紀前期地層剖面圖

SECTIONS SHOWING THE MESOZOIC AND EARLY TERTIARY FORMATIONS IN SHANTUNG

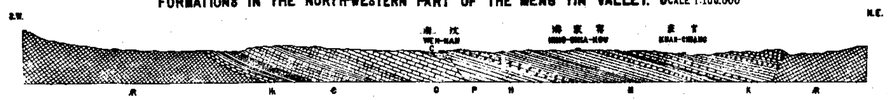
FORMATIONS AND FAULTS IN CENTRAL SHANTUNG, THROUGH THE FEI HSIEN, MÊNG YIN AND LAI WU VALLEYS. SCALE VERTICAL 1:100.000



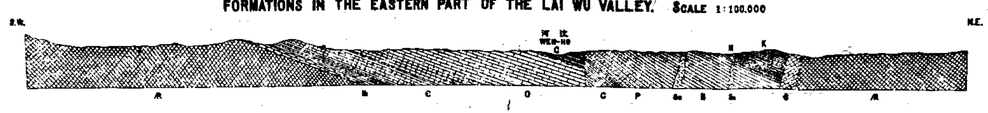
FORMATIONS IN THE SOUTH-EASTERN PART OF THE MÊNG YIN VALLEY SCALE 1:100.000



FORMATIONS IN THE NORTH-WESTERN PART OF THE MÊNG YIN VALLEY. SCALE 1:100.000



FORMATIONS IN THE EASTERN PART OF THE LAI WU VALLEY. SCALE 1:100.000



FORMATIONS IN THE TZŬ-CHUAN PO-SHAN COAL FIELD SCALE 1:100.000

FORMATIONS IN THE LAI YANG VALLEY SCALE 1:100.000

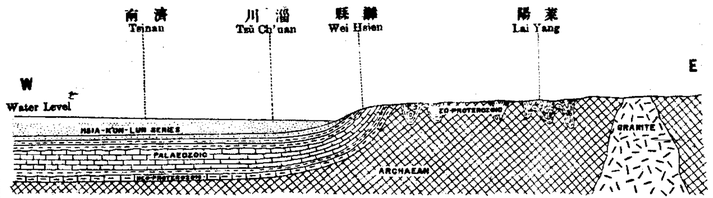
FORMATIONS IN CHIAO HSIEN DISTRICT. SCALE 1:100,000

A. 泰山系 TAI-SHAN COMPLEX　W. 五台系 WU-TAI SYSTEM　Si. 矽質灰岩層 SILICEOUS LIMESTONE　C. 寒武紀地層 CAMBRIAN FORMATIONS　O. 奧陶紀灰岩層 ORDOVICIAN LIMESTONE　C. 古生代煤系 PALAEOZOIC COAL SERIES　P. 石英砂岩層 QUARTZOSE SANDSTONE　H. 下崑崙系 HSIA-KUN-LUN SERIES　S. 上崑崙系 SHANG-KUN-LUN SERIES

St. 三台系 SAN-TAI SERIES　M. 蒙陰系 MÊNG-YIN SERIES　L. 萊陽層 LAI-YANG FORMATION　Cs. 青山系 CHING-SHAN FORMATION　Ws. 王氏系 WANG-SHIH SERIES　K. 官莊系 KUAN CHUANG SERIES　Pr. 斑岩 PORPHYRY　Sn. 正長岩 SYENITE　An. 安山岩 ANDESITE　Bs. 玄武岩 BASALT

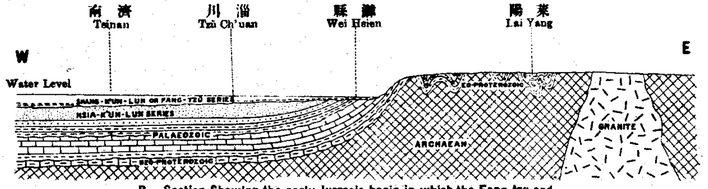
IDEAL SECTIONS SHOWING THE MIGRATION OF THE BASINS OF DEPOSITION IN DIFFERENT PERIODS.

圖像想布分地盆積沉代時各東山



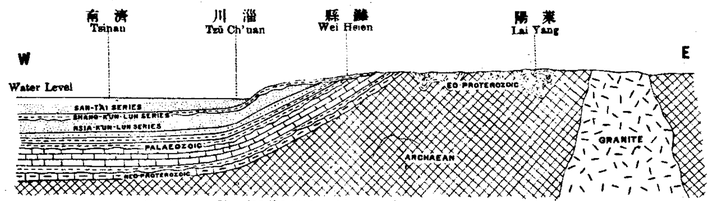
A. Section Showing the Triassic basin in which the Hsia-k'un-lun Series was deposited.

下崑崙系在三疊紀盆地中沉積



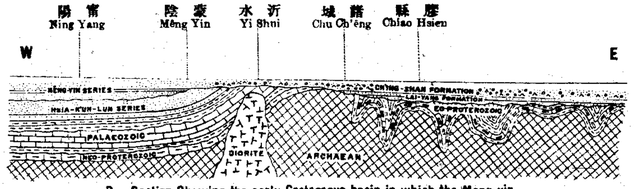
B. Section Showing the early Jurassic basin in which the Fang-tzu and Shang-k'un-lun series were formed.

坊子系及上崑崙系在侏羅紀初期盆地中之沉積



C. Section Showing the westward regression of the basin during late Jurassic time; and in the basin the Santai Series accumulated.

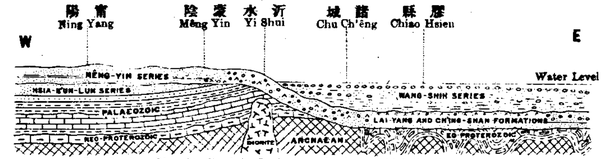
侏羅紀末期盆地向西退縮時三台系之沉積



D. Section Showing the early Cretaceous basin in which the Meng-yin Series and the Lai-yang and Ch'ing-shan formations were deposited and the overlap of the Ch'ing-shan formation on pre-Mesozoic formations.

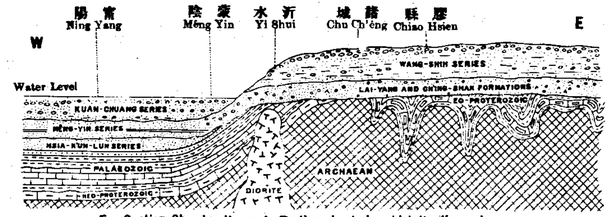
層山青層陽萊及系陰蒙

面剖之層地代生中前蓋覆層山青及積沉之中地盆期初紀堊白在



E. Section Showing the late Cretaceous basin in which the Wang-shih Series was deposited in Eastern Shantung.

積沉之中地盆期末紀堊白系氏王部東東山



F. Section Showing the early Tertiary basin in which the Kuan-chuang Series accumulated in Western Shantung.

積沉之中地盆期初紀三第在系莊官部西東山

STRUCTURAL GEOLOGY

The structural features concerning the whole province are a little more complicate and would be discussed not only in regard to its internal parts but in comparison with external regions surrounding it as well. But the areas here in question cover only the lesser part of Shantung and the formations dealt with are all included in the later portion of the geological column. Thus the structural features here mentioned are merely those that relate to the formations discussed in this paper.

Migrations of Basins of Deposition: (see ideal sections)

Towards the close of the Palæozoic era Shantung, except its eastern part which had long been exposed to erosion, was covered by the shallow Permian sea which, however, retreated before the end of Palæozoic time giving way to extensive deposits of continental sediments. This condition seems to have existed continuously to the late triassic as is indicated by the conformable contact between the Hsia-k'un-lun series and its underlying quartzose sandstone. But during the period of sea-retreat the whole province came to light likely without high relief and without any disturbance. Nor was there any marked disturbance at the end of triassic time, though sedimentation was interrupted. This may be deduced from the existence of a disconformity between the Hsia-k'un-lun series and its overlying formations.

At the beginning of the Jurassic period the site of continental deposition lay in northwestern Shantung, the margin of the basin lay on the north of the T'ai An, Lai Wu, Yi Shui and An Chin districts, and the left parts were still subject to denudation. In this basin the Fang-tzŭ and Shang-k'un-lun series were deposited. But during the middle Jurassic time the margin of the basin gradually migrated westward, the region formerly subject to deposition including Wei Hsien, Ch'ang Lo, Lin Ch'ü, Yi Tu etc., becoming elevated, while the Po Shan, Tzŭ Ch'uan, Chang Ch'in and Li Chêng districts with the area north to them were still within the area of deposition, remaining so until the end of the Jurassic period. So the Sânt'ai series was deposited upon the Shangk'unlun series without discontinuity. At that time the Fang-tzŭ series as well as the long since elevated part of the Hsiak'unlun series become subject

to erosion. This can be inferred from the fact that there is an apparent gap between the Hsiak'unlun series and its overlying Mêngyin series, and between the Fangtzŭ series and its overlying Ch'ingshan formation, judging by the fossil contents and the indications of erosion. At the close of the Jurassic period deposition came to an end and the Santai series came to be exposed. The whole province seemed to be above the level of deposition, though it is questionable whether the site of deposition had advanced into the eastern part of Shantung.

At the commencement of the Cretaceous period river deposits again spread over the area discussed, though there seem to have been more localized. There were two areas; one seemed to advance from the east and covered the long since exposed land of eastern Shantung, and in early Cretaceous time the margin of that basin lay to the east of the Chü Hsien and An Ch'in cities; another advanced from the west and occupied western Shantung, and the margin of that basin lay on the west of the Lin Yi and Yi Shui cities. Then the area including one part of the Lin Yi, Chü Hsien, An Ch'in and Yi Shui districts, and Lin Ch'ü, Ch'ang Lo, Wei Hsien, Yi Tu, Po Shan, Tzŭ Ch'uan, Chang Ch'in and Li Ch'êng districts with the regions north to them formed an elevated land, the southern part of which formed a barrier between these two basins of deposition. Igneous activity seems also to have taken place. In the eastern basin the Laiyang formation was deposited upon the T'ai Shan Complex and the Wu T'ai System. The early Cretaceous area of deposition spread westward covering the land-barrier and eventually meeting the western basin in which the Mêngyin series was formed on the Hsiak'unlun series. The Laiyang formation began to be deposited and continued into the Ch'ingshan formation which extended westward to overlie the formations prior to the late Jurassic and seemed finally to connect with the upper members of the Mêngyin series. As above indicated, there is an apparent progressive overlap of the Ch'ingshan formation upon the pre-late Jurassic formations.

In middle Cretaceous time river activities subsided and all parts of Shantung seemed to become free from sedimentation. Not very long after this, however, occured deposition set in on the east, but only the eastern part of Shantung was involued. The margin of the area of deposition may be traced

between the Lin Yi, Chü Hsien and An Ch'in cities and the Chu Chêng and Kao Mi cities. In this basin the Wangshih series was deposited, the pebbles of the conglomerate beds contained in it being partly derived from the lavas of the Ch'ingshan formation. It is evident that between the Ch'ingshan formation and the Wangshih series there exists a disconformity which confirms the occurrence of a shifting of the locus of deposition followed by a return to its former position in middle Cretaceous time.

At the end of the Cretaceous period the basin of deposition migrated eastward, the whole province rising above the water level. During the early Tertiary time deposition of river sediments again advanced from the west, the sediments being spread over the western part of Shantung, the margin of the basin lying within the Lin Yi, Mêng Yin, Lai Wu and T'ai An districts. The Kuanchuang Series was deposited in this basin. In the Lai Wu valley the Kuanchuang series contains in its lower part diorite pebbles and feldspar grains. As the dioritic intrusion is most probably contemporaneous with or a little later than the Mêngyin series, the presence of dioritic pebbles in the Kuanchuang series can be used to prove the existence of a disconformity between the Mêngyin series and the Kuanchuang series and to confirm the view of a transgression of the site of deposition during the early tertiary time, deposition appears to have continued throughout Eocene time after which i ceased except for some of the more recent loess and fluviatile deposits.

FOLDING AND FAULTING: (See Sections)

Toward the end of the Eocene time the whole province seemed to have gradually been affected by the warping which continued to attain its maximum development thereafter. Mostly likely in Oligocene, less probably in Miocene but not in the post-Miocene time the warping has developed extremely, and according to the topographical features, the attitude of the high mountains and the thickness of the formations, the top of the warp seemed to occur in the northern part of central Shantung, probably in T'ai An dsitrict, with the height not less than 5000 meters, the length of the surface of the warp amounts to about 300 miles and the width to about 140 miles. The flexure in some places on the northern margin appears clearer, but the

other marginal parts were affected by folding, faulting and erosion. Then the volcanic activity took place according to the existence of basalt flow on the Eocene strata. As soon as the warp has reached its maximum development, the earth crust was broken because it could not resist the force of warping. The faults and the folds which play an important role in the structure of Shantung resulted from the break of the warp.

In the tectonic features of Shantung the faults are much more important than the folds; for the former occur in many places in Shantung and show the apparent effects upon the strata, whereas the latter are mostly local and less manifest. Of course, when the warping reached its maximum development, the strata seemed all to have been bent. But after the break of the warp the bent portions were mostly dissected by erosion and interrupted by faults, only on the marginal parts of mountainous region of Shantung take place the folds, some of which seem to be not of great importance in the structural features concerning the whole province.

In the areas here in question the folding did not develop. It only occurs in the so called lowlands of eastern Shantung and in the Chü Hsien valley. In An Ch'iu the strata of the Ch'ing-shan formation dip to southeast or to east with the dipping angles of from 10-30 degrees. In Chu Chêng the dips of the strata of the Lai-yang formation Ching-shan formation and Wang-shih series are generally to northwest with the dipping angles of from 18-40 degrees. This shows that the strata of the formations form a broad and shallow syncline. And, in the southern part of Chiao Hsien the strata of the Lai-yang formation, Ch'ing-shan formation and Wang-shih series incline toward northwest or north-northwest with the dipping angles of from 20° to 48°, in the northern part of Chiao Hsien the strata of the Wang-shih series dip to south with the dipping angles of 10 degrees. This indicates also the existence of the shallow and broad syncline in the lowlands of Eastern Shantung. The axis of this syncline extends in southwest-west and northeast-east directions, In addition to this, there is another syncline in Chü Hsien valley. The strata of the Ch'ing--shan formation and Wang-shih series which constitute its left limb dip to north-west with greater dipping angles, wheras those composing its right limb incline generally toward southeast with the dipping angle of about 40 degrees.

The southern part of this syncline is narrow while the northern part is more broad, and the axis lies in southwest and northeast directions. But according to the continuity of the formations from the Chü Hsien valley to the lowlands of Eastern Shantung, the two synclines seem to form only one syncline commencing from the southern part of Chü Hsien terminating in the northern part of Chiao Hsien. Aside from the above mentioned areas there is no place where the strata appear to be folded. But the undulation of the strata frequently occurs everywhere the Mesozoic and early Tertiary formations are distributed.

As soon as the warp had been broken the faulting began to develop. All the big faults which are important from the structural point of view resulted during that time. The Mesozoic and early Tertiary formations were nearly entirely affected by the faulting, so that the big faults constantly occur in the regions where the formations mentioned are developed. The latter often compose the downthrow sides of the former. The big faults are characterized by either vertical or horizontal movement. The vertical faults are generally trough faults giving rise to the formation of graben-like valleys. The Fei Hsien, Mêng Yin and Lai Wu valleys were formed in this way by the trough faults between which the Mesozoic and early Tertiary formations are preserved. The trough faults are nearly parallel to each other, and extend generally in a northwest and southeast direction, though some parts change to an eastwest direction. The upthrow sides of these faults are usually composed of the pre-Mesozoic formations, whereas the downthrow sides consists of the post-Palæozoic formations, that is, the sediments mentioned in this paper. Somewhere the throw can be estimated at not less than 4000 meters. The Yi Hsien coal field is confined on the northern side by a big vertical fault, the downthrow side of which comprises the Hsia.k'un-lun series as well as the Palæozoic formations. The upthrow side is made of the Cambrian and pre-Cambrian strata. The throw is smaller than that of the above mentioned trough faults. The western part of this fault is nearly westeast in direction but the eastern part extend to southeast east. The Lai Yang valley is also limited on the southern side by a normal fault which is westeast in direction. The upthrow side is composed of the Wut'ai System and the downthrow side comprises the Laiyang formation, Ch'ingshan formation and Wangshih series. The throw can be estimated at also not less than 4000 meters. On the south-

ern side of the Fang-tzŭ coal field there is a normal fault, the direction of which is generally westeast. The T'ai Shan Complex constitues the upthrow side and the Fang-tzŭ series and Ch'ingshan formation compose the downthrow side, and the throw is much smaller than the above mentioned ones. On the western side of the Chū Hsien valley there occurs also a normal fault, the direction of which is north-south. The upthrow side consists of early Palæozoic and Archæan strata, while the downthrow side is made of the Ch'ingshan formation and the Wangshih series with the Permo-Carboniferous coal series, and the throw is small. Between the Cambrian strata and the Fang-tzŭ series at Kao Chên and Wu T'u of Ch'ang Lo there exist the normal faults. But they are small and unapparent. On the western side of the Mêng Yin valley lies a north-south-extending normal fault which seems to interrupt the trough faults of that valley.

The faults of horizontal displacement occur in the northern part of Shantung, the Tzu-ch'uan Po-shan and Chang Ch'iu coal fields were affected by them. The direction of the faults is nearly northsouth and the offsets produced by the harizontal movement are between 10 li and 30 li. The principal horizontal displacements are two in number, one cutting the Chang ch'iu coal field, another separating the Chang Ch'iu coal field and the Tzŭ-ch'uan Po-shan coal field. Only the latter is related to the younger formations. Contemporaneously with the horizontal movement, the vertical dislocation, most likely took place for the formations on the right side of the fault occupy a much higher position than that of the formations on the left side. The left set of the formations includes the Hsia-k'un-lun series, Shang-k'un-lun series and Sant'ai series which are in fault contact with the Palæozoic formations on the right side.

Aside from the above mentioned faults there seems to be a big normal fault on the northern margin of the lowlands of Eastern Shantung. But it can not be traced by direct observation and its existence can only be deduced from some outcrops of the strata. In the northern part of Chiao Hsien and Kao Mi frequently occur the outcrops of the Wang-shih series, the strata of which are nearly horizontal and somewhere dip to north with the dipping angles of not more than 10 degrees. But in the southern part of Ch'ang Yi

and western part of P'ing Tu the outcrops of the T'ai Shan Complex were often met with. Between these outcrops of different formations there seems to exist a big normal fault running in west-east direction. The T'ai Shan Complex forms the upthrow side and the Wangshin series composes the downthrow side.

The faults which are small and unimportant to the structure of the areas here in question are not described.

In regard to the age of the big faults Bailey Willis[1] inferred that the faulting occurred during the early Tertiary and thought that the Wenho conglomerate, the uppermost part of the Kuan-chuang series, was formed later than the faulting and the material contained in the conglomerate was derived from the upthrow sides of the big faults.

Bailey Willis observed the wenho conglomerate in the environs of the Hsin T'ai city, stating that, in his book, the conglomerate lies upon Sinian limestones on the east of T'sai-kia-chuang, upon the basal red sandstone of the Sint'ai series 5 miles south of Sint'ai-hsien and upon the red gravelly clays in the upper part of that formation on the east of Sin-T'ai, the fact that it rests promiscuously upon several different formations is in itself a strong indication that it is unconformable on the older strata; that further evidence on this point is furnished by the structure of the rocks bordering the fault line east of Sin-t'ai, the red gravelly shales here dip 22° toward the fault, but the conglomerate scarcely half a mile away lies nearly horizontal and that the conglomerate'beds south of Sin-t'ai contain fragments of soft red sandstone, if the fragments were derived from the basal member of the Sin-t'ai series, it is to be referred that the red strata were undergoing erosion at that time, and that the conglomerates are therefore unconformable upon the Sin-t'ai series. These facts were cited by him to prove the existence of an unconformity below the conglomerate, which led him mistakenly to infer the date of the faulting. He realized that the Sin-t'ai series was formed prior to the faulting and affected by the faults. Whereas, owing to the presence of the unconformity misconceived, he assigned the Wenho conglomerate not affected by the faults and therefore later than the faulting. But so far as we have observed, there is no unconformity below the Wenho conglomerate which is one part of the Kuan-chuang series. At many localities in the Lai Wu and Fei Hsien valleys as

(1) B. Willis, Research in China, Vol. I, past I, pp. 57-58.

well as in the Mêng Yin valley, we saw the fact that the conglomerate does not lie upon sinian limestones (i, e, Cambrian and Ordovician limestones) but is really in fault contact with them. The basal red sandstone of the Sin-t'ai series is the Hsiakunlun series of this paper. In the Mêng Yin valley it extends to occur northwestward from Wennan, and on the south of Ts'ai-chiâ-chuang the Kuanchuang series dips generally to southeast. The Mêngyin series which ought to occupy the place between them was not met with in the western part of the valley. Therefore in the western part of the Mêng Yin valley the Kuanchuang series is frequently in fault contact with the Hsia-kunlun series, though the real contact is scarcely found owing to the covering of the alluvial deposits. It is probable that the contact which B. Willis met with is exactly the fault contact between them. On the east of Sin-t'ai (i,e, Hsin-t'ai) we always observed that the Wenho conglomerate follows the Sint'ai series without any discontinuity. Not only in the Mêng Yin valley but also in the Fei Hsien and Lai Wu valleys the upper part of the Sin t'ai series and the Wenho conglomerate generally dip toward the same direction, either toward the fault or away from the fault. A local disturbance may take place at the locality where B. Willis found the different inclinations of the strata of the Sin-tai series and the Wenho conglomerate. So far as having been indicated before, between the Kuanchuang series and the Mêngyin series as well as between the Mêngyin series and the Hsiak'unlun series there exists a disconformity, so that the Wenho conglomerate (one part of the Kuanchuang series) can contain the materials derived from all the formations prior to the Kuanchuang series. It is not confirmable that the presence of the basal red sandstone of the Sin-t'ái series in the Wenho conglomerate was cited to prove the existence of an unconformity below that conglomerate.

As being proved above the Wenho conglomerate is really the uppermost part of the Kuanchuang series which certainly belongs to the Eocene, and continuously follows the latter. The Kuanchuang series has been brought in fault contact with the T'ai Shan Complex, breccias existing along some parts of the fault line. The following section showing this point was met with at a locality about 1 li northeast from the Hsin T'ai city. Hence it is undoubted that the Kuanchuang series including its upper part, the Wenho

conglomerate, is older than the faulting which might be dated in the Oligocene or the Miocene. On the other hand, since in northern China the Pliocene red

Kuanchuang series being in fault contact with T'ai shan Complex, breccia existing between them.

clay has not been affected by faulting and folding, the movement can not be later than Miocene.

We are probably not wrong when we say that the folding is contemporaneous wish the faulting

A PRELIMINARY NOTE ON SOME YOUNGER MESOZOIC PLANTS FROM SHANTUNG.*

BY. TSANHENG C. CHOW.

This collection of plant fossils was obtained in the summer of 1923 by Mr. H. C. T'an from Lai Yang Hsien in Shantung. The plants were found in a thin-bedded yellowish and grayish shale often in association with fossil fish, and insects. The fossil-bearing formation according to Mr. T'an's record, is about 700 meters in thickness, and it consists of sandstones and shales in alternation. In the latter rocks both animal and plant fossils are found. The formation is overlain by tuff conglomerate, in which Dinosaurs have been found, and it lies unconformably on the Archæn rocks.

The fossils are preserved in the form of impressions sometimes with a thin film of carbonaceous matter still remaining, which is very difficult to take off from the rock, and to treat by maceration. Therefore the microscopic examination of specimens is impossible.

Owing to the lack of literatures the fossils are provisionally determined by mere comparison with a few available European and American descriptions and illustrations of mesozoic floras.

The plant fossils are mostly branches of Conifers, with a few specimens of *Baiera* and *Zamites* in association. It seems most probable, that this flora belongs to Lower Cretaceous time.

Genus BRACHYPHYLLUM Brongniart

This provisional genus may be defined as one of arborescent conifers the twigs of which are thick, irregularly distichous in the mode of branching. The leaves are squamate, short, thick, adpressed and crowded, Phyllotaxis is spiral. The leaves must have been somewhat fleshy in life time, so that their mutual pressure caused them to assume a rhombic, pentagonal or hexagonal outline.

In this collection we find several specimens which are well recognizable as belonging to this genus. The leaves and leaf-scars of some specimens

* Fuller descriptions and illustrations of these species will appear in the *Palæontologia Sinica*.

are well preserved, they are usually rhombic or hexagonal. No cones have been found in attachment to or in association with the branches.

The geological range of the genus so far as we know, like its geographical one, is very extensive. The genus has been found in the Upper Triassic, becoming prominent during the Jurassic and Lower Cretaceous, and dying out during the first half of the Lower Cretaceous. Our specimens are provisorily classified into three species of the genus.

Brachyphyllum obesum HEER.

Pl. 1, Figs. 2—6.

This species has originally been described by Heer from the Lower Cretaceous strata of Almargen in Portugal. It is also represented in the Potomac formation in North America, referred by Fontaine to *Brachyphyllum crassicaule*, and there are many specimens recorded both from Jurassic and Cretaceous rocks which differ in no important features from Heer's type.

The specimens represented in this collection are small twigs ranging from 3 mm. to 7 mm. in thickness. The leaves or leaf-scars are squamate and closely adpressed to the axis. They vary as usual from rhombic to hexagonal in outline. Phyllotaxy spiral.

The species as noted above, had originally been described by Heer from the Lower Cretaceous strata of Almargen in Portugal, and was later described by Saporta from a specimen from the Aptian of Portugal. Therefore the species is a rather characteristic one of Cretaceous time.

Brachyphyllum magnum Chow (sp. nov.)

Pl. 1, Fig. 1.

The twigs of the species branch sparingly, dichotomously, and in one plane; leaves and leaf-scars have rhombic outline and with their longer dimensions in the direction perpendicular to the axis of the twigs. Leaves and leaf-scars of the lateral twigs are very large, covering almost the whole breadth of the twig in the from of impressions. The lateral twigs are pinnately arranged and attached at obtuse angles to the main branch. These two fragmentary specimens represent the distal portions of a branch, and are counterparts of each other. The thickness of the main branch is 7 mm, the lateral twigs are 5 mm. thick and from 10 mm. to 30 mm. long. The apeail

end of some younger lateral twigs tends to bifurcate, so it usually becomes thickner than the basal part of the twig. There are no fertile cones found either attached to, or associated with, the sterile branches. According to the mode of branching and its spiral phyllotaxis, this specimen certainly belongs to this genus. Because of the detailed difference compared with the other species of the genus, the specimen is described as a new species under the name *Brachyphyllum magnum*.

Brachyphyllum multiramosum Chow (sp. nov.)

Pl. 2, Figs. 1—2.

The specimen represents only a fragment of the distal part of a small branch, the twigs of which are spirally and closely attached to the main branch. They vary from 5 mm. to 2 cm. long, and sit at acute angles on the main branch. The entire length of the fragment is only 4 cm. The small leaves and leaf-scars are closely adpressed and impricate, and seem spirally attached to the axis. The specimen must have been a young twig of a conifer. No cones have been found in association with this sterile branch. On account of the numerous small rami of the plant, the specific name *Brachyphyllum multiramosum* is given to the specimen.

Genus SPHENOLEPIS Schenk

The generic name *Sphenolepidium* was instituted by Heer in place of *Sphenolepis* by Schenk for Wealden coniferous branches, because the latter name had previously been used for a genus of fishes. The name *Sphenolepis* has been restored by Berry, because its use by zoologists does not constitute a serious objection to its retention.

Sphenolepis may be defined as a conifer having alternate branches and twigs. The leaves are decurrent, more or less imbricated, acute, more or less adpressed.

The genus appears in beds of Rhætic age both in Europe and South America. It has also been recorded from the Upper Jurassic of Portugal. Species of this genus are widespread and characteristic of the Welden and other Lower Cretaceous formation and they are represented in our collection by remains of both sterile and fertile branches. In some specimens of the collection the seed-like grains have been found attached to the small twigs. The specific names of the specimens I venture to propose, are given in the following descriptions.

Sphenolepis elegans Chow (sp. nov.)

Pl. 1, Fig. 8.

The branches of the specimens are slender, with the twigs given off alternately at a fairly wide angle. The small and more or less acute leaves are imbricated and closely adpressed to the axis, but they are free at the apices of the lamina. Phyllotaxy spiral. The species is characterized by having one or two small leaves in the axis of which the lateral twigs are given off These four beautiful specimens are only fragments of two branches, only the distal parts of which are preserved. They are preserved in a thin-bedded yellowish shale in the form of impressions. The carbonaceous matter of the plant is sometimes still retained on the leaves and branches of the specimen. The specific name *Sphenolepis elegans* is instituted for this specimen because of its beautiful foliage.

Sphenolopis arborescens Chow (sp. nov.)

Pl. 2, Fig. 3.

The specimens represented in the collection are only fragments of branches, the largest one of which attains a length of about 10 cm. and has a diameter about 4 mm. The leaves are small, imbricated and closely adpressed to the axis. The lateral twigs are alternately arranged and attached at wide angles to the branch. Some twigs seem to bear clusters of fertile leaves, and even the seed-like remains are also found attached to small twigs. In one specimens both reproductive and vegetative shoots are found on the same twig and the latter are usually at the distal end. I have examined and compared the specimens with the figures of some European and American *Sphenolepis*, but I have failed to find any likeness among them. So I venture to propose this specific name for its arborescent nature.

Genus PAGIOPHYLLUM Heer

Pagiophyllum sp.

Pl. 1, Fig. 7.

The generic name *Pagiophyllum* was instituted by Heer in place of *Pachyphyllum* Pomel, on the ground that the latter name had been used for a member of the Orchidaceæ. The stem of the specimens represented in this collection is rather thick, with more or less slender branches given off at an obtuse angle. The branches seem to be tapering gradually from the base to the apex, assuming a somewhat conical form. The leaves are densely

imbricated and adpressed to the axis. The specimens appear to be identical with types described by Heer from the Cretaceous rocks of Portugal

GENUS PALÆOCYPARIS SAPORTA

Palæocyparis cf. *flexuosa* Sap.

Pl. 2, Fig. 4.

The specimen consists of two counter-parts of a small fragmentary shoot preserved in sterile form in a grayish thin-bedded shale. Small twigs are in the same plane, leaves are more or less triangular, imbricated and adpressed, rarely free at the apex of the lamina.

On comparing the specimens with Portuguese types described under the name *Palæocyparis flexuoas* by Saporta from Cretaceous strata, they are found to be essentially identical with each other, except for the fact that the larger branches of the present specimens do not seem to have borne any leaves. The species *Palæocyparis flexuosa*, as above noted has been described by Saporta from the Lower Cretaceous beds of Portugal.

GENUS ARAUCARITES PRESL

Araucarites sp.

There are several cone-like vegetative specimens in this collection, which seem to be rather comparable with *Araucarites sternbergi* figured by Prof. Seward in his book "Fossil Plants" (p. 268, vol. 4). One specimen is well preserved, and the leaves of the shoot are reflected at the apices and spirally disposed on the axis. It is about 4 cm. long and 7 mm. thick.

The species *A. sternbergi* was founded on sterile branches from the rich Eocene flora of Haring in Tyrol, being practically identical in habit with foliage-shoots of *Araucaria excelsa* and other recent species. Owing to the great difference of the geological age of these two horizons I hesitate to describe our specimen under the same specific name.

GENUS BAIERIA BRAUN

Baiera cf. *australis* M'Coy.

Pl. 2, Fig. 7.

Thi. is the only member of the Ginkgoales represented in the collection, and is of a rather typical form of leaf, as seen in the genus *Baiera*. The lamina of the leaf passes gradually into the petiole, is broadly cuneate, with the edges forming an angle of about 90° Lamina deeply divided into

two halves which are again dissected into 6 segments. Segments are linear with obtuse or rounded apices. Venation of the segments is not well preserved, petiote 2 cm. long. By comparing this specimen with those described by Dr. Halle from the Jurassic rocks of Patagonia in South America, the specific identity appears highly probable.

The fossils of Ginkgoales are very rare in this formation, since only one specimen has been obtained in the whole collection. Typical form of *Baiera australis* has hitherto been recorded only from Victoria, though some Patagonian specimens were compared by Halle with this species.

Genus ZAMITES Brongn.

Zamites sp.

Pl. 1, Fig. 9; Pl. 2, Fig. 5.

The specimens represented in this collection are two isolated segments, the larger imperfect one of which measures 9 cm. long and 7 mm. broad. The apex of this segment is obtuse or rounded, while the basal portion is not preserved. The smaller and complete segment measures only 4.5 cm. long and 5 mm. broad, and both its apex and base are preserved. The apex of this smaller segment is acute and the base is rounded and more or less contracted at the point at which it is attached to the twig. The veins are very fine, and parallel to one another and also to their margins. With regards to the form and venation of the segments, the specimens are certainly identical with the Genus *Zamites*. But because of the imperfectness of the specimen the specific determination is not possible.

Genus THINNFELDIA Ett.

Thinnfeldia sp.

Pl. 2, Fig. 6.

In the collection we find a single leaf formed of four segments, which are joined to a common petiole. The angle between the edges of the two outer segments is very large and forms a semicircle. Every segment divides into two equal halves, each bearing several acute pinnules on both sides of the rachis. The lamina of the pinnules on each side of the rachis are joined together at the base. The veins are given off from the rachis to the lamina of the pinnules, and they bifurcate either at the base or near the margin of the pinnule. The general form and venation of the leaf is rather comparable with some forms of *Thinnfeldia*. It is most probably a young leaf of that plant.

EXPLANATION OF PLATES.

Pl. 1.

Fig. 1. Brachyphyllum magnum nov. sp.

Figs. 2-6. Brachyphyllum obesum Heer.

Fig. 7. Pagiophyllum sp.

Fig. 8. Sphenolepis elegans nov. sp.

Fig. 9. Zamites sp.

Pl. 2.

Figs. 1-2. Brachyphyllum multiramosum nov. sp

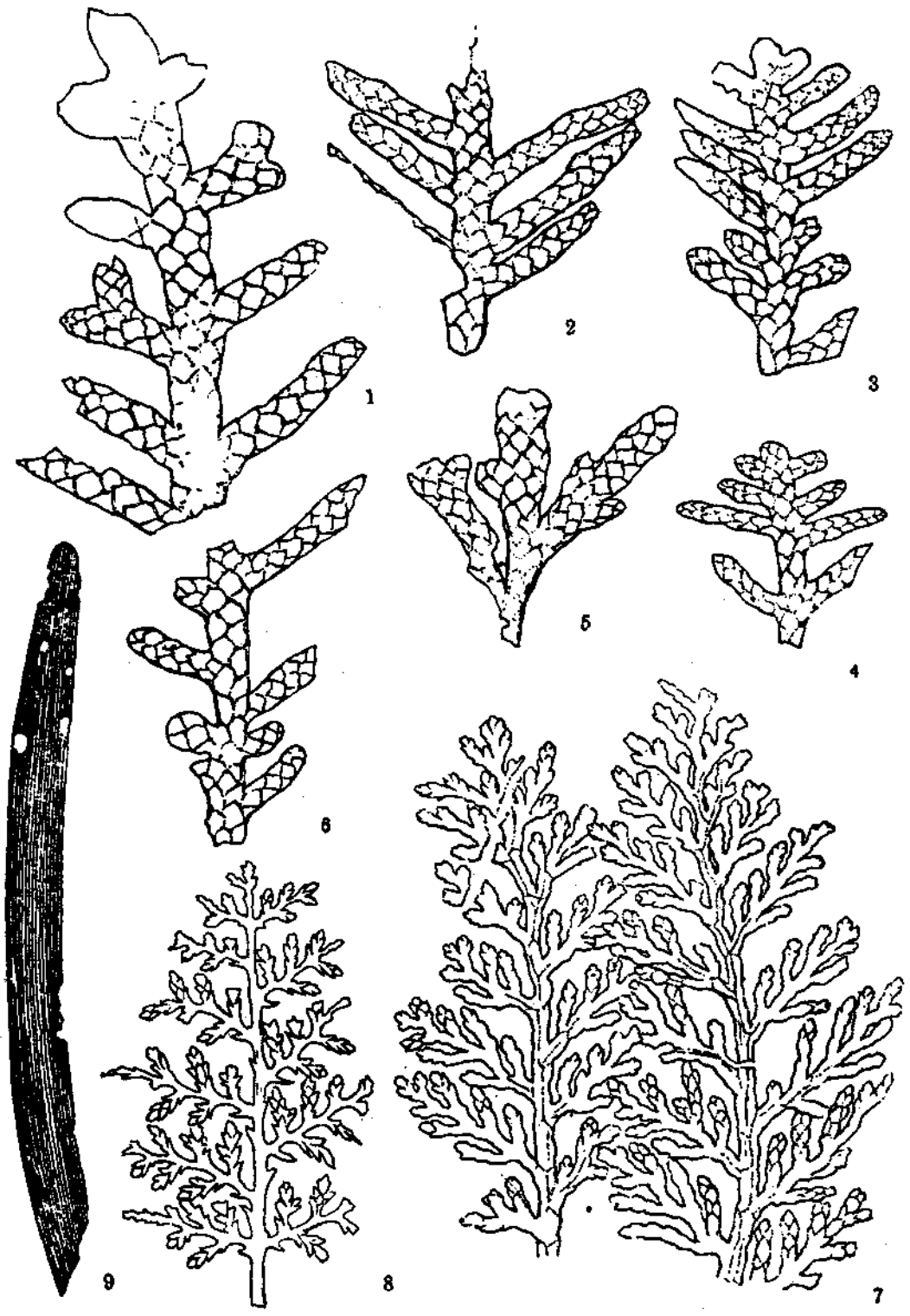
Fig. 3. Sphenolepis arborescens nov. sp.

Fig. 4. Palæocyparis cf. flexuosa nov. sp.

Fig. 5. Zamites sp.

Fig. 6. Thinnfeldia sp.

Fig. 7 Baiera cf. australis M'Coy.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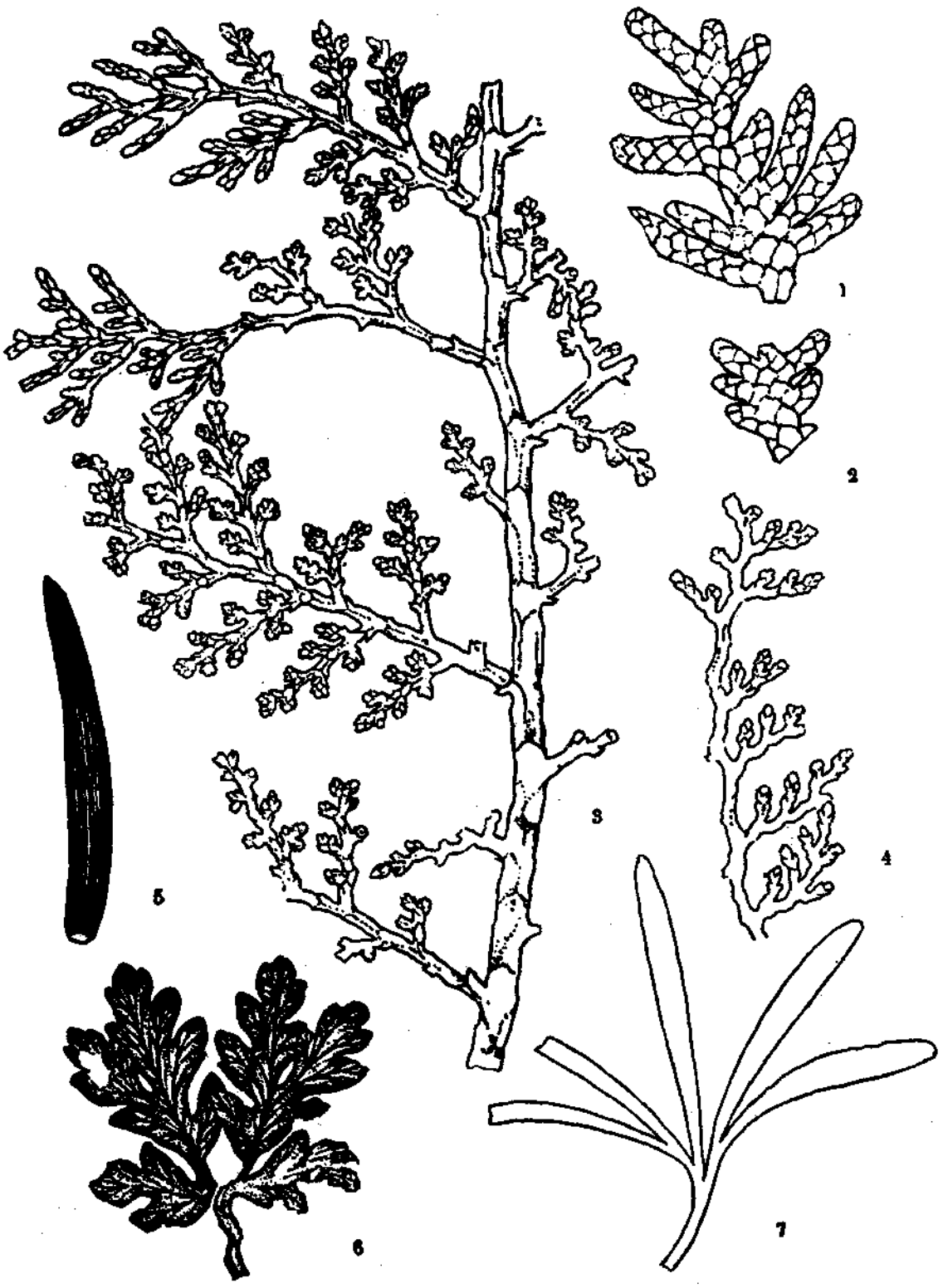
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CRETACEOUS FOSSILS FROM SHANTUNG.

BY A. W. GRABAU

(With two plates and seven text-figures)

The material collected by Mr. H. C. T'an of the Survey in the Cretaceous beds of Shantung, as described by him in a preceding paper, includes a number of distinct faunas. So far each locality and each horizon has furnished species peculiar to itself and not found at any other locality. Nor, excepting some Mêngyin species, are there any localities known elsewhere where the same species are found again. It is true the paper-shales of the Trans-Baikal region in Siberia, are similar to those of Laiyang. With, however, the possible exception of *Estheria middendorfi,* which in our beds is represented by a form half the size of the Siberian form, there are no species in common, though it can not be denied that *Lycoptera sinensis,* the characteristic fish of our beds, is a close relation of *L. middendorfi* of the Siberian paper-shales. Both shales were no doubt deposited under similar conditions, which were evidently those of playa lakes occasionally flooded by intermittent streams, and both are most probably of the same age.

The Siberian beds have been variously assigned to horizons ranging from the Jurassic to the Miocene. Reis*, summarizing the discussion of the age indicated by the faunas and floras of these beds, says:

"So erscheinen nach allem doch die Kennzeichen, welche für ein jung-jurassisches-altcretacisches Alter der Turgaschiefer sprechen, das Uebergewicht für sich zu beanspruchen"

The flora of the Laiyang beds, described in a preceding paper by Mr. Chow, seems to me to have a decided Lower Cretaceous aspect, nothing like it being known from the Upper Jurassic or older formations of Asia. Moreover many forms agree with, or closely represent, species found in the Lower Cretaceous of western Europe, or in the Potomac formation of eastern North America. The insect fauna too, is wholly distinct from the Jurassic insect fauna found in the Ust Balai Basin of Siberia and referred to the Jurassic on the basis of the associated plants.

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* Otto M. Reis, Die Binnenfauna der Fischschiefer in Transbaikalien. Explor. Géol. et Minières le long du Chemin-de-fer de Sibérie. Liv. XXIX pp 1-68.

The occurrence of *Proteroscarabæus* in our shales, a true representative of the SCARABÆIDÆ further suggests the post-Jurassic age of these beds, since no undoubted member of this family has been found in strata older than the Eocene (see discussion under the genus). The highly specialized character of the species too, indicates a relatively young age, for even if some of the Upper Jurassic species should turn out to be truly referable to this family, they are all less specialized than the form obtained from our beds.

The age of the lower Mêngyin beds is confidently referred to the Lower Cretaceous (Wealden), for the leading species of *Unio* are of Wealden types and correspond to species obtained from equivalent strata in Szechuan and described by Frech.

The lower Chingshan formation may also be of Lower Cretaceous age, though the common and only pelecypod of the fauna has a decided Laramie aspect.

The Wangshih series is unhesitatingly referred to the Upper Cretaceous, because of the abundance of *Pisidium*-and *Sphærium*-like pelecypods, and the general resemblance of the fauna to that of to the North American Laramie formation.

The stratigraphy of the several formations may be briefly summarized here, the reader being referred for details to Mr. T'an's paper in an earlier part of this bulletin, from which these summaries are derived.

A. Generalized Section in Lai-Yang-Hsien Eastern Shantung. (After H. C. T'an)

In descending order:

II. CRETACEOUS FORMATIONS

3. *Wangshih Formation* (Upper Cretaceous). Chiefly red clay with some conglomerates and with reptilian bones at two horizons near the middle. Red clay and gray coarse sands and conglomerates in the lower part.

Thickness about .....2,000 meters

Disconformity.

2. *Chingshan Formation* (Lower? Cretaceous). Brown tuff-conglomerates, with some layers of red clay near the top, and with red-brownish clay and conglomerate containing reptilian bones; green clayey shale with pelecypods; violet-brown clay shale and yellow and reddish sandstone in the basal portion.

   Thickness about..... 1,200 meters

   From the green shale, between the basal brown shales and the reptile-bearing beds, the following species have been obtained (Loc. 219).

PELECYPODA: *Leptesthes chingshanense* Grabau

PLANTÆ: Indeterminable plant remains.

Disconformity (?)

1. *Laiyang Formation* (Lower Cretaceous). Shales and sandstones of various colors, mostly yellow and green, sometimes calcareous, alternating with beds of yellow sandstone. Red beds scarce or absent. Near the middle a series of grayish paper-shales weathering yellow, at two levels separated by sandstone, and containing a rich flora, and a fauna of *Estheria*, insects, and fish. (Loc. 218). Basal part conglomeratic and with some indeterminable plants.

   Thickness about.....700 meters

The following species have been described from these beds. The plant descriptions by Mr. Chow are given in the preceding paper.

PLANTÆ: *Brachyphyllum obesum Heer; B. magnum* Chow; *B. multiramosum* Chow; *Sphenolepis elegans* Chow; *S. arborescens* Chow; *Pagiophyllum* sp.; *Palæocyparis* cf. *flexuosa* Sap.; *Auracarites* sp.; *Baiera* cf. *australis* M'Coy; *Zamites* sp.; *Thinnfeldia* sp. PHYLLOPODA: *Estheria* cf. *middendorfi* R. Jones. IN-

SECTA: *Sinoblatta laiyangensis* Grabau; *Laiyangia paradoxiforme* Grabau; *Proteroscarabæus yeni* Grabau; *Samarura? gregaria* Grabau. PISCES: *Lycoptera sinensis* Woodw.; *Lycoptera ferox* Grabau.

Great Unconformity.

I. ARCHÆAN GNEISS.

B. Generalized Section at Chiao-Hsien, Eastern Shantung.

II. CRETACEOUS FORMATIONS.

3. *Wangshih Formation* (Upper Cretaceous). Chiefly red clay with conglomerate and sand at the top, and at various horizons. A conglomeratic bed with reptile bones above the middle, and green clay and some conglomerate about 700 meters above the base, the clay containing pelecypods and gastropods (Loc. 220).

Thickness about.....2,000 meters.

From the green clay about 700 meters above the base, the following species have been obtained:

PELECYPODA: *Cyrena (Sphærium?) tani* Grabau; *Cyrena (Pisidium) shantungense* Grabau; *Cyrena (Pisidium?) wangshihense* Grabau; *Cyrena (Pisidium) retrorostrum* Grabau; *Cyrena (Pisidium) altiformis* Grabau. GASTROPODA; *Limnæus?* sp. *Cyclophorus?* sp.

Disconformity.

2. *Chingshan Formation* (Lower Cretaceous?). Brown tuff-conglomerate and tuff with lava, no fossils.

Thickness about..... .....1,200 meters

Disconformity?

1. *Laiyang Formation* (Lower Cretaceous). Chiefly sandstones of yellowish and greenish color, alternating with

shales. Near the middle a bed of shale with plant-remains; no fish or insects have been found here.

Thickness about.....900 meters

Great Unconformity.

I. ALGONKIAN GNEISS.

C. *Mêng-Yin Valley Section*

This section is incomplete, being bounded by faults. For details see Mr. T'an's paper.

From the shales of this formation at Ning-Chia-Kou a number of fossils have been obtained and sent to the survey by Pater Alfred Kashel. These include: PELECYPODS: *Unio (Lampsila?) johan-böhmi* Frech; *Unio* cf. *menkii* Dunker; *Myce-topus mengyinensis* Grabau. GASTROPODS: *Bithinia mengyinensis* Grabau; *Valvata suturalis* Grabau.

The first two species of pelecypods have been described by Frech from beds referred by him to the Wealden in Szechuan province (Richthofen, Vol. V). The Mêngyin beds yielding these fossils are referred to the same horizon.

DESCRIPTION OF SPECIES.

PELECYPODA

Genus ***LEPTESTHES*** Meek

Leptesthes chingshanense Grabau (sp. nov.)

(Text - Fig. 1.)

This shell belongs to the Corbiculoid group of the *Cyrenidæ*, and although its internal structure is only partially preserved, it appears to belong to the above genus which is characteristic of the Laramie group of the western United States.

Shell thin except at the hinge-line, where it is much thickened; transverse; the length and height about as 1.5:1 (ranging from 1.4: 1 to

1.6:1) with the beak about 2/5 the distance from the front of the shell in the adult; somewhat nearer 2/3 the distance from the front in the young. Greatest convexity of valves in umbonal region, nearly flat in lower half and gently convex in both anterior and posterior parts. Anterior end broadly rounded; posterior end obliquely truncated with the posterior angle rounded. A faint angulation may sometimes be seen extending from the umbonal region to the posterior ventral margin delimiting the truncated region, but this is never very sharp. The posterior region is flattened for some distance above the truncated end. The anterior dorsal slope is slightly concave.

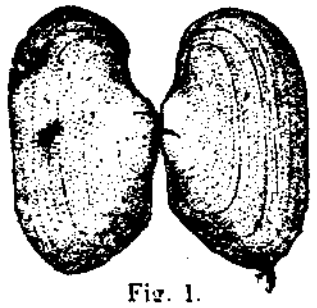

Fig. 1.
Leptesthes chingshanensis Grabau. Type with both valves in contact, nat. size.

Surface of shell marked by many faint growth-lines, and by occasional stronger ones, indicating periodic modification in growth. Because of the tenuity of the shell neither muscular impressions nor pallial line are sufficiently marked to make a pronounced impression on the internal mold except in rare cases. The former appear to be subequal in size, the anterior adductor being elongate and lying a short distance in front of the beak. Pallial line without sinus.

The lateral teeth are rather strong, those posterior to the beak forming a pronounced impression on the internal mold. There is one strong lateral tooth in the right, and two fainter ones in the left valve behind the beak, these extending within a short distance of the posterior dorsal margin. The teeth show a faint cross striation or transverse notching as in species of *Corbicula* generally but this is never strongly marked. The anterior teeth are heavy, but not well preserved.

Escutcheon well-marked, having a maximum width of 2.5 mm. where the length is about 18 mm.

The following measurements show but slight variations in the adult.

	1	2	3	4 (young)
Total Length	29. mm.	25.5 mm.	34. mm.	11. mm.
Length of anterior portion	12. mm.	10. mm.	13. mm.	4. mm.

	1	2	3	4 (young)
Height	18. mm	18. mm	22. mm	7. mm.

This shell is smaller than the genotype *Leptesthes fracta* Meek§ of the Laramie of Wyoming, though the proportion of length and height are nearly the same. The type specimen of the American species figured by Meek shows a posterior truncation which is however less oblique than that of our species. Moreover, according to White (U. S. Geol. Surv. 3d Ann. Rep. p. 439), this is not normal for the species but a slight deformity of the type. It is not shown in the other specimens figured by White, though it is possible that these are not con-specific with the type. The convexity of our shell is also much less than that of the American species.

Horizon and Locality: This species is common in the gray shales which form the basal part of the Chingshan Formation which disconformably overlies the Laiyang Formation in the Laiyang Valley. It is the only identifiable invertebrate and is associated with some plant remains of indeterminate character. Reptilian remains have been found in somewhat higher strata. The shells usually occur either with the valves closed or widely spread, rarely with the valves separated. This shows that the species lived where found, being often still in the vertical position in which it was probably embedded in the mud.

Genus ***Unio*** Retzius.

Subgenus *Lampsilis* Rafinesque

Unio (Lampsilis) johan-böhmi Frech

(Figs. 2a-b)

1911. *Unio Joh-Böhmi* Frech—in Richthofen China, Vol. v. p 223, pl. 31, figs. 3a-c,4.

This species, originally described from the Lower Cretaceous (Wealden) beds 10 li N. of Yün-Yang-Hsien, near Kwei-Chou-Fu, province of Szechuan, appears to be abundantly represented in the middle part of the Mêngying series at Ning-Chia-Kou, Shantung. A number of internal molds,

§ U. S. Geol. Surv. Territories Vol. IX, p. 161.

none of them preserving the shell intact, have been obtained here by Pater Alfred Kaschel and sent to the Survey.

These shells are much elongated, with the umbo about one fifth the length from the anterior end. The umbones are not very prominent and the beaks appear to be but moderately incurved. Dorsal margin gently arcuate or nearly straight for the greater part of the length behind the beak, curving abruptly, or passing rather sharply into the posterior subtruncate margin which meets the ventral margin in a regularly, and sometimes rather sharply rounded posterior end.

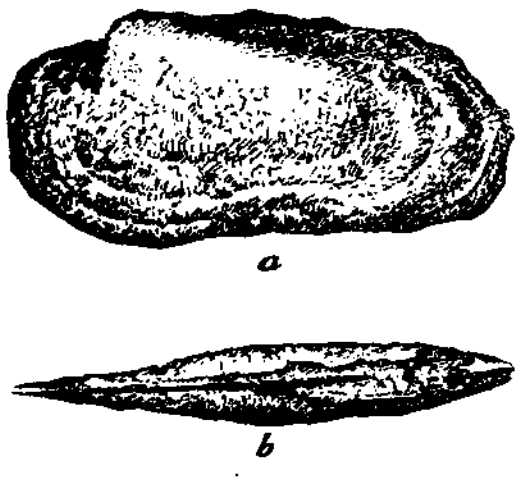

Fig. 2.
Unio (*Lampsilis*) *johan-böhmi* Frech; left (a) and dorsal (b) aspects of internal mold of a strongly compressed individual; nat. size.

Ventral margin nearly straight or even slightly concave in the greater part of its extent, curving upward posteriorly somewhat abruptly, and more sharply so anteriorly to form a rounded anterior end. In front of the beak, the internal molds are rather sharply depressed on the dorsal margin and indented by the pseudo-cardinal teeth. In the types figured by Frech, these are very strong but none of our specimens show more than their impression in the mold.

The posterior hinge-margin of the mold is marked by a moderate depression indicating a corresponding thickening of the hinge of the shell, this being, however, less pronounced than the anterior hinge impression.

In one of the molds there is a suggestion of a faint oblique angulation in the posterior portion of the shell, but this is not pronounced enough to form a definite feature. In spite of the rather imperfect character of the molds, I see no reason for considering this form other than the species described by Frech from Szechuan. The ventral concavity of the two specimens figured by Frech, is more pronounced than in our mold but a third specimen figured by him scarcely shows this at all. It is, however, quite noticeable in one of our specimens.

Only approximate measurements of the molds can be given, since they are imperfect and somewhat crushed. Some of these are as follows, those of No. 3 being of the most perfectly preserved mold.

	(1)	(2)	(3) (Figs. 2a-b.)
Length of shell.....	.....75 mm.	.....65 mm.±	.....58 mm.
Height at umbo.....	.....28 mm.	.....22 mm.	.... .26 mm.
Height in posterior fourth	.....28 mm.	.....22 mm.±	.....24 mm.
Greatest thickness	.....18 mm±	...15 mm.±	..... 9 mm.

This form resembles somewhat the modern *Unio distortus* Heude which lives in the headwaters of the Jao-tcheou river, south Kien-té and in the Ts'ing-yang district, vicinity of Nanking, in central China.§ That form, however, has a more pronounced umbonal ridge, above which the shell is flattened or even faintly depressed. This feature is only faintly indicated in one of our molds, which agrees rather better with the young of the modern species than with the adult. On this account one might be tempted to regard the Cretaceous Shantung and Szechuan forms as ancestral to the species living today somewhat farther south aud east, a view not incompatible with the persistence of uniform continental conditions in China from the Cretaceous to the present (See Stratigraphy of China, Cretaceous and Tertiary palæogeographic maps). On the other hand these similarities of characters may be due to parallelism in development.

Unio cf. *menkii* Dunker

(Fig. 3)

cfr. *Unio Menkei* Dunker; Frech in Richthofen China, Vol. V. 1911, pl. 31, Figs. 5a, b.

Frech has figured a less elongated and higher form of *Unio* from the Wealden of Osnabrück and Osterwald, Germany for the purpose of comparison with his *Unio johan-böhmi*. A single internal mold from the greenish tuffs of the Mêngyin formation of Ning-Chia-Kou, Shantung, also sent to us by Pater Kaschel, appears to agree with this form. The shell was apparently smooth, of moderate convexity, the height and length being as

§ Conchyliologie Fluviatile de la Province de Nanking et de la Chine Centrale par le R. P. Heude S. J. Paris. 4th fasciele, pl. 62, figs. 122 a, 122b.

1:1.5, instead of 1:2.2 or even 1:2.7 as in the preceding species. In the specimen figured by Frech the proportions of height to length are as 1:1.65. The beaks are approximately one third the length of the shell from the front, and are not strongly pronounced or incurved. The ventral border is gently arcuate or nearly straight in the center, meeting the posterior border, which is also gently arcuate, in a rounded posterior-ventral margin. Anteriorly the ventral border curves more strongly, meeting the anterior dorsal border in a rather strong curve. There is a faint broad and rather ill-defined median depression on the mold of the right valve, but this may be a deformation. In the young (as shown by the growth-lines) the beak is nearer the center, being only slightly in front of the middle of the length of the shell.

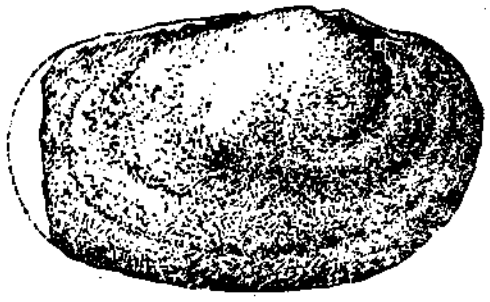

Fig. 3.

Unio cf. menkii Dunker, right side of internal mold, nat. size.

Among our modern Chinese species *Unio modestus* Heude[1] most nearly resembles this species in the rounded posterior end free from angulations, and in the general compressed character of the shell. The modern form, which is common in the upper parts of the rivers of Ning-Kouo-hsien in Anhui province, differs, however, from the fossil form in its proportionally somewhat greater length, being in this respect intermediate between the present form and *Unio johan-böhmi* which is associated with it in the same beds, the two species having been obtained from the same hand specimen. Frech reports some fragmentary specimens from Szechuan which may belong to this species.

Of the west American forms figured by White[2], *Unio priscus* Meek and Hayden from the Laramie formation, comes nearest to our form, agreeing with it in general form and proportions. The ventral border however is straighter in the American form and the beak somewhat nearer the anterior end.

The following measurements serve to compare the Shantung and the European specimens:

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1. Heude *loc. cit.* 2nd fascicle, pl. XIV, No. 20.
2. 3d Ann. Rep. U. S. G. S. 1883, pl. 14, Fig. 1.

	Shantung Specimen (Fig. 3)	European specimen figured by Frech
Length	48 mm. ±	66 mm.
Height at Umbo	32 mm.	40 mm.

Genus ***Mycetopus*** d'Orb.

These elongated edentulous fresh-water Naiadacea are represented by a number of species in the rivers of central China today, but have not been reported from older horizons so far as I am able to find out. It may be that the species here referred to this genus does not truly belong to it, but since the internal characters of our shell cannot be ascertained from the molds which alone represent this species, and since the external form agrees rather closely with that of young individuals of several of the modern species, it is placed in this genus for the present. More extensive collections may enable us to decide for or against its retention in this genus.

Mycetopus mengyinensis Grabau (sp. nov.)

(Figs. 4a, b. 5a-b.)

Shell small, greatly elongated, with nearly parallel dorsal and ventral margins. Hinge apparently edentulous. Valves equally convex, greatest convexity behind and somewhat below the umbones. Beaks about one-fifth the length from the anterior end. Just in front of them the internal mold is marked by the impression of a strong oblique subumbonal internal ridge or callosity, which extends to the rather pronounced anterior muscular impression. This feature is also recognizable, though less strongly marked, in modern Chinese species of this genus. The hinge-line of the mold extends in a straight line behind the beak for a distance equal to about three-fifths the length of the shell, and then curves into the posterior margin which is regularly rounded.

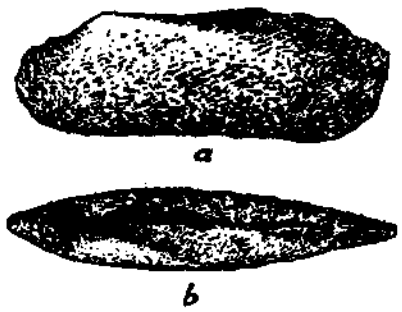

Fig. 4

Mycetopus mengyinensis Grabau, left (a) and dorsal (b) aspects of internal mold; nat. size.

There is no depression in the hinge-line, showing that the valves met internally with edentulous and unthickened hinge margins. Anterior to the beak, the mold is depressed, and characterized by the impressions of the two oblique callosities already referred to, but so far as can be ascertained from the two specimens now in our possession, there is no dentition.

The anterior end of the mold appears somewhat nasute, because of the dorsal depressions, rounding regularly into the ventral margin which is straight for the greater length of the shell, except for a very gentle median concavity. Posterior muscle scar situated close to the posterior-dorsal margin, this and the anterior one being disposed much as in modern species of the genus *Mycetopus*.

	(1)	(2)
Length	44 mm.	36 mm.
Height at umbo	15 mm.	14 mm.
Height at corresponding distance from posterior end	15 mm.	14 mm.
Thickness of mold	9 mm.	8 mm.

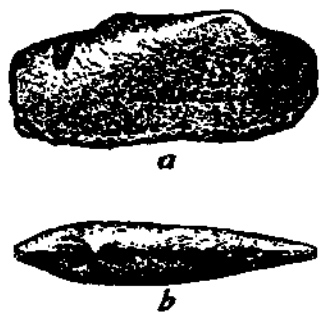

Fig. 5.
Mycetopus mengyinensis Grabau, right (a) and dorsal (b) aspects of a smaller internal mold showing impressions of subumbonal ridges; nat. size.

Among modern Chinese forms a young of *Mycetopus oleivorus* Heude[1] comes nearest to our form, though the former is many times larger. With a length of 98 mm. the umbonal height of the type specimen of that form is 19 mm., while the height of the posterior end is 10.5 mm., and the beak is about 1/4th the length of the shell from the front. This gives a proportion of height to length as 1:5. In a young stage of this shell, however, where the length is 39 mm. the umbonal height is 11.5 mm., giving a proportion of 1:3.4 which is only slightly greater than that of our fossil species. The adult *M. oleivorus* reaches a length of 190 mm.; and an umbonal height of 35 mm., and has a much more pronounced umbonal ridge and obliquely subtruncate posterior end.

1. loc. cit. pl. XXIII, fig. 48.

It would at first glance seem that the specimens in question are the young of *Unio johan-böhmi* with which they are associated, but the apparent edentulous character of the hinge speaks against this. Moreover the young of *U. johan-böhmi* are less elongate in proportion, with the dorsal and ventral margins arched and not parallel. The present form is therefore regarded as distinct. Of American fossil forms *Anodonta parallela* White[1] from the Laramie formation, approaches very closely to our form, though it is larger. With a length of 61 mm. and an umbonal as well as posterior height of 19 mm., the proportion of height to length are as 1:3.2 which is very little larger than in our forms. The posterior end of the American form is somewhat more sharply rounded and the ventral margin shows no concavity. Otherwise the two might be considered co-specific.

This species it at present known only from the Mêngyin formation at Ning Chia-Kou where two specimens were obtained by Pater Kashel.

Genus **CYRENA** Lam. (*sens. lat.*)

The shells here placed provisionally under this generic term, used in its comprehensive sense, are small and mostly preserved with the two valves in conjunction, but it has not been possible to obtain any specimens showing the character of the hinge. In the only case where the interior of the shell was exposed the hinge teeth appear to be absent or at best very feebly developed, and not sufficiently definite to enable me to determine their character. This is in part due no doubt to their being broken.

In form some of the shells suggest *Pisidium* and others appear to be so nearly equilateral as to suggest the genus *Sphærium*. The former genus has, however, been regarded as absent from strata older than Eocene, though White has described a species from the Laramie. *Sphærium* has, however, been obtained from strata of Upper Cretaceous age, several species being described by White from the Laramie. These genera have been separated from the Cyrenidæ by Dall who created for them the family Sphæriidæ, because of their small size, feeble and short ligament, simple pallial line and absence of hinge-plate. The cardinal teeth are variable, thin and often defective, but the laterals are distinct.

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1. 3d Ann. Report U. S. G. S. pl. 19, fig. 5.

Cyrena (Sphærium?) tani Grabau (sp nov)

(Figs. 6a, b.)

Shell small moderately convex equivalve, though by pressure the beak of one valve may appear above that of the other; subcircular, with the length somewhat in excess of the height, though sometimes nearly equaling it. Beak about two fifths the length of the shell from the anterior end. Shell slightly depressed in front of the beak and with a short ligamental area behind. Anterior end regularly rounded, posterior end formed of three successive gentle curvatures meeting in a more abrupt curve, and giving the shell a subtruncate appearance behind.

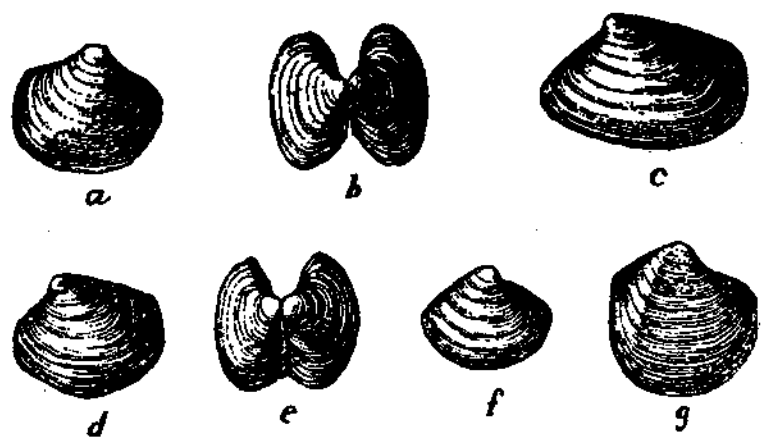

Fig. 6.

Cretaceous Cyrenas, all enlarged three times *a*, *Cyrena* (*Sphaerium*) *tani* Gr. right valve; *b*, the same, two valves in conjunction, partly opened, viewed from above; *c*, *Cyrena* (*Pisidium*) *shantungense* Gr. left valve; *d*, *Cyrena* (*Pisidium?*) *wangshihense*. Gr. left valve; *e*, the same with the valves conjoined, and partly open; *f*, *Cyrena* (*Pisidium*) *retrorostrum* Gr. right valve; *g*, *Cyrena* (*Pisidium*) *altiformis* Gr. right valve. Pisidium beds of Wangshih Formation (Upper Cretaceous) Chiao-Hsien, Shantung.

Surface smooth except for fine lines of growth and coarser lines of growth-pauses at subregular intervals.

Measurements:

The following are the measurements of three characteristic specimens.

	1	2	3
Length	7.5 mm.	5.0 mm.	6.0 mm.
Height	7.3 mm.	4.3 mm.	4.5 mm.
Distance of beak from anterior end	3.0 mm.	2.0 mm.	2.5 mm.

No. 1 is a typical form (Fig. 6a) with the valves in conjunction and slightly compressed so as to bring the beak of one valve over the other. No. 2 is a more convex form with the valves spread (Fig. 6 b), and probably represents the dimensions more correctly. No. 3. is like No. 1 but smaller.

Horizon and Locality: Fairly common in the gray shales in the lower part of the Wangshih series of Chiao-Hsien, east Shantung, (loc. 220) Coll. H. C. T'an, after whom the species is named. The horizon is Upper Cretaceous

Cyrena (Pisidium?) shantungense Grabau (sp. nov.)

(Fig. 6c.)

Shell small, elongate, wider than high, with the beak in the anterior third. Convexity moderate, not inflated. Beaks small, slightly incurved, with a slight depression in front, and a straight but sloping hinge line behind, which extends for nearly four-fifths the distance from the beak to the posterior end into which it curves abruptly. Posterior end regularly rounded and broader than the anterior. Ventral margin gently arcuate.

Greatest convexity of the shell a little above the middle. Surface marked by fine growth-lines and by regular equi-distant, and rather pronounced strong concentric lines marking periodic interruptions of growth, these sometimes giving the shell the appearance of being marked by regular concentric wrinkles.

Measurements. Two characteristic specimens give the following measurements:

	(1) (Fig. 6c)	(2)
Length	8 mm	7 mm.
Height	5 mm	5 mm.
Distance beak to ant. end	3 mm	2 mm.

This shell is readily distinguished from the preceding species by its elongate form, long sloping hinge line, and anteriorly placed beaks as well as by the strong concentric growth-interruptions. From *C. (Pisidium?) wangshihense* it is distinguished by its proportionately greater length, sloping

hinge-line, and the absence of an incipient umbonal ridge or angulation.

From the fact that many specimens occur in a somewhat crushed condition, the characters do not always appear clearly, and it may not always be readily possible to distinguish this from the next species. In normal specimens however the distinctions are readily seen.

Horizon and Locality: In the Wangshih formation of Chiao-Hsien, east Shantung (loc. 220) associated with the preceding species. Fairly common.

Cyrena (Pisidium?) wangshihense Grabau (sp. nov.)
(Fig. 6d,e)

Shell small, elongate, wider than high, with the beak in the anterior third, inflated. Beaks rather strongly incurved, with a pronounced depression in front and a long straight hinge-line behind, which slopes much less than in the preceding species. Posterior end broadly arched or subtruncate, the posterior dorsal portion of the shell separated from the lateral parts by a faint, though evident umbonal ridge, which extends obliquely across the shell from the beak to the posterior ventral border. Ventral margin gently arcuate joining the posterior margin rather abruptly, but curving regularly into the frontal margin which is more narrowly and strongly rounded than the posterior. Surface marked by fine lines of growth, and occasionally stronger growth-cessations which are, however, irregularly spaced.

Dimensions:

Length	6 mm.
Height	4.5 mm.
Beak to front	2 mm.
Thickness abt	4 mm.

This shell is readily distinguished from the preceding species by the faint umbonal ridge, sub-truncate posterior end, stronger convexity, and slightly different proportions.

Horizon and Locality: Associated with the preceding species, but less common.

Cyrena (Pisidium) retrorostrum Grabau (sp. nov.)
(Fig. 6f.)

Shell minute, transverse, with anterior end slightly longer than the posterior, a feature characteristic of typical *Pisidium*. Beaks incurved and pointing forward, with a rather pronounced depression in the cardinal margin in front of the beak. Hinge-line short; greatest convexity in umbonal region; anterior end rather sharply rounded, posterior end broader; posterior ventral border faintly subtruncate, ventral border broadly rounded.

Surface with subregularly spaced coarse growth-wrinkles and fine growth-lines.

There is some variation in the forms included under this species, this being chiefly in the relative length of the anterior and posterior ends, and in the proportion of length to height. The measurements of the type are: Length 5. mm., length anterior end 2.75 mm., height 4. mm.

Horizon and Locality. In the Wangshih formation of the Upper Cretaceous of Chiea-Hsien, east Shantung, associated with the preceding species; rare. Coll. H. C. T'an.

Cyrena (Pisidium) altiformis Grabau (sp. nov.)
(Fig. 6g.)

Shell with height and length nearly equal, and with beak in the posterior third. Beaks elevated and moderately incurved, with a very pronounced depression in front of the beak. Anterior end regularly rounded into basal margin.

Hinge-line short; posterior end subtruncate, with a rather pronounced umbonal ridge extending from the beak to the posterior ventral margin, the posterior portion of the shell bounded by it being depressed-convex or flat Surface with fine growth-lines and at subregular intervals with somewhat more pronounced lines, but no marked wrinkles.

Dimensions of type: length 6 mm.; height 5.8 mm.; length of posterior end 2 mm ; of anterior end 4 mm.

This shell is readily distinguished from the others described, by the subequal length and height, the pronouncedly posterior position of the beak,

the rather strong umbonal ridge, and the subtruncate posterior end. The growth lines are also more regular than in most of the other species.

Horizon and Locality: In the Wang-shih formation of Upper Cretaceous age. Chiao Hsien, east Shantung, associated with the preceding; rare. H. C. T'an Coll.

GASTROPODA

Genus *BITHINIA* Gray.

Bithinia mengyinense Grabau (sp. nov.)

(Figs. 7a-d)

This species is at present known only from internal molds to which thin layers of the shell adhere. The height of the largest specimen was probably not much over 12 mm , the height of the mold being 11 mm. with a maximum diameter of the last whorl of 9.5 mm. The apex is not preserved in the mold, but the apical termination of the mold indicates the existence of an apical septum. Whether the apical whorls were decollated in the shell or not can not be determined. The original number of volutions may have been between 5 and 6, but only four remain in the mold. These enlarge rapidly but uniformly, until the diameter of the tube of the final whorl is 4.5 mm. The amount of embracing is comparatively small, being considerably below the ambitus of the whorl, and thus producing deep sutures. The final whorl embraces about one third of the preceding one. The whorls are uniformly and regularly rounded. the apertural end of the mold being circular in the largest specimen, but somewhat ovoid in a smaller one. The umbilicus is narrow and apparently covered by a thickening of the inner lip. The apical angle in the large mold is 60°, in the smaller about 54°, the height of the latter is 8 mm. and the maximum diameter of the shell at the last whorl about 5.5 r m., the greatest apertural diameter of the whorl itself being 4 mm. Surface, so far as preserved, smooth, with growth-lines very fine.

This shell resembles the internal molds described by O. Reis from the fish beds of Transbaikalia under the name *Paludina pura* Eichwald. Our species, however, cannot be placed in the genus *Paludina*, the enlargement

ot the whorls being too regular, the last whorl having a less proportional diameter, and the amount of embracing being much less than in species of that genus. The apical angle of our shell is wider than that of the Siberian form, and the final whorl proportionately smaller. Of modern Chinese species *B. umbilicaris* Möllendorf comes perhaps nearest to our form in size, rate of increase of whorls, and apical angle.

Horizon and Locality: In the Mêngyin formation of Ning-Chia-Kou, Shantung, Lower Cretaceous. (Coll. P. Kashel)

Genus *VALVATA* Müller

Valvata suturalis Grabau (sp. nov.)

(Figs. 7e-g.)

Shell smooth low-spired, round-whorled, and broadly umbilicated; represented by internal molds to which only a part of the shell adheres.

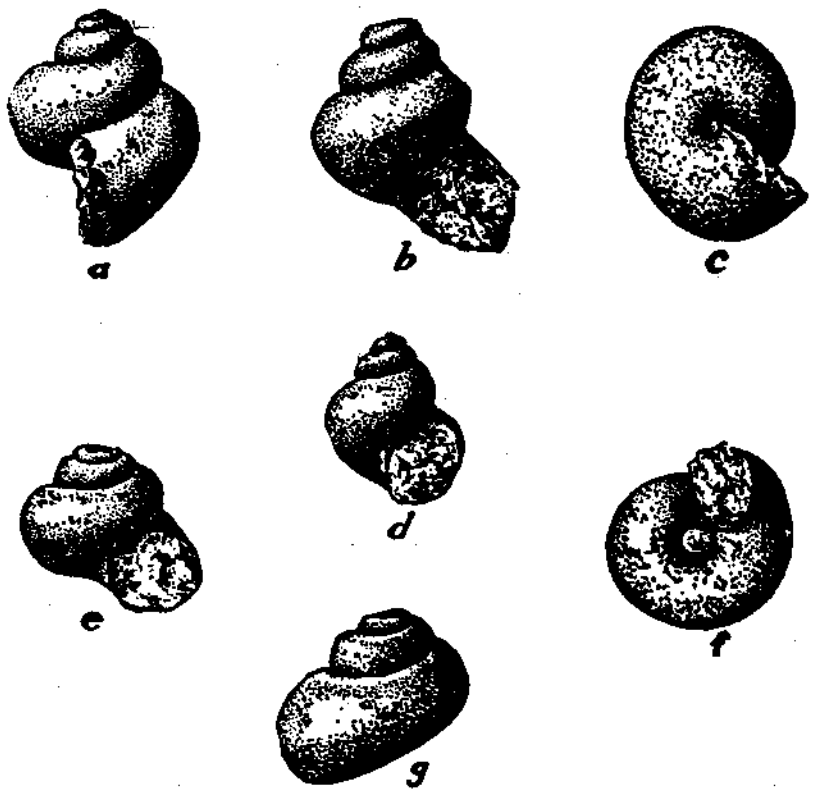

Fig. 7.

Lower Cretaceous Gastropoda from Shantung; all enlarged 2½ times. *a–c, Bithinia mengyinense* Grabau, *a* lateral, *b* apertural, *c* umbilical views of the type, an internal mold; the umbilicus in *c* is covered by the inner lip in the perfect shell; *d* the same species, another smaller individual retaining part of the shell at the inner lip which extends over the umbilical region. *e–g Valvata suturalis* Grabau; *e* apertural, *f* umbilical, *g* lateral views of the type, an internal mold. f. shows the relatively large umbilicus. Mêngyin Formation, Ning-Chia-Kou, Shantung.

Whorls few, rather rapidly and regularly increasing, with comparatively slight embracing in the later whorls, producing a well-marked suture. Apical whorls not preserved, there being an indication, in the mold, of the existence of an apical septum. Earlier whorls more strongly embraced than the later, producing a lower apical spire. The original number of whorls appears to have been four, but only three are preserved in the largest mold. Aperture broadly ovoid, more broadly rounded below than above, and with the longest diameter oblique to the axis of the shell. Umbilicus of moderate size, not covered by the inner lip which is continuous with the outer one.

This shell resembles somewhat closely *Valvata piscinalis* Möll. of the fresh-water Miocene of Transylvania, but the spire is somewhat more elevated; the apical angle is nearly the same, being somewhat greater than 90°. Our species is also somewhat larger. The height of our largest mold is 8.5 mm., greatest diameter of shell in last whorl 9 mm., diameter of aperture 4.7 mm., diameter of umbilicus about 2.5 mm.

This shell might be mistaken for a broader form of the preceding species, except for the wide umbilicus which is a characteristic feature and on which account it is referred to *Valvata*, in spite of the rather strongly elevated spire. The shell was apparently smooth with occasional stronger growth-lines, the direction of which coincided with the axis of the spire.

Horizon and Locality: Represented by a number of internal molds in the collection of Father Kashel from the Mêngyin formation at Ning-Chia-Kou, Shantung, where it is associated with the preceding. Lower Cretaceous.

Genus ***Limnæus*** Cuvier

Limnæus? sp.

Several crushed shells from the *Cyrena* shales of the Wangshih series of Chiao Hsien, East Shantung (loc. 220) appear to belong to this genus of fresh water shells. They are too imperfect for precise determination.

Genus ***Cyclophorus*** Montf.

Cyclophorus? sp.

A number of crushed, round-whorled, thin-shelled and low-spired gastropods with well-marked umbilicus, appear to belong to this or a related

genus of terrestrial mollusks. They were obtained from the *Cyrena* shales of the Wangshih formation at Chiao-Hsien, East Shantung.

CRUSTACEA.

Genus *ESTHERIA* Ruppel

Estheria cf. *middendorfi* R. Jones

1862 *Estheria Middendorfii* Rupert Jones, Fossil Estheriæ, Palæontographical Society Monographs, Vol. XIV, pp. 111-114, pl. IV, figs. 12-22, text fig. 11.

1865 *Estheria Middendorfii* Jones, Eichwald, Lathæa Rossica, Vol. II, pt. 2, pp. 1181-1183.

1865 *Estheria orientalis* Eichwald, Lathæa Rossica ibid.

1910 *Estheria Middendorfii* R. Jones, Reis, Die Binnenfauna der Fischschiefer in Transbaikalien—Explor. Géol. et Minières le long du Chemin-de-Fer de Sibérie. Liv. XXIX, pp. 40-41, pl. II, figs. 24-25, pl. IV, figs. 19, 20,23.

Original description: "Carapace-valves thin, suboblong, straight on the dorsal margin, nearly the whole of which is occupied by the hinge-line; umbo forward, not preserved in the many specimens seen; ends well rounded, and nearly equal; ventral margin gently and nearly symmetrically curved. Ridges distinct, about twenty-four, sometimes more numerous, and crowded towards the ventral edge; interspaces bearing an open, irregular reticulation, often passing into thin, transverse, somewhat irregular riblets; the irregularly hexagonal areas of the reticulation when highly magnified, are seen to be delicately punctured."

So far as our rather poorly preserved specimens permit us to judge, they agree in all essentials with the above description except size, and I have little hesitation in referring them to the same species. The length of a left valve of a large specimen is 10 mm. while the umbo is about 2 mm. from the anterior end; the height of this specimen is 5.5 mm. A right valve measuring about 8.5 mm. in length has a height of 4.5 mm., while the hinge-line is about 5.5 mm. long. A typical specimen figured by Jones as of natural size has a length of nearly 21 mm. and a height of 13 mm. One

figured by Reis has a length of 22 mm. and a height of 14 mm. It thus appears that our specimens are only about half the size of the Siberian forms, nevertheless I shall for the present refer them to this species, though further collections may produce material to show that our form is distinct.

The details of sculpture described by Jones and Reis are not recognizable in our specimens.

Horizon and Locality: In the paper-shales of the Laiyang formation, 1 li N. of Nan-Wu. Lai-Yang Hsien, Shantung (Loc. 221). Lower Cretaceous. H C T'an Coll. Geol. Surv. China. Cat. No. 429. Associated with plants and *Lycoptera ferox* Gr. and *L. sinensis* Woodw.

INSECTA

Few fossil insects have so far been described from eastern Asia and every addition to the insect fauna, however fragmentary, is of interest. This is especially true of the Mesozoic insect fauna, for during this era the Asiatic continent was not only as large as, but larger than it is today. It thus most probably included a variety of habitats, and hence the insect fauna may be expected to be a varied one. Moreover as eastern Asia is one of the few northern lands of great extent on which Cretaceous strata are largely represented by continental deposits, we may expect to find here the record of a fauna so far largely unknown, and represented elsewhere by a gap in the faunal succession of insect life.

The only insect faunas heretofore known from the Mesozoic of eastern Asia were obtained from Siberia and described in the Russian literature* One of these is from the Ust Balei Basin in the Irkutsk region, the deposits of which, from the associated plant remains, have been described as belonging to the Middle Jurassic. Among the insects described from these strata are the following**.

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* As this literature is at present only in part available, full citation and comparison can not be made; this it is hoped, can be made before the fuller descriptions and illustrations of these forms appear in the Palaeontologia Sinica.

** Brauer, Redtenbacher, and Ganglbauer, Fossile Insekten der Jura-formation Ostsibiriens. Mém de l'Acad. Imp. des Sciences de St. Petersbourg, VII ser., vol. XXXVI, No. 15, 1886.

Order ORTHOPTERA

Family LOCUSTOPSIDÆ Handl.

Parapleurites gracilis Br. Redt. & Gangl.

Family LOCUSTIDÆ

Pseudohumbertiella grandis (Br. Redt. & Gangl.)

Order BLATTOIDEA

Family PORoBLATTINIDÆ Handl.

Ophismoblatta sibirica (Br. Redt. & Gangl)

?Ophismoblatta maculata (Br. Redt. & Gangl.)

Order COLEOPTERA

Timarchopsis czekanowskii Br. Redt. & Gangl.

Carabocera prisca Br. Redt. & Gangl.

Doggeria sibirica Handl.

Memptus braueri Handl.

Memptus redtenbacheri Handl.

Coleopteron—gen. & sp.?

Order PERLARIA (only in Siberia)

Mesonemura maaki Br. Redt. & Gangl.

Mesoleuctra gracilis Br Redt & Gangl.

Platyperia platypoda Br. Redt. & Gangl.

Order ODONATA

Palæophlebia synlestoiaes Br. Redt. & Gangl.

Samarura gigantea Br. Redt & Gangl.

Samarura minor Br. Redt. & Gangl.

Samarura pulla Br. Redt. & Gangl.

Samarura angustata Br. Redt & Gangl.

Samarura rotundata Br. Redt. & Gangl.

Order PLECTOPTERA (Larvæ)

Mesobäetis sibirica Br. Redt. & Gangl.

Mesoneta antiqua Br. Redt. & Gangl.

Order PANORPATAE Brauer

Mesopanorpa hartungi (Br. Redt. & Gangl.)

Order LEPIDOPTERA

*Phragmatoecites dames*i Oppenheim

Palæocossus jurassicus Oppenheim

Order DIPTERA

Mesopsychoda dasyptera Br. Redt. & Gangl

Nematocera Br. Redt. & Gangl.

Incertæ Sedis.

Baseopsis? sibirica Br. Redt. & Gangl.

Carabid larva. Br. Redt. & Gangl.

Colcoptera larva. Br. Redt. & Gangl.

From the Turga shales of the Turga river, the deposits which have furnished *Lycoptera middendorfi,* Reis§ records the following insects.

Phryganidarum gen. sp. (rare), *Ephemeropsis orientalis* Eichwald (common). Handlirsch* also records *Phacelobranchus braueri* Handle from Turga, basing this species on part of the material originally identified by Brauer, Redtenbacher and Ganglbauer as *E. orientalis* Eichw.

Ephemeropsis trisetalis Eichw. is recorded from these beds on the Towega River, Nertschinsk, E. Siberia, and *E. orientalis* Eichw. from Konduyewskaya on the Turga in Nertschinsk. From Byrka *Ephemeropsis middendorfi* Handl. is recorded, a species which Reis would unite with *E. orientalis*. From deposits of the same age on the Witim river the following insects are recorded by Reis: *Carabid* (gen. & sp. indet.), *Rhynchophoron* (gen. & sp. indet.), *Staphylinid* (gen. & sp. indet.), *Phryganid* (gen. & sp. indet.), *Libellulid* (gen. & sp. indet.). Finally from the corresponding beds near Irkutsk, Heer records a Coleopteron under the name *Elatoides sibiricus* Heer**. The age of the deposits on the Turga and Witim rivers is probably Lower Cretaceous.

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§ O. M. Reis, Die Binnenfauna der Fisch-schiefer in Transbaikalien. Explor. Géol. Min. le long du Chemin-de-Fer de Sibérie, Liv. XXIX, 1910.

* Die Fossilen Insecten p. 604 pl. 46 fig. 33.

** Mem. Acad Sci. St. Petersb. XXII, no. 12, p. 41, pl. 27, fig. 9, 1876.

New Species from Shantung.

Order *Blattoidea*

Genus *SINOBLATTA* Grabau (gen. nov.)

Among the material collected by Mr. T'an from the Laiyang shales is a specimen of a cockroach represented by both the crushed specimen and its counterpart. The animal exposes its ventral side and the wings are only partly shown. Hence it is not possible to relegate it to any of the genera whose diagnosis is based on wing structure. The form of the body and the large size of the head are unlike any other fossil form I have seen recorded, and since it can not be referred to any of the genera described, it is placed under a new generic name.

Only two species of Blattoidea have so far been recorded from Mesozoic rocks of Siberia, these are both referred by Handlirsch to his genus *Ophismoblatta* and are both from the Jurassic beds of Ust Balei, East Siberia. One *O. sibirica* (Br. Redt. & Gangl.), is represented by a wing, the other *O? maculata* (Br. Redt. & Gangl.) by a body fragment including parts of the thorax and abdomen. This is doubtfully referred to the same genus because of the association. As the genus *Ophismoblatta* is founded on the wing and as the body fragment is too imperfect to admit comparison with our specimen it has seemed best not to refer the latter to this Siberian genus.

The characters of the genus can at present not be separated from those of the species but the large oval head with the large eyes, the somewhat heart-shaped form of the prothorax, and the relatively long femur of the legs, may be taken as perhaps of generic significance. The scapular vein of the tegmina appears to be very strong since its course is apparently well marked in the impression.

Genotype and only known species: *Sinoblatta laiyangensis* Grabau (sp. nov.).

Horizon. At present only known from the Lower Cretaceous Laiyang formation of Shantung.

Sinoblatta laiyangensis Grabau (sp. nov.)
(Plate I, fig. a.)

The only specimen in our collection is nearly complete so far as the body is concerned but the individual lies upon its back and thus only the margins of the wings, which were apparently closed, are seen.. These do not permit of the determination of the detail of the nervation and so the only characters that can be described are those of the ventral side of the body.

The head is unusually large for nymphæ of this group and in its compressed character on the shale surface shows a nearly oval form, 2 mm. long, and with the width half again as great as the length i. e. 3 mm , this being somewhat behind the middle; anterior end regularly rounded. On one side a large sub-oval impression is shown which appears to be an eye; its mate on the opposite side is not preserved. Two long slender antennæ are inserted, one on either side of the head just in front of the eye. They taper very gently from a basal width of about one-third of a millimeter, and one of them can be traced for a length of 7 mm., its original length being apparently much more than that. These antennæ are distinctly and sharply segmented, about 10 segments occurring in the space of 1 mm. A slightly projecting thickening on one side suggests the maxillary palp. The mouth parts are not distinguishable in the impressions.

The prothorax (prosternum) is large, somewhat wider than long. Anterior end regularly rounded with the head loosely articulated, posterior end subtriangular, the sides converging so as to form nearly a rectangle. Anterior pair of limbs appear inserted near the middle. Meso- and meta-thorax not differentiable. Of the second and third pair of legs the femur, tibia and tarsus are generally well preserved but the inner joints are not recognizable. The femur is swollen in the center and rather long. It appears to be smooth. The tarsus is comparatively long and thin but its joints can not be made out.

Only faint impressions of the wings are noticeable but the veination can not be definitely determined. In the right anterior wing or tegmen (left as seen from below in pl. I, fig. a.) the mediastinal and scapular veins are recognizable at their anterior portion while the branching veins of these

systems are also indicated, but the detail of arrangement can not be determined.

The abdomen is only partly preserved the posterior segments being wanting.

Total length of specimen to end of last preserved segment of abdomen about 17 mm. Total original length perhaps 20 mm. Length of head 2 mm., width of same 3 mm., length of prothorax 5 mm. Greatest width 6 mm.; other parts in proportion.

Horizon and Locality. In the Laiyang shales (fish beds) at Pa-Tzu, Lai-Yang Hsien, Shantung; 1 specimen (counterparts). Coll. H. C. T'an. (G. S. C. Mus. Cat. 425, 426.)

Order?

Genus ***LAIYANGIA*** Grabau (gen. nov.)

Among the insects obtained from the Laiyang fish beds is one that presents a number of anomalous characters, which make it difficult to ascertain its true relationships. I confess myself entirely at a loss in attempting to refer it to any known order, much less described genus, though the lamentable fact that we are at present without adequate literature references may be in part responsible for this. Nevertheless a rather thorough examination of standard works on modern insects and of Handlirsch's "Die Fossilen Insekten", and a review of the orders of insects as there outlined, gives me no clue as to the systematic position of the form here to be described. It is of course true, that the strong vertical compression of the body has considerably altered its form, and the remarkable appearance of the thorax may be in part due to this. Yet it seems doubtful if mere compression could account for the marked character of this part of the body since the parts, as preserved, are extremely symmetrical. Under these circumstances I can only describe the fossil as carefully as the material permits, and leave the interpretation and systematic reference to the future. If the wings alone were preserved one would probably not hesitate to place the insect among the Blattoidea but the other characters of the body entirely forbid such a reference.

As only a single specimen of this form is known, the generic characters must be essentially those of the species. The chief of these may be summarized as follows:

Head oval, rather large, not transverse, and apparently loosely joined to the thorax. Antennæ and mouth-parts not determinable. Prothorax moderately large about as long as wide, and apparently distinct from the mesothorax to which it is only joined in the median portion. The combined mesothorax and metathorax large, forming together a truncated cone (as compressed on the rock surface) fully twice as wide behind as in front, and strongly lobed with oblique lobations; abruptly ending behind. Legs slender with long many-jointed tarsus. Two pairs of well developed wings approximately of equal length, the anterior about three times as long as wide, the posterior apparently wider. Veination simple, the principal veins all beginning far back. Costa marginal, sub-costa simple, meeting the wing margin near the mid-length. Radial simple, meeting the margin a little in front of the mid-length of the wing. Radial sector branching off near the base of the radial, and sending a number of branches to the front margin of the wing. Media also beginning far back, much branched, the branches extending to both the frontal and back margins of the wing, cubitus few-branched (about 4 in the genotype); anal field sharply outlined by a strong arcuate anal fold, which has a remarkable resemblance to that of the wings of the *Blattoidea*. Anal veins not preserved; cross veins not shown. Posterior wings with more complicated nervation, the subcosta (?) giving off a number of short branches to the frontal margin of the wing; cross-veins apparently well developed. Abdomen remarkable in that the anterior ring is much contracted as in many Hymenoptera, the next one abruptly widening again thus giving the insect a contracted "waist". Posterior part of abdomen not preserved.

Genotype: *Layangia paradoxiformis* Grabau (sp. nov.)

Horizon: Lower Cretaceous, Laiyang formation, Shantung.

In attempting to interpret the structure of this insect we might assume that the meso - and meta-thorax are very short and that the greater part of the triangular lobed structure here referred to the thorax might in reality be a part of the abdomen, the posterior part of which is abruptly

contracted and has an unknown terminal portion. In that case we must consider the sudden expansion of the body behind the contracted ring as illusory and only apparent, this appearance being brought about in some way by the crushing. While this would do away with the anomaly of a lobed thorax, it would still leave us with a form differing markedly in appearance and in wing structure from any known type. In such a form the posterior wings, which are evidently folded over the body, would project for almost half their length beyond the end of the abdomen. Moreover, there is a faint but not to be disregarded indication of a posterior leg which proceeds from a point that would fall upon the prolongation of the line separating the fourth and fifth lobes of the supposed thorax. This is shown in the figure somewhat more strongly than its actual appearance. Until better preserved material then shows the contrary, I shall regard the lobed conical portion of the body as forming the combined meso- and meta-thorax.

Laiyangia paradoxiformis Grabau (sp. nov.)

(Plate II, fig. b.)

The specimen appears to expose the ventral surface. Head of regular oval outline 2 mm. long, width 1.3 mm., with antennæ and mouth parts crushed and much distorted; loosely joined to the prothorax, with the appearance of a short thick neck between them.

Prothorax comparatively small, somewhat heart-shaped, with the greatest width in the anterior third. Length about 2.5 mm., greatest width about 2.25 mm. Anterior pair of legs not preserved. The prothorax seems to be distinct from the rest of the thorax and partly separated from it by posterior lateral indentations so that it is connected only in the central portion with the meso-thorax. Meso- and meta-thorax forming a truncated cone in outline, defined in front by the indentations which separate it from the prothorax and sharply contracted behind to the narrow "waist" which unites it with the abdomen. At the anterior end of the meso-thorax the width is 4 mm., at the posterior end of the meta-thorax it is 7.5 mm. The sides of the thorax converge forward in a regular manner, forming straight lines except for the lobation.

This part of the thorax is divided into five lobes on each side by

oblique lateral indentations which are continued by obliques lines towards the center. The lobes are rounded on the exterior and increase slightly in size from before backwards, the posterior pair being the largest. The posterior lateral borders of the thorax converge at the same angle as the lobe-lines, the constriction producing a waist 2.5 mm. in width. A median groove, about 1/3 mm. wide and generally well-marked though shallow, extends along the entire center of the thorax including the prothorax.

So far as may be judged from the position of the wings the anterior two lobes of this part of the thorax belong to the meso-thorax and the posterior three to the meta-thorax. Thus identified the lobes of the meso-thorax are less distinct than those of the meta-thorax.

Of the second pair of legs one is partly preserved, the inner leg joints being apparently redoubled and more or less dissociated. The best preserved part seems to be the tarsus for it is made up of five distinct joints each provided with setæ distally, the last joint forming a long claw, which is however, not very distinct. The leg-joints themselves are slender and delicate.

Anterior pair of wings about 3 times as long as wide, the length being 12 mm. and the width a little less than 4 mm., with the end rather regularly rounded. Anal field large and well-defined by a strong anal furrow of sub-semicircular outline, and strikingly like that found in the tegmina of the Blattoidea; nervures only in part traceable. Subcosta simple, reaching the costal margin at about the middle of the wing-length and closely approaching the anal furrow at its proximal end. Radial simple, close to the subcostal at the proximal end, where it almost seems to merge with it, diverging from it distally and joining the costal margin some distance in front of the subcostal, leaving a somewhat wider space than that between the succeeding branches of the radial sectors. The junction of the latter with the radial is not clear but its divergence from it is pronounced and it can be traced for some distance. It gives rise to at least six subparallel branches which are convex outward, joining the costal wing margin at regularly spaced distances. The sixth of these branches appears to bifurcate not far from the center, the two divisions of this branch reaching the margin at about the same intervals as the preceding simple branches. The median can not be continuously

traced, but appears to have numerous branches (at least 12) which reach the outer margin of the wing.

The cubitus appears to be four-branched, the original two branches again bifurcating near the margin. This is however not very clear.

The nervures of the anal group are not preserved, the large field bounded by the anal furrow appearing blank in both wings except for a few faint and indefinite impressions. No cross-veins are seen in the specimen, they being either absent or so fine that they were not preserved.

One of the posterior wings is partially shown, but does not allow precise tracing of the nervures. The subcosta, however, appears to extend farther out on the wing than is the case in the tegmina, and also appears to send off short branches to the costal margin. The length of the posterior wings, so far as can be ascertained, is about the same as that of the anterior pair but they appear to be broader. However, too little of them is preserved to permit definite characterization. They appear, however, to retain numerous cross-veins. The abdomen is poorly preserved. All that can be determined, is that the anterior ring is much contracted, being in the compressed state only 2.5 mm. wide. The next ring is abruptly widened to about 6 mm. but the detailed character of this and the succeeding rings, if such existed, can not be determined. If the abdomen was long enough to extend to the end of the posterior wings when these were closed, its length was at least 8 mm. Length of specimen as preserved 17 mm. (The veination of the wing is indicated as follows: *C, costa; Sc, Subcosta; R, radial; Rs, radial sector; M, media; Cu, cubitus; A, anal fold.*)

Horizon and Locality. A single specimen was obtained from the thin gray shales which form the fish-beds of the Laiyang formation 2 li north of Po-Tzu in Lai-Yang-Hsien, Shantung Province. The horizon is regarded as Lower Cretaceous. Coll. H. C. Tan.

Order COLEOPTERA

Division LAMELLICORNIA

Family SCARABÆIDÆ

Genus ***PROTEROSCARABAEUS*** Grabau (gen. nov.)

As only a single specimen is known, the generic and specific charac-

ters can not readily be delimited; still certain striking characters may be regarded as of generic value.

Head triangular with converging sides and laterally placed eyes. Antennæ lamellicorn with seven (?) leaf-like appendages which could be spread fan-like. Head and prothorax intimately united, their sides nearly continuous. Prothorax (pronotum) widest behind the middle, in front of which the sides converge to the head with the sides of which they are continuous. Posterior portion more abruptly contracted thus sharply dividing the pro-thorax from the meso-thorax. Anterior pair of legs with broad tibia with serrate or notched outer margin, and without tarsi.

Meso-thorax and meta-thorax united; abdomen six ringed. Second and third pair of legs somewhat different, the latter with longer and stouter tarsus ending in a double spine. Distal end of tibia with two spines. Elytra subtruncate posteriorly not wholly covering the end of the abdomen; longitudinally marked by close-set rows of fine spots.

There can be no doubt that we have here a true Scarabæid. This is shown in the modification of the anterior pair of legs, where the tarsi have become obsolete while the tibia is expanded into a broad blade-like structure, with lateral spinose serrations and evidently adapted for digging purposes. These blades are much like those of the sacred scarab of the Mediterranean region (*Ateuchus sacer*) but are broader, and the notches more complicated. The scarabæoid character is also shown in the structure of the antennæ which show the characteristic leaf-like appendages of the *Lamellicornia*. Our genus differs from the sacred scarab in lacking the six-pointed coronal frontal margin, which instead is slightly nasute. The prothorax of our species is much more strongly contracted behind than is usually the case in the modern or even Tertiary beetles of this group.

No undoubted members of the family *Scarabæidæ* have heretofore been obtained from strata older than the Tertiary. Those Jurassic forms that have been placed here by various authors are considered by Handlirsch as either positively referable to other families, or as being so indefinite that they may with equal propriety be referred to any one of a number of families.

This Lower Cretaceous form therefore represents the oldest known member of the family, in fact the only pre-Tertiary form which definitely shows those characters which are readily recognizable as belonging to that family.

Genotype: Proteroscarabæus yeni Grabau

Horizon: Lower Cretaceous, Laiyang formation.

Locality: Lai-Yang Hsien, Shantung.

Proteroscarabæus yeni Grabau (sp. nov.)

(Plate II, fig. a.)

Head sunk into the prothorax and apparently closely united with it, there being only a faint line of demarkation between the two. Outline of head subtriangular, with the anterior end rounded and somewhat constricted laterally, so as to give it a slightly nasute appearance. There is a suggestion, on one side, of fine setæ or bristles, which margined this portion of the head but this is not very clear. Sides of the triangle somewhat lobate but not strongly notched, the most pronounced of the lobes marking the position of the eyes which are laterally placed and somewhat behind the middle. On one side of the head is preserved a part of one of the lamelliform feelers which, however, is somewhat crushed and apparently not in place. The joints are very short, their number not ascertainable but there appear very faint impressions of seven delicate leaf-like appendages of somewhat varying length but all wider than long and spread in an irregular fan-like manner. With one or two exceptions, these leaf-like blades are not represented by chitinous (carbonized) films but are mere delicate impressions. The joints of the antenna however, are preserved in carbonized chitin.

Length of the head, as exposed, a little less than 3 mm., greatest width, near the junction with the pro-thorax, a little less than 4 mm.

Pro-thorax distinct and nearly free, the pronotum forming with the head an inverted heart-shaped outline. The anterior margin of the pronotum, where it joins the head, is gently concave while the sides for more than half the length are gently convex or nearly straight, sloping outwards to form the greatest width, which is a little posterior to the middle. Beyond this they are

more sharply rounded backwards and then abruptly converge backwards to the narrow connecting portion with the meso-thorax. The anterior width of the pronotum is nearly 4 mm., its greatest width 7.5 mm., and the width at the contracted posterior end about 3.75 mm. Its median length is about 4 8 mm. This measurement is, however, only approximate as both the anterior and posterior lines of demarkation are not very accurately determinable. The left one of the anterior pair of legs is well preserved, but the right one is only represented by a fragment. As compressed on the shale, the left leg shows the broad blade-like tibia without terminal coxal joints, a characteristic of the *Lamellicornia,* and more especially of the *Scarabæidæ.* The outer margin of this blade-like tibia, which has an exposed width of 1.5 mm., is marked by a series of short spines often hook-like. The posterior one is short and slightly recurved, the next anterior is blunt and broad. In front of this is a longer and rather sharp spine with a smaller slightly backward directed subsidiary spine on its posterior or outer margin. The fourth spine from behind is larger than the others and like them somewhat asymmetric. It also has a small secondary spine on its posterior or outer margin. The fifth spine from behind is the longest. It is slender with nearly parallel sides ending in an abruptly recurved pointed hook. Finally the last one shown is abruptly bent outwards at nearly right angles at the tip which thus forms a laterally projecting spine, behind which there is a second shorter and narrower laterally projecting secondary spine. This final portion of the modified tibia is, however, less clearly outlined. In its general character this tibia, evidently modified as in modern forms for digging, is like that found in recent genera of scarabs such as *Ateuchus,* but it is broader, and with the spines more varied, the posterior ones being proportionately shorter and the anterior proportionately longer.

Meso- and meta-thorax apparently united, their combined length about equal to that of the pro-thorax. Elytra well-marked, coriaceous, with regularly curving outer margin and subacute posterior end. When closed the posterior border appears subtruncate, with the last segment of the abdomen projecting beyond it. Surface of elytra marked by numerous very fine gently curving lines of fine spots or pustules, which in general are parallel to the

outer margins of the elytra but are not very readily visible. Posterior pair of wings not exposed.

The second pair of legs proceeds from the shoulder region of the meso-thorax; that on the right side is nearly complete as is also the third one, while the corresponding legs on the left side are crushed, and have their parts distorted and commingled. Only a small terminal portion of the femur of the second (meso-thoracic) leg is exposed, this being somewhat larger than the tibia. The latter is furnished with a row of backward-projecting spines or setæ on the inner margin and ends in a pair of strong spines, an outer and an inner, between which the tarsus articulates. The tarsus appears to be formed of five joints which have been somewhat crushed and disarranged. It terminates in a curved spine. Posterior (meta-thoracic) leg longer and more robust than the second, with a broad femur mostly hidden, and a broad gently curved tibia serrated on its inner side (and possibly also furnished with bristles or setæ) and likewise ending distally with two terminal spines. The tarsus is long but its elements can not be separated. It appears to be delicately fringed on the inside, and ends with two slender slightly curved spines. These are, however, only faintly shown.

Abdomen with six segments faintly visible through the elytra, the last segment rounded posteriorly and projecting beyond the distal margin of the elytra when closed.

Length of entire specimen 19.5 mm. Greatest width across elytra near posterior part of thorax 10.5 mm.

This beautiful and unique specimen of the oldest known scarab is named in honor of Dr. W. W. Yen, the noted Chinese scholar and statesman, and Minister of Agriculture and Commerce.

Horizon and Locality. A single specimen only was obtained from the Laiyang paper-shales, 1 li north of Man-Wu in Lai-Yang-Hsien, Shantung. Coll. H. C. Tan. (Cat. Chinese Geol. Survey 428).

Order ODONATA

Genus *SAMARURA* Brauer, Redtenbacher and Ganglbauer.

This generic name was proposed for larvæ of Odonata or dragon flies first obtained from the Middle? Jurassic beds of the Ust Balei basin, in

eastern Siberia. Their most characteristic feature is the possession of three leaf-like or petaloid terminal appendages. Handlirsch suggests that these forms belong to his suborder Anisozygoptera. Five species were described as listed above (p. 165) all of which are comparatively large.

A larva of this type is abundant on certain layers of the Laiyang paper-shales, but the specimens are generally imperfect, and especially the terminal portion of the abdomen is poorly preserved or wanting. Only a few specimens show the terminal appendages and these have the form of the species described from Ust Balei. Only two are however visible these being symmetrically disposed, but the apparent absence of a third may be an accident of preservation for, in the Ust Balei specimen only two of the three are sometimes visible, the third being covered. Though not identical with any of the species described from the more northern region, our forms appear to be congeneric with them, and here for the present I shall place them, although I recognize the fact, that the persistent appearance of only two terminal appendages in all the specimens which preserve this part of the body, points to a distinct generic type.

Samarura gregaria Grabau (sp. nov.)

(Plate I, figs. b-d)

This form is uniformly smaller than those described from Siberia and less slender; being proportionally about twice as wide as these more northern forms. Owing to the generally incomplete character of the specimens, it is difficult to ascertain the number of exposed abdominal segments but they are usually not over eight, including the terminal one. In an apparently complete form, the seventh seems to be followed by the terminal lobed segment. In a ventral aspect, however, the seventh sternum appears very long and may cover additional segments, though none have been observed in any of our specimens. The segments appear in most cases rectangular, but are really somewhat wider at the posterior than at the anterior end, the posterior lateral angles of each segment overhanging the anterior part of the segment behind it, in some cases being apparently prolonged into short spines. This is, however, as a rule only seen when the segments are in contact, but where, as is usual, they are slightly separated. the lateral slopes of the segments seem to be

aligned so as to form a continuous side line to the abdomen. The width of the abdominal rings or segments as flattened on the shale surface, range in a typical specimen, from 1 mm. at the front, to 0.5 mm. or slightly less in the seventh segment. The length of the first four segments is generally about 0.5 mm. each, but the posterior segments are longer, the ante-penultimate, with an anterior width of less than 1 mm., having a length of 0.7 mm. or more, and sometimes appearing quadrilateral. In another specimen, however, which also shows seven somites in addition to the terminal one, the sixth shows an anterior width of a trifle over a millimeter. The next segment visible is, however, short and less than 0.7 mm. in width. The width of the anterior somite in this specimen is nearly 1.5 mm. In life the maximum diameter of the abdominal rings was probably less than 1 mm. on the average.

The lobes of the terminal segment are circular, or nearly so, and so far I have not been able to determine positively that there are more than two, though in at least one specimen, there is a faint suggestion of a third flattened between the others If it should develop that there are really only two such appendages this species will have to be referred to another genus.

Thorax of compressed specimens broader than abdomen. The thoracic rings appear to be short but are so much crushed that the details can not be made out.

The legs are long, the posterior or metatarsal pair, when extended, nearly or quite reaching the end of the body. The femur is always slightly swollen and broader than the tibia, and the tarsus appears to be rather long. There are no wings. The head is small, subcircular and two short antennæ are preserved in some specimens, these often appearing fimbriate*. Neither head nor thorax is sufficiently well preserved to show details.

These larvæ are of nearly uniform size, measuring a trifle less than 8 mm. in length, exclusive of the antennæ. They are sometimes crowded together in great numbers on the thin paper-shales, but separate individuals are also found. They are not directly associated with the land-plants (conifers, etc.) preserved in these strata, but carbonized stems, apparently of

* This, I believe, is due to the mode of preservation and not an original feature. In fig. b. it is a little too strongly emphasized by the artist.

aquatic plants, are found with them in some cases.

Horizon and Locality. Lower Cretaceous Laiyang paper-shales, 1 li N. of Pa-Tsu, Lai-Yang-Hsien, Shantung. H. C. T'an Coll. (Geol. Surv. China. Cat. 423, 424, etc.).

PISCES.

Genus LYCOPTERA *J. Müller.*

Lycoptera sinensis Smith-Woodward.

1901.—*Lycoptera sinensis* Smith-Woodward. Catalogue of the Fossil Fishes of the British Museum, Pt. IV., p. 3, text fig. 1.

Woodward's description: "Length of head with opercular apparatus slightly less than the maximum depth of the trunk, and occupying scarcely more than one quarter of the total length to the base of the caudal fin. Vertebræ about 45 in number, 20 being caudal. Pectoral fins when adpressed, scarcely reaching more than halfway to the origin of the pelvic pair; other fins apparently as in the type species".—

In the majority of individuals, the length of the head is much less than one-fourth the length of the body to the base of the caudal fin, the ratio in a typical adult specimen, where the length is 100 mm., being as 1:3.57, and less in younger specimens. The position of the dorsal fin is in front of the anal, whereas in *L. middendorfi* it is behind. There are 13, and in exceptional cases, 14 axonosts in the anal fin of the adult, but only 12 in the younger specimens. In like manner there are 12 principal rays in the outer part of the anal fin (basiosts) of the smaller individuals, this number increasing to 13 or even 14 in the adult, while splitting of some of the rays still further increases their number. Preceding the principal rays there are 3 shorter or fulcral rays. The dorsal fin has 11 axonosts or ray supports, and 10 principal rays in the outer part (basiosts), preceded by at least 2 fulcral rays (4 in some specimens).

The details of arrangement of the rays of the anal fin are also characteristic.

The species will be fully described and illustrated in a paper on the Lower Cretaceous Fishes from North China to be published in Palæontologia Sinica, Series C. Vol. III.

Horizon and Localities: Common in the Laiyang shales in Lai-Yang Hsien, Shantung (Loc. 218, 1 Li NE of P'o-Tzu; 221, 1 Li N. of Nan-Wu; 222, 2 li N. of Po'Tzu; etc.) Coll. H. C. T'an.

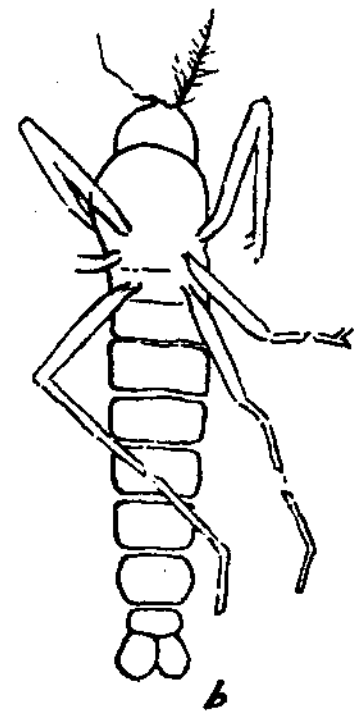
Lycoptera ferox Grabau (sp. nov.)

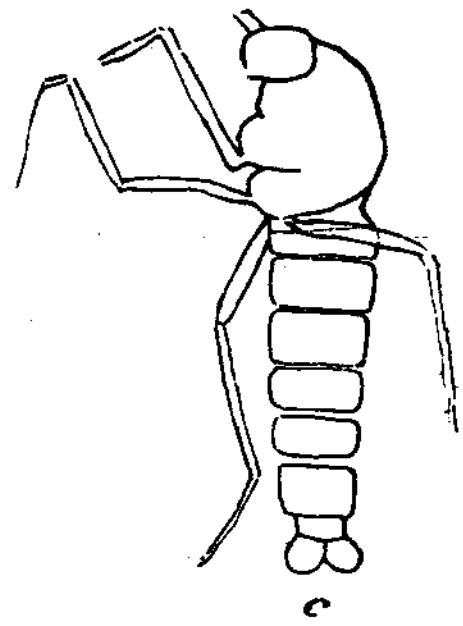
Slender, with the body scarcely or not at all increasing in height behind the head, which is generally as high as the body. The length, exclusive of the tail rays, is about 5 times the height, or six times that, when the entire length is taken. The ratio of the length of the head to the length of the body ranges from 1:3.70 to 1;3.85 wher the caudal rays are omitted, or, when the entire length is taken, it is as 1:4.70. The dorsal fin lies in front of the anal, and the pectoral fin reaches to about four fifths the distance to the front of the pelvic carrier. The arrangement of the rays in the caudal fin is peculiar, in that the ventral lobe is shifted forward more than in the other species of the genus.

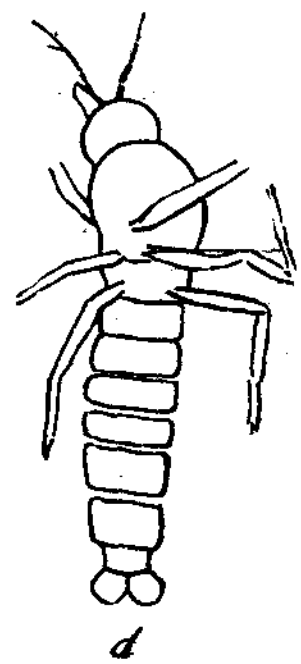
The appearance of the head is the most distinctive feature, the front being abruptly rounded and truncate in the lower part from the forward shifting of the frontal and ethmoid bones. The mouth thus appears more ventral than in *L. sinensis*, where it forms the forward pointing end. The gape is short but wide, giving the animal a rather ferocious appearance.

This fish will be described in detail with the others in Palæontologia Sinica, Ser. C. Vol. III.

Horizon and Localities: Associated with the preceding species in the Laiyang shales of Lai-Yang Hsien, Shantung (Loc's. 218, 221, 222). H. C. T'an Coll.

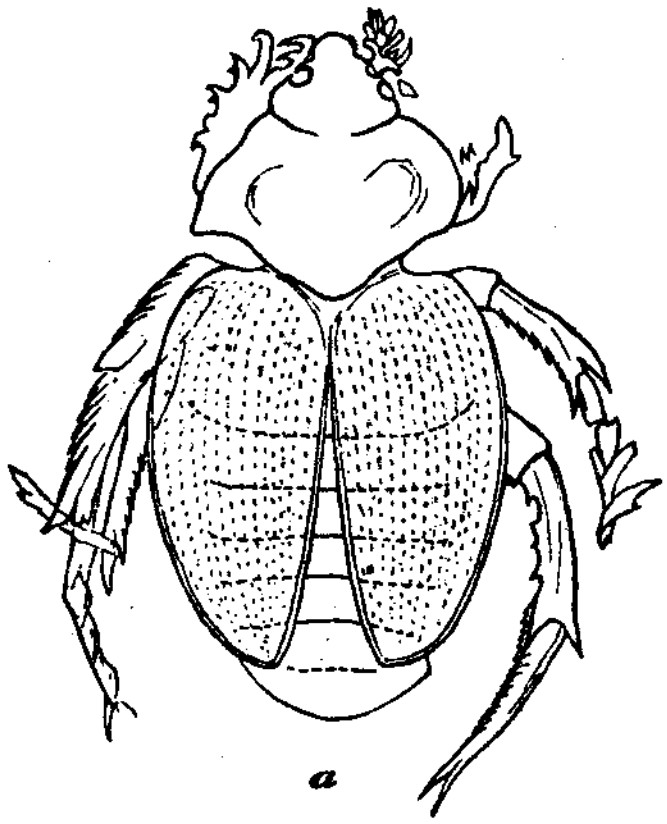


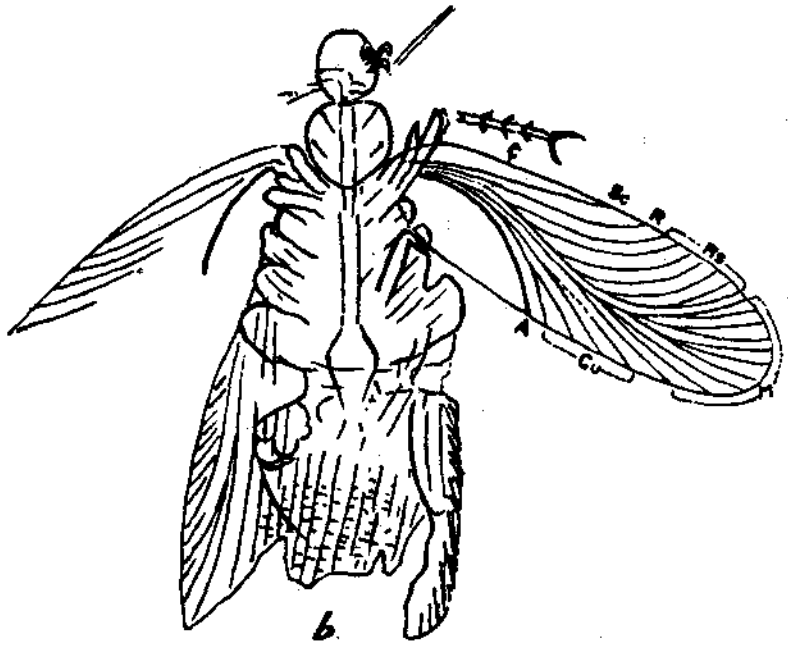




Lower Cretaceous Insects.

a Sinoblatta laiyangensis Grabau (enlarged 3 times); *b-d Samarura gregaria* Grabau, three larvæ in different attitudes (enlarged 8½ times). Laiyang Formation, Lai-Yang-Hsien, Shantung.





Lower Cretaceous Insects.

a. *Proterocarabaeus yeni* Grabau (enlarged 4 times).

b. *Laiyangia paradoxiformis* Grabau (enlarged 4 times).

Laiyang Formation, Lai-Yang-Hsien, Shantung.

CRETACEOUS MOLLUSCA FROM NORTH CHINA.

By A. W. Grabau.

(With 2 Text-Figures.)

The Mollusks described in this paper were obtained from three separate localities in North China, as follows:

1: Yan Lui-T'un, Yi Hsien, Fêngtien. Collected by Mr. H. C. T'an (Loc. 1901). Approximate location: Long. 121° E., Lat. 41° 20' N.

2: Ling Yuan Hsien, Jehol (Chengtefu). Collected by Mr. T. O. Chu (Loc. 2103). Approximate location: Long. 117° 58' E., Lat. 41° N.

3: Near An Chun, Hun-Yüan-Hsien, N. Shansi. Collected By Dr. J. G. Andersson (Loc. 59). Approximate location: Long. 113° 35' E , Lat. 39° 40' N.

All three localities lie to the northwest of the mid-Mesozoic mountain ranges (Yenshan Range* or ancient Nankou, etc., ranges, and ancient Tsingling ranges) and in a series of basins which very probably lay within the same general intermontane region. The Jehol locality lies between the other two, the following being the approximate distances in a straight line, in general from N. E. to S. W.

Yi-Hsien to Jehol.....130 miles.

Jehol to Hun Yüan.....200 miles.

Yi-Hsien to Hun Yüan.....330 miles.

So far as the present collections permit us to judge, the two extreme localities belong to essentially the same geological horizon, the only species found in the south-western region, *i. e.*, Hun-Yüan in Shansi, namely *Corbicula anderssoni* Grabau, also occurring in the north-easternmost region, *i. e.*, Yi-Hsien in Fêngtien, the distance between the two localities being about 330 miles. The intermediate locality in Jehol apparently belongs

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* This name has been applied to the late Mesozoic predecessor of the modern Nankou Range by Dr. W. H. Wong.

to a distinct, and I believe somewhat older horizon, though we have at present only one specimen of *Corbicula* (*C. jeholense* Grabau) to show this.

Stratigraphy and Age of the Beds

Jehol: Beginning with the intermediate locality, the horizon of which we believe to be ascertained, we find here the following succession according to Dr. Andersson and Messrs. Chu and Tung*.

Upper Porphyry beds.

Jehol series. Shales, slates, and sandstone with subordinate conglomerates. In the upper part occur thin-bedded paludal beds, forming platey layers of rock resembling the "Flinze" in the lithographic limestone series of Solnhofen, and these carry a rich fish fauna.

Thickness of entire series.....50 to 100 meters

Lower Porphyry beds.

In other sections the fish-bearing beds are found lying unconformably on siliceous limestone and gneiss (C. Tung).

The only abundant fossils in these beds are two fish, the larger of which has been described as *Lycoptera jeholense* Grabau, and the smaller, which is also the most abundant, as *L. jeholense* var. *minor* Grabau**. These small fish are often so numerous that a slab of about 1 foot square will show from 50 to 100 individuals. Besides the fish a few plant remains provisionally referred to the genus *Czekanowskia*, fragments of insects, and *Estheriæ* have been found, and the single molluscan shell herein described as *Corbicula jeholense* Grabau.

The age of these beds was formerly held to be Jurassic, but the evidence afforded by the plants, insects and mollusks of the corresponding fish-beds of Shantung, the fish of which were clearly contemporaneous with the Jehol fish, and apparently derived from them, has led us to assign a Lower

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* C. Tung–1923. Bull. Geol. Soc. China, Vol. 2, No. 1, p. 6, and J. G. Andersson, Museum Explanations.

** A. W. Grabau–Lower Cretaceous Fishes from North China. Palæontologia Sinica, Series C, Vol. III.

Cretaceous or Wealden age to these deposits. This has been fully dicussed for the Shantung formations in the preceding paper.

These deposits were laid down in a shallow playa basin formed on the gently warped surface of the late Jurassic peneplane, to the north of the subdued Yenshan mountain range, which was formed near the end of Jurassic time, and which had essentially the location of the present Nankou Ranges north of Peking. This formed the divide between the northern basin and those of Shantung.

FÊNGTIEN: A similar warp-basin, lying 130 miles farther to the northeast, is that of Yi-Hsien, in Fêngtien. The stratigraphy of this basin has been studied in some detail by Mr. H C. T'an from whose notes the following section is reproduced (in descending order):

FÊNGTIEN VOLCANIC SERIES. Lavas, tuffs and tuff-conglomerates with intrusions.

Disconformity

YIHSIEN FORMATION. Gray sandstones and conglomerates at the top, passing downward into yellow and gray sandstones and clays, and consisting at the base of gray and yellow sandstones and gray and greenish clayey shales. Some distance below the middle are yellow and gray thin-bedded sandstones, white-gray and greenish clayey shales, and dark-gray shales containing the gastropods and pelecypods herein described, together with coal-seams, and igneous intrusions. Total thicknes exposed.....900 meters.

SUBJACENT BEDS—not exposed.

The fossiliferous beds of the Yihsien Formation exposed at Yang-Lui-T'un. consist in part of dark gray rather massive clay shales, crowded with pelecypods and rarely with specimens of gastropods. Only a single species of pelecypod seems to be common in these shales, this being the species herein described as *Corbicula anderssoni* Grabau. The specimens range from young individuals to adults, the measurements of which are given below. All the shells are more or less crushed and flattened, but the shell-surface is

generally preserved. With these occur occasionally small shells which may be referable to *Pisidium*, but they are too imperfectly preserved for description. The only gastropod noted in these shales is too much crushed for determination, but appears to be referable to the genus *Vivipara (Paludina)*.

With these shales, and apparently interbedded with them, are calcareous beds several inches in thickness, and composed almost entirely of shells of several species of the fresh-water gastropod *Campeloma* embedded in a fine argillaceous calcilutyte. These Campeloma beds are structureless, the shells lying in all positions, and they evidently represent local accumulations of dead shells in the shallow waters of the basin. They are not worn, though occasionally specimens were crushed subsequent to entombment. The lime of the mud which cements these beds is not derived from the wear of the shells themselves, but is of extraneous origin, and probably represents chemical precipitation. It may, of course, be due to segregation by calcareous algæ, the structure of which has been entirely obliterated, as is commonly the case in modern *Chara* marls. The presence in the matrix of minute particles suggestive to some extent of spore-capsules, may bear out this supposition.

While shells of *Campeloma* predominate, there are also occasionally present pelecypod shells apparently of the same species as those found in the shale. Other fossils have not been noted. The species of *Campeloma* described are as follows:

1: *Campeloma clavilithiformis* Grabau (sp. nov.)

2: *C. fengtienensis* Grabau (sp. nov.)

3: *C. yihsiensis* Grabau (sp. nov.)

4: *C. tani* Grabau (sp. nov.)

Of these no. 3 appears to be the most abundant, the others being of occasional occurrence. All the forms are closely related and they may represent merely mutations of a common stock. However, for the sake of emphasizing the distinctive features they are described as separate species.

The character of the fauna suggests an Upper Cretaceous age for the formation in question. The nearest allies of our forms are found in the

Laramie beds of western North America, and while it is not believed that the horizon is necessarily as late as that of the Laramie beds, the Upper Cretaceous age seems to be indicated. Nevertheless, because of the limited number of species, we must concede the possibility of an early Cretaceous, if not late Jurassic age.

It is a fact of considerable interest, that not a single species of this fauna has been found in common with the Upper Cretaceous molluscan fauna of the Shantung basin described in the preceding paper. If they are of equivalent age, this may be explained by the fact that the two basins were separated by the ancient Yenshan mountain range which, though probably subdued in Upper Cretaceous time, nevertheless formed an effective barrier between the basins. The Shantung localities lie only about 260 miles south east of Jehol or 240 miles south of the Fêngtien basin, yet the separation was complete. The same effectiveness of the barrier is noticeable in the character of the fish faunas of the Lower Cretaceous horizon of the Shantung basin when compared with the contemporaneous fish fauna of the Jehol basin on the north of the barrier. This is more fully discussed in the monograph on the fish faunas above referred to. On the other hand, the Shantung basins seem to have several species in common with the far distant Szechuan basin, from which they are separated by an interval of more than 800 miles. This Szechuan basin is, however, on the same side of the mountain barriers of the period as were the Shantung basins, i.e., to the south of them, so that inter-communication was apparently more easily effected.

N. Shansi: The fossiliferous formation of this basin is exposed near An Chun in Hun-Yüan-Hsien, north Shansi, where the specimens herein described were obtained by Dr. J. G. Andersson in 1922. The formation is a compact argillutyte of dark purplish-gray color, very massive and with conchoidal fracture. The only fossil found abundantly is the pelecypod *Corbicula anderssoni* Grabau, these Shansi specimens being taken as the types of the species. The shells are well preserved, embedded in all positions in the mud, either as separate valves or with both valves in conjunction. They are usually brilliantly white in color forming a strong contrast with the rock. Occasionally, however, they are stained yellow by iron oxide. The

surface characters are well preserved and the internal structure is sometimes ascertainable.

Although somowhat smaller on the average than the Fêngtien shells, they agree with them in all essential characters, and I do not think that more than one species is represented. No other species have been recognized.

This specific identity suggests that the formations of the two locatities are essentially contemporaneous, and the Hunyüan formation of Shansi is therefore likewise referred to the Upper Cretaceous. As above noted, the two localities are 330 miles apart, with the Jehol region lying between them. They apparently belonged to the same general intermontane basin. The relationships of these strata to the other formations of the region, are as yet undermined.

Description of the Species

Class PELECYPODA

Order TELEODESMACEA Dall

Family CYRENIDÆ Gray

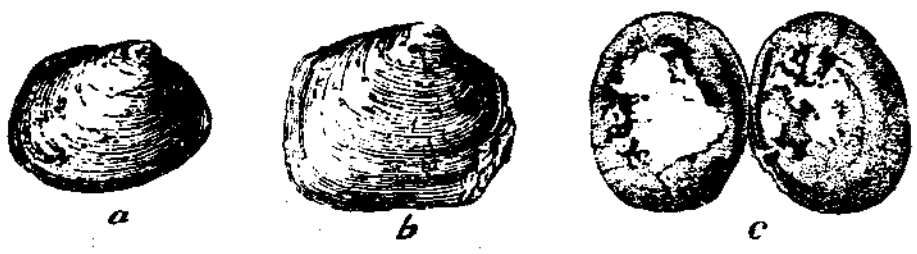
Genus *CORBICULA* Megerle

Corbicula anderssoni Grabau (sp. nov.)

(Text Figs. 1a-b.)

Shell small to medium-sized, moderately convex, the greatest convexity above the middle. Outline subelliptical with the beak below the umbonal line and turned forward to a somewhat more marked degree than in the common modern Chinese species of the genus. Its position is in the anterior third of the shell. In front of it is a marked, though not deep or broad depression, continuing as an oblique concavity to the front. Anterior end of less height than posterior, rounding regularly into the ventral margin. Hinge line straight, extending for the greater part of the length of the shell behind the beak, and bending rather abruptly into the posterior margin, which is broadly rounded or even faintly subtruncate, but passes with a regular rounding into the ventral margin.

In the right valve there are two well marked, rather narrow and sharp lateral teeth, seen in the posterior portion of the hinge, lying parallel to the hinge line, and with a somewhat broader channel between. The lower of these teeth is generally the stronger and more continuous, the upper one being somewhat thinner and not extending as far back as the lower (specimen cat. 418). Above the upper is a broad channel before the hinge margin is reached. In this respect the hinge is very similar to that of *C. subelliptica* Meek and Hayden of the American Laramie. In the specimens from the Yihsien shales, which are generally much flattened, the space between the two teeth of the right valve appears to be somewhat wider, the corresponding tooth of the left valve being stronger than either of those in the right valve. In a Shansi specimen (cat. 419-a) the lower of the posterior teeth continues as a low curved ridge for some distance parallel to the posterior margin. Anterior tooth simple.



Figs. 1a–1b, *Corbicula andersoni* Grabau. *a*, right valve, holotype from Shansi × 2; *b*, right valve from Fêngtien, × 2; 1*c*, *Corbicula jeholensis* Grabau. Internal molds of both valves showing the form and deep impressions of the lateral teeth. Jehol shales, Jehol, × $2\frac{3}{4}$.

Left valve with 3 obliquely converging cardinal teeth and a single, rather sharp posterior lateral tooth. The crenulation of the teeth, characteristic of modern species of the genus, is not visible, though in a few cases it appears to be faintly indicated. This non-development of the crenulation is however, a feature characterizing many of the fossil species referred to this genus.

Measurements: The following measurements in millimeters show the variations in size and form of this species.

Specimen No.	Shansi Specimens							Fêngtien Specimens			Laramie Specimens
	1 (417)	2 (419a)	3 (419)	4 (420)	5	6	7	8	9 (421)	10	11
Length	11.	12.	10.	10.	12.	10.6	12.2	15.5	12.5	15.	20.
Height	8.	10.	7.	8.	9.3	7.6	9.5	14.	8.5	12.	15.5
Beak to front	3.	4.	2.5	2.5	3.4	3.2	3.5		3.5	3.5	16.
Length of hinge-line	6.	7.	6.	6.	7.5	.....	6.	.....	6.	8.	13.
Ratio length to height (=1)	1.34	1.20	1.43	1.25	1.29	1.40	1.30	1.10	1.47	1.25	1.30

No. 11 is a specimen of *Corbicula subelliptica* from the Laramie of North America. Nos. 8-10 are specimens from the Yihsien shale of Fêngtien and are more or less crushed, hence the proportions are not those of the original shell, but of flattened individuals. In spite of this it is probably true that the shells from the Yihsien shale are somewhat larger as a whole than those of the argillutyte from Shansi, where they are preserved in an uncrushed condition. No. 9 is the least crushed and corresponds fairly well with the dimensions of some of the larger specimens from Shansi. A specimen from the gastropod limestone of these beds, in which the original contour of the shell is preserved, has a height of 13.5 mm. which corresponds to a length of perhaps 16 mm. or more, though this is not fully preserved. An earlier stage of this shell however, measured on the growth-lines, has a length of 11.3 mm. and a height of 9.5 mm., giving a proportion of 1.19:1. while a still earlier stage measures 6.3 and 5.mm. respectively, giving a ratio of 1.26:1. All these specimens show the posterior subtruncate margin and in spite of the rather marked variations, I do not think that more than one species is represented.

Surface of the shell marked by very fine and subregular concentric variciform undulations and a few stronger growth interruptions. The surface-marking is like that of modern Chinese species of the genus but finer.

The species has the general form and proportions of *Corbicula subelliptica* Meek and Worthen, of the Laramie beds of western North America, though the slightly subtruncate character of the posterior end seen

in most of our specimens is not seen in the Laramie form so far as illustrations permit us to judge. The measurements of a typical form of the American species are given in column 11, from which it is seen that though larger, the proportions are like those of the Chinese species. The dentition, as already noted, appears also to be similar.

Horizon and Localities: The species is common in the Hunyüan argillutytes of Hun-Yüan-Hsien, Shansi, being mostly well preserved and uncrushed. There are scarcely any other organisms in this rock except what appears to be young shells of this species. A crushed gastropod and fragments of another larger shell *(Physa?)* have been found, but the characters of these are not determinable. These specimens were collected by Dr. J. G. Andersson in whose honor the species is named.

In the Yihsien shales of Fêngtien this species also appears to be common, but the specimens are all more or less crushed. The individuals are as a rule somewhat larger than the Shansi specimens but a part of this is due to the flattening of the shell. Associated with these shells is a large species of *Paludina* and a small *Sphærium?*. In somewhat more calcareous beds of the same formation four species of *Campeloma* occur, these shells being sometimes so abundant as to form a shell layer. These specimens were collected by Mr. H. C. T'an.

It is difficult to determine the precise age of these faunas. That they are Cretaceous admits probably of little doubt, though both the genera *Corbicula* and *Campeloma* have Jurassic representatives. Nevertheless, the character of the pelecypods and the presence of a number of species of *Campeloma* points rather to a Cretaceous age. The *Corbicula,* as already noted, resembles most closely an American Laramie species, while some of the species of *Campeloma* also show relationships to Upper Cretaceous species of America Until further evidence then is obtained for more precise paralleliza-tion, we may regard these formations as representing a fresh-water Upper Cretaceous horizon.

• U. S. Geol. Surv. Terr. Vol. 9, and 3d Ann. Rept. U. S. Geol. Surv. Pl. 20, Figs. 10, 11.

Corbicula jeholense Grabau (sp. nov.)

Text-Fig. 1c.

This species is represented only by the internal molds of both valves of one specimen, the valves, still in conjunction, having been spread apart. The form and character of the hinge are well shown.

This form is smaller than the preceding species and of proportionately greater height. Greatest length a little above mid-height. The beak is situated about one third the length of the shell from the anterior margin, and is slightly curved forward. In front of it, the shell margin descends rather rapidly to the line of greatest length, while behind the beak the hinge margin is gently curved to within a short distance of the posterior extremity of the shell. Posterior end of the shell regularly curved, showing no signs of truncation such as is found in *C. anderssoni*. Frontal margin of the shell curved to about the same degree, both frontal and posterior margins passing without any abrupt change into the somewhat more broadly rounded ventral margin. Contour of shell moderately and regularly convex, the greatest convexity at about two-thirds the height, and slightly in front of the mid length.

Left valve with a strong gently convex (dorsad) posterior lateral tooth and an equally strong slightly concave (dorsad) anterior lateral. In the right valve the anterior socket is defined by a rather pronounced, gently concave lateral tooth below, and by a fainter one above. The posterior socket is likewise bounded below by a rather strong gently convex tooth which extends from the beak to the posterior margin of the shell, but is most pronounced in the median area. The bounding ridge or tooth above is less sharply defined. The sides of the lateral teeth, and the borders of their sockets in the right valve, appear to be faintly notched transversely. Cardinal teeth not well preserved, apparently two in each valve, not, or only very faintly bifid Muscle scars not determinable. As the shell is only represented by internal molds, the surface sculpture is not shown, but from the inpressions it appears that the shell was thin and marked only by fine concentric growth-lines.

Measurements: The following measurements have been obtained Length 7.5 mm., height 6.3 mm., distance of beak from front 2. mm

Length of posterior lateral tooth 4.5 mm. As shown by these measurements, this species has somewhat different proportions than those of *C. anderssoni*. In that species the proportion of height to length ranges from 1:1.26 to 1:1.43 for the Shansi shells, with an average in seven individuals of 1:1.32 and from 1:1.10 to 1:1.47, in the Fêngtien forms, with an average in four individuals of 1:1.28. The ratio in the present specimen is nearly 1:1.2. On the whole then the present species appears to be proportionately shorter than is the case in *C. anderssoni*, although the proportions fall within the range shown by that species. The most marked difference however, is the rounded posterior margin of *C. jeholense* as compared with the subtruncate margin of *C. anderssoni*.

Horizon and Locality: In the Jehol fish-beds of Lower Cretaceous age at Jehol in North China (Cat. 633). Only one specimen, and that an internal impression, has been found.

Class GASTROPODA

Fam. VIVIPARIDÆ Gill.

Genus *CAMPELOMA* Rafinesque

Campeloma clavilithiformis Grabau (sp. nov.)

(Text-Figs. 2a, b.)

Shell of medium size, high-spired, with the whorls embracing to the ambitus; apical angle of young about 59°, of adult 42°. Apex decollated above a septum, leaving 5 whorls. First preserved whorl rounded, low, and embraced by the next up to the ambitus; exposed part about half as high as the diameter. Second preserved whorl also rounded above, more than twice as high as first. Both first and second preserved whorls marked by delicate fine regular riblets, seen only under high magnification. The riblets stand vertically but are gently concave forward in the centre and they average four or five to 1 mm. (Fig. 2b). The next two whorls are so gently convex as to appear nearly flat, and the suture between them is scarcely depressed. The last half of the body-whorl develops a distinct subsutural shelf, while the shoulder of the whorl becomes quite flat but not vertical. The shoulder is separated from the lower part of the whorl by a blunt and not pronounced,

though distinct, angulation. The last three whorls show lines of growth only.

Length of shell, exclusive of decollated apex, 14 mm., length of body whorl 7.5 mm., greatest diameter of body whorl 7.8 mm.

This species resembles *Campeloma multilineata* Meek and Hayden from the Laramie of western North America, which has the same subsutural shelf developed in the last whorl. That species has, however, a greater apical angle (50° or more) and is also a much larger shell. It also shows spiral lines which are not visible in our shell.

Horizon and Locality: In a calcareous layer in the Yihsien formation of Upper? Cretaceous age, Yang-Lui-T'un, Yih-Hsien-Fêngtien. H. C. T'an Coll. (Mus. G. S. Ch. Cat. 422-(1)).

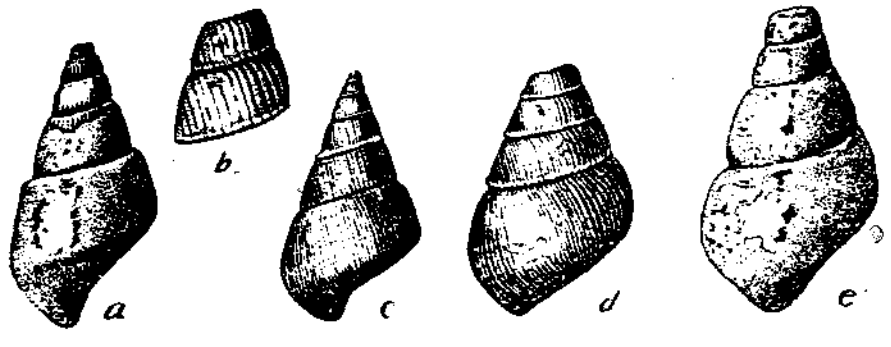
Campeloma fengtienensis Grabau (sp. nov.)

(Text-Fig. 2c.)

Shell high-spired, similar to the preceding in general form, with seven whorls including the minute apical whorl. Apical angle of adult 42°, the young somewhat higher. Apical whorl minute, rounded; second whorl rounded; third somewhat flatter, embracing the second to below the ambitus, thus producing a deeper suture than in succeeding whorls. Succeeding whorls flattened, only the shoulder exposed, each whorl embracing to the ambitus of the preceding whorl, which is characterized by a blunt shoulder-angle. In the fourth whorl begins a faint keel-like projection of the shoulder angle, appearing as a thickened spiral line which is seen just above the suture In the fifth whorl this keel becomes pronounced, forming a thick ridge above the suture. In the 6th whorl it has again become faint and disappears in the seventh or body-whorl where only a blunt angulation remains. The flattened shoulders with the faint impression of the sutures, produce a slender trochoid form of spire. Below the shoulder-angles the body-whorl is regularly rounded to the umbilicus which is, however, covered by the inner lip.

The fine ribbing of the early whorls is scarcely shown in this species. Exceedingly fine spiral lines are discernable on the body-whorls but the shell is chiefly marked by very delicate, subregular growth-lines.

Several other specimens, apparently of this species, have a slightly greater apical angle in the adult, this ranging from 44° to 45°, while the young has an apical angle ranging as high as 54°. The keel of the 4th and 5th whorls is well shown. The growth-lines in the adult are also somewhat coarser than in the type, resembling in this respect the growth-lines of the next species. It may be that these two grade into each other and the forms described represent only extremes of variation.



Figs. 2 a, b, *Campeloma clavilithiformis* Grabau, *a*, shell with apical whorls wanting × 2; *b*, uppermost two whorls preserved, enlarged × 6 to show the fine ribbing; *c*, *Campeloma fengtienense* Grabau, entire shell × 2; *d*, *Campeloma yihsiensis* Grabau, shell with apical whorls wanting × 2; *e*, *Campeloma tani* Grabau, internal mold of shell with apical whorls wanting × 2.

This species is characterized by the marked shoulder angulation, which, in the intermediate (neanic) whorls, is furnished with a stout keel; by the flat shoulder of the later whorls, which embrace to the shoulder angle, and by the smooth character of the adult except for growth lines. Length of type 13 mm., greatest diameter of body-whorl 7.5 mm.

This shell may be compared with *C. producta* White from the Laramie beds of western North America. That species, however, grew to larger size and shows a very faint constriction of the whorls just below the suture.

Horizon and Locality: Associated with the preceding. (Type Mus. G. S. Ch. Cat. 422-(2)).

Campeloma yihsiensis Grabau (sp. nov.)

(Text-Fig. 2d)

Shell similar to the preceding but more robust with an apical angle of 52°-53°. Earliest whorls not preserved in the type, which shows only four whorls. The first of these is rounded above, showing that the suture above

it was rather strongly impressed. This is shown to be the case in a specimen in which part of the preceding whorl is preserved. It becomes somewhat flattened towards the ambitus, which is characterized by a moderate angulation. The second preserved whorl (probably the 5th of the entire shell) has its shoulder flattened, and embracing to the angle of the preceding whorl, the suture being scarcely impressed. The shoulder angle of this whorl is strongly marked and in places constricted into a faint, or even pronounced keel, by a delicate impressed line above it. The next whorl is again more rounded, embracing to immediately below the shoulder-angle of the preceding whorl, the suture being slightly impressed. The final or body-whorl is still more strongly impressed, and the shoulder angle faint or almost obsolete.

Surface marked by rather coarse irregularly spaced growth-lines, which, however, are more uniform and regular in the earlier whorls. A few faint spiral lines are discernable on the last two whorls, these being scarcely pronounced enough to be called spirals.

This species resembles *C. fengtienensis* in the general character of the whorls and the development of an incipient keel in the neanic whorls, a feature much more pronounced in *C. fengtienensis*. The present species has, however a much larger apical angle, and the surface is marked by much coarser and more strongly curved growth-lines. These differences may of course be due to difference of sex. Length of shell exclusive of apical whorls, 13 mm. (original length perhaps 16 mm.), greatest diameter of body-whorl 8. mm.

Horizon and Locality: Associated with the preceding in the Yihsien formation of Yang-Lui-T'un, Yih-Hsien, Fêngtien. Coll. H. C. T'an; several specimens. The age is probably Upper Cretaceous. (Type Mus. G. S. Ch. Cat. 422-(4)).

Campeloma tani Grabau (sp. nov.)

(Text-Fig. 2e)

Shell high-spired when complete, with 6 or 7 volutions (only 4 preserved in the type specimen); apical angle 40°. Whorls gradually and regularly increasing in size, rounded, with no demarkation of a shoulder, and

embracing slightly below the ambitus, with the result that the suture is of moderate depth. Surface smooth, growth lines very fine.

This shell is readily distinguished from the others previously described by the round whorls, well-marked suture, and absence of angulation especially in the young. In the last whorl a faint angulation may occasionally develop. The apical angle varies somewhat, being in some cases as high as 45° and appearing even greater in slightly crushed specimens. On the other hand a more slender shell with an apical angle of only 38° otherwise shows the characteristics of this species.

Length of type, exclusive of apical whorls, 16 mm.-original length perhaps 19 mm; greatest diameter of body-whorl 9.5 mm. The species is the most primitive of those so far described, the young (neanic) whorls being rounded, whereas, in the preceding two, they are already angulated, a feature which does not appear in the present species until the adult (in some cases), while the keel never develops.

Horizon and Locality: Associated with the preceding. The species is named after Mr. H. C. T'an who collected these faunas. (Type, Mus. G. S. Ch. Cat. 422-(3)).

A LOWER CRETACEOUS AMMONITE FROM HONGKONG, SOUTH CHINA.

By A. W. Grabau.

(With I Plate)

Introduction

A discovery of exceptional interest and importance in Chinese geology was brought to the notice of the Geological Survey in a letter dated Feb. 19, 1923, in which the discoverer, Dr. C. M. Heanley of Hongkong, outlined his determination of the stratigraphic succession in the district within 30 miles of Hongkong, and mentioned the finding of an ammonite in one of the formation of the series. At the request of the Director of the Survey Dr. Heanly generously forwarded the specimens he discovered for study and description and it is on this material that the following note is based. Accompanying these specimens was a second letter from Dr. Heanly, dated June 12, 1923, in which he gives certain further details of the formation, and with it he sent an outline map showing the occurrence of the several rock series. Subsequently Dr. Heanly prepared a short paper on these deposits which will appear in the Bulletin of the Geological Society of China. From these data the following succession is obtained, in descending order.

Formation 4: Sandstones and conglomerates; the latter with calcareous cement, while the predominant cement of the older conglomerates is silica and iron oxide. "It contains fragments of red septarian nodules in ts conglomerates, these being exactly like the septaria found in situ in the red clays of formation 3. Boulders of an older conglomerate are found in the conglomerate of this 4th. formation; the boulders of the older conglomerate also contain the red septarian nodule fragments so that there must be something missing between formation 3 and 4"*. The dips of these strata are rarely more than 15°, and the series is much freer from small faults than any of the other formations. The calcareous conglomerate contains boulders of an older conglomerate which in turn contains, besides others, limestone pebbles in which Prof. J. S. Lee recognized *Fusulina* cf *mansuyi* Deprat, *Fusulinella*, etc. probably indicating Permian age. This conglomerate must

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Letter of Feb. 19.

be older than any of the formations listed below since none contain pebbles of this type.

Unconformity (?)

FORMATION 3: "This has a well defined basal conglomerate consisting chiefly of quartz–felsite pebbles and pebbles derived from formation 2; it consists of thick layers of bright red shale, red conglomerate and red sand. There are red septarian nodules in the shales" [1]. The dips of this formation are generally between 25° and 40°. No fossils were found by Dr. Heanly.

Formations 3 and 2: are separated by an area of igneous rock and there is a fairly well defined basal conglomerate along most of the line where formation 3 is in contact with the igneous rock.

Disconformity (?)

FORMATION 2: This consists mostly of red and purple shales and quartzite with lines of white pebble conglomerate and quartzite. This massively bedded conglomerate is the most prominent feature of the entire series, consisting almost entirely of milk-white, well rounded pebbles of quartz, and of quartz sand. This is the formation in which the ammonites were found. "There is a well defined current bedding in the neighborhood of the fossils showing that they are underneath the larger masses of quartz-pebble conglomerate, though the dip is nearly vertical" [2]. The strike is north-east and south-west and the dips mostly at angles above 60° often above 80°.

The matrix in which the ammonites are embedded is a dark gray to brown iron-stained cellular rock which has the appearance of a cellular lava and abounds in iron pyrites, which is either scattered through it in fine grains or occurs in crystal masses of small cubes and octahedrons. Other portions appear to be a fine-grained dark-gray structureless and more or less argillaceous clastic rock. Weathering has stained the more porous portions a deep reddish-brown iron oxide color. The ammonite shells were apparently included as fragments, or else were carried in by floatation and

1. Letter of Feb. 19.
2. Letter of June 12.

subsequently broken. The material of the internal mold appears to be much the same as the enclosing matrix, being cellular where broken, but smooth where in contact with the shell and of a deep red brown iron oxide color.

DESCRIPTION OF THE SPECIES

Genus HOPLITES Neumayr.

Subgenus BLANFORDIA Uhlig.

Hoplites (Blanfordia) wollichi (Gray)

var. *hongkongensis* Grabau (var. nov.)

Plate I, Figs. a-c

cfr. 1830-32. *Ammonites Wallichi.* T. E. Gray, Illustrations of Indian Zoology, Calcutta Vol. I, pl. C, fig. 3.

1904. *Hoplites Wallichi* G. Boehm, Beiträge zur Geologie von Niederländish-Indien, Palæontographica. Supplement IV, pl. III, fig. 4, pl. IV; pl. V, fig. 1 a-b. Text-figs. 7.9, p. 31.

1910. *Hoplites (Blanfordia) Wallichi* Uhlig. The Fauna of the Spiti Shales (2) Palæontologia Indica, Ser. XV, Vol. IV, fasc. 2, p. 186; Plate XXXI, figs. 1 a-c, fig. 2; Plate XXIX, figs. 1 a-b; figs. 2 a-b; figs. 3 a-b; Plate XXX, fig. 1 a-c (further literature references).

This well-known and widely distributed Indo-Pacific species of a Lower Cretaceous ammonite is represented in the Hongkong strata by a fairly well preserved internal mold comprising something more than half of the outer volution of a medium-sized individual, several impressions and fragments of parts of volutions, and a fairly good impression of the inner whorls, which appear to belong to the same form. Unfortunately the suture is not shown in any of our specimens, but the form and ribbing are so characteristic that there can be no mistake in identifying these specimens with this variable Lower Cretaceous species, though certain characters seem to demand its separation as a distinct variety. The vertical height of the largest fragment of whorl is 29.5 mm. at the largest end, 25 mm. in the middle (about 35 mm. farther back as measured on the venter), and 20 mm. at the smaller end (another 35 mm. farther back). At this rate of increase the height of the volution at the outer-most part (preserved on the umbilical side but

broken on the venter) approximately another 35 mm. further forward, would be about 33 mm. while the total diameter of the shell at this rate would be about 85 mm., and the umbilicus 35 mm. The corresponding thicknesses of the whorl from behind forward are: 19 mm., 20.7 mm., 21 mm., and 22? mm. These measurements give proportions which agree fairly well with those of typical forms from the Spiti shales as shown in the following table where the diameter of the shell is taken as 100.

	Spiti shells			Hongkong shell
Diameter of shell	132 mm	76 mm.	109 mm.	85 mm.
Diameter of shell (100) to width of umbilicus	37	33	39	40
Diameter of shell (100) to height of last volution above the volution line	35	37	35	38
Diameter (100) to thickness of last volution	41	32	31	26

In the Hongkong specimen the proportions of umbilical width and height of last volution are slightly larger than the greatest in the Spiti specimens while the proportional thickness of the last volution is less. It must, however, be remembered that the diameter of the shell and the width of the umbilicus are only estimated.

The umbilical wall slopes abruptly to the umbilicus in the inner portion, but rounds outward into the flanks of the whorl.

The ribs begin faintly on the rounded portion, the steep inner slope being without ribs. From this point of origin the ribs quickly increase in height and definition, becoming broadly rounded with interspaces of the same or slightly greater width, with regularly rounded bottom. The distance from crest to crest of the ribs when first defined, ranges from 3 to 3.5 mm. The oldest of the ribs preserved bifurcates about 5 mm. above the inner margin of the volution (vertical projection, or nearly 10 mm. from the suture

measured on the curvature), *i.e.*, at about one fourth the height of the volution. The branches diverge rapidly until at the ventral angle their crests are nearly 5 mm. apart, the ribs having a width of about 2 mm. and the interspaces of perhaps three, though no sharp line of demarkation separates them.

The next two ribs forwards are simple and undivided, increasing in height, but only slightly in width; and diverge only slightly. The next two ribs are also simple forming the 4th. and 5th. primary ribs originating on the umbilical margin. These, as well as the third, are slightly flexuous. Two intercalated ribs appear between the 3rd. and 4th. and the 4th. and 5th. principal ribs, these originating at about one-third the height of the whorl above the volution line. These ribs all become of equal size on the ventro-lateral angle, where their crests are approximately 5 mm. apart. The succeeding ribs all bifurcate, the bifurcation being below the middle, and first indicated by a broadening of the rib at about one-third the height of the whorl above the volution line. The resulting branches develop to the same thickness and spacing as the other ribs. All show a slight flexuosity, but this is never very pronounced.

The venter is flattened and the ribs are interrupted by a smooth flat depressed area, about 5 mm. wide, or less than one fourth the greatest width of whorl at the outer preserved end. On the ventro-lateral border the ribs are slightly bent forward and reach their greatest thickness. They end ventrally in a thickness rounded termination which, however, is never a node.

In the ribs this fragment is not unlike the specimen of *Hoplites (Blanfordia) wallichi* (Gray) from the Lochambel beds of the Spiti shales os the Himalayas, figured by Uhlig on plate XXX, fig. 1 of his memoir on the Spiti ammonites. The ribs of our specimen are, however, less flexuous than in that form, the bifurcation begins somewhat earlier, and the thickening of the rib-ends on the ventro-lateral margins is more pronounced. The median ventral area of our form is also somewhat flatter, though scarcely less depressed. In the Spiti form too, the ribs all bifurcate, whereas in our form there are four simple and two intercalated ribs in the third of a volution preserved, nevertheless the two forms are very close in this respect. There

is however, also a difference in the section, the umbilical slopes in our specimen being somewhat more abrupt than in the Spiti from.

In other specimens of *H. (Bl.) wallichi* from the same horizon and locality in the Himalayas, both simple and intercalated ribs occur, but the bifurcation is generally at or above the middle and the ribs are slightly more flexuous (see Uhlig, Pl. XXIX).

The ventral thickening of the ribs and the flatness of the ventral surface resembles that of *Hoplites (Acanthodiscus)* cf. *michaelis* Uhlig (Plate XXI fig. 2b) but the ribs of that form are mostly simple, and they are moreover, marked by a faint tubercle above the middle, this being the point where bifurcation occurs in some of the ribs. The ventral depression is also less marked than in our form. In the adults of that subgeneric group moreover the ribs are strongly tuberculated both on the side of the whorl and at their ventral termination.

Except for the earlier bifurcation of the ribs and the more pronounced broadening of their ventral terminations, our specimen might be considered an immature form of *H. (Bl) wallichi*. In some of the specimens figured by Boehm from the Dutch East Indies (Plate V. fig. 1, text-fig. 7, p. 32. Palæontographica, Supplement IV, I.) the flexing of the ribs agrees with that of our specimen and there are both simple and intercalated ribs at irregular intervals.

The inner whorls of another specimen probably of this same form are preserved as an impression in the rock. Form this the cast shown in fig. *c*, of plate I was made. This is about 35 mm. in diameter and shows about 3½ volutions, the outer-most having a vertical height of about 13 mm., while the exposed part of the volution next below is only about 4 mm., though the total height is about 6. This makes an overlapping of the outer upon the next inner whorl of about one third the height of that whorl. The umbilical margin of the outer preserved whorl is rather steep, rounding abruptly to the volution line, and is smooth, the ribs beginning only above the marginal rounding. They are mostly simple, rarely bifurcating, and then close to the point of origin, which is never thickened.

The ribs are comparatively narrow and sharply defined increasing in height towards the venter. They are straight, or rarely with a slight backward flexure near the ventro-lateral border and are separated by wider interspaces. Near the ventro-lateral margin their crests are 2.5 mm. apart, while near the point of origin, this distance is only 1.6 mm. The number of ribs on this part of the shell, which in comparison with the other fragment represents approximately the next inner whorl, is between 40 and 44 whereas that of the next whorl within that is about 40, of which one or two show bifurcation. The whorls next within do not show the ribs with sufficent clearness for the determination of their number, but so much can be ascertained that this is not far different from that of the next surrounding whorl.

The ventral characters of these whorls can be ascertained.

If this specimen really represents the younger stages of the type of which the previously described fragments form the later whorls, it appears that this variety differs rather markedly from those forms generally referred to *Bl. wallichi*, since there is no indication of bifurcation of the ribs near the ventral margin as is the case in these forms, instead of which there is an occasional bifurcation near the umbilical border. Whether this is to be regarded as a more primitive or a more specialized condition can not be determined with the material at hand. According to Uhlig in the more specialized species of *Blanfordia* it sometimes happens that "the previously close connection of the secondary with the primary ribs becomes lower and intercalary ribs make their appearance"[1]. It is possible that with specialization the point of bifurcation moves umbilical-ward and finally results in complete separation of the ribs. In that case the early stages represented by the specimen shown in fig. *e*, plate I, are more advanced in this respect than the larger whorl-fragment represented by fig. a-b of the same plate, where bifurcation generally occurs in the inner third of the whorl, though in one case it is quite near the umbilicus.

Geological Horizon and Occurrence: *Blanfordia wallichi* is a common and characteristic species of the upper or third stage of the Spiti

1. Uhlig. loc. cit. p. 160.

SHALES of the Himalayas. This division, now generally designated the LOCHAMBEL GROUP, is characterized by numerous *Hoplitidæ* of Neocomian or Lower Cretaceous affinities, and represents the European Berriasian and Valanginian, and even the lower zones of the middle Neocomian, *i.e.*, the Hauterivian, if not the Barremian as well. It is also reported from the middle divisions of the Spiti shales, where it is apparently rare, if the stated occurrence at this horizon is not erroneous.

G. Boehm has obtained this species in several varieties and in large numbers from the Lower Cretaceous (border beds of Jurassic and Cretaceous) of the islands of Taliabu and Mangoli of the Sula group in the Dutch East Indies (about Lat. 2° S. Long. 125° E.) These beds, Boehm considers as unquestionably the equivalent of the Lochambel beds of the Himalayas and Tibet. He has again found this species in Dutch New Guinea (Lat. 2° 22' S. Long. 139° 50' E.) In both cases *Hoplites wallichi* is associated with *Phylloceras strigile* which is also found in the Spiti beds, and is considered by Uhlig as belonging to Tithonian and Neocomian horizons. Boehm does not hesitate to refer his fauna to the Valanginian (possibly Barriasian).

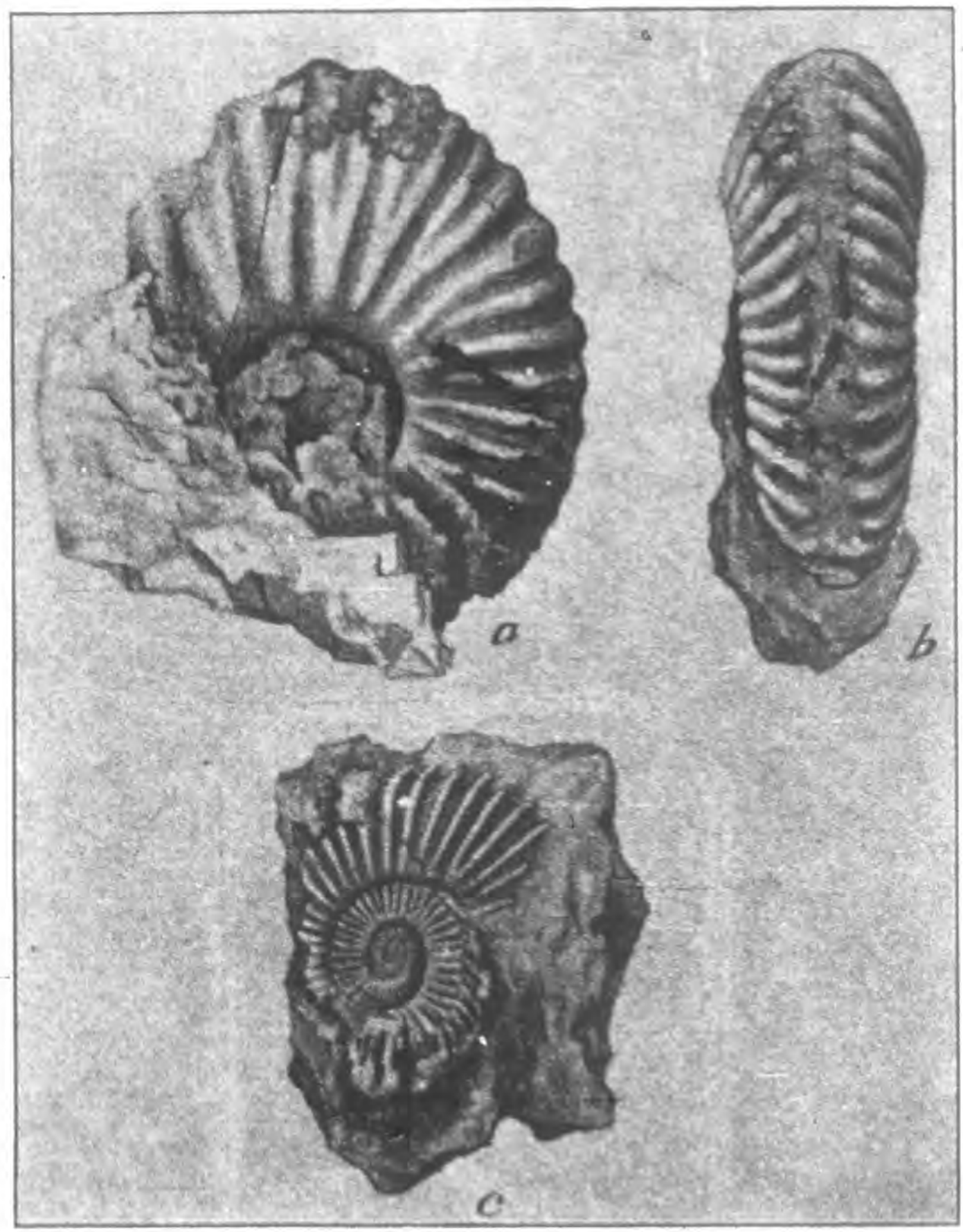
It thus appears that there can be no question as to the Lower Cretaceous age of the Hongkong beds in which these ammonites occur. The embayment in which they were deposited belongs undoubtedly to the Indo-Pacific province, which was characterized by these forms, and of which the Spiti sea, both in the later Jurassic stage and in the Lower Cretaceous (Lochrmbel) stage, was an extension. There is at present no evidence that the Himalaya geosyncline in which these late Spiti shales were deposited, extended eastward across Burma, and southern China to the Hongkong region. In fact, what is known of the stratigraphy of these regions, is against such a supposition. It appears far more likely that these beds were formed in a geosyncline parallel in a general way to the south east coast of China, flanked probably by elevated mountain folds of perhaps late Jurassic age on the west, these mountains including strata of Carboniferous and younger pre-Cretaceous age which furnished the clastic material of the formations from the Cretaceous to the Tertiary inclusive. Most of these were apparently continental deposits, but that the Pacific sea on the east gained

temporary access to this geosyncline is shown by the occurrence of these ammonites.

If the stratigraphic succession given above on the authority of Dr. Heanly is correct, it would follow that formation No. 3, which contains pebbles derived from the ammonite-bearing Lower Cretaceous bed No. 2 is in disconformable contact with it, and is therefore considerably younger. It may be tentatively referred to the Upper Cretaceous.

Formation 4 is said to be still younger than formation 3, containing fragments of septarian nodules which were apparently derived from the septaria of formation 3. Its age may therefore be Tertiary.

If these correlations are correct, the latest folding of the strata in this region probably corresponds to the Miocene and younger periods of orogenic disturbance, so marked in the Himalayas and in the Red Basin of Szechuan These problems must await the detailed study of this region which has fortunately been undertaken by the geologists from the University of British Columbia.



A Lower Cretaceous Ammonite from Hongkong.
Hoplites (*Blanfordia*) *wollichi* (Gray) var. *hongkongensis* Grabau;
a, Side view of the largest fragment obtained, natural size;
b, Ventral view of the same specimen, natural size;
c, Gutta percha cast of the inner whorls, taken from impression in rock, natural size.

CONTRIBUTION TO THE FAUNA OF THE KWEICHOU FORMATION OF CENTRAL CHINA.

By A W. Grabau

(With four text-figures)

Introduction

The Kweichou formation was named by Willis and Blackwelder from the outcrops along the Yangtze at Kweichou and on the Taning-ho. They, however, included in their formation, the sandstones and limestones which overlie the Wushan limestone and the coal-bearing shales next succeeding, which had previously been noted by Pumpelly and von Richthofen, and from which these earlier investigators had obtained plant remains which were described by Newberry and by Schenk as of Jurassic age. More recently, David White has shown that these are better referred to the Rhætic. The limestones underlying have furnished marine fossils which Girty described as suggestive of Permian age. The Rhætic plant-bearing and coal series has recently been named the Hsiangchi series by Prof. J. S. Lee of the National University, who restricts the name Kweichou series to the overlying grayish sandy shales from the base of which, at Kweichou in Hupeh, Mr. Y. T. Chao has collected the fauna herein described. This is clearly the same formation as that previously described by von Richthofen from the Szechuan border of the Yangtze and from which Frech has described a Wealden fauna obtained near Kweichou-fu and elsewhere in Szechuan. The species described by Frech are:

1. *Unio cremeri* Frech
2. *Unio johan-böhmi* Frech
3. *Cyrena (Miodon) cf. kilioni* Frech

The species obtained by Mr. Chao at Kweichou in Hupeh, are the following:—

1. *Unio cremeri* Frech
2. *Unio chaoi* Grabau (sp. nov.)
3. *Unio (Lampsilis) johan-böhmi* Frech
4. *Mycetopus mengyinensis* Grabau

5. *Cyrena kweichouensis* Grabau (sp. nov.)

6. *Cyrena hupehensis* Grabau (sp. nov.)

Of these 6 species nos. 3 and 4 have also been obtained from the Mêngyin formation of Shantung, as described in a preceding paper in this Bulletin. This formation is essentially equivalent to the Kweichou formation (as restricted) on the Yangtze, and like that is a Lower Cretaceous continental formation, essentially of the Wealden type of western Europe. On the Yangtze the series has a thickness, according to Professor Lee, of about 2,200 meters.

Description on the Species

Unio cremeri Frech

1911. *Unio cremeri* Frech. In Richthofen China, Vol. V, p. 223, pl. 31, fig. 1 a, b.

This species, originally described by Frech from outcrops of the same formation in Szechuan, is represented by 4 individuals in the collection from the Ichang gorge. None of them is complete but all four show the umbonal portion and the characteristic ornamentation. The largest specimen in our collection has both valves in contact but somewhat crushed and with the posterior end broken away. It is slightly larger than that figured by Frech, but because of crushing does not preserve the thickened non-pustulose anterior portion in the same degree as that shown in Frech's figure. The umbones are strongly incurved, with a deep and strong anterior subumbonal depression, while the anterior end was markedly nasute. The young stages are much more subcircular than the adult, in which the shell is elongate.

The pustules are confined to the younger stages of growth, occupying about $\frac{2}{3}$ of the shell, the last third being essentially free from them or, when the pustules occur, they are few and scattered. In the pustulose stage, the pustules disappear in the anterior portion of the shell, which is only characterized by coarse growth-lines. They extend however, nearly to the hinge margin posteriorly, though they become weaker Their most pronounced development is in the median portion of the shell where they are crowded, varying from subcircular to elongate, with the long diameter parallel

to the direction of the growth-lines, and from 2 to 3 times the transverse diameter. In this specimen they are less regularly arranged in concentric lines, more numerous and more crowded than in the specimen figured by Frech. The longest pustule observed is 6 mm., with a transversed diameter of a little over 2 mm. All the pustules are blunted rounded, none of them being sharp.

Another specimen, the umbonal portion of a right valve, shown the beak strongly incurved with a pronounced anterior depression and a strongly developed broad non-pustulose shell area below it which, however, is not elevated as in Frech's type but flattened. The pustules of the central area are smaller and sharper than in the specimen previously described and were apparently largely confined to the young shell.

The other specimens show the pustules even more restricted, and widely scattered in the later stages of growth. The shell is thick, especially in the umbonal region the fragment of the right valve above noted, having a shell-thickness of 11 mm. It is composed of numerous parallel layer of shell substance.

Formation and Locality: In the argillaceous sandstones of the Kweichou formation of the Yangtze gorge, above Ichang, Hupeh. Coll. Y. T. Chao, 4 specimen. The original type described by Frech came from the same horizon 5 li above Fuchow, province of Szechuan. The age is Lower Cretaceous or Wealden.

Unios with this type of shell ornamentation are not uncommon in modern Chinese waters, the most noteworthy being *U. leai* Gray var. *truncatula* Neum. which lives in the Grand Canal and Lake Tai-hu, province of Kiangsu. Other varieties and other species were described and figured by Huede, and the form seems to be common in Central China. None of them however, show the strong incurvature of the beak and the pronounced impression below it which characterize this species and give it the character of a *Quadrula,* to which subgenus it may be referable. The surface characters are probably independently developed in different genetic series.

Unio chaoi Grabau (sp. nov.)

(Figs. 1a-e)

Shell small, short for the genus, appearing sometimes eubrotund and strongly inflated in the umbonal region. The ratio of height to length varies somewhat markedly so as to permit the recognition of two types, one shorter with a ratio of 1:1.13 to 1:1.4, and a longer in which the ratio ranges from 1:1.33 to 1:1.40. A young form (f of the table) shows an intermediate ratio 1:1.26. The beaks lie about two-fifths the length of the shell from the anterior end, but are not very prominent; they are only moderately depressed below the level of the umbonal region. There is only a slight excavation in front of the beak, this being less pronounced than the depression behind the beaks.

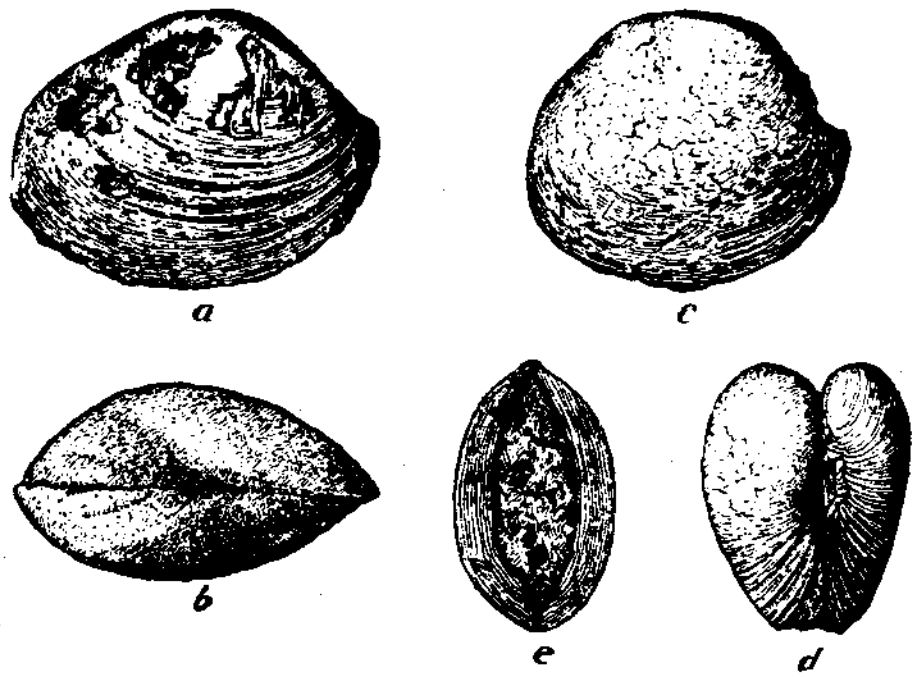


Fig. 1. *Unio chaoi.* Grabau nat. size. *a*, long form showing right side; *b*, dorsal view of same; *c*, short form, right side; *d*, anterior view of the two valves; *e*, median longitudinal section showing thickness of shell and laminate character. Kweichou formation, near Kweichou, Hupeh.

Anterior end rounded, sometimes slightly nasute, curving into the ventral border, which is gently arcuate, never becoming quite straight; posteriorly the ventral bordor curves upward more abruptly into the subangular posterior end. This varies somewhat in the different individuals being more

rounded in the shorter and more sharply angulated in the longer individuals, with the angulation always obtuse. A faint rounded umbonal ridge extends from this angle to the umbonal region but is never very prominent. The shell surface above it is sometimes nearly flat and in rare cases slightly concave.

Greatest thickness of the shell about one third the height below the umbonal region, the convexity below this being very gentle, except when flattened or depressed by compression. Surface marked only by lines of growth, which near the front may be somewhat lamellose, and in some cases rather pronounced wrinkles may develop. When exfoliated the shell appears to be finely striated radially.

Measurements:

	a	b (Fig. 1c,d)	c (Fig. 1a,b)	d	e	f
Length	37.8	35.8	41.5	45.0	40.0	29.5
Height	32.5	31.5	31.5	32.0	26.0	23.5
Greatest thickness	19.5	23.5	22.0	19.5	26.5	17.0
Beak to front	17.0	13.5	16.0	19.0	17.5	13.5
Ratio, Height to Length	1:1.13	1:1.14	1:1.33	1:1.40	1:1.54	1:1.26

In section the shell is seen to be composed of a number of strong and nearly uniform lamellæ, some of which show a fine prismatic structure. In a specimen about 30 mm. in length there are 9 such layers, aggregating a total thickness of shell-substance of 4.5 mm. in the thickest part. The thickness of the entire shell is about 18 mm. (Fig. 1e).

This shell resembles somewhat *Unio brachyopisthus* White[1] of the Laramie of the western United States, but is larger and more elongated, while the beaks are more central than in the American form. Of modern Chinese forms *Unio superstes* Neum.[2], and *Unio heres* Neum.[3], from

1. 3d Ann. Rept. U. S. G. S. Pl. 16, figs. 7, 8, p. 433.
2. Neumayer M., in Wissenschaftliche Ergebnisse der Reise des Grafen Bela Szechenyi. Vol. II, pl. I, fig. 3, p. 643.
3. Ibid. pl. I, fig. 6, p. 644.

Talifu Lake are not unlike our form, but in both the beaks are more anterior. The former is also more elongate than our form bnt has the umbonal ridge and the posterior angulation which characterize the present species. These features are less marked in *U. heres* which is of about the size of our species, though less inflated and with more anterior beaks.

Horizon and Locality:—In the Kweichou beds of the Ichang gorge of the Yangtze, near Kweichou, Hupeh. Associated with *U. cremeri*, etc. 15 specimens. The species is named after Mr. Y. T. Chao one of the active and enthusiastic young palæontologists of the Survey, who collected these fossils.

Unio (Lampsilis) johan-böhmi Frech.

1911. *Unio Joh-Böhmi* Frech; in Richthofen China, Vol. V, p. 223, pl. 31, figs. 3 a-c 4.

1924. *Unio (Lampsilis) johan-böhmi* Grabau; Cretaceous Fossils from Shantung; this bulletin p. 149, fig. 2.

This elongated *Unio* previously described by Frech from the Kweichou formation of Szechuan and identified in the Mêngyin formation of Shantung, is represented by several poorly preserved specimens in the collection of Kweichou fossils made by Mr. Chao at Kweichou, Hupeh. These show some variation both in size and in the position of the beak, but I shall for the present refer them all to the above species, since the material is not in a sufficiently good state of preservation to permit any other proceeding. The shell is preserved in these specimens, and is generally of moderate thickness showing, where fractured, a distinct lamellose character. The surface however is exfoliated and corroded so that the growth-lines are more or less obscured, and the shell is rough.

A medium-sized specimen agrees essentially with the figures published by Frech, but the anterior end is somewhat crushed and corroded thus giving the appearance of a more anterior beak than is actually the case. The length is about 55 mm. but was originally probably nearly 60 mm. when the anterior end was perfect. The greatest height is 32 mm., this being near the center of the shell and behind the beak. The thickness is 14 mm. but this is

less than the original, the valves being somewhat crushed. A young stage of this shell, outlined by the rather obscure growth-lines, has a length of 34 mm. with the beaks which are rather strongly corroded about 6.5 or 7 mm. from the front, i.e., about one fifth the length of the shell. The height at this stage was about 12.5 mm. If the original length of the shell was 60 mm. the beak was about 12 mm. from the front, i.e., $\frac{1}{5}$th the length of the shell; but it may have been something less, say perhaps $\frac{1}{6}$th the length of the shell. This agrees essentially with the position which it holds in Frech's types.

This shell is proportionally somewhat higher than Frech's types and the Mêngyin specimens, but this may be due, in part at least, to the crushing which has correspondingly reduced the thickness. The basal margin is, however, gently arcuate as is the case in one of the specimens figured by Frech, lacking the concavity seen in the basal margin of the others. In this respect it corresponds to most of the internal molds from the Mêngyin formation.

A second specimen more strongly crushed vertically has a length of about 60 mm. with the beak 10 to 11 mm. from the front or between $\frac{1}{6}$th and $\frac{1}{5}$th the length of the shell. There is a small but distinct excavation beneath the beak in front, and the dorsal excavation behind it is also rather strongly marked. Teeth not determinable.

A third specimen is much larger than the others and may belong to a different species, though the shell is not well enough preserved for precise determination. The fragment at first sight suggests *Unio menkii*, but the shell is too long, and the beaks too near the anterior end for reference to this form. The original length was apparently about 90 mm. with the beak about 15 mm. from the front or $\frac{1}{6}$th the length of the shell. The greatest height is behind the nmbo and is about 40 mm. This is a faint excavation below the beaks in front, and from this point to the ventral margin the anterior margin is regularly rounded as in the typical forms. The ventral margin is gently arcuate, without concavity; characters of posterior end not fully determinable, but apparently as in the Mêngyin shells.

This is the largest individual of this species so far obtained and probably represents a full-grown shell.

Horizon and Locality:—In the Kweichou sandy shales at Kweichou, Hupeh, Coll. Y. T. Chao.

Mycetopus mengyinensis Grabau

(Fig. 2.)

1924. *Mycetopus mengyinensis* Grabau; Cretaceous Fossils from Shantung; this Bulletin, p. 153, text-figs. 4 & 5.

This shell previously described by me from the Mêngyin beds of Shantung, is represented in the collection from Kweichou by a single small specimen, which, however, preserves most of the shell. The length of the shell is only 11.5 mm. while the beak lies 2.3 mm. or one-fifth the length of the shell from the front. The height at the umbones is about 5 mm. while near the posterior end of the hinge-line it is 5.5 mm. The hinge-line is straight for about 6 mm. behind the beak after which the shell margin slopes obliquely downward to the rounded posterior end. A faint but definite umbonal ridge extends from the beak to the junction of the dorsal posterior slope with the rounded posterior ventral end; the postero-dorsal portion thus outlined, and which is bounded behind by the oblique sloping shell edge, is gently concave. The ventral border is straight, without concavity, and the anterior, somewhat nasute, end is narrowly rounded. A slight excavation occurs below the beaks.

Fig. 2.

Mycetopus mengyinensis Gr. Small left valve preserving shell × 2, Kweichou.

The shell surface is smooth except for fine subregular lines of growth. The thickness of the shell substance is slight. Though smaller than the Mêngyin specimens this shell undoubtedly belongs to the same species.

Horizon and Locality:—In the finer shales of the Kweichou formation, Kweichou, Hupeh. Coll. Y. T. Chao, 1 specimen.

Genus *Cyrena* Lam.

Cyrena kweichouensis Grabau (sp. nov.)

(Fig. 3.)

Shell thin, of medium size, not inflated, elongate, with the beak about one-fourth the length of the shell from the anterior end. Umbo

not prominent, the shell margins on either side sloping away so as to form an angle of about 110°. Anterior margin faintly excavated beneath the umbo, straight for about half the height of the shell below the beak, then curving regularly into the ventral margin which in gently convex. The posterior end appears to be more sharply rounded, but this is due to the fact that the curvature continues further dorsally passing into the much more obliquely sloping and nearly straight dorsal or hinge margin, which in the type specimen is 7 mm. long (total length of shell 13 mm.). A posterior lateral tooth is indicated by a depression parallel to the hinge margin. Greatest convexity of the shell near the middle from which point the shell curves nearly equally to the umbonal and ventral margins, somewhat more abruptly to the front and more gently to the posterior end. Surface of shell marked only by faint lines of growth.

Fig. 3.
Cyrena kweichousensis Gr. left valve. × 2. Kweichou.

Measurements of two shells gave the following proportions:

	1	2
	Type (fig. 3.)	
Length	13.0 mm	9.5 mm.
Height	8.5 mm	7.0 mm.
Beak to anterior end	3.0 mm	2.3 mm.

This shell resembles the one figured by Frech as *Cyrena* sp (Richthofen V, pl. 31, fig. 7) from the Wealden of Oberkirchen, Germany and which he states is intermediate between *C. caudata* A. Roemer, and *C. majuscula* A. Roemer. That shell however, if the figure is of natural size (Frech forgets to mention this detail) is nearly three times as large as our form, having a length of 32 mm. and a height of 22. The form figured by Frech as *Cyrena* cf. *kiliani* n. sp. from this formation at Kweichou-fu, Yun-yan-hsien, Szechuan, if of natural size, is likewise nearly three times as large as our form and also has less elevated umbones which are situated much further back than in our species.

Horizon and Localitg.—In the sandy shales of the Kweichou formation at Kweichou on the Yangtze, province of Hupeh. Coll. Y. T. Chao It is apparently a common form though usually much crushed.

Cyrena hupehensis Graban (sp. nov.)

(Fig. 4.)

Shell of medium size, moderately convex, elongated with the beaks in the anterior third. Umbones not prominent, a very faint excavation occurs beneath the beaks, below which the shell margin is straight and slopes diagonally forward, passing into the round anterior end. Ventral margin rounded, on a larger radius than the front; posterior margin more sharply rounded below, obliquely sub-truncate in the upper part. Hinge-line straight for about half the length ot the shell behind the beak, or about one-third of the entire length of the shell.

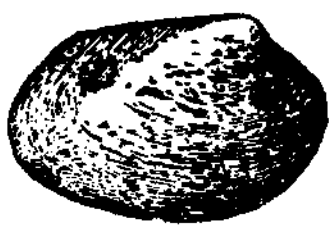


Fig. 4.
Cyrena hupehensis Graban. right valve; showing muscular scars. × 2. Kweichou.

A very faint umbonal ridge extends from the beak to the posterior ventral margin, the posterior dorsal region thus outlined being less strongly convex than the rest of the shell. being sometimes even flattened, but not concave.

Greatest convexity of the valve behind the beaks and somewhat dorsed of the median longitudinal line. The central part of the shell is gently arched but near the ends the curvation of the shell becomes rather abrupt. Dorsoventrally the curvature of the shell is rather regular

Surface marked by fine growth lines, which in the anterior-ventral region are supplemented by wrinkles.

Hinge structure unknown. Muscular impressions dorsad of the median longitudinal line, very faintly marked on the internal mold.

Measurements.—A typical left valve measures length 17 mm., greatest height 11 mm., beak 4.5 mm. behind front end.

Horizon and Locality.—Rather common in the calcareous layers of the Kweichou formation of Kweichou on the Yangtze, in Hupeh province. Y. T. Chao, Coll.