序

山旺一是山东省临朐县城东22公里的一个小山村。这里的地层由许多薄如纸张的硅藻土页岩组成，它形成于距今大约1800万年，地质历史上的早中新世。我国古人曾形象地将这里的地层比喻为"万卷书"。

这里因盛产各种精美完好的古生物化石而闻名遐迩，素有"化石宝库"之称。

山旺化石现在已经发现的有十几个门类600余种，植物化石包括苔藓、蕨类、裸子植物和被子植物，其中以植物的枝叶最多、花、果实和种子保存也很完美。

动物化石包括蜘蛛、昆虫、鱼、两栖、爬行、鸟和哺乳动物。昆虫化石翅脉清晰，色彩斑斓；蝌蚪、变态蛙、成体蛙再现了两栖类从水到陆的生活周期。难于保存为化石的鸟类，在这里也多有发现，到目前为止已发现了五种鸟化石。

早期的长颈鹿一三角原古鹿和东方祖熊骨架是迄今世界上保存最完好的标本。60多个柄杯鹿组成了颇为壮观的柄杯鹿群，它们和近无角犀、矢木氏近貘、山旺意外螈螈等一起组成了山旺哺乳动物群。

山旺盆地较大规模的发掘，实际上从1955年就开始了，当时的发掘目的并不是为了化石。硅藻土是一种化工原料，也是一种很好的保温材料。由于化石本身伴生在硅藻土矿床之中，因此开矿取土时连同化石一并发掘出来，这种发掘办法往往被硅藻土的社会需求量所左右，挖挖停停，一直延续到1980年。既然是开矿，就免不了要放炮，动用推土机、铲车等，当然，对化石来说无疑是破坏性的开采。从化石来看，既无人管理也无人重视。不少高等院校、科研单位和博物馆都在山旺采集过标本，北京自然博物馆、上海自然博物馆和山东省博物馆都有专门的山旺化石陈列。硅藻土矿的采矿工人也多次发现化石珍品，山旺山东鸟就是1976年采矿工人发现后送交山东省博物馆的。

1978年10月，中国古生物学会在山旺召开了现场会，听取了关于硅藻土矿的发展设想和对化石保护的报告，中国科协向国务院申报了建立"山旺化石自然保护区"的建议，山东省政府1979年7月正式向国务院申请建立"山旺化石自然

PREFACE

Shanwang is a small village 22km E to the Linqu County, Shandong. Nearby, the very fine-layered diatomacerous shale is well developed. It was formed in the Miocene, about 18 million years ago. It has long been depicted as Wan juanshu"the book of ten thousand volumes".

The place is well known for its exquisite and well-preserved fossils, likened often to "A treasure house of fossils".

So far more than 6 hundred species belonging to ten-odd phyla of organisms have been found. Among the plants there are briophyte, pteridophyte, gymnosperm and angiosperm. The fosslized stems and leaves are the most numerous; the flowers, fruits and seeds are often delicately preserved.

Among fossil animals there are spiders insects, fishes, amphibians, reptiles, birds and mammals. The insects, sometimes, preserved their original gorgeous colour,with the veins of the wings clearly seen. Tadpoles, metamorphoing frogs with long or short tails and fully adult frogs recapitulated their life-ciclc from water to land. The birds are usually rare preserved as fossils, but five species have so far been found here.

In fact, the excavation in great quantities of the Shanwang Basin began in 1955, its purpose at that time is not for fossil but open mines such as diatomite, phosphorus and peat. Diatomite is a raw material for chemical industry. Because of the fossils associated with this mines, so they have been excavated together, this way of excavation was influenced by the social need of the diatomite and the work continued to 1980 intermittently, there were bound to use bulldozers and trucks and demolitions in the work,it is undoubtedly doing great damage to the fossils. Although no one took the matter seriously, many colleges and scientific institutes have collected fossil samples in Shanwang. The Beijing Natural Museum, Shanghai Museum and Shandong Museum all have exhibits of the Shanwang fossils specially. Some valuable fossils had been founded by the workers of the diatomite mine. The fossil Shandongornis shanwangensis was found by the workers in 1976 and was delivered it to the Shandong Museum.



山旺古生物博物馆 Shanwang Paleontological Museum

保护区"。1980年2月17日国务院批复，将山旺列为国家级自然重点保护区。山东省政府批准成立了相应的化石保护管理机构——山旺古生物保护所。1985年4月5日成立了"山旺古生物博物馆"。目前馆藏标本两万多件，如今山旺古生物博物馆已成为中国科学院、中国地质大学、北京大学等科研、教学单位的基地。通过学术交流和广泛的国际合作，山旺化石的研究工作正朝着多学科、综合研究的方向发展。

难能可贵的是作者把长期工作实践中积累的大量资料以图册的方式奉献给大家，让更多的世人认识山旺，了解山旺。

黄兰坡

1994年6月13日

In 1978, the paleontological society of China convened an on-the-spot meeting in Shanwang and the Chinese Scientific Association reported the State Council the proposal for establishing the" Shanwang Natural protectorate", and on February 17, 1980, the State Council approved the report and Shanwang was classified as first-rate natural protectorate, the government of Shandong Province established a corresponding administrative setup. The Shanwang Paleontological Protect Institute, the government of Linqu County founded the Shangwang Paleontological Museum on April 5,1985, there are more than twenty thousand samples in the museum at present. It has become a scientific base and by academic exchanges and international cooperations, the research work of Shanwang fossils is developing to a multidiscipline and synthetical study.

总论

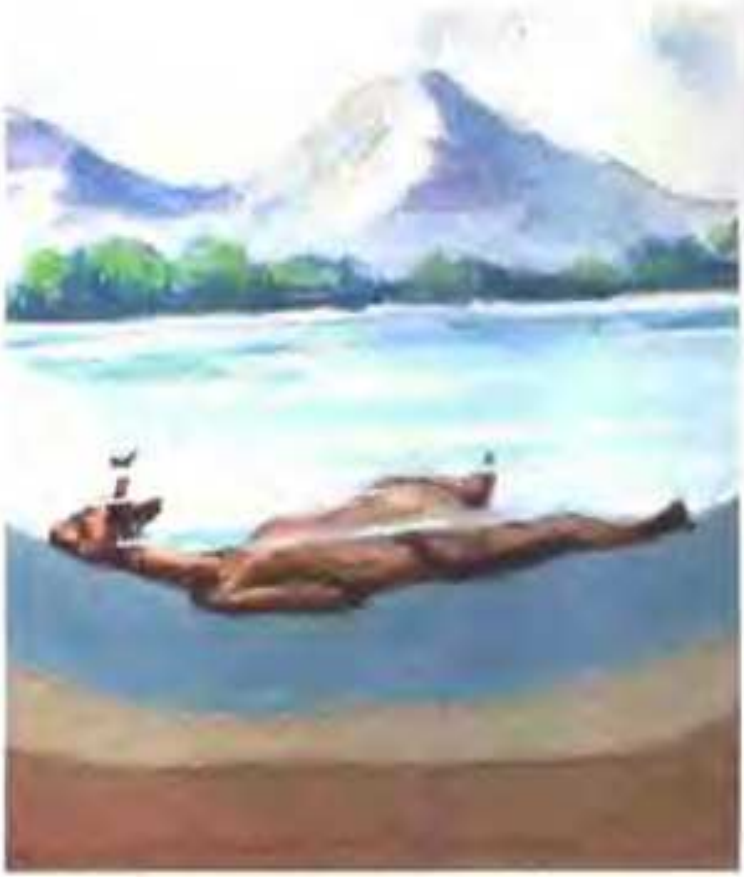
OVERVIEW

1.什么叫化石
WHAT IS FOSSIL

生物体或其遗物(如排泄物)埋入地下，在与空气隔绝无氧化分解作用，经过较长时间(通常以百万年计)的交代作用，地下水中的矿物质部分地或接近全部地将有机物质交代替换，使生物体或其遗物“岩石化”，但仍保留其外部形态和内部结构，这样就形成了化石。

生物的遗迹(如脚印)或生物体的印痕(如皮肤印痕)也能石化并保留其外部形态，一般称之为痕迹化石。

最早的化石定义要比现在的含义广泛得多，18世纪初，人们把地下挖出来的任何物体，不论是岩石，还是矿物，或者其它什么东西，都笼而统之称为化石。因此，当时的地质学家遂将拉丁文“挖出”(fossilis)一词转用于化石，过了不久，人们认识到岩石、矿物和古生物遗骸统称为“化石”有些混乱，就把化石(fossil)一词的含义只限于岩石 中保留下来的动植物遗体和遗迹。



a

The living organism itself or its excrements buried underground and under the condition of being completely cut off from air and without oxidation, went through a long time (generally counted in millions of years) replacement, the mineral materials replaced the organic matter, and the organism or its excrements became "petrified", but without altering the original substances, so the fossil formed.

The vestiges of organism (as footprint)or its molds (as skin molds) also could be petrified, it is generally called imprint fossil.

The term fossil was at first loosely applied to any excavated object found underground whether rocks, minerals or odds and ends, but it gradually came to be restricted to the organisms as now defined, including any recognizable organic structure or impression of the same,preserved from the geologic past.



b

化石的形成

Formation of animal fossils



c



d

a

动物死后，遗体被冲到湖里或低洼沼泽地带

This animal happened to die in a lagoon or swamp

b

遗体迅速被砂泥掩埋，不致受细菌的侵蚀，或氧化作用的破坏而腐烂消失

The body was rapidly covered by sediment and was protected from decay or destruction by oxidation and scavengers

c

在地下水的渗透作用下，矿物质代替了遗体的有机物，最后形成了化石

All or part of the organic structure of the skeleton was replaced by minerals in the water which filtered through the bones. The remains were thus preserved as fossils

d

化石因所在岩层被剥蚀或地壳变动而露出地面

The fossils were exposed when the rocks were weathered or disturbed by earth movement

2.中新世
MIOCENE

代 Era	纪 Period	世 Epoch	主要生物演化 Evolution of major life-forms	距今大约年代 Years ago
新生代 Cenozoic	第四纪 Quaternary	全新世 Holocene	现代植物 Modern plants　人类时代 Age of man	0.01百万年 (million)
		更新世 Pleistocene		1.64百万年 (million)
	第三纪 Tertiary	上新世 Pliocene	 	5.2百万年 (million)
		中新世 Miocene		23.3百万年 (million)
		渐新世 Oligocene		35.4百万年 (million)
		始新世 Eocene		56.5百万年 (million)
		古新世 Palaeocene	被子植物 Angiosperms　哺乳动物 Mammals	65.0百万年 (million)

中新世是地质年代学中的一个名称。它代表新生代晚第三纪的一个地质历史时期。其延续的时间大约为距今2330—520万年前。山旺组地层沉积时期即属于早中新世晚期。

中新世的气候比现在温暖得多，大部分现生动、植物在当时或已出现或其最近的祖先已产生，因此中新世是生物演化历程中的一个重要时期。

The Miocene is a term of Geochronology,representing a period of geological history in late Tertiary of Cenozoic. It lasted for as long as 23.3—5.2 million years BP.The sedimentation time of the Shanwang Series was in the later stage of early Miocene.

The climate in Miocene was much warmer than that of today. Most of the modern animals and plants either appeared or their close ancestors had already came forward at that time,therefore,Miocene is an important period in the evolutive course of the organisms.

3. 万卷书
THE BOOK OF TEN THOUSAND VOLUME



据临朐县志记载："县山东南五里，有作山麓溪间边有特别产状，曰"万卷书"……其质非土非石，平整洁白，层迭若纸，揭示，内现黑色花纹，有虫、鱼、鸟、草……花卉像状态。"

这里所说的"万卷书"乃是一种[illegible]的岩层，它由硅藻遗体和粘土构成，由于含有[illegible]，内含大量古生物化石，[illegible]，[illegible]可层层揭起，宛若书页，所以[illegible]称为"万卷书"。

According to the records of Annals of Linqu County: "Common saying, 5 li SE of the Lingshan Mountain there are special outcrops at the stream sides on the foot of the mountain which is called 'the book of ten thousand volumes'. Its texture is neither soil nor stone it is smooth and spotlessly white and appeared repealedly as paper layer when it has been uncovered, there are black patterns of insects, fishes, birds, beasts, flowers and so on."

What is called the book of ten thousand volumes here is a special bedded rock which is composed of remains of diatoms and clays, because it is as thin as papers and contains a large number of fossils and would become warped after slight weathering, and just like the book pages, then be vividly analogied as "the book of ten thousand volumes."

4. 地质概况

A SURVEY OF GEOLOGY



山旺组硅藻土页岩

山旺地区位于华北地台鲁西台背斜的东北部，昌乐凹陷的南端，其东侧为郯庐断裂带的主干断裂之一鄌郚—葛沟深断裂，西界为盐都大断裂。区内少有褶皱构造，发育大量NE—NNE向和NW向的断裂构造，它们均为郯庐断裂系的组成部分。

本区地势平缓，属低山丘陵地形，大部分海拔高度为200—400米。

山旺地区大面积分布的地层是新第三纪基性—超基性火山岩及沉积夹层，仅西南部出露有少量太古界片麻岩，一些盆地内有较厚的沉积岩系。鉴于新第三系剖面上火山岩地层占绝对优势，岩性地层单位应以岩浆活动的旋回性及其岩石组合特征为依据。根据这一原则，本区新第三系可划分为三个组，从下往上依次为牛山组、山旺组和尧山组。这些地区产状平缓，基本上没有褶皱构造，侵蚀切割强烈，发育一系列平行区域构造线方向的深切沟，沟内主要为厚层的第三纪和第四纪沉积物，因此可以推断，本区第三纪以来的构造活动以地壳整体抬升和断裂为主。

山旺盆地的平面形态为圆形，直径约一公里左右，是一个以牛山组玄武岩为基底的中新世盆地。其外围的地层主要由牛山组玄武岩组成，岩性单一，主要是致密块状碱性橄榄玄武岩，某些层位上含有较多的深源包体。盆地内出露的地层主要为山旺组，根据岩性组合特点可以划分为上、中、下三段。

下段地层出露于盆地边缘，呈环形分布，由下部的火山集块角砾岩及其上覆的次生火山角砾岩组成，上部可见少量沉积夹层和动植物化石碎片。地层厚度1—27米，局部可达50米，与下伏牛山组玄武岩整合接触。

中段的下部为硅藻质页岩、硅藻土、夹油页岩夹层，含有较多的磷结核和丰富的生物化石，常见薄层火山碎屑岩透镜体；上部为黄绿色泥岩、粘土质页岩，厚50米左右。与下段地层呈过渡关系。

上段的下部为碧玄岩(β)，上部为碱性橄榄玄武岩(β')，中间夹平均厚度约为一米的碳质页岩，厚约4—20米。

The Shanwang area is situated in the northeastern part of the plateformal antiform of western Shandong of the North China platform, and at the southern side of the Changle Depression. The east side is the main fault,the Tangwu-Gegou deep fault of the Tancheng-Lujiang fault Zone; and the western side is Yidu great faut.Few fold structure was found in this area, and a large number of NNE and NW faults developed, they all belong to the Tanchen-Lujiang fault system. The terrain slopes of the area gentlely, is a hilly land with an elevation generally of 200—400 meters.

The strata extensively distributed in the Shanwang area are the Neogene basic and ultrabasic volcanic rock and interbedded sedimentary rock, only a few Archean gneiss lie on the southwestern part, and there is rather thick sedimentary rock in several little basins. The Neogene system here which can be divided into three series from bottom to top successively are Niushan, Shanwang and Yaoshan series. The beds are dipping gentlely, there are not the fold structure on the whole and the beds are often affected by small faults, a series of deep gullies parallel to the main tectonic direction developed and deposited thick loess in them, thus, the inferences can be drawn that the tectogenetic movement took up lift and fault as the dominant factors.

The Shanwang basin is a roundshaped one with a diameter about 1 kilometer, and the basal bed of this Miocene basin is basalt of the Niushan series. Immediately above the Shanwnag series extends the protecting cap of basalt, mainly the fine and compact olivine basalt.The Shanwang series, main strata in the basin, can be divided into the upper, middle and lower sections.

The lower section of the Shanwang series is exposed around the basin, composed of volcanic agglomerate breccia. The thickness is 1—27m,and locally 50m. This part overlies the basalt conformably.

The lower part of the middle section are composed of diatomaceous shale, interbedded with oil shale, containing much phosphorite nodules and abundant organic fossils; and the upper part of is yellowish mudstone, clay shale, the thickness about 50 meters, transiting to the lower section.

The lower part of the upper section is basanite, and the upper part is alkaline olivine basalt, I meter of carbonaceous shale between them. The total thickness 4—20 meters

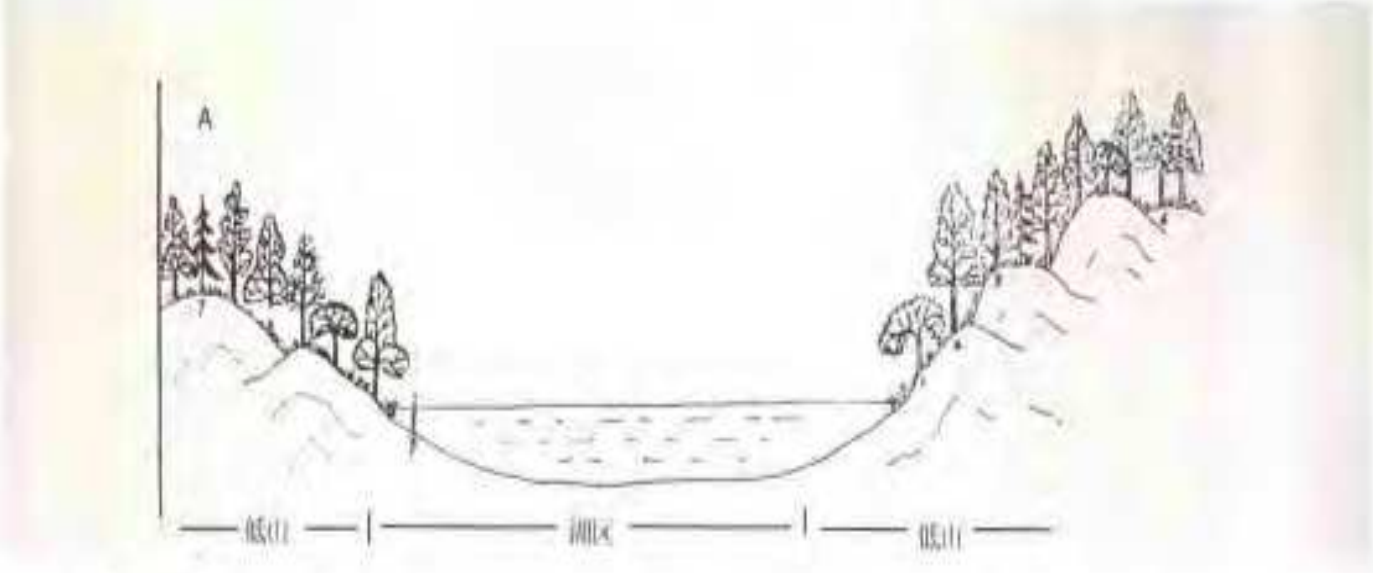


俯瞰山旺盆地地貌

5. 山旺湖演化的主要阶段
THE MAIN STAGES OF EVOLUTION OF THE SHANWANG LAKE

山旺湖是一个纵横约一平方公里的小湖盆，从地质历史的发展角度分析，在山旺组地层沉积之前，山旺一带正处于地壳运动活跃阶段，形成了大规模的多次火山喷发，在此基础上在山旺一带逐渐形成了一个四周高中央低的小凹地，随地壳活动的加强，该处不断下降，四周的水流逐渐汇聚于这一近圆形的小湖盆中，至此形成了山旺湖的雏形。

The Shanwang Lake was a lake basin one kilometer in length and breadth.Before the sedimentation of the Shanwang series, this area was at active period of crust movement. There were extensive volcanic eruptions many times, and on what had been formed, the Shanwang area shaped a depressed ground. Along with the enhancement of crust movement, this area had subsided gradually, and the streams all around co-verged in the lake basin, it was the embryonic form of the Shanwang Lake.



A. 山旺湖形成的初期

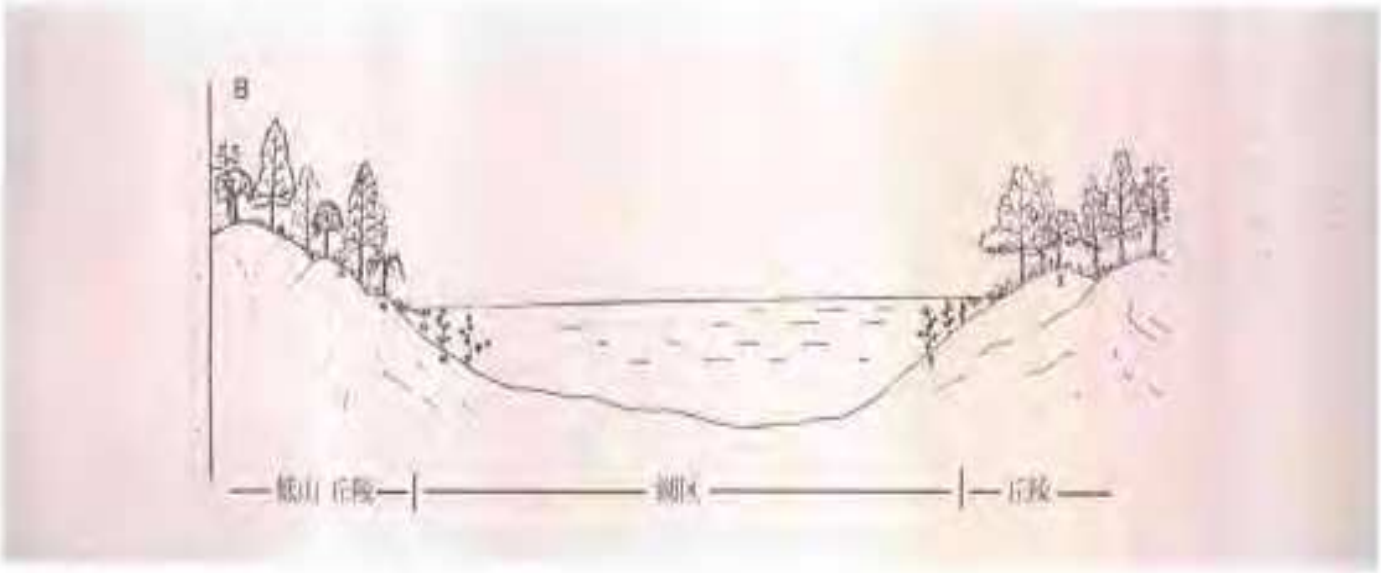
在地层上主要由一套粗碎屑的砂泥岩组成，中央数层薄层黑灰色泥岩及灰白色硅藻土，厚度由几十米至几米不等，多分布于湖的四周边缘地带。

此时湖水面积极小，地势高差较大，在四周较高的山地里则有较多的山地针叶树林，反映在孢粉植物群中山地针叶树种花粉的含量明显增多，相反一些喜湿热的亚热带成分如木兰、冬青则少见；山核桃属的含量也不如中期繁盛。水体面积尚小，一些水生的黑三棱、眼子菜、麦尚不常见；相反该阶段一些生态适应幅度较广的属种，如胡桃属、栎属等相对较多，因而在低洼的湖岸四周形成了以阔叶落叶林为主的植物景观，在湖岸浅水地带开始生长少量的黑三棱、眼子菜等水一沼生植物。从植物群的生态环境分析，大多数属种反映了南温带的特性，但也有一定数量的亚热带成分及少量的典型亚热带成分，所以此时的古气候应为北亚热带气候下的温暖期。

THE INITIAL STAGE OF THE FORMATION OF THE SHANWANG LAKE

Stratigraphically, it consisted of a group of clastic sandy clay, interbedded with thin dark-grey mudstones and grey-white diatomites, distributed in the border districts of the lake.

The space of the lakewater was rather small and the coniferous trees grew flourishingly at the mountainous regions all around, and in the lowlying lakesides, the broadleaf trees and deciduous-leaf trees as the dominant plant landscope and at the shallow lakewater near the borders, a few Burreed and potamoget on were developed. On the basis of the analysis of the ecological environment of the flora in this area, the climate at that time should be a warm period under the Northern Subtropical climate.

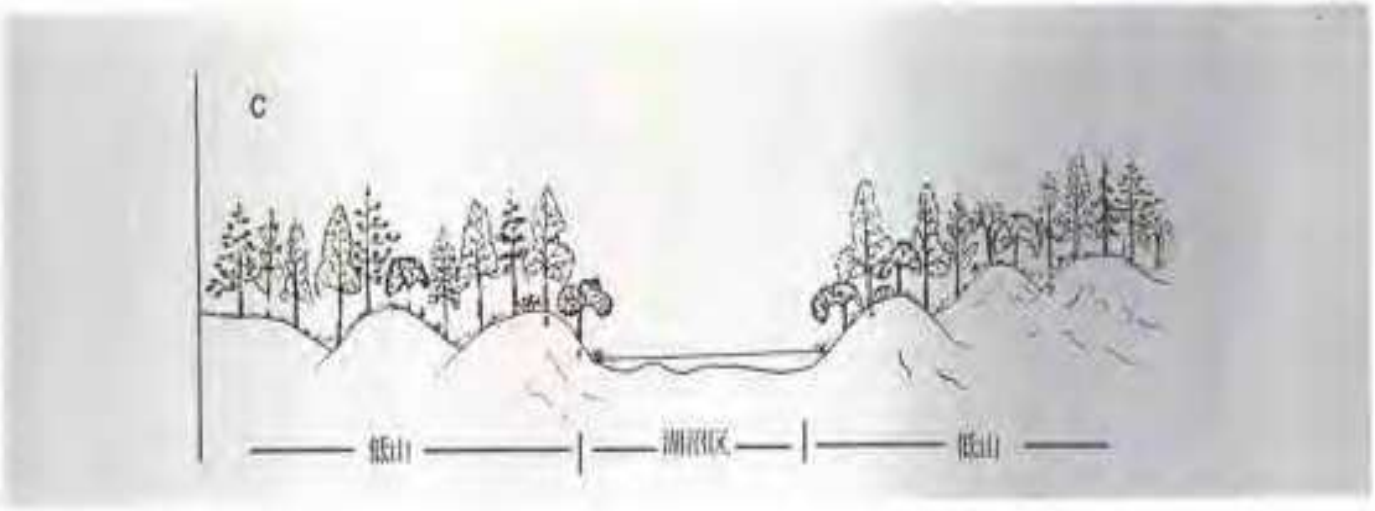


B. 山旺湖发展的全盛阶段

该阶段为山旺组地层的主体，一般厚度大而稳定，由一套细的灰白色硅藻土和杂色泥岩、页岩等典型的湖相沉积地层组成，因而该阶段湖盆面积最大，地势渐趋平缓，加之气候更为温暖湿润，使得性喜湿热的亚热带植物得到进一步发展，因而在湖岸四周的平原上形成了一片片郁郁葱葱含有常绿阔叶成分的落叶阔叶混交林。只在距湖较远的四周低山丘陵地带才长了一些以松科各属为主的山地针叶树，形成了针叶阔叶落叶混交林。由于气候温暖雨量充足，在湖岸浅水地带开始繁盛一些水生草本植物，在湖中尚有一些蕨科植物生长。此时的古气候较早期更加温暖湿润，古气候带上划归北亚热带的暖湿期。

THE PRIME STAGE OF THE DEVELOPMENT OF THE SHANWANG LAKE

In this stage, the main part of the strata of the Shanwang series was developed. On the whole, the stratigraphical units thick and stable, are composed of a set of grey-white fine diatomite, parti-coloured mudstone and shale, thus the space of the lakebasin was greatest in this stage, the terrain slopes of the place were gradually gentle and the climate was further warm and moist, there were mixed forests of broadleaf and deciduous leaf trees that contained evergreen broadleaf component parts. Only at the hilly land far around the lake, some coniferous trees mainly Pinus were developed. Owing to the warm climate and rich rain water, some aquatic herbaceous plants came to grow and some Trapaceae plants developed in the lake. The climate at that time in the Shanwang area was further warm and moisten, it was a warm-moist period of the Northern subtropical zone.



C. 山旺湖衰亡阶段

此时由于地壳运动复趋活跃，一次又一次的火山喷发，地势高差分异再次加大，使湖泊面积大大缩小，湖水变浅，局部出现了沼泽。所以该阶段地层分布非常局限，厚度很小，主要岩性为黑色炭质页岩及杂色泥岩，反映了湖泊沼泽相的沉积类型。从孢粉植物群看，再次出现了山地针叶树种相对增加的趋势，喜静水生活的菱科植物消失，一些陆生草本植物的含量明显增加，而亚热带成分较中期显著减少，气候上反映了温带气候的因素加强。从整体上仍不失为亚热带古气候。所以该阶段可以称为亚热带的温凉期。

总之，山旺湖兴衰演变过程大体上受地壳活动的控制和气候变化的影响。在山旺湖形成阶段古地理表现为低山丘陵，湖盆面积不大。古气候处于亚热带的暖湿期。古植被为针叶—落叶阔叶混交林。山旺湖的发展及全盛阶段，由于地壳活动相对平静，湖在不断下沉，加之降雨量增加，湖水面积进一步扩大。古气候处于亚热带的暖湿期。古植被表现为含常绿成分的阔叶落叶林。在山旺湖的消亡时期由于火山喷发，地壳运动复趋活跃，湖区全面抬升，形成残湖—沼泽。古气候反映为亚热带的温凉期。

THE DECLINE STAGE OF THE SHANWANG LAKE

As the crust movement became active again at that time, the volcanic eruptions broke out repeatedly,the difference of heights of topography in this area enhanced,that caused enormous losses to the lake area, and the marshlands appeared locally,therefore, the strata of this stage are very limited and thin,the main rocks are dark carbonaceous shale and particoloured mudstone, reflecting the sedimentary style of marsh.The sporopollen statistics shows that the species of the mountainious coniferous vegetation increased relatively again, and the Trapaceae plants disappeared, some terrestrial plants obviously increased but their subtropical composition was reduced, thus this stage may be called a pleasantly cool period of the subtropical zone.

To state succinctly, evolution of the Shanwang Lake was controlled by the levels of crust movement and the climate variations on the whole.

6. 研究简史与现状

BRIEF HISTORY AND PRESENT SITUATION OF THE RESEARCH

1934年秋，就职于中央地质调查所新生代研究室的杨钟健和卞美年到山东泗水、新泰一带工作，途经济南时，前往齐鲁大学(现山东大学)拜访地质系主任施寇特(Scott)教授，杨钟健和卞美年在参观陈列室时曾看到采自山旺的鱼和植物化石，唯当时未觉其重要，当结束了泗水、新泰工作返回北京后，反感此化石之重要。

1935年春，当时的中央地质调查所所长翁文灏得知山东昌乐一带发现"龙骨"，杨钟健也曾认为昌乐一带地层中可能产恐龙化石，随即杨钟健奉派赴昌乐一带调查。

至济南，杨钟健再次造访齐鲁大学施寇特教授，详询山旺化石发现经过及产地情况。据施氏介绍，化石系产自山旺村之东北1—1.5公里处，是1900年(清宣统元年)12月由保罗·贝尔金(Paul Berge)采自临朐县山旺村之东北解家河，经由滕县海斯(Hays)博士转赠齐鲁大学的。

In the Autumn of 1934, Young Chung-chien and Bian Meinian, in the employ of the Cenozoic Laboratory of National Geological Survey, went to the Sishui-Xintai area of Shandong Province for field work. They paid a visit to Professor Jas Cameron Scott, Chief of the Department of Geology of Qilu University, they noticed the fossil fishes and plants in the exhibition hall of the department, but they had no time to pay attention to them, and when they returned to Beijing, they thought highly of these fossils.

Later on, in Spring 1935, Weng Wenho, the Director of the National Geological Survey, was informed that some "dragon bones" had been recently unearthed in Changle, Shandong, andYoung Chungchien also considered it is possible to find dinosaur fossils in the Changle area, then he set out to condact a research into this case.

When he visited Prof. Scott again in Jinan Young acquired detailed situation of the Shanwang fossils. As far as Scott knowing, the fossils recovered in the place 1—1.5km N.E. from the Shanwang village, they were excavated by Paul Berge in 1900 and he handled these fossils to Hays who lived in the Tong County at that time, then the fossils were attributed to the Qilu University.



杨钟健教授(1897—1979)



杨钟健等在山旺(1935年)

杨钟健偕技工三人遂追索至临朐县城东之山旺村，借宿于一周姓家，周家对杨等礼遇有加，极为敬重。

杨钟健对山旺之行曾做如下描述："出山旺村为一山脊，至解家河岸边，见河西有页岩出，细审之，叶、花、昆虫、鲋鱼等化石甚多，更往西有黄砂及页岩，内含玄武岩弹甚多，其中见有龟及哺乳动物化石碎块。"

杨钟健等此行收获颇丰。

1936年3月杨钟健将已完成的报告及对蛙、鱼化石的研究论文交《中国地质学会志》，同年6月正式发表。杨钟健在论文中首创"山旺统"地层单位名称，将"万卷书"译为"Wan chuashoe"并解释为"the book of ten thousand volumes"。杨钟健将所采的硅藻化石交由斯克瓦顷夫(B.W.Skvortzow, 1937)研究，植物化石由胡先骕研究，鱼类化石由杨钟健和张春霖合作研究，龟鳖类化石交给了卞美年。有关论文多于1936—1937年刊出，唯龟类化石的研究报告迄今未能问津。

1936年5月阮维周及方俊在临朐调查硅藻土储量时，又采到一些化石，他们将哺乳动物化石交与杨钟健研究发表。

1937年6月杨钟健与钱耐(R.W.Chaney)再赴临朐调查采集。同年因日本军国主义发动侵华战争，不得不停止野外工作，室内工作也因中央地质调查所西迁而停辍，只有德日进

Thereupon, Dr. Young, in the company of three skilled workers, traced to the Shanwang village, put up for nights in a Chow's family, and they were accorded courteous reception.

Dr. Young described what he was during his research in Shanwang: "At this place, the fossiliferous series is exposed as a narrow and limited strip along a valley the series..., Just as the shales, the sandy-gravel of Shanwang is fossiliferous, but instead of plants and small animals, it contains rich remains of large mammals."

This trip of Young and others rewarded rich harvest.

During the March 1936, Young Chung-chien delivered the survey report and the thesis about the Shanwang's fossils of frogs and fishes to the Bulletin of the Geological Society of China, and published in June of the same year.Young initiated the stratigraphical unit of "Shanwang Series", and explained the "Wan Chuashoe" into "the book of ten thousand volumes". The botanical study of the diatomaceous earth had been undertaken by Dr. B. W. Skvortzov (1937), the plant fossils had been recognised by Dr. Hu Xiansu, the fish fossils were studied by Young Chung-chien and Zhang Chunlin, and the turtle fossils had been delivered to Bian Mienian. The relevant treatises published in 1936-1937, only the study of turtle fossils still not come out.During June of 1937,Young Chung-chien and R.W.Chaney went to Linqu again to collect fossils. They had to give up the field work because the invasion of Japanese militarism, and the work of laboratory was stopped for the National Geological Survey moved to West China, but Drs.Teilhard de Chardin, P. and Chaney did some relative study in Beijing and U.S.A. separately.

In 1939, Teilhard de Chardin,P. published his academic

(Teilhard de Chardin,P.)及钱耐分别在北京和美国作了些工作。

1939年德日进研究发表了题为“山东中新世鹿化石”的论文。

胡先骕和钱耐系统地描述了山旺地区的古植物群及沉积特征。其研究成果分别于1938年11月和1940年10月出版。此后，山旺化石的研究工作中断了一段很长的时间。

解放后，一些生产单位和地质部门曾先后对山旺盆地的矿产资源及地质概况做过多次调查和踏勘，50年代后期，地质及古生物工作者来临朐开展工作，北京地质学院师生在山旺进行

thesis "The Miocene Deer Fossil in Shanwang, China."

Drs. Hu Xiansu and Chaney described systematically ancient flora and sedimentary features of the Shanwang area, and published during Nov.1938 and Oct.1940 separately. Afterward, the study of Shanwang's fossils was suspended for a long time.

After the founding of the P.R.C., some mining and geological units have done survey and reconnaissance of the mineral resource of the Shanwang Basin repeatedly in the late 1950s, many working personnel of geology and paleontology



1935年[illegible]教授在山旺野外采集

区域地质调查时，又先后发现了一些植物、爬行类和两栖类化石。随着硅藻土的开发利用，工人曾发现了不少珍贵的标本，如皮毛犹存的硅藻鼠，中国第一只完整的鸟化石——山旺山东鸟等。



室内修理 *Lagomeryx* 化石

came to Linqu to develop work. The teachers and students of the Beijing Gieological College found some fossils of plant,reptile and amphibious animals. Along with the exploration of the diatomaceous earth, the mining workers had found many precious fossils such as Diatemys shanwangensis which still preserved its skin and hair, and the first intact bird fossil of China, the *Shandongornis shanwangensis*



周明镇（左）和胡承志教授1978年在山旺

60年代末，胡长康(1969)发表了"山东临朐皇冠鹿和无角犀零星材料"，宋之琛(1969)发表了"山东山旺中新世地层中的孢粉组合"，60年代初，孙艾玲(1961)研究发表了"山东山旺中新世蛇化石"，张席提(1963)发表了"山东山旺中新世硅藻土的形成环境和古生物群分析"……在近十几年内约有50余篇(册)研究报告发表，论文涉及古生物学的各个门类及古生态、古环境、古地磁、绝对年龄、火山岩等诸多学科。山旺化石研究的过程是从单一属种的描述和鉴定，逐渐趋向多学科的综合研究。从30年代杨钟健教授开始，到1978年中国古生物学会在临朐山旺召开现场会，其间山旺化石的研究工作进展比较缓慢，研究面也较窄，大部分集中在脊椎动物的单属、单种的研究描述。1978年以后到现在，这段时间短，发展快，特别是中国古生物学会在山旺召开现场会以后，关心重视山旺的人越来越多，国内外地质古生物学家不断地考察了解山旺，尤其是近几年，山旺化石的研究工作进展较快，研究范围越来越宽。

In 1969, Hu Changkang published "The Fragmentary Material of Stephanocemas cf. thomsoni and Plesiaceratherium in Linqu, Shandong". In the same year, Song Zhishen published "Sporopollen spectrum in the Miocene strata in Shanwang, Shandong". In the early 1960s, Sun Ailing published "The Miocene snake fossils in Shanwang, Shandong", besides, Zhang Xiti published "The evolved circumstances of Miocene diatomite and analyse of the Paleobiocenology in Shanwang,Shandong". In recent ten odd years, there are over fifty research reports have been issued that concerning every category of paleontology and paleoecology, paleoenvironment, paleomagnism, absolute age, volcanic rocks and other disciplines.



地远眺



中国古生物学家在山旺野外采集

1981年中国科学院地球化学所对山旺地区新生代玄武岩进行了研究(王慧芬等，1981)他们解释了山旺地区的沉积环境和化石的成因。

古生物化石的研究包括古植物(真菌、硅藻、孢粉、裸子植物、被子植物)、蜘蛛及昆虫和古脊椎动物。

The course of the study of Shanwang fossils is from the description and identification of the unitary genus and species gradually tending to a synthetical study. From the study of Prof. Young Chung-chien in the 1930s to 1978, the study of Shanwang fossils during this time was rather slowmoving,and the subject concentrated on the vertebrate fossils.From 1978 till now, the scope of the Shanwang study is widespread.

In 1981, Wang Huifen and others, in the Institute of Geochemistry, the Chinese Academy of Sciences, engaged in research of the Cenozoic basalt in the Shanwang area, and explained the sedimentary environment and the cause of formation of the fossils.

The paleontological study includes paleobotany (funguses, diatom, pollen-spore, gymnosperm, seedplant), insects and vertebrate paleontology.



裴文中和卢衍豪教授在野外观察山旺化石

分类概述

SYSTEMATIC OUTLINE

1. 山旺植物群

THE FLORA IN SHANWANG

山旺植物群包括苔藓、蕨类、裸子植物、被子植物，其中以鹅耳枥属、槭属为优势属，其次为榉属、山核桃属、金线梅属、弗特吉属等，偶见有华旌节花、拟银鹊树、香椿等。

山旺的植物多以叶或小叶保存下来，但也发现不少的果实和种子：如槭属的翅果，苗檢属的种苞，栾属的膀光果，梧桐属的蓇果，油杉属的种子等。

山旺植物群计有乔木87种，灌木24种，木质藤本7种，草本植物24种(包括水生的金鱼藻、眼子菜及生于湖边的蓼科、禾本科及莎草科植物等)。山旺植物群的植物种类，绝大多数属于落叶阔叶者，其中最丰富的代表种几乎全为落叶型植物。

从山旺植物群的组合分析，一千八百万年以前，山旺盆地是一个浩水茫茫的浅水湖，湖中有金鱼藻、眼子菜(皆为浅水植物)，湖边有蓼科、禾本科及莎草科植物，湖周及山坡具亚热带特色的森林，葱葱郁郁。

山旺的植物化石极其丰富，到现在为止，除近100种藻类外，已发现植物142种，分属46科98属。苔藓、蕨类、裸子植物，各1种，被子植物139种，其中单子叶植物3种。在双子叶植物中，既有典型的温带植物，如槭树科、桦木科、榆科、杨柳科、蔷薇科等，也有分布于亚热带的常绿及落叶阔叶植物，如樟科的樟属、木姜子属、山胡椒属，无患子科的无患子属，金缕梅科的华枫香，金缕梅属，豆科的皂荚和羊蹄甲属，胡桃科的山核桃属，省沽油科的银鹊树属(*Tapiscia*)，大风子科的山羊角树属(*Carriera*)和榆科的麻楝属(*Chukrasia*)等，是典型的温带或亚热带低—中山区分布的植物。

山旺植物群的现代近似种主要分布在亚洲，并多集中在我国长江流域一带，尤其长江南岸的庐山、黄山、湖北省的神农架地区。这说明在1800万年前的山旺地区，年平均温度比现在高，年降水量比现在也大，属温暖湿润亚热带气候。和山旺植物群相似的类群，同样出现在日本的中新世地层中，这证明中新世时我国山东和日本属于相同的气候带，具有相似的气候特点。

The plants of Shanwang consist of bryophyte, pteridophyte, monocotyledon, dicotyledon. The Carpinus and Acer are regarded as the superior genera, and the Zelkova, Carya, Antenoron next. Occasionally, the plants in Shanwang are preserved by leaves or microphylls, but a fairly amount of fruits and seeds have been found, such as the pterodium of Acer, the seed profuses of Ulmus, the fruits of Koelreuteria,



山旺盆地中新世植物景观复原图



Plants in Shanwang Basin at Miocene

the gourds of Firmiana, and the seeds of Keteleeria.

The plants in Shanwang numbered 87 species of arbors, 24 species of bushes, 7 species o dinochloa, 7 speceies of herb. The bulk of Shanwang flora belonged to fallen leaf and broadleaf trees, among them, the representative species were almost the fallen leaf plants.

Based on the analysis of the plant assemblage of Shanwang, the Shanwang Basin was a widespread shallow lake before 18 million years. There were Antirrhinum and Potamogeton in the lake, and at the borders of the lake the Polygonaceae, Gramineae and Cyperaceae existed, and all around the lake and the hillslopes, the subtropical forest grew luxuriantly.

The fossil plants in Shanwang are rich and varied. Up till now, 142 species of plants have been found (besides nearly 100 species of algae), belonging to 46 families and 98 genera respectively. The bryophyte and pteridophyte each has one species, the gymnosperm has 4 species, the angiosperm has 139 species in which the monocotyledon has 3 species. Both the typical plants of temperate zone such as Aceraceae, Betulaceae, Ulmaceae, Salicaceae and Rosaceae, and the subtropical plants such as Cinnamomum, Litsea, Lindera of the Lauraceae, the Ficus of the Moraceae, the Sapindus of the Sapindaceae, the Liquidambar, Hamamelis of the Hamamelidaceae, the Gleditsia and Pueraria of the Leguminosae, the Carya of the Juglandaceae, the *Tapiscia* of the Staphyleaceae, the *Carriera* of the Flacourtiaceae exist in the dicotyls.

The modern species similar to the Shanwang flora mainly dirtributed in Asia, and concentrated in the Huanghsan, the Lushan the Shengnongjia Mountains in the southern shores of the Yangze River, the fact shows that the annual mean temperature of the Shanwang area 18 million years ago was higher than that of it now, and the case of the annual precipitation is the same , the climate at that time belonged to subropical, besides, the flora appeared in the Miocene of Japan like the Shanwang flora, it indicates that the Shandong Province and Japan belonged to same climatic zone in Miocene.

硅藻

DIATOM

硅藻是藻类植物中属种最多的一类单细胞植物。山旺硅藻土中的硅藻化石，属种繁多，数量丰富，保存极其完好。在发现的15属95种和变种化石中，约85%现在种，15%的绝灭种或是山旺湖特有种。化石群中的优势种是直链藻属(*Melosira*)的一些种，其次是羽纹藻(*Pinnularia*)等。在古山旺湖的深水处，有浮游直链藻，浅水处大量出现岩岸底栖型硅藻(舟型藻、羽纹藻等)，近岸处有数量可观的寄生或附生的桥穹藻、异端藻等，这充分显示了该湖当时范围不大，水浅而稳定，是一富营养型的较为典型的淡水湖泊。

硅藻土是由硅藻壳体堆积而成，不同的壳体上具有各异的孔纹构造，因而使硅藻土有极强的吸附作用。

The diatom is a unicellular plant, and a kind of algae hold a maximum of genera and species.The diatomaceous fossils in Shanwang are abundant and well-preserved, there are 95 species and some variants have been found, among them, about 85 species are extincted or peculiar to Shanwang. The dominant species here belong to the *Melosira*, and then the *Pinnularia*.

In the deep places of the ancient Shanwang Lake, the planktonic melisira lived, and the benthonic *Nayicula* and *Pinmularia* appeared in a large number in the shallow water, and there were a considerable number of *Cymbilla* near the lakeshore .It shows that the lake limited in scope and was a nourishing freshwater one.

The diatomite was accumulated of the shellbodies of diatom, the different shell body with respective porosities and with the result that the diatomite possess strong absorption.



山东桅杆藻（*Fragilaria shanwangensis*）

简记：壳面线形或线状椭圆形，末端钝圆形。长25—45微米，宽9—10微米。轴区呈不规则线形或发育不完全。线条纹较粗，呈平行排列，70微米中有10—11条。

山东桅杆藻与*Fragilaria bicapitata* 在外形特征上颇为相似，但内部构造不同。前者的轴区断续出现，很象轴区的原始发展阶段，后者是明显的窄线形，线纹数也略有差异。

Valve linear or linear elliptical with round end. Length 25—45μm, breadth 9—10μm. Striae robuste and 10—11 parallel in 70μm.

The *Fragilaria shanwangensis* is similar to the *Fragilaria bicapitata* Mayer in external form but different in interior structure.



▲山东桅杆藻(*Fragilaria shanwangensis*)

山旺舟形藻(*Navicula shanwangensis*)

简记：壳面阔椭圆形，末端呈短喙状顶缘较平的圆形。长38—44微米，宽23—25微米。轴区窄，呈线披针形，中央区扩大近圆形。脊缝呈较宽的线形。线条纹射出状排列，线条粗，由密集点组成。点线条近末端呈明显的聚集状排列，在中部10微米中有6—7条，在末端10微米中有10—11条。此种与*Navicula meridicpacifica*的外形特征颇为相似，但前者点条纹粗而稀，中央区近圆形，后者点条纹密，点非常明显，中央区横向扩大。其点线纹的排列特征与*Navicula semen*相似，尤其是末端线纹的排列更为相近，其它特征又不相同。

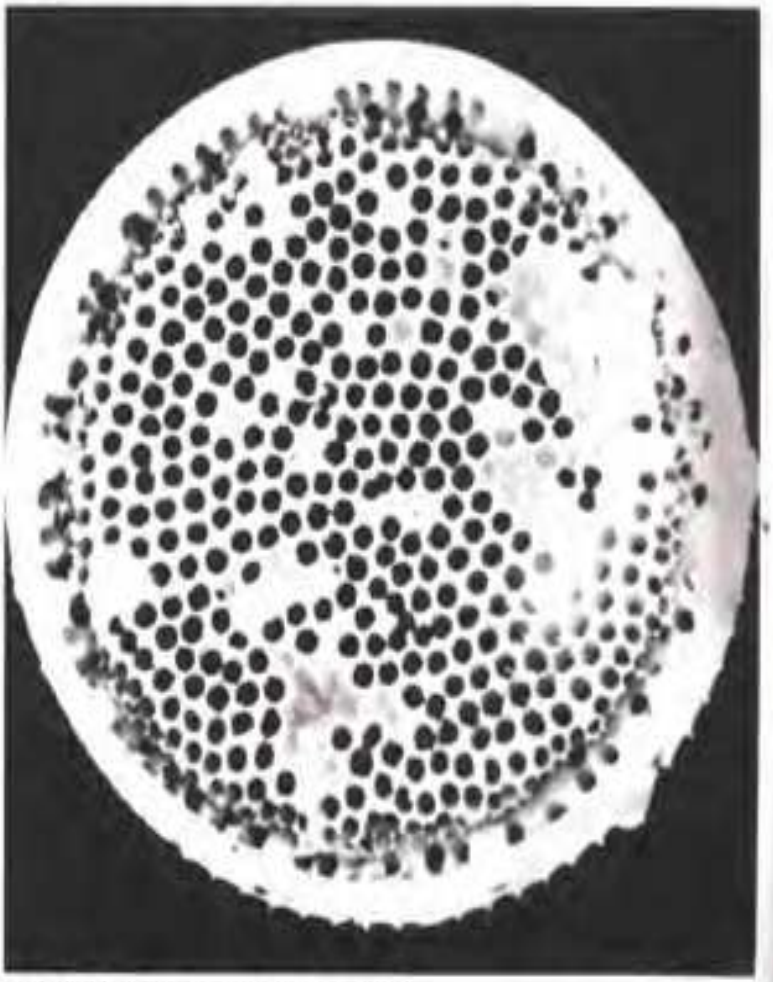
Valve broad elliptical, length 38—44μm,breadth 23—25μm. Striae fobuste and 6—7 in 10μm in the middle part, and 10—11 in the end.

山东桥穹藻(*Cymbilla shanwangensis*)

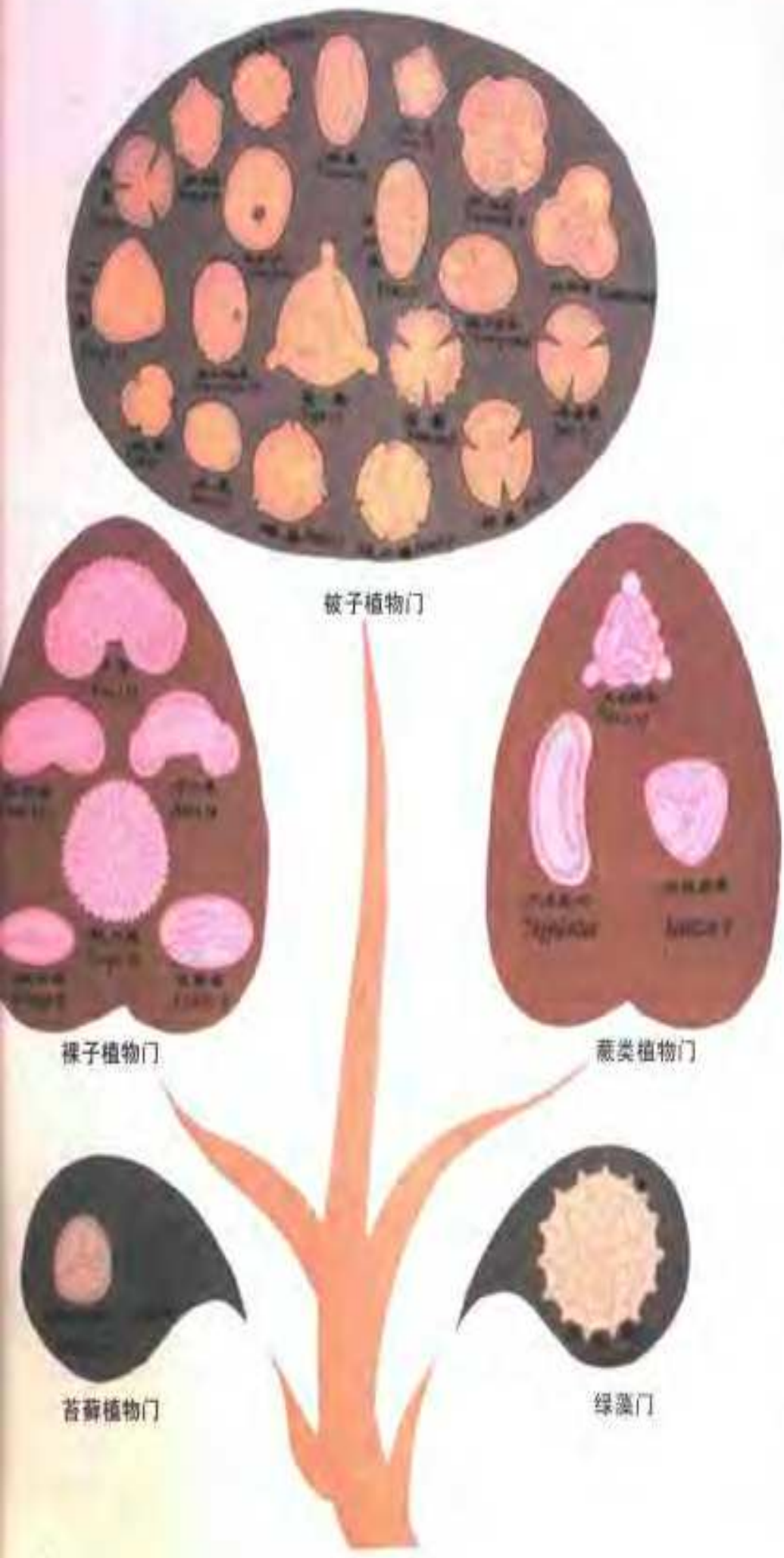
简记：壳面宽披针形，背缘拱形，腹缘在中部明显凸出，形成三曲波形，末端呈略尖的圆形，长48—55微米，宽17—20微米。轴区线形，中央区几乎扩大。脊缝呈扁心的线形。线条纹射出状排列，由密点组成。在10微米中有22—24个点，线纹10微米中有11—12条。

Cymbilla shanwangensis 与 *Cymbilla schmidtii* var. *conifera*有些相似，但后者腹缘呈不明显的三曲波形，线纹也少。外形特征又与*Cymbilla ehrenbergii* var. *hungarica* f. *ventricosa* 相近，但内部线纹和轴区等特征差异较大。

Valve boat-shaped, length 48—55μm, breadth 17—20μm. Striae 11—12 in 10μm. The *Cymbilla shanwangensis* is somewhat like the *Cymbilla schmidtii* var. *conifera*, but the ventral edge of the latter assumes faint triplicate curve shape and less striae.



▲远距直链藻（*Melosira distans*）



孢子花粉
SPOROPOLLEN

孢子是苔藓和蕨类植物的生殖细胞，而花粉是种子植物雄性生殖细胞。山旺硅藻土中有藻菌类、蕨类孢子，有松、云杉、铁油杉、冷杉、落叶松、油杉、柏、麻黄属等裸子植物花粉，被子植物花粉，不但种属多，而且数量大，其优势种属有山毛榉科的栎属，榆科的榆属，朴属、榉属，胡桃科的山核桃属、胡桃属，金缕梅科的枫香属及桦木科各属，还有腊瓣花属，山黄麻属，杨梅属，杜仲属，冬青属。这些花粉的母体植物的现代分布区，主要在暖温带至亚热带地区，山旺盆地出现的冷杉、云杉花粉系远山区较高地势处生长的裸子植物的花粉经风的搬运而至。

Spores are the reproductive cells of Bryophyte and pteridophyte, and pollens are the male reproductivc cells of the seed plants. There are spores of algae and pteridophyte spores and pollens of gymnospermand angiosperm in the diatomaceous earth in Shanwang, that not only are abundant in genera, but also have numerical superiority, the superior families and genera are the *Quercus* of the Fagaceae,the *Ulmus* and *Celtis* of the Ulmaceae, the *Carya* of the Juglandac, the *Liquidambar* of the Hamanelidaceae and various genera of the Betulaceae. The maternal plants of these pollens in present distributive areas mainly in warm temperate to subtropical zones. The *Picea* and *Abies* pollens appeared in the Shanwang Basin were carried by wind from the plants grew at the far mountain areas.

大植物
PLANT

▶ 尾金鱼藻(*Ceratophyllum miodemersum*)

为水生草本。茎细长，在化石中茎的保存长度达40多厘米。叶在节上轮生，1—2回二岐分叉，裂片丝状，长1—2厘米。

Aquatic herb, stem slender, some stems preserved in the fossil has reached 40 odd cm, Verticellate leaves and dichotomy. The lobes filiform, length 1—2cm.

▼ 北海油杉（*Keteleeria ezoana*）

叶条形，长3.1厘米，宽0.33厘米，基部圆形，微偏斜，顶端钝。中脉直行。到顶端变细。带翅的种子近圆形，长6—7毫米，宽5—7毫米，顶端具木质子翅，呈长三角形，最宽在中下部约0.8—1.2厘米，长1.4—2.0厘米。翅的末端钝。

Leaves strip-shaped, length 3.1cm, breadth 0.33cm, leaf base round and lightly slanting, leafapex blunt. The central vein goes straight and becomes slender to the apex. The winged seed nearly round, length 6-7mm, breadth 5-7mm, the crown of the seed with woody wing that is long triangular in shape,breadth 0.8-1.2cm, length 1.4-2.0cm, the end is blunt.







◀ 忍冬叶弗特吉(*Fothergilla viburnifolia*)

叶菱状倒卵形，长3.6—8.8厘米，宽2.6—5厘米，顶端渐尖，基部窄圆形，微不对称。仅叶的上部边缘具疏齿，叶柄粗壮(多保存不完全)。为不对称的离基三出脉或三出脉，中脉细长，微折曲，基部一对侧主脉，一侧伸至叶全长的一半以上，另一侧仅伸至1/3处，侧主脉具几条外脉，间距整齐，沿着叶缘形成环，侧脉3—4对，互生，以45°角从中脉生出，微弯曲，伸达叶缘齿尖；三次脉一般以近直角从侧脉生出，间距整齐，在侧脉近顶处有的分枝进入叶缘齿尖；细脉形成明显的多边形网眼。

Leaves rhombic, length 3.6—8.8cm, breadth 2.6—5.0cm, the leafapesx gradually sharp, leafbase narrow round, leaf stalk strong. Unsymmetrical trinervious veins, the central vein slender and slightly winding.

▼大叶板栗(*Castanea miomollissima*)

叶长卵形，长7—14厘米，宽2.9—4.9厘米，顶端急尖，基部宽楔形至圆形，微不对称，一侧不下延。叶柄粗壮，长1厘米。叶缘具齿，齿尖具细长刺。中脉强壮，直或微弯曲；侧脉10—12对，与中脉的夹角为45—55°，在近基部夹角更大，直行达缘脉序；三次脉连接于侧脉间，间距稀，近垂直于侧脉，在近叶缘处形成环；细脉网状。

Leaves long ovatus, length 7—14cm, breadth 2.9—4.9cm, leaf apex sharp, leaf base broad cuneiform to round. The leafstalk thick and strong, 1cm long, the leaf margin with leafteeth. The central vein strong, 10—12 pairs of lateral veins, with 45—55° angles to the dentral vein.



▼ 胡桃属(*Juglans* Linn.)

落叶乔木。叶为奇数羽状复叶，小叶长卵圆形或卵状披针形，侧小叶大多具宽叶基，少数叶基较狭，叶缘具齿或全缘，小叶顶端的侧脉伸入叶齿，其余侧脉沿叶缘向上伸展，并彼此相连，亦有全部侧脉俱伸入叶齿者，大多数侧脉不分支，第三次脉较密集且规则，在相邻侧脉间形成长方形网格。果实为核果。卵形或球形，外果皮富于纤维质，内果皮骨质，具不规则的皱褶，或近于平滑，有2—4室，二瓣裂，种子有薄种皮，基部二裂，顶部四裂。本属的叶与山核桃属的叶较难区别。

本属的某些种的叶是全缘的，一般顶端狭小，叶片较大，侧小叶多为长卵圆形，侧脉常向顶端呈弧形伸出。

Deciduous arbor, leave feathery compound, the leaflets ovatus, the lateral leaflets mostly have broad leafbases.The fruit is drupe, ovate or round.The exocarps are rich in fibre and the endocarps are bone matrix with irregular folds or near smooth.



▲胡桃*Juglans* sp.

▼ 桦木属(*Betula* Linn.)

落叶乔木或灌木。单叶，互生，有柄。叶卵形或椭圆形，亦有呈圆形者。叶顶尖，叶基圆形、截形或心形，叶缘有重锯齿，或为圆齿或缺刻，叶基部全缘，羽状达缘脉序，侧脉有时稍向下弯曲(特别是近基部几对)，个别的微呈弧形，近基部几对侧脉常对生，且具外脉，在侧脉间缺少明显的横的梯状网结脉，而是形成小的多角形的脉网。柔荑花序。果实为小坚果，有膜质的翅。

Deciduous arbor or shrub. Simple leaf, ovatus or elliptic. Leaf apex sharp, leaf base round, the leaf margins have double leafteeth.





▲枫杨(翅果)*Pterocarya* sp.



▶鲁葛藤(*Pueraria miothunbergiana*)

叶为三小叶组成的复叶，顶生小叶及侧生小叶均有发现。顶生小叶近圆形，长约8.5—1.85厘米，宽5.5—16厘米，顶端不全，明显地渐尖，基部宽圆形，有时具不明显的浅裂。叶全缘或微波状，叶柄粗壮(保存不全)。掌状3出脉，中脉直，侧初生脉以50—60° 角分出，微弯曲达小叶中部以上；侧脉5对，以40—45° 角从中脉生出，近边缘急弯曲，与叶缘平行后消失，自侧主脉伸出外脉6—9条，弯曲伸向叶缘，外脉近边缘整齐分支达缘；边缘三次脉不整齐地连接于次生脉间，间距大。质地坚硬。侧生小叶基部不对称，中脉弯曲，其它特征同顶生小叶。

Leaves compound, leaf stalk strong, palmately tricussate veins. The central veins straight, 5 pairs of lateral veins with 40—45 angles from the central veins.

◀华山核桃(*Carya miocathayensis*)

奇数羽状复叶，小叶5—7个，大小不等，一般叶轴最下一对较小，其它向上渐次增大，小叶均无柄，一般长5—15厘米，宽2—4.6厘米，顶生小叶常呈倒卵状披针形，基部渐狭，呈楔形，其它小叶多为卵状披针形，顶端长渐尖，基部微不对称，圆形或宽楔形，叶缘具明显锐锯齿。中脉微弯曲；侧脉15对以上，多在20对左右，弧曲，近叶缘处分支，小的分支进入叶缘齿，侧脉与中脉的夹角为70° ，近叶基的夹角较大；三次脉不整齐，连结于二次脉间，与侧脉近于垂直。叶质地坚硬。核果近球形，顶端微突出，长2.7厘米，径约2.3厘米，壳厚近2毫米。在内侧显示出纵肋，具2瓣核仁，长1.5厘米，宽2毫米。

Leaves feathery compound, 5—7 leaflets without leafstalk and Length generally 5—15cm, breadth 2—4.6cm. The quality of leaf is hard, and the drupes near globular, slightly protruding at the tops, with length 2.7cm, diameter about 2.3cm, thickness of the crust near 2mm.



▶多花蕊(*Berchemia miofloribunda*)

叶卵形到阔卵形或卵状椭圆形，长3—11厘米，宽2.3—7.1厘米，顶端钝尖，基部宽，叶全缘或微波状，叶柄粗壮，一般直，稀弯曲，长1—1.5厘米。中脉较粗，直伸；侧脉9—13对，互生或近对生，以40—50°角自中脉生出，基部与中脉的夹角较大，彼此平行伸展，弧曲，向上弯至叶缘；三次脉连接于侧脉间，彼此平行，整齐，垂直于主脉。叶质地坚硬。

Leaves ovumform to broad ovumform, length 3—11cm, breadth 2.3—7.1cm, the leaf apex is blunt and sharp, leaf stalk strong, generaly straight, length 1—1.5cm. The central veins rather thick and lateral veins 9—13 pairs. Leaf quality hard.

▼柄豆芙(*Podogonium oehningense*)

叶披针形或宽披针形，长3.5—7厘米，宽1—2.1厘米，顶端急尖，基部不对称圆形或稍窄，全缘，小叶柄粗壮，长不足5厘米。中脉较粗，一般直，稍弯曲；侧脉多对(20—30对)，羽状，与中脉的夹角在近基部约75—85°，上部约60—70°，弧曲，在叶缘内分叉，环结，有间脉；三次脉细密，彼此构成不规则脉网。叶质坚硬。荚果椭圆形，具长梗，长3—4厘米，粗强，果顶端急尖，基部渐狭，微偏斜，边缘一边凸起，可能为脊，具一粒种子，种子不显。

Leave needle-draped form, length 3.5—7cm, breadth 1—2.1cm, leaf apex sharp, leaflet stalk strong, length is less than 5mm. The central vein is rather thick, generally straight, lateral veins 20—30 pairs and feathery, the trifid veins fine and closely woven, the leaf quality hard.



▲柄豆芙(*Podogonium oehningense*)

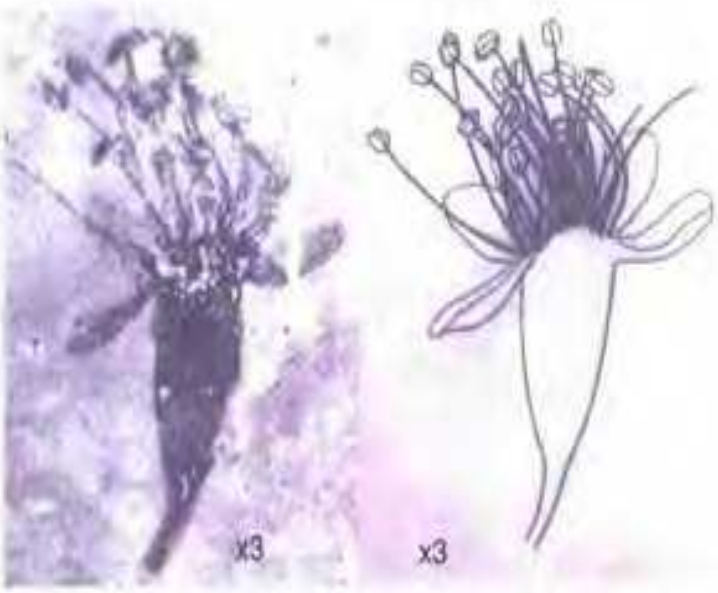




▲截形阿斯芜(*Astronium truncatum*)

花整齐。花萼具5个萼片，萼片开展，排列为一轮，具萼筒，萼片长椭圆形，很少倒卵形，顶端钝圆，长约1.3—2厘米，宽5—7毫米，萼片上具有很清晰的4—5(稀6)条脉纹，平行伸展。

Flowers neat, the calyx has 5 sepals, and the sepal long elliptic with blunt and round tip, length 1.3—2cm, breadth 5—7mm, there are 4—5(rare 6) veining over the sepal.



Flower actinomorphic, epigynous, pentamerous. Hypanthium campanulate-tubular, about 7mm long, 3.5mm in diameter, usually slender-stalked at the base. Sepals 5, shorter than hypanthium, lanceolate, 5—6mm long. Petals usually suborbicular or obovate, shorter than sepals. Stamens about 20, filaments 8—9mm long, anthers subglobose.

▶似槐蓝蝶形花（*Papilionacea indigoferoides*）

花为两侧对称。花萼下部联合成短的被丝托，萼片齿裂5枚，大小近相等。花瓣5枚，大小不相等。雄蕊明显为二体型(9枚雄蕊的花丝联合仅在顶端才分离，另1枚雄蕊的花丝独立生出)，顶端花药明显较大。

讨论：对现代的豆科植物，有分为三个科的。其中蝶形花科具有两侧对称的花，花冠蝶形(大小不等)，分旗瓣、翼瓣、龙骨瓣。雄蕊10枚，合生为单体或二体等特征。该化石花具有以上特征，雄蕊为二体，据9枚雄蕊花丝联合成一体的程度，与生存植物蝶形花科的槐蓝属(*Indigofera*)的花近似。在花药处取样作原位花粉分析，发现几粒蝶形花科的花粉，为数极少，但确证该花化石属蝶形花科无疑。

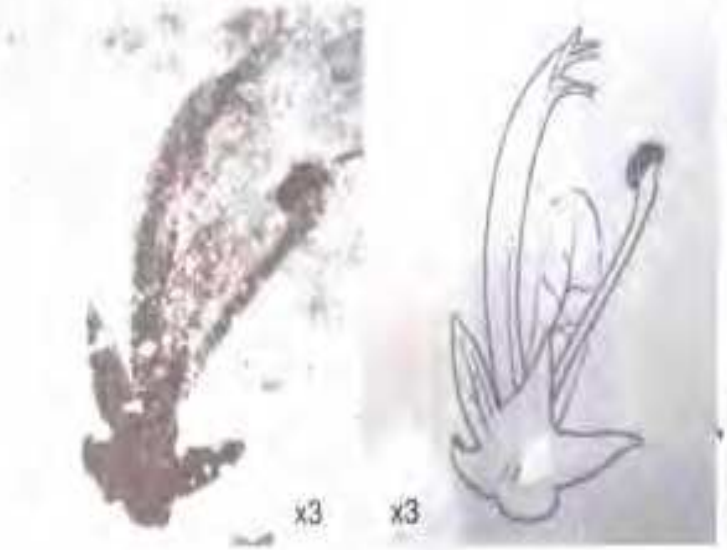
花粉特征：花粉粒长球形，具3孔沟，外壁具网状雕纹，与生存蝶形花科的花粉形态特征相似。

◀大萼始苹果(*Archimalus calycina*)

花两性，辐射对称，具有被丝托(由花托、花被、雄蕊共同形成)。被丝托呈倒圆锥形或钟形，下部渐收缩成花梗。萼片狭披针形。花瓣短而宽圆，均从萼筒边缘生出。雄蕊的花丝分离，花丝长于萼片与花瓣。花药圆球形。子房下位。

讨论：该花具有类似蔷薇科两性花，通常整齐，周位花或上位花(子房下位)；花轴上端发育成钟状、杯状或圆筒状被丝托，在被丝托边缘着生萼片、花瓣和雄蕊；萼片与花瓣同数，通常4—5枚；雄蕊5至多数，花丝分离等特点。蔷薇科的四个亚科中，仅苹果亚科(Maloidea)为子房下位，化石花具该亚科特征。又以萼片长于花瓣，花瓣短、宽卵形，被丝托直径(与整个花大小比例)较大而不同于任何生存属。

在花药处取材作原位花花粉分析两次，均未发现蔷薇科的花粉，说明该化石上的花药仍属印痕类型。整个花保存精美，但无内部结构。



Flower zygomorphic. Hypanthium short, bowl£shaped. Sepals 5 (preserved 3), nearly equal in size, triangular—vate,2—3mm long, 1.5mm wide. Petals 5, unequal in size, standard about 8 mm long, the lateral ones (wings) smaller, about 4mm long. Stamens obviously diadelphous, filaments of nine stamens connate, only distinct at the apical part, the 10th one free alone, with a large ellipsoid anther, 2mm long, 1mm wide at apex.



▲复叶似豆(*Leguminosites climensis*)

羽状复叶，具细长的柄，保存有对生的小叶8枚，中部较大者长2.3厘米，宽0.6厘米，小叶披针形，基部为不对称的圆形，顶端有一尖刺，长约半毫米。叶缘全缘。中脉直，直达小叶顶端成刺；侧脉细，甚多，弯曲，在近叶缘处同三次脉连接形成脉网。在小叶的近轴一侧自叶基沿叶缘向上伸出一条侧脉，其长约为小叶的三分之一；三次脉在侧脉间呈现粗网状。几乎无柄或有极短而强的小叶柄。叶质坚固。

Feathery compound leaves with fine and long stalks, the opposite leaflets 8, and the bigger one in the middle part 2.3cm long, 0.6cm wide. The central veins straight, lateral veins fine and much. Leaf quality hard.

▼圆基香椿(*Toona bienensis*)

奇数羽状复叶，小叶披针形，长6—9.7厘米，宽2.3—3.1厘米，基部偏圆形，明显不对称(顶端小叶圆形，对称)，顶端渐尖，小叶柄粗壮，长1—2毫米。叶边全缘或微波状。中脉在2/3以下较直，向上弯曲度明显；侧脉羽状，弧曲，近对生，12—16对，以55—60°角从中脉生出，在叶缘附近弯曲，不环结；三次脉自二次脉垂直斜向生出，成脉环。

Feathery compound leaves, the leaflets spread needle-shaped, length 6—9.7cm, breadth 2.3—3.1cm, the stalk of leaflet strong, 1—2m long.





▼华臭椿(*Ailanthus youngii*)

小叶宽披针形，长6—10.3厘米，宽1.9—3.5厘米，顶端渐尖，基部不对称的圆形或楔形。叶全缘，或微波状，近基处具1—2裂片状齿。叶柄粗壮。中脉微弯曲，粗壮；侧脉10对以上，互生，两侧分出角不等。近基的夹角约80°，上部的约50°，一般位基部的分出角较大，近边缘处分支后环接，具间脉，间脉在1/2处或1/3处消失，三次脉不显。翅果矩圆状椭圆形，长约3厘米，种子卵圆形或圆形，径5—7毫米位于中部。

Leaflet broad and needle-shaped, length 6—10.3cm, breadth 1.9—3.5cm, the apex is getting sharp.The leafstalks strong, central veins slightly culve and strong. The lateral veins more than 10 pairs.



◀华吴萸莫(*Evodia miosinica*)

小叶卵形至长椭圆状卵形，长5.4—10.1厘米，宽3—6厘米，顶端急渐尖，短尾状，基部宽圆形或宽楔形。全缘或微波状。叶柄长1.1厘米，顶生小叶的叶柄更长。中脉微弯曲。或直；侧脉6对，稀为9对，平均以60°角从中脉生出，位基部的夹角略大，近边缘分支，分支向前弯曲环结，弧曲脉序；三次脉不整齐连结于侧脉间，间距稀。质地坚硬至半革质。

Leaflets ovumform to elliptic ovumform, length 5.4—10.1cm, breadth 3—6cm, the leaf apex sharp and the leaf base broadly round, leaf stalks length 1.1cm, hard quality.

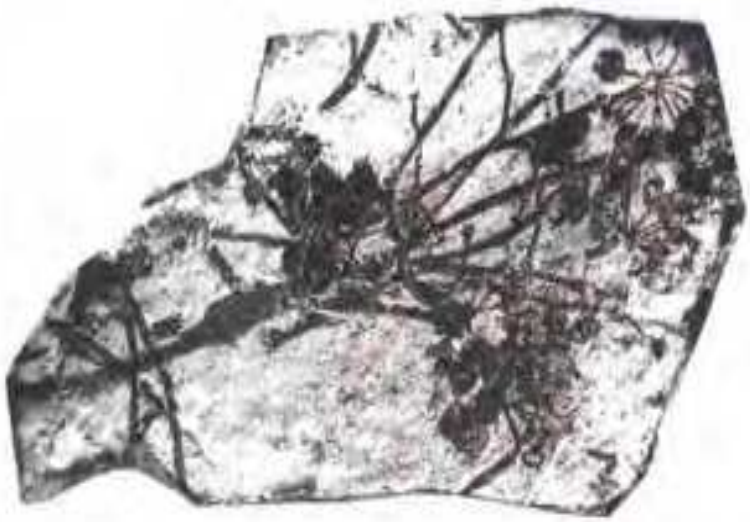


▲臭椿翅果

▲臭椿属(*Ailanthus*)

落叶乔木。叶互生，奇数羽状复叶，小叶13—41个，对生，具短柄。侧生小叶长椭圆状卵形，叶顶渐尖，基部楔形或圆形，全缘或波状缘，少数具锯齿。小叶在近叶基处两侧各具1—2个腺点，顶端小叶具长的小叶柄，常三裂，中裂片较侧裂片大，小叶的叶脉为羽状弧曲脉序，侧脉互生，少数近对生，至近叶缘处叉状分支，有些侧脉较短，未伸至叶缘，侧脉与中脉的夹角较大，至近基处几乎达90°，三次脉形成多角形脉网。果实为披针形翅果，在其中央部分有一个圆而扁平的种子。

Fallleaf arbor, the leaflets 13—41 pieces with short stalks, the lateral leaflets long elliptic and the apex gradually sharp.



◀械叶刺楸(*Kalopanax acerifolium*)

叶掌状5—7裂，广圆形，长6.3—14.6厘米，宽7.2—16厘米，基部浅心形或为宽心形，边缘具明显而具短尖的细锯齿。叶柄粗壮，长近7厘米。叶的裂片宽三角形至阔卵形，裂片有时有大的缺刻状裂齿，呈三角状，裂片顶端渐尖，基部一对裂片短窄。掌状7出脉，基部一对细短，微向外弯曲，其它初生脉粗壮，直或微弯曲，近中脉的侧主脉与中脉夹角约40—45°，弧曲，在叶缘附近向上弯，呈环状，其分支伸入齿尖，裂片内具有几对近对生的二次脉，到叶缘弯曲形成脉环；三次脉形成不规则的网，靠近裂片边缘和二次脉连接成环，具有分支到更小的边缘齿。

Leaves palmate and 5—7 aperture, length 6.3—14.6cm, breadth 7.2—16cm, the leaf stalks strong, near 7cm long.



▶眼子菜(未定种)(*Potamogeton* sp.)

水生草本，茎细长分枝，叶有沉没于水中或浮于水面的，互生或对生，沉于水中者通常线形，浮在水面者有柄，化石为沉没水中者，线状披针形，通常长2—3厘米，宽2—5毫米，顶端钝头，基部近圆形或窄狭，无柄，边缘呈波状，叶脉不清楚。化石与现代分布于全球的菹草(*P. crispus*)近似。此现代种多生长在静水池沼中。

Hydrophyte and herbaceous. Stem slender and branches. The leaves either sank in or floated on the water, the sinking one generally linear,and the floating one with stalks, the fossils belong to sink-type, length 2—3cm, breadth 2—5mm.

2. 山旺动物群
THE FAUNA IN SHANWANG

动物是指那些具有主动活动能力，靠摄取别的生物体(动物或植物)维持生命的那一部分生物。动物可分为无脊椎动物和脊椎动物两大类别。无脊椎动物的本身门类繁多，现在已知有二十多个门类。山旺动物群中的无脊椎动物的主要代表是昆虫。

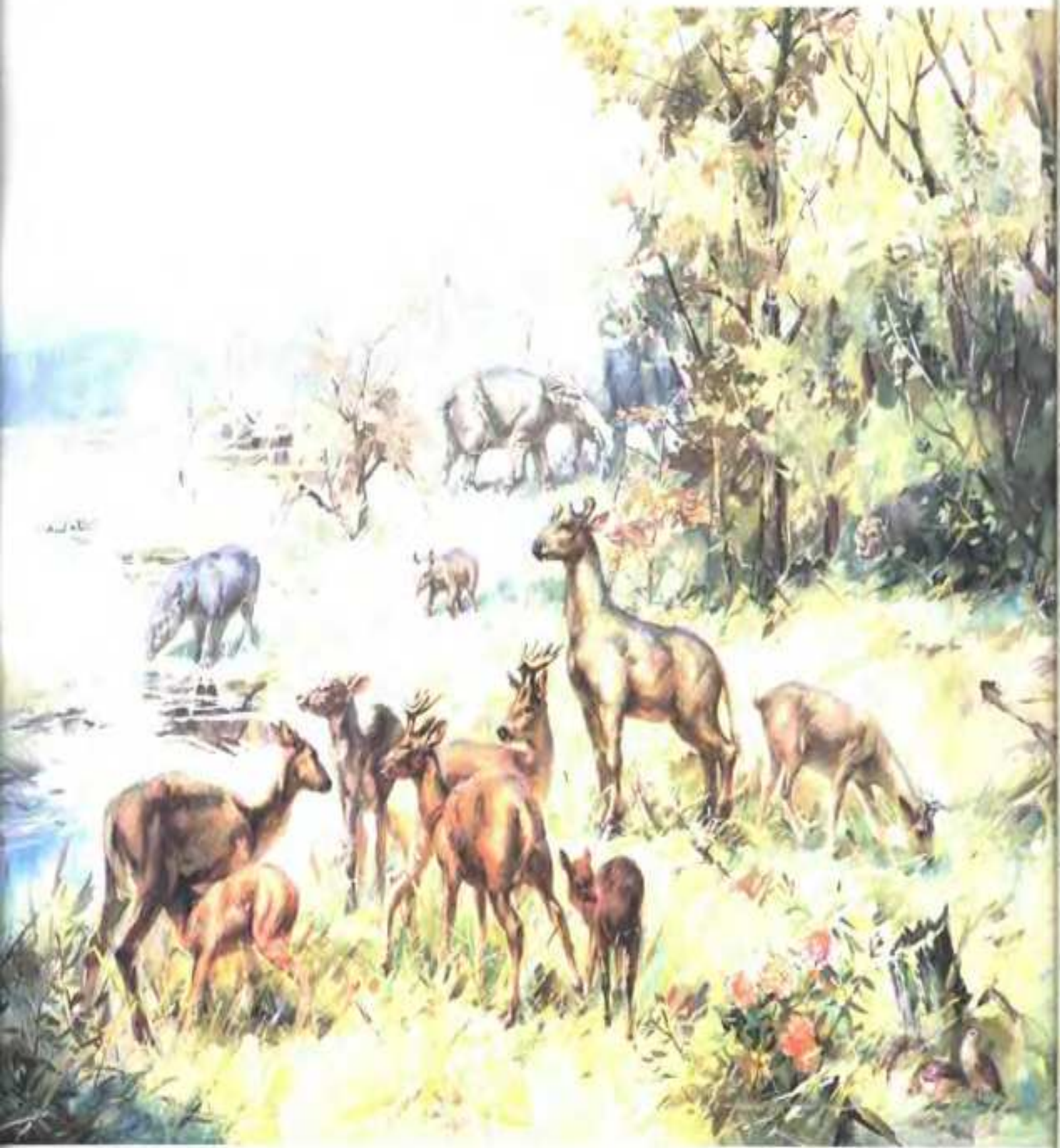
脊椎动物是动物界中最高等的一个类群，分类上属于脊椎动物门，它以具有内骨骼，特别是具有脊柱为主要特征，以区别于所有无脊椎动物。脊椎动物又根据发生的时代的早晚和进化水平的高低又再分为鱼、两栖、爬行、鸟和哺乳动物五大类。它们在山旺动物群中都有代表，构成了山旺动物群中最令人注目的一个组成部分。

The main representative in the Shanwang fauna is insect class, and vertebrates in Shanwang all have five classes.

The fishes, amphibious, reptiles, birds and mammals all have their representatives in the Shanwang fauna, making a spectacular component part of the fauna.



山旺盆地中新世景观复原



onstruction of Miocene Shanwang

节肢动物
ARTHROPODA

昆虫纲

昆虫纲Inseetes(又名六足纲Hnseets)化石最早记录—泥盆纪。

昆虫是行空气中呼吸的动物，躯体分头、胸、腹三部，胸部生有三对足，故又名六足类(Hexapoda)。由于昆虫强烈的辐射适应和高度的繁殖能力，可以在不同的气候带(包括严寒的极地，酷热的赤道…)和不同的地理环境(湖泊、河流、沼泽、草原、荒漠…)中找到它们的踪迹。昆虫化石为解决地层时代的划分和对比(特别是煤系地层)以及对古地理、古气候的研究提供了有益的依据。

山旺昆虫化石种类丰富，保存完整，有的个体甚至保留有绚丽的色彩，目前已研究的计有12目84科221属400种。其中，膜翅目蚁类占有绝对的优势，鞘翅目步甲类也很丰富，其它重要份子有双翅目的毛蚊、半翅目的蝽象及膜翅目的姬蜂等。大型蜻蜓、微小蚜类的发现，在新生界页岩中应属珍品。

山旺昆虫化石，绝大多数可与我国长江以南诸省和印度等地的现代种对比。因此，在昆虫区系上山旺应隶属于东洋区，古山旺当时是亚热带和暖温带气候，不少新种与现代种类比较，具有虫体大，较原始的特征。

The fossil insects in Shanwang are abundant and well-preserved, some individuals even keep magnificent colours. 12 orders, 84 families, 221 genera and 400 species of it have been studied.Among them,the Hymenoptera ants take the lead, other important members are the Bibio of Diptera, Ichneumonidae of Hymenoptera et al. The discovered large Blattpoidea and small Aphidini are treasures in the Cenozoic shales.

Owing to the adaptability to the strong radiation and high reproduction capacity, the insects could be found in different climatic zones and various geographical circumstances, thus, it proposed useful basis to solve stratigraphic division and correlation and the problems of paleogeography and paleoclimate.

From the analysis of the features of the Shanwang's fossil insects, a large number of them can be contrast with the modern species in various provinces to the south of the Changjiang River and India, therefore, the insects of Shanwang should belong to subtropical and warm temperate zones.

Insects (Hexapodes), their initial record of fossils are in Devonian.



蜻蜓目Odonata
▲室长足蜓
Epophthalmia zotheca



革翅目Dermaptera
◀ 怪离蠼螋
Apanechura asceta

▼山旺异蠼螋
Allodahlia shanwangensis



同翅目 Homoptera

▼石蛉蝉*Oncotympana lapidescens*





▲隐脉大蚜
Cinara reconditivenia



▶沼生大蚜 *Cinara limnogena*

异翅目 Heteroptera

▼山东岗缘蝽 *Gonocerus shandongensis*





◀黑缘壮蝽
Urochela nigilimbo



▲黑壮异蝽 *Urochela melaina*

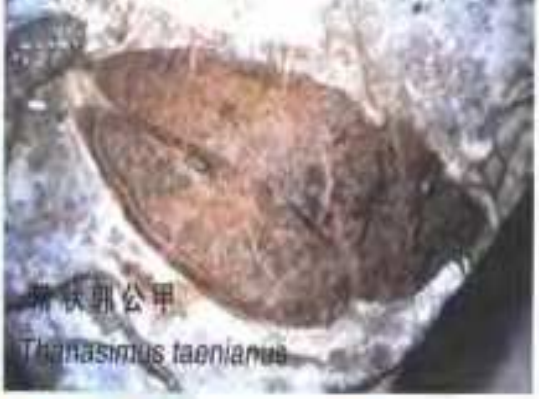
鞘翅目 Coleoptera



山东花甲
Dascillus shandongianus



亮紫鞘甲
Elytrophagus porphyreucus



Thanasimus taeniarus



热带胸叶甲
Chrysothoracus tropicus



极大水龟虫
Hydrous pergrandis



黑色异丽
Anomala turua

透翅毛蚊
Bibio tranopterus



双翅目 Diptera



槽形角伪瓢甲
Engonius alviolatus



扁肿毛蚊*Bibio ventricosus*

膜翅目Hymenoptera


华东吉丁蜂
Doryctes huadongensis


山旺木蚁
Camponotus shanwangansis


双色大叶蜂
Clavellaria bico


Tenthredopis plurilocellata


长棘大叶蜂
Clavrellaria longispina


山旺木蚁
Camponotus shanwangensis


胖木蚁
Camponotus plenus


山东蜜蜂
Apis shandonpica


卫叶蜂
Tenthredo rhysia


山旺锥柄蚓蜾
Eumenes shanwangensis


Xyelecia xiejiaheensis


临驹蚁
Formica linquensis


山旺小腹蚁
Aphaenogaster shanwangensis

蜘蛛 ARACHNIDA

蛛形纲(Arachnida)化石最早记录—志留纪。蜘蛛和昆虫是节肢动物中两个截然不同的类群，蜘蛛属蛛形纲，昆虫属昆虫纲(Insecta)。除蜘蛛外，蝎、蜱、螨等都属蛛形纲。蛛形纲动物虽然种类繁多，构造各异，大都是陆生的，有一些是水生的，也有寄生的种类，但都是呼吸空气的节肢动物。它们没有触角及真正的颚。躯体通常分为头胸及腹部，一般无环节的构造，头胸部有附肢六对，第一二对属头部附肢，第一对称螯肢(chelicera)，由上颚和钩状末端部构成，基部具毒腺，第二对称脚须(maxillipalp)，形若步足，其基部形成颚状突起以助摄食，然雄性者则变为生殖辅助器官，具有储精、传精构造，其余4对属胸部附肢，亦称步足。昆虫只有三对，而蜘蛛有四对。二者由此甚易区别。

蜘蛛口开于两颚须基部，用以吸取猎物之汁液。

蜘蛛为肉食性动物，其食物大多数为昆虫或其它节肢动物。蜘蛛用网捕获食饵后，通过螯肢将毒液注入猎物之体内，其消化酶渗入猎物组织各部，很快将其分解为汁液，然后吸入消化道。

蜘蛛能吐丝结网，主要是体内有各种不同的丝腺，蜘蛛的丝是一种骨蛋白，十分精细，坚韧而具弹性，"吐"出的丝遇空气而变硬。目前已知蜘蛛有8种不同的丝腺，一种蜘蛛可同时具备几种不同的丝腺，但还没有发现同时具有8种丝腺的蜘蛛。

蜘蛛种类多，繁殖快，有的牵丝结网，有的徘徊巡游，纵身跳跃捕捉过往"猎物"。

Spiders and insects are two different groups in Arthropoda, the former belongs to Arachida, and the latter belongs to insect. Although the animals of Arachnide a great variety and different in structures, they are all Arthropoda breathing of air. The insect only has three pairs of foot, but the spider has four foot, thus it is very easy to differentiate one from the other.

Spiders are canivorous animals, their food mostly is insects or other Arthropoda. They have a great variety with high breeding rate.

The initial records of fossil Arachnida are in Silurian.





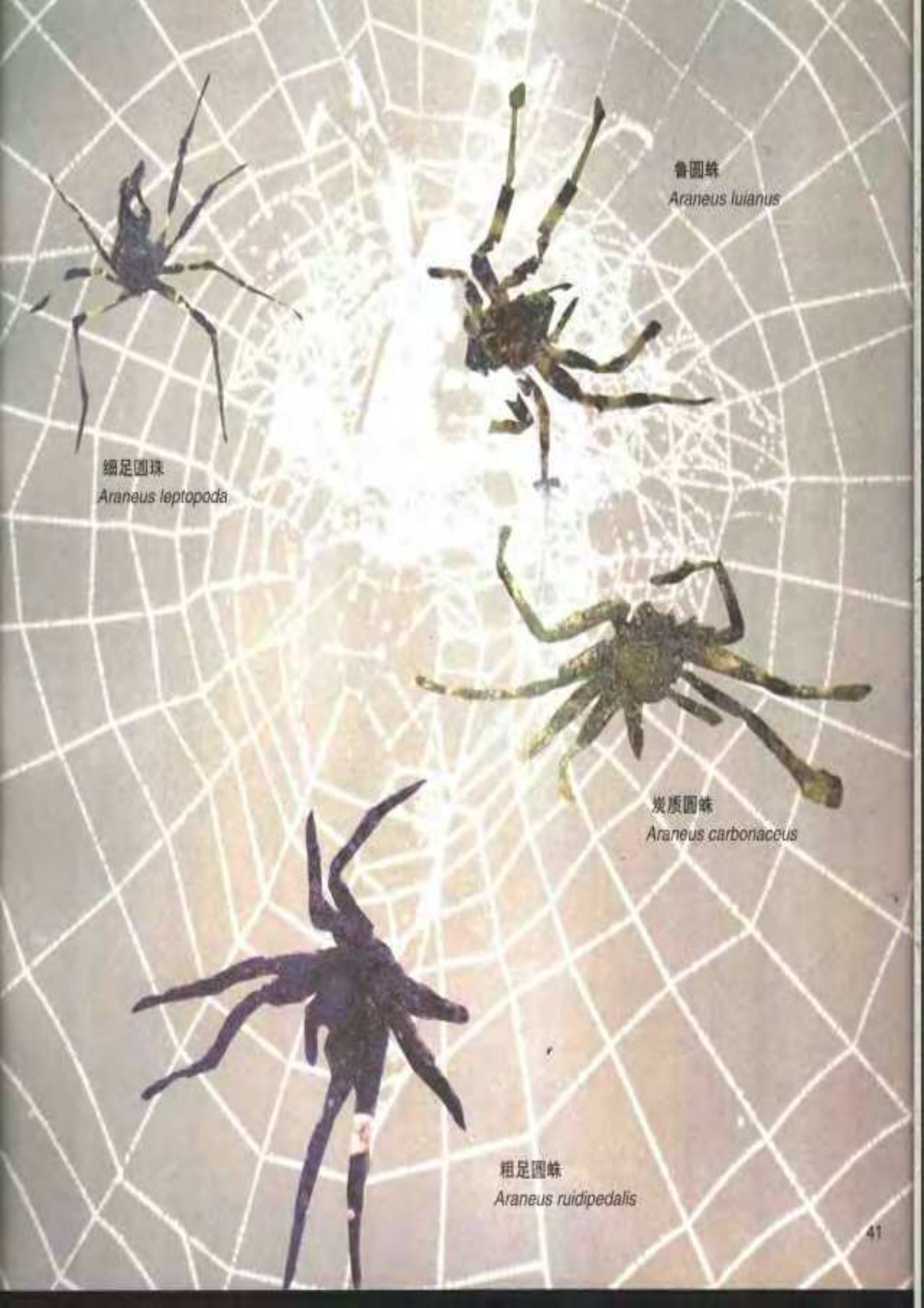
蜘蛛目Araneida

▲褐异蛛
Ectona brunnea

◀腿拉蛛
Drassodes femurus

▼地生狼蛛
Lycosa subterranea





鲁圆蛛
Araneus luianus

细足圆珠
Araneus leptopoda

炭质圆蛛
Araneus carbonaceus

粗足圆蛛
Araneus ruidipedalis

鱼类 FISHES

山旺盆地含有丰富的鱼化石，自1936年我国的古生物学家杨钟健教授和鱼类学家张春霖教授做过一些初步的研究和报道外，一直到1982年才开始对山旺的鱼类化石进行系统的整理和研究。

山旺的鱼化石具有显著的区域性特征，是我国特有的鱼群组合。它们主要包括鲤形目的鲤科和鳅科及鲈形目的鮨科，仅鲤科(Cyprinidae)就包括6属9种，其中大部分的种属都已经绝灭了，少数种类距今二、三百万年前已接近现生鲤科鱼类的面貌。

山旺的鱼化石目前研究发表的共7属10种。其中鲤科化石6属9种，鳅科化石1属1种。

There are abundant fossil fishes in the Shanwang Basin. Ever since 1936, Profs. C.C.Young and Zhang Chunlin had made some study, but the fossil fishes did not get systematical research until 1982.

The fossil fishes in Shanwang obviously possess regional features and is a combination of fish group peculiar to other regions of China, they mainly included the Cypriniformes and Perciformes, there are 8 genera and 10 species in the Cyprinidae only, and most of them have already extincted, a few species being similar to the features of modern Cyprinidae as early as 2—3 million years ago.

The issued fossil fishes in Shanwang included 7 genera and 10 species at present. Among them, the Cyprinidae amounts to 6 genera and 9 species and the Cobitidae only 1 genus and 1 species.



▲临朐鲁鲤 *L. linchiiensis*

鲤科 Cyprinidae

鲁鲤属 *Lucyprinus*

临朐鲁鲤 *L. linchiiensis*

鱼体纺锤形，侧扁，背腹缘浑圆，体高大于头高，头长小于头高，口端位，吻钝，侧线鳞约28个，尾鳍分叉，尾柄高为柄长的1.4倍。圆鳞，咽齿为次臼齿形，3行齿。

Body fusiform, flatting in lateral, the dorsal and ventral edges round, depth of body bigger than that of head, and length of head smaller than depth of head, lateral line scales 28. Caudal forked, depth of caudal peduncle about 1.4 times length of it. Rounded scales, pharyngeal teeth three rows.

司氏鲁鲤 *L. scotti*

鱼体略高，短纺锤形，背腹缘弧形，体高大或等于头高，头长略大于头高。口端位，吻尖。侧线鳞见到16—17个，尾柄高为尾柄长1倍。下咽齿为近圆锥形和次臼齿形。

Length of body slightly vertical, short spindle shaped, dorsal and ventral edges curved, depth of body higher or equal to depth of head, and length of head slightly more than depth of head, sharp snout. Lateral line scales 16—17,depth of caudal peduncle has twice the length.



▲山旺齐鲤 *Q. shanwangensis*

扁鲤属 *Platycyprinus*

奇异扁鲤 *P. mirabilis*

体长为体高的1.3倍，头长的1.4倍，体长为尾柄长之5.5倍，尾柄高的3.8倍，头高为头长的1.7倍，尾柄高为尾柄长1.5倍，侧线鳞21—22个，从鱼体中央通过。

The body length is 1.3 times the body depth and 1.4 times head length; and body length is 5.5 times length of caudal peduncle and 3.8 times depth of caudal peduncle; depth of head is 1.7 times head length, depth of caudal peduncle is 1.5 times length of it. Lateral line scales 21—22, through the middle of trunk.

齐鲤属 *Qicyprinus*

鱼体长纺锤形，侧扁，背腹缘呈弧形或腹缘平直。口端位，吻略尖，背鳍起点位于腹鳍起点略后，鳍式III-11，臀鳍III-5，两者都有带锯齿的硬棘，尾柄细长，尾鳍长，深分叉。下咽齿3行，咽齿次臼齿形和侧扁形。

Body elongate fusiform. Flatting in lateral, dorsal and ventral edges curved or the ventral edge straight, mouth terminal, caudal peduncle long and thin, peduncle elongate. Caudal deeply forked.

山旺齐鲤 *Q. shanwangensis*

背鳍距吻端显著大于距尾鳍基长，腹鳍距胸鳍小于距臀鳍基长，腹鳍距臀鳍几等于距尾鳍基。尾柄长大于尾柄高。体长为体高2.8—3倍，为头长2.4—2.8倍，为头高3—3.5倍，体长为尾柄长5.8—6.3倍，体高为尾柄高2.4—2.7倍，为尾柄长2—3.2倍。侧线鳞约27个，在鱼体中央通过。尾鳍深分叉。下咽齿3行，咽齿有次臼齿形齿和侧扁形齿。

Dorsal origin much nearer the end of snout to the dorsal fin. Length of caudal peduncle longer than the depth of it, body length is 2.8—3 times body depth, and 2.4—2.8 times head length, 3—3.5 times head depth; the body length is 5.8—6.3 times the length of caudal peduncle, body depth is 2.4—2.7 times caudal length. Lateral line scales 27.Caudal deeply forked.

颌须鮈属 *Gnathopogon*

大头颌须鮈 *G. macrocephala*

体长为高4.1倍，为头长3.1倍，头高3.4倍，约为尾柄长5倍，尾柄高7.6倍，头长为眼径3倍，为尾柄长1.6倍，为尾柄高2.6倍，尾柄长为尾柄高1.5倍，背鳍起点距吻端大于距尾鳍基。

Length of body is 4.1 times body depth, 3.1 head length, 3.4 head depth and about 5 length of caudal peduncle, 7.6 depth of caudal peduncle. The head length 3 diameter of eye and 1.6 caudal length and 2.6 its depth.

山旺颌须鮈*G. shanwangensis*

鱼体细长，体侧扁，背腹缘平直。口端位，吻尖，口裂小，眼睛略靠前上方，背鳍位于腹鳍起点略前，背鳍条III-7；臀鳍条III-6；胸鳍条10根，腹鳍条约7—8根，脊椎34个，尾柄细长，尾鳍分叉。背鳍起点距吻端略大于距尾鳍基，臀鳍距腹鳍小于距尾鳍基。体长为体高5.9倍，为头长3.6倍，为头高5.1倍，为尾柄长5.3倍。头长为眼径3.4倍，尾柄长为尾柄高2.2—2.7倍。



▲大头颌须鮈 *G. macrocephala*

G. shanwangensis

Body small and elongate. Back and ventral straight. Mouth terminal and mouth gape small. Origin of dorsal fin is nearer to the caudal fin base than to the rostum. The body length is 5.9 times the body depth, 3.6 head length, 5.1 head depth, head length 3.4 diameter of eye. Caudal peduncle length is 2.2—2.7 its depth.

中新似雅罗鱼 *P. miocenicus*

背鳍起点至吻端距大于至尾鳍基距，尾柄长大于尾柄高，体长为体高2.7—4.5倍，为头长3.1—3.5倍，为头高4.3倍。为尾柄长5.1—6.6倍，头长为眼径2.7—3.3倍，尾柄长为尾柄高1.2—1.6倍。

Dorsal origin much nearer caudal base than end of snout, the length of caudal peduncle more than its depth, body length 2.7—4.5 body depth and 3.1—3.5 head length, 4.3 head depth, 5.1—6.6 caudal length.



▲中新似雅罗鱼 *P. miocenicus*

雅罗鱼亚科 Leuciscina

似雅罗鱼属 *Plesioleuciscus*

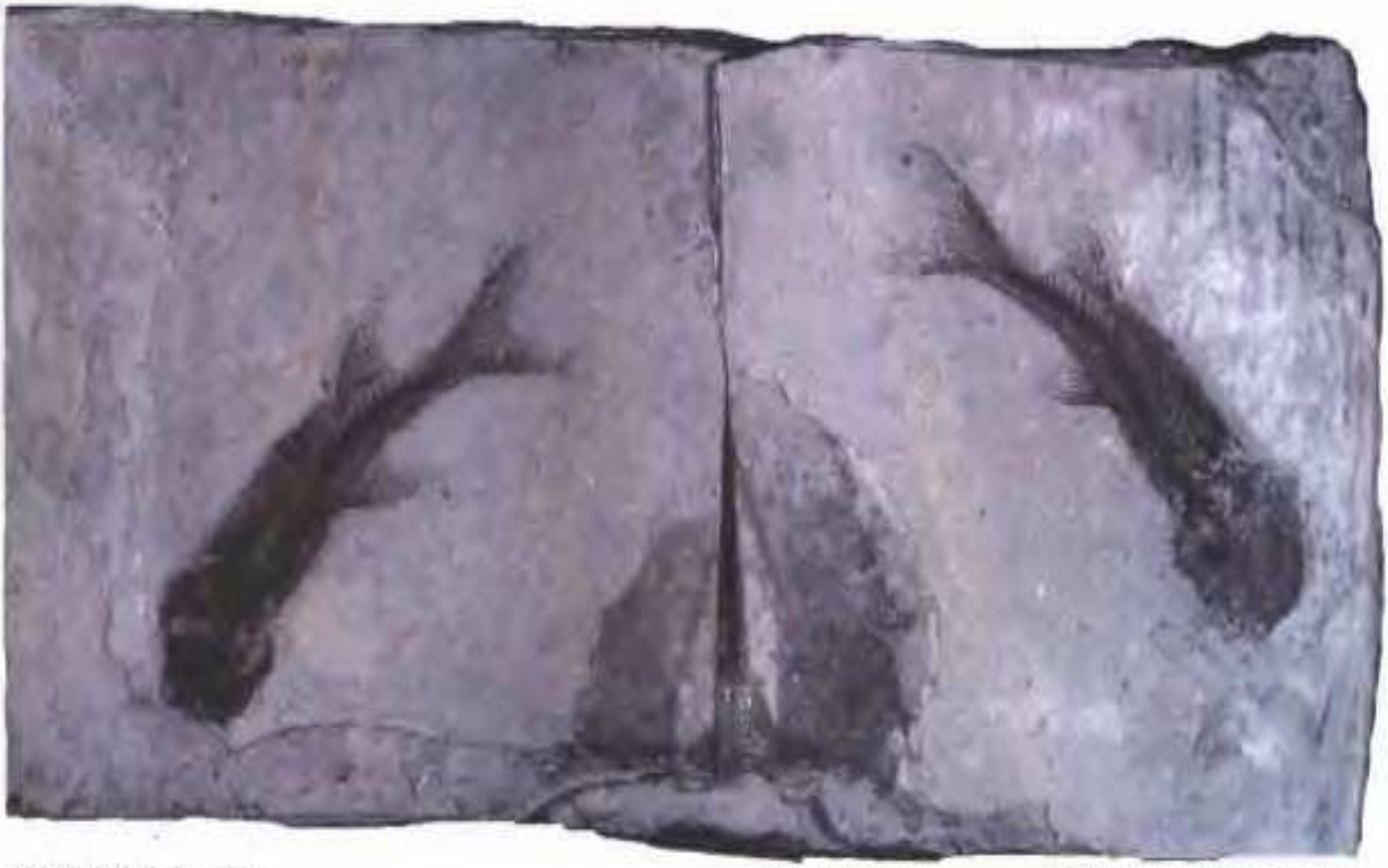
鱼体纺锤形，侧扁，口端位或亚上位，口裂短，吻钝或锐，前上颌骨具吻突。下颌稍突出，齿具窄的冠状突，上筛骨固着在额骨前缘，无前筛骨，背鳍位于腹鳍略后，背鳍条III·7，臀鳍条III·8，二者均无硬棘。胸鳍III·3—15，腹鳍条8—9根。尾鳍分叉。圆鳞。

Body fusiform. Mouth terminal, Mouth gape small. Lower jaw protruding slightly. Dentary with rather narrow coronoid process. Dorsal rays III·7, Anal rays III·8, Pectoral rays III·3—15, Caudal forked, scales round.

优美似雅罗鱼 *P. nitidus*

鱼体小，头中等大小，眼眶大，口裂十分倾斜，背腹缘略呈弧形，背鳍位于腹鳍起点之后，背鳍条III·7，臀鳍条III·8，胸鳍条14根，腹鳍条8根。背鳍起点距吻端显著大于距尾鳍基，腹鳍距胸鳍长约等于距臀鳍长。体长为体高的3倍，为头长的2.9倍，为头高3倍，为尾柄长6.5倍，头长为眼径2.5倍。体高为尾柄高2.5倍，尾柄长为尾柄高1.2。尾鳍深分叉。

Body small, dorsal and ventral edges curved, dorsal fin behind the origin of ventral fin, dorsal origin much nearer caudal base than end of snout. Length of body 3 times body depth, 2.9 head length, 3 head depth, 6.5 caudal peduncle, and head length 2.5 diameter of eye, the caudal deeply forked.



▲中新似雅罗鱼*P.miocenicus*

担尼鱼亚科 Danioninae

弥河鱼属 *Miheichthys*

鱼体小，体高，头大，额骨宽短，顶骨大，眼眶大，口端位，上下颌骨十分倾斜，背鳍位于腹鳍之间。背鳍条III·8，臀鳍条II·9，两者均无硬刺，尾鳍分叉。下咽齿三行，咽齿侧扁,锥形。具弯钩状齿尖。

Body small and vertical, head big. Fontals broad and short. Parietals and orbits large. Mouth terminal. Mouth gape quite oblique. Dorsal fin between the pelvic and the pectoral fin. Dorsal rays III · 8, anal rays II · 9. Vertebrae 30. Caudal forked.

山东弥河鱼*M. shandongensis*

鱼体小，头大，头高等于体高，背腹呈弧形，背鳍III·8，臀鳍II·9，胸鳍腹鳍至臀鳍距大于至胸鳍距，体长为体高1.8倍，为头长2.3倍，为头高1.8倍。为尾柄长4.6倍，尾柄高大于尾柄长，尾鳍分叉。

Body small. Head large, head depth equal to body depth, dorsal and ventral curved. Body length 1.8 times body depth, 2.3 head length, 1.8 head depth, 4.6 caudal length, Caudal forked.

花鳅亚科Cobitinae

花鳅属 *Cobitis*

长胸鳍花鳅 *Cobitis longipectoralis*

鱼体小，细长且侧扁，背腹缘平直。头小，口亚下位，吻部略向前伸出。额骨窄长，前颌骨与筛骨愈合为筛颌骨。眼位于头中部。脊椎42个。背鳍起点位于腹鳍起点之前，背鳍条III·7，臀鳍条III·5。尾鳍近于截形，后缘略凸出，尾鳍条I·14·1。

Body small, elongated and compressed. Dorsal and ventral edges straight. Head small. Mouth subinferior. Rostrum slightly projecting. Frontals narrow and elongated. Prevomer and ethmoid united into ethmoprevomer. Vertebrae 42. Origin of dorsal fin before that of the pelvic, fin rays III·7. Anal fin base rather short, fin rays III·5, Caudal fin rays I·14·1.

两栖类 AMPHIBAINS

在脊椎动物中，两栖类是一个较小的门类。泥盆纪末期，当时某种总鳍鱼类的后裔冒险从水中爬上陆地，成为最早的两栖类，它们开拓了脊椎动物登上陆地的光辉历史。它们在石炭纪和二迭纪尤为繁盛。因此石炭纪和二迭纪又作两栖动物的时代。

鱼石螈(Ichfhyostega)是介于进步的总鳍鱼类和典型的早期两栖类之间，目前已知的原始两栖类。

最早的两栖动物化石—鱼石螈，发现于格陵兰岛泥盆纪末期(3亿5千多万年前)。鱼石螈没有胸腹鳍，已有相当粗大的腿了，腿上还长着足趾，但鱼石螈的"鱼性"未脱，它们的牙齿、头骨、带鳍条的尾巴以及尾巴上残留的鳞片等等，都还与古代的总鳍鱼相似。因此，鱼石螈化石的发现，充分证明两栖类是古代的总鳍鱼类进化来的。



中国第三纪两栖类化石发现得不多，研究程度也不深，解放前仅见于一些零星的报道(Schlosser,1924;Bien, 1934)。从1936年发表第一篇关于两栖类的文章，近半个多世纪只有棘社蛙(刘玉海，1961)、中新原螈(杨钟健，1965)、临朐蟾蜍(杨钟健，1977)及强壮大锄足蟾(离克勤，1986)等四篇两栖类的研究报告问世。近些年来山旺发现了近百件完整的两栖类标本，它们包括有尾目的蝾螈和无尾目蟾蜍科、锄足蟾科、雨蛙科、蛙科、姬蛙科和树蛙科等十几个属种的代表，无尾类中除成蛙之外，还有大量蝌蚪和正处在变态过程中的变态蛙化石。

Amphibians is a rather small class in the vertebrate. At the end of Devonian, some descendants of Crossopterygii took risks to crawl onto the land and became the earilest amphibia. These animals were specially prosperous in Carboniferous and Permian periods.

The Ichfhyostega was an animal interposed between the progressive Crossopterygii and typical early amphibians, so far a primitive amphibia.

The earliest fossil amphibians, Ichfhyostega, found in the late Devonian system in Greenland, it has not dorsal and ventral fins and with rather massive legs, and grew hallux. However, it cannot but keep some characters of fish, it is similar to ancient Crossopterygii in teeth, skull, tail and the scales remainover tail, therefore, it is fully proved that the amphibians have evolved from the Crossopterygii.

There are a few fossil amphibians of Tertiary which have been found in China, only odd reports appeared before (Schlosser, 1924; Bien, 1934), and since 1936, there are only four pieces of writings issued, the *Bufo linquensis* (Young,1977), the *Rana yushensis*(Liu ,1961), the *Macropelobates cratus* (Gao ,1986) and the *Procynops miocenicus* (Young,1965). In recent years, there are nearly one handred specimens of fossil amphibians found in Shanwang, including salamanders of Urodela and some families of Anura, and there are many fossil tadpoles and metamorphic frogs among them.



▲中新原蝾 *Procynops miocenicus*

中新原蝾是杨钟健于1965年建立的蝾螈亚科的一个新属。它是一种体小、四肢纤弱的两栖类。它的尾短，仅为身长的1/2。全身可能具有较匀细的瘤状斑点。但无大背或两侧大的斑点。头大小和一般性质与东方蝾螈很相近，但比之约小1/4或1/3，为已知蝾螈中最小者。

It is a new genus of salamad found by C.C.Young in 1965. Unusually small. Limbs feeble. Caudal length less than one half of the whole body. Body probably covered by tuberous spots, certainly without large sagital and lateral tuberous decoration. Skull similar to Cynops orientalis in size and general feature. On the whole the present form is much smaller in size than the latter.



▲变态中的蛙 Metamorphic

▼玄武蛙*Rana basaltica*



玄武蛙*Rana basaltica*

头骨通常三角形，前后长(11.2毫米)明显大于头后部最大宽(9.5毫米)，头骨保存很好，小牙齿的痕迹也能很好地辨认。

玄武蛙(*Rana basaltica*)个体比亚洲蛙(*Rana asiatica*)小，但肢骨较粗壮，腰带宽大，头骨较尖，长大于宽。

Skull triangular, and well prerserved, the anterior-posterior length being decidedly longer than the maximum breadth of the posterior part of the skull(11.2mm>9.5mm). Traces of small teeth can be observed. Although smaller than R.asiatica, the R.basaltica has relatively thicker limb bones, its skull longer than wide, is more pointed.



▲临朐蟾蜍*Bufo linquensis*

临朐蟾蜍(*Bufo linquensis*)

特征：个体大，头宽显著大于头长，吻宽圆。上颌无齿，亦无犁骨齿。副蝶骨前突极短，不及两侧突间宽度之半。荐前椎八个，均前凹型，椎横突粗壮发达。尾杆骨与荐椎呈双髁关节，且发育尾杆骨嵴。荐椎横突宽大，与身体长轴垂直相交。肩带弧胸型。腰带降成U形，无髂嵴，坐骨结节发达。后肢短粗，股骨S形弯曲明显。胫短，跗节长于胫长之半。

Bufonidae

Bufo linquensis

Diagnosis Size large. Head strikingly wider than long; snout wide and round; no maxillary teeth and no vomer teeth developed. Parasphenoid blade shorter than its half width across alae; alae well developed and perpendicular to blade.Presacral vertebrae eight, in Procoelous form; diapophyses massive and much developed. Urostyle articulates with sacral by double condyles. Sacral diapophysis strongly expanded. Pectoral girdle in arciferal type. Pelvic girdle in U shape, no ilial crest present. Leg short, tibiofibula shorter than femur.



▲蝌蚪Tadpole



两栖类进化图

Evolution of Amphibians

爬行类 REPTILES

爬行类是一种进化速度十分缓慢的动物。最早的爬行类出现于距今约三亿年前的石炭纪，中生代(距今约二亿四千万年到七千万年前)最为繁盛，几乎“统治”整个世界。当时，不仅有陆地上生活的各种各样的恐龙，而海里有鱼龙和蛇颈龙，空中有飞龙等。所以中生代又有“龙的时代”之称。可是，到了距今七千万年前后，大部分爬行类相继绝灭。能闯关过隘而延续至今的只有鳄类、龟鳖类和有鳞类(蛇和蜥蜴)以及仅残存在新西兰的喙头类(喙头蜥*Sphenodon*)。鳄类只有鳄(*Crocodylus*)、短吻鳄(*Alligator*)和食鱼鳄(*Gavialis*)三个属25个种，分布在热带和亚热带地区。山旺的爬行动物化石包括：龟鳖类、鳄类和蛇类。

由于爬行类的卵具有一层防止胚胎干燥的羊膜，爬行类才得以摆脱对水的依赖，可以在陆地产卵和孵化，不再象两栖类那样必须在水的环境下经过变态的各个阶段。

羊膜卵的出现，完成了从两栖动物到爬行动物的进化过程，是脊椎动物进化史上重要的一次突破。

蛇亚目分为盲蛇超科(Typhlopoidea)、蟒蛇超科(Booidea)和游蛇超科(Colubroidea)。

游蛇是蛇类中最大的一个“家族”，它几乎包括了所有的无毒蛇和热带的一些毒性较小的蛇。它们的化石记录始于中新世。

游蛇科 Colubridae

游蛇亚科 Colubrinae

Mionatrix diatomus 硅藻中新蛇

身体中等大小，体长0.5—1米。牙齿细小，分布紧密。上颌齿15个左右，牙齿向后稍增大，但最后两齿无特殊增大现象，与前面牙齿之间也无齿隙。颚骨齿11个左右。翼骨齿很细小，沿内侧边缘分布。翼骨呈扁的三角形。椎下突遍及全身，突起较短，但前后高度相若，向后无增高现象。

在我国爬行动物化石的研究方面，蛇类化石几乎是一个空白，我们对蛇化石所知甚少。在此以前只有 Schlosser M (1942) 和卞美年(Bien M. N. 1934)提到在内蒙古爱坦丁上新世和华北周口店更新世地层中发现过一些零星不能鉴定的蛇类骨骼。从60年代开始相继在山旺盆地发现了不少保存十分完好的蛇化石。

The reptiles are animals evolving slowly, the earliest one arose in Carboniferous period and flourishing in Mesozoic era, they occupied a dominant position in the world at that time, but the greater part extincted in succession about 70 million years ago, only the Crocodylia, Trionychidae, squamata(Ophidia and Lacertilia) and Sphenodon have lasted to now. The fossil reptiles in Shanwang include some Chelonia, Crocodilia and Ophidia.

Because the eggs of reptiles have an amnion to protect the embryo dry, the reptiles could be extricated themselves from relying on water and might laied eggs and hatched.

The Ophidia include Typhlopoidea, Booidea and Colubroidea.

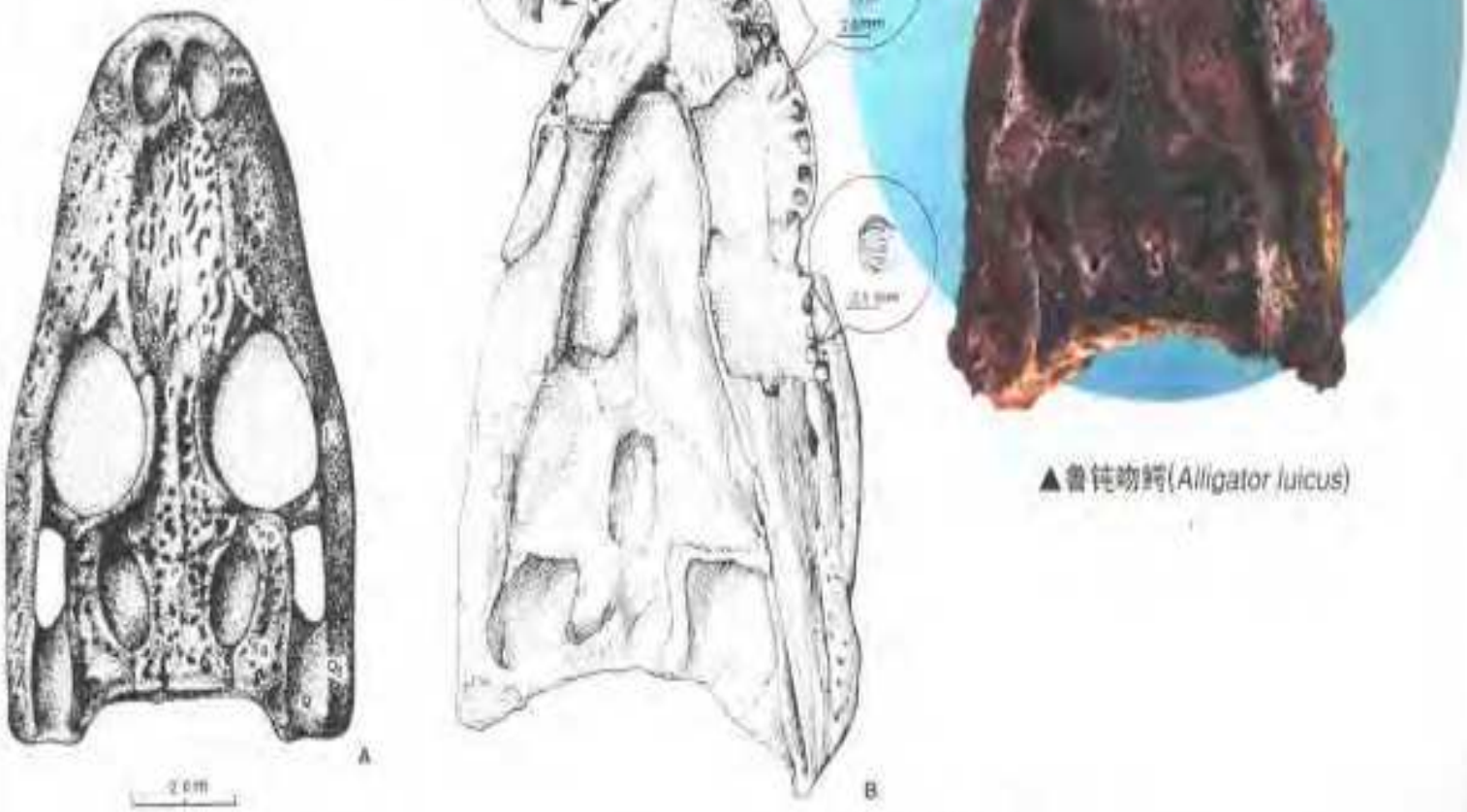
The Colubroidea is the greatest family of Ophidia, it almost contains all kinds of nonpoisinous snakes and some relatively poor poisonous snakes in the tropics. Their fossil record started from Miocene.

Body median size,with length 0.5—1 meter.Teeth small and closely spaced.Maxillary teeth about 15 in number,slightly enlarged and recurved posteriorly,last two teeth not enlarged abruptly,also without distance with their anterior ones.Palatinal teeth about 11.Pterygoid teeth small,spreading along the inner margin.Pterygoid triangular.Hypapophyses extends throughout the whole vertebral column,with shorter process and without posterior extention.

Fossil snakes has hardly been recorded in China except several isolated bones noted by Schlosser (1924) and Bien (1934),discovered in the Pliocene in Nei Moggol and in the Pleistocene in Zhoukoudian.However,from the 1960s,some rather completely preserved specimens were discovered from Shanwang.



硅藻中新蛇 *Mionatrix diatomus*



▲鲁钝吻鳄(*Alligator luicus*)

鲁钝吻鳄(*Alligator luicus*)

它是山旺盆地1984年发现的唯一的一件鳄类标本，山旺动物群的组合非常丰富，但爬行动物化石却相对稀少，仅有蛇、龟、鳖的零星材料见诸报道，鳄类化石的发现不仅丰富了山旺动物群，而且为研究鳄类在亚洲的早期历史提供了新的资料。

*Alligator luicus*为一较小的鳄类，头骨仅长105毫米，头骨扁平，吻端浑圆，头骨顶面为舌状，吻部短而宽，吻长50毫米只占整个头长的47.6%，吻颈部宽55毫米，为吻长的1.1倍，这种情况在钝吻鳄中，既使在它们幼年个体中也极为罕见。

Alligator luicus

A rather small crocodilia. Skull length only 105mm, short and wide with blunt snout, the snout is broad and short, length 50mm, the basal breadth 55mm.

It was found in Shanwang in 1984, so far it is the only specimen of Crocodilian collected from here. The composition of the Shanwang fauna is very rich, but the fossil reptiles are relatively rare, this material not only enriched the Shanwang fauna, but also supplied the study of the history of Asian Crocodilia with new evidence.



羽毛

鸟类 BIRDS

鸟类是一种善于飞行的脊椎动物。鸟类的骨骼致密，髓腔大，许多骨骼愈合，具有发达的肌肉及羽毛，心脏的构造保证新鲜血液的供给，大大提高了鸟类新陈代谢的能力，更加适应飞翔的生活方式。

鸟类分为古鸟亚纲(Archaeornith)及今鸟亚纲(Neornithes)两大类群。1861年发现于德国巴伐利亚州索伦霍芬(Solonhofen)侏罗纪地层中的始祖鸟(*Archaeopteryx*)是目前发现的古鸟亚纲中最早鸟化石的代表。但是一般认为始祖鸟并不是现代鸟类的祖先，它只是鸟类进化主干上的一个侧支。始祖鸟虽然已具有羽毛，但其骨骼发育程度上与爬行类十分相近，仍长尾，有牙，四趾具爪等。

白垩纪的鸟大都属今鸟亚纲，它们与现代的鸟已十分接近，骨骼已进一步愈合：如头骨，骨盆和脊椎，前肢骨骼等，尾骨已退缩，胸骨扩大等。

由于鸟类骨壁薄而纤细，且多生活于森林和湖沼地带，鸟每难于保存下来，完整的化石更不多见。

山旺细腻的硅藻土页岩为保存完整的鸟化石提供了有利的条件，到目前为止，已发现了五种完整的鸟化石：山旺山东鸟(*Shandongornis shanwangensis*)，硅藻中华河鸭(*Sinahas diatomas*)，硕大临朐鸟(*Linquornis gigantis*)以及秀丽杨氏鸟(*Youngornis gracilis*)，齐鲁杨氏鸟(*Youngornis qiluensis*)和许多羽毛化石。

山旺是中国目前所知出产完整鸟化石种类最丰富的产地。

Aves are divided into two kinds : Archaeornithes and Neornithes.

The *Archaeopteryx* founded in the Jurassic system from Solonhofen, Germany in 1861, is the earliest fossil bird up till now, but generally considering, it is not the ancestor of the modern birds but a branch of the evolution of birds. Although it already had feather, the development of bones fully similar to that of the reptiles, still remaining long tail, teeth and four limbs.

The birds of Cretaceous already belong to the Neornithes, they are very alike the modern birds, their bones healed further.

Because of the bony plates of birds are thin and slim, and they are mostly living in the forest and lake regions, their bodies often difficult to preserve, moreover, the perfect fossils become even more rare.

The fine diatomaceous shale in Shanwang provided a favourable condition to preserve the perfect fossil birds, 5 species of intact fossil birds have been discovered till now; the *Shandongornis shanwangensis*, *Sinanas diatomas*, *Linquornis gigantus*,*Youngornis gracilis and Youngornis qiluensis* and many fossil feathers.

鸡形目 (Galliformes)

淮科(Phasianidae)

山旺山东鸟(*Shandongornis shanwangensis*)

特征：个体中等大小，头大，嘴峰短粗有力，锥状，上嘴峰稍长于下嘴峰，前端略下弯，但不成钩状，前肢发达，腿不细长，但跗蹠骨的长度大于胫骨长度的一半，不等趾足，四趾，趾粗壮，第一趾较它趾为短，位置略高。

注：从化石保存情况推断，该标本应是原地埋藏，至少搬运不远，但死亡时曾作过少许挣扎，以至标本呈两翅左右展开，两脚直伸的保存姿态。

山旺山东鸟是我国首次发现的中新世鸟类，也是我国第一次发现的完整鸟化石。

Size medium. Skull comparatively large, bill short, massive and cone-like. Upper bill slightly longer than lower one, and with its anterior end bending little downwards, but not forming a hook. Bones of wing developed, hind legs not much elongated. Foot anisodactylous in form, toes massive, first one higher and shorter than others.

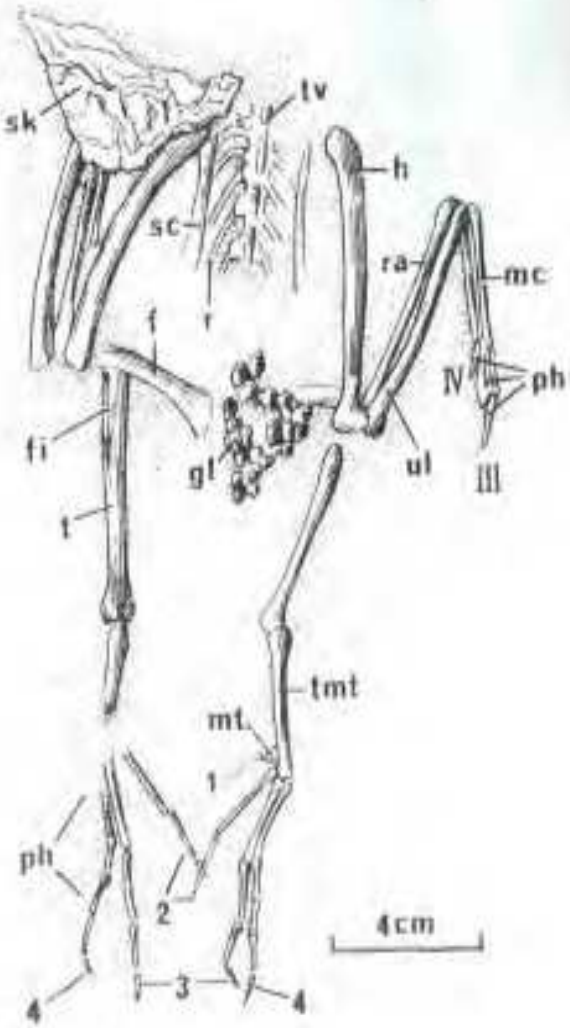
It is the Miocene bird found for the first time and also an intact fossil bird first in China.

▼秀丽杨氏鸟(*Youngornis gracilis*)

是秧鸡科乃至鹤形目保存最完整，时代也最早的化石代表，它肌胃中依然保存的胃石，更为鸟类化石中所少见，首开我国记录。秀丽杨氏鸟是一种个体较小的涉禽。生活习性有点和现生的小田鸡(*Porganapusilla*)近似。

It is the most well-preserved and the earliest fossil bird in Rallidae even Gruiformes. The gastric stones are gathered, truly a rare record in fossil bird. It is a small wading bird, the babits and customs similar to the present *Porganapusilla*.





鹤形目(Gruiformes)

秧鸡科(Rallidae)

▲齐鲁杨氏鸟(*Youngornis qiluensis*)

特征：一种中型个体的秧鸡。四肢各骨纤长，肱骨稍长于尺骨，掰踝骨则短于胫骨，也比中趾加爪的长度为短。四趾均细长，三趾朝前，一趾朝后为不等趾足(anisodactylous foot)，后趾稍高而稍短。上述特征与秀丽杨氏鸟甚似，但它明显大于后者，因而各骨长度也比之为长，唯其股骨反而比之为稍短，且其股骨头稍扁平，显示了两者间之差异。

A medium-size pallidae. Bones of limbs slender and long. Humerus is slightly longer than ulna, and the tarsometatarsus is shorter than tibia. Three phalanx forward and one backwards, that is anisodactylous foot, the characters very much like Youngounis gracilis but obviously being bigger than it.





鸡形目(Gallitormes)

雉科(Phasianidae)

▲硕大临胸鸟(*Linquornis gigantis*)

这是一种大型的鸟类化石，与现生的孔雀大小相近。该鸟可能营陆地生活，出没于近水的丛林草地，用其粗健的趾爪，在地面上觅食。

It is a large fossil bird, size roughly near to that of the modern peacock.

It perhaps lived on land and the forests and grasslands were the haunts of it.

雁形目(Anseriformes)

鸭科(Anatidae)

▶ 硅藻中华河鸭(*Sinanas diatomas*)

鸭科化石中保存最完整、时代最早的化石代表，它的骨骼构造和现生绿头鸭(*Anasplatyrhynehos*)近似，与现生家鸭的祖先有一定的亲缘关系。

The representive fossil of the most intact and the earliest in the Anatidae. Skeleton structure like the modern *Anasplatyrhynehos*, with a parental relation of modern ducks.



哺乳动物 MAMMALS

哺乳动物是脊椎动物中最高等的一个门类，以体被毛发，恒温，胎生，乳汁哺乳后代为主要特征。最原始的哺乳动物发生于距今二亿多年前的三叠纪晚期，但其真正的繁盛时代则是在恐龙灭绝以后，距今约七千万年的新生代时期。

现生哺乳动物的主要门类和基本格局是在距今约二千万年前才形成的。山旺动物群形成于约一千八百万年前，因此，对研究现生哺乳动物起源，演化有重要的意义。

The main characteristics of mammals are growing hairs and nurturing younger generation with their own milk, and the most high-level kind of vertebrate. The original mammals occurred in the late Triassic, more than two hundred million years ago, but its truly prosperous era was in Cenozoic, about seventy million years BP.

The major kinds and basic features of present mammals were formed before sometime about twenty million years BP. The Shanwang fauna formed nearly 18 million years ago,thus,it possess important significance in the study of the origin and evoltion of present mammals.

啮齿目(Rodentia) 和翼手目(Chiroptera)

啮齿目是哺乳动物中门类最多的一个目。它最主要的特征是上下颌各具有一对终生生长的门齿。现生的松鼠，旱獭，各种鼠类均属此目。而蝙蝠则属于翼手目，其特点是前肢具有翼膜。它们的个体通常都很小，因此常常和食虫目等一起笼统的被称之为"小哺乳动物"。

山旺的啮齿类化石是解放后才发现和研究的，特别是最近几年有较多精美的材料被发现。

The Rodentia is an order with maximum categories in the mammals, its main characteristics are in its upper and lower jaws respectively growing a pair of lifelong incisors.The modern squirrels, marmots and varied rats are all parts of this order. The present bats belong to Chiroptera, the peculiarity is their anterior limbs possessing pterygoid membranes. Their bodies generally small and often together with the Insectvora called "micromammals".

The fossil rodentia were discovered and studied after the founding of the P.R.C.,and many exquisite specimens have been collected in recent years.

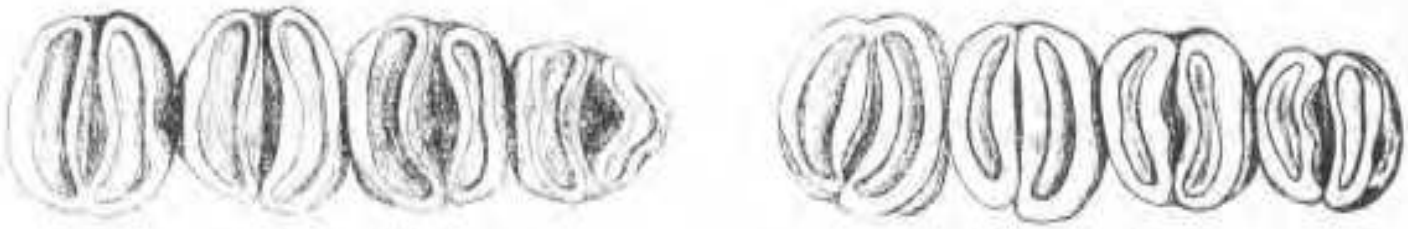
山东硅藻鼠(*Diatomys shantungensis*)

特征：个体中等的啮齿类。齿式1013/1013。门齿釉质层光滑，颊齿低冠，方形，大小相近，具有长的齿根。前臼齿臼齿化，上、下臼齿均呈双脊形，在咀嚼面上形成两个近于相等的釉质环形脊，上前臼齿在前脊的前外侧有一小的附脊；下前臼齿的前脊由三个尖组成，中部向前突出。头骨的轮廓与鼠类(Murine)相似。下颌骨的角突大，与垂直支在同一平面上(即松鼠型角突Sciurognathous)。骨骼构造适应地上疾走。长尾。

简记：山东硅藻鼠是一具近于完整并带有部分毛须痕迹，侧向受压的骨架印模。由于该标本的咬肌—颧弓结构(啮齿类分类上的主要依据)已无法分辨，因此难于确定其确切的分类位置。单就牙齿而论，它和*Megapedetes* (非洲南部和东部的一种中新世跳兔)及某些栗鼠(*Geomyoids*)相似。如今后能证实山东硅藻鼠有大的眶下孔和豪猪型的咬肌结构，那么它应归入跳鼠科(Pedetidae)相近的一类，反之，象目前这样把山东硅藻鼠置于栗鼠超科(Geomyoidea)。

Medium size. Dental formula 1·0·1·3/1·0·1·3. Upper incisor smooth. Cheek teeth brachyodont,squared, with longer roots; Molar bi-lophed, with two equal enamel rings on the grinding surface. The contour of skull similar to that of a murine skeleton definitely of a scampe-ring type with a relatively longer tail.

The poor preservation of the total deterioration of the infraorbital-zygomasseteric structure of the skull renders difficulty for a precise determination of the new form. Judgying from the bi-lophed structure of the teeth,*Diatomys* may be grouped either with the Pedetidae or with certain geomyoids.



山东娃鼯鼠 *(Diatomys shantungensis)*

亚洲梅氏松鼠 *(Meinia asiatica)*

特征：一种个体很小的飞松鼠。齿式：1·0·2·3/1·0·1·3。颊齿低冠，构造简单，上、下齿凹深，凹中有珐琅质褶嵴。P^3小，柱状，P^4小于M^1，二者皆方形，都无次尖，但有强大的前附尖及明显的中附类，原小尖、后小尖和弱的外脊；M^3次三角形，外侧尖极发达，无后脊。下颊齿菱形，没有下中尖和下中脊，但具下中附尖及前边尖的痕迹。下外脊和下次脊不连续。齿冠釉质层粗糙。

简记：松鼠类(Sciurids)最早的记录发现于北美早渐新世，由于它们能适应多种生态环境，因而它们具有广泛的地理分布和地史分布。在新第三纪和第四纪地层中，欧洲和北美都发现了相当数量的属种，而亚洲，则较为稀少。中国，该科最早的化石记录见于上渐新统，但上第三系的材料却极为零星。

Meinia asiatica 的P^3—M^1有四条横嵴，下臼齿菱形应归入Sciurptera类，并与亚洲的飞松鼠有接近的亲缘关系。

辛普生(Simpson，1945)把松鼠科(Sciuridae)分成鼯鼠亚科(Petauristinae)和松鼠亚科(Sciurnae)，鼯鼠亚科包括具有飞行功能的松鼠类，其它(包括真松鼠、花栗鼠、旱獭和草原狗等)都归入松鼠亚科。

飞松鼠系一严格栖息于森林和树丛中的啮齿类，不易保存为化石。

亚洲梅氏松鼠突出的颅顶和粗大的尾巴，四肢长，前后肢相差不大，表明它不可能属于适应挖掘生活的松鼠类。

亚洲梅氏松鼠上臼齿呈方形，齿尖粗钝，齿脊低，后小尖不发育等，反映其牙齿的压榨功能或以植物种子及以坚果为主食的习性，而区别于适应草食，为切割所具有的三角形上臼齿，锐利的齿尖，高的齿脊和发达的后小尖的地松鼠。

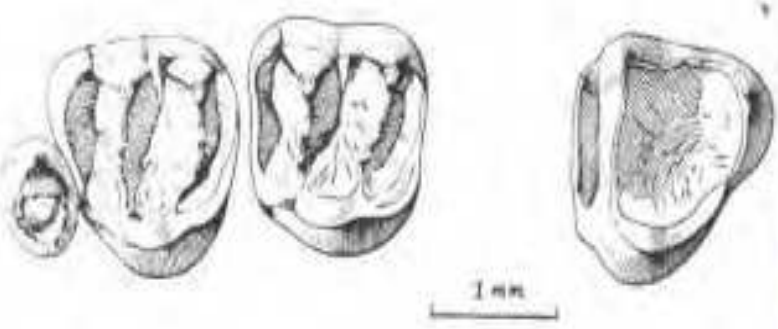
亚洲梅氏松鼠短短的吻部，较突出的鼻骨，则是现生的飞松鼠，如鼯鼠所具有的特征。

Meinia asiatica

A rather small sciuroptere. Dental formula:1·0·2·3/1·0·1·3. Cheek teeth brachyodont and simple in occlusal pattern.Enamel surface of trigon and talonid cavities heavily rugose, lower cheek teeth rhomb, lacking mesoconid and mesolophid, but with clear mesostylid and vestige of anteroconid,and ectolophid disconnecting to hypolophid.

The earliest record of Sciurids found in early Oligocene system in Noth America, and abundant genera of it have been found in the Tertiary and Quaternary systems in Europe and North Amirica. Quite few fossil squirrels have been found in Asia.The earliest one found in China is in the upper Oligocene series.

Meinia asiatica can be matched the Sciuroptera from Europe, and with close parental relation of Asian flying squirrels.



亚洲梅氏松鼠 *(Meinia asiatica)*左P^3—M^1 M^3



山旺半圆齿鼠 (*Ansomys shanwangensis*)

特征：一种个体稍大的半圆齿鼠，具有近锥状的齿尖和较强的附属嵴上臼齿原脊直；原小尖中部收缩，有分成双尖的趋势；中脊发育，M^1次圆形，后尖退化成后尖脊。下颊齿次小尖发育，M_3次方形，下内尖强大，下次小尖相对退化。

简记：山旺半圆齿鼠是一近乎完整的骨架，其轮廓分明，背腹向强烈受压挤，头骨完全破坏。肩带、脊椎和腰带部分也因受挤压而模糊不清。

山旺半圆齿鼠是陆生、喜水、山林或小溪边缘的一种山河狸。山河狸化石的最早记录出现于北美的上始新统，迄今只发现在全北区。地史上它们没有明显的繁荣时期，但在渐新世初、中新世前期似乎也有过相对的兴旺。从山旺半圆齿鼠的构造，我们可以看到山河狸颊齿的演化过程。

Ansomys shanwangensis

A relatively large *Ansomys* with cuspated cheek teeth and strong accessory crests. Protoloph straight; protoconule constricted at its middle part with a tendency to split; mesoloph developed; *the Ansomys shanwangensis* was a Aplodontidae of terrestrial animal and had a natural inclination for water.



▲山旺半圆齿鼠 (*Ansomys shanwangensis*)

奇蹄目

后肢具有奇数蹄，并以中央一蹄(第三趾)为轴心，距骨为单滑车型的哺乳动物，其中包括貘、爪兽、雷兽、犀牛及马等几大类。山旺发现的化石中主要有貘和犀两大类。

现代貘仅生活在东南亚和中南美洲，个体比现代猪稍大些。貘科化石的记录始自欧洲和北美的渐新世。它的发现与研究虽然已有百余年的历史，但第三纪地层中，特别是在晚第三纪早期的地层中的发现的貘化石几乎全是零散牙齿，因此对貘类早期进化了解很少。山旺发现的矢木氏近貘，是目前亚洲新第三纪地层中保存最好的貘化石，为我们研究貘类早期进化提供了重要的科学依据。

矢木氏近貘鼻骨已大大缩短，已具有和现生貘同样的活动软鼻，以柔软的树叶为主要食物，是典型的亚热带动物。

Plesiotapirus yagii 和日本平牧动物群中的貘的性质相近，到目前为止，山旺动物群和平牧动物群中至少有一个共同的种和一属能在上很接近的动物，它为研究和探讨亚洲大陆和日本岛的陆生哺乳动物的迁徙提供了新解释。

矢木氏近貘(*Plesiotapirus yagii*)

特征：大小与现生最小的貘 *Tapirus roulini* 相近。

面部高，从Prosthion至鼻切迹后端为一向上隆起的弧线；门齿排列紧密，不得到加大，下犬齿完全退失，鼻骨短，而位置特别靠后。

正模产于日本岐阜县美浓市，Tanohira的平牧组(Hiramaki)。

简记：*Plesiotapirus* 是貘科进化树的一个旁支，它没有留下后代，也不可能进化成现代的貘，它的分布范围可能仅限于亚洲中间地带的东部，现生的马来貘或其祖先，显然是由大陆迁移来的。

貘科化石的记录始自欧洲和北美的渐新世。中中新世才出现真正的貘(*Tapirus*)。日本岐阜县平牧组曾发现与山旺相同的貘。



Perissodactyla

A kind of mammals of posterior limbs with odd number hooves, the astragalus is single pulley-type, including Tapiridae, Chelicotheriidae, Brontotheriidae, Rhinocerotidae and Equidae. The fossil Perissodactyla from Shanwang are mainly Tapiridae and Rhinocerotidae.

Plesiotapirus yagii

The modern tapir only lived in Southeastern Asia and Central and Southern America, the individuals being larger than the modern pigs.The record of fossil Tapiridae begins in the Oligocene in Europe and North America, but the fossils almost fragmentary teeth. The specimens of it from Shanwang are the most well-preserved one and provided important scientific basis for the study of their evolution.

Size comparable with that of the smallest extant species, *Tapirus roulini*. Its facial part anterior to the orbit remains unreduced and high, with the lower border of the nasal notch strongly convex upwards. The nasals are short, strongly retracted backwards. The holotype was found from the Hiramaki Formation,Mino City of Gifu Prefecture, Japan.



Plesiaceratherium gracile

近无角犀属 *Plesiaceratherium*

特征：大或中等的原始无角犀。上门齿(I¹)较弱，下门齿(I_2)大，稍弯曲。无角，鼻切迹较深，头部较窄。上颊齿前尖浑圆，前臼齿的外齿带消失。通常内侧尖有弱的缝。下前臼齿窄而长。外壁沟浅，下原尖外角扁平，下前臼齿外壁每每具有垂直的珐琅质纹络。四肢长，前脚四趾。

细近无角犀(*Plesiaceratherium gracile*)

山旺动物群中个体最大的一类动物，个体与现生犀牛差不多，但头上无角，四肢较为纤细，前足四指，以植物枝叶为食。是典型的亚热带动物。现生犀类头上都有角，前足三趾。分布在非洲和南亚的局部地区。

特征：一种中等大小的近无角犀，头骨窄长，下门齿扁平，肢骨细长，下前臼齿外壁具有细弱的珐琅质纹络。

简记：近无角犀是杨钟健教授1937年依山东临朐山旺早中新世地层中发现的一些零星的牙齿和肢骨而建立的一个属，近些年来，在山旺相继又发现了许多无角犀(Aceratherinae)的材料，除一保存十分完整的*Diaceratherium*骨架外，其余皆为近无角犀，它们包括三具保存十分完美的骨架其中一为幼年个体，九件比较完整的头骨和多件肢骨。

1986年阎德发和K.海希西把欧洲的*P. fahlbuschi*、*P. platyodon* 和*P. mirallesi* 也归入了近无角犀属，至此，近无角犀目前包括产于欧洲和亚洲的四种犀类。

嵌齿象 (*Gomphotherium* sp.)

嵌齿象在长鼻类进化上是比较原始的象类，它的外部形态和现代的大象已十分接近，但它们的牙齿构造比较特殊，山旺发现的标本只是臼齿的一部分，嵌齿象的每个臼齿，是由几个大的乳头状的瘤组成的，因此古生物学家常常把类似有这种构造的长鼻类称为乳齿象。

Plesiaceratherium gracile

Its individuals are the largest in the Shanwang fauna, the body size like the modern rhinoceros but without horn. Limbs rather slender, the anterior foot with four toes. It feeds on vegetables. A typical subtropic animal.

In 1986, Yan Defa and K. Heissig concluded the European *P. fahlbuschi*, *P. platyodon* and *P. mirallesi* into *Plesiaceratherium*, and it included four rhinoceros discovered from Europe and Asia till now.

Gomphotherium sp.

It was rather primitive elephant in the evolution of proboscidea, its form was already quite like the modern elephants but the stucture of their teeth were ather special. This specimen is only a part of its molar, each molar of the *Gomphotherium* was composed of papilla tumours, thus the paleontologists always called them as *Mastodon*.

偶蹄目

前后肢均具偶数蹄，并以一对中蹄为轴心，一般第3和第4趾为着力点，第一趾即使在很古老的类型中几乎也从来没有出现过。距骨为双滑车型的哺乳动物。现代大多数有蹄动物都是偶蹄类，如猪、骆驼、鹿、羊、牛等。山旺发现的偶蹄类只有猪和鹿两大类。

Mammals whose limbs are all possessed even number hooves and the astragalus is dorble pulley-type. The fossil Artiodactyl found from Shanwang only Suidae and Cervidae.

▼山东原河猪(*Propotamochoerus shandongensis*)

一种个体较小的猪，头短小，颧弓向两侧伸展，雄性有细长的下獠牙，但不向外斜伸，牙齿结构简单原始。

Size rather small, head short. The male with long lower protruding teeth. Dental pattern simple and primitive.

▼半岛原河猪(*Propotamochoerus penisulus*)

一种大型的猪，头骨伸长，牙齿冠面构造较复杂，但面部构造仍较简单，颧弓不向两侧明显扩展，四肢粗壮。

A large size species. Skull extended. Structure of corona dentis is rather complicated. Limbs strong.





山旺的鹿化石

鹿是山旺哺乳动物群中发现数量最多保存最好的化石，到目前为止，保存完整的骨架就有60余个。在过去的40多年中，不同的研究者先后为山旺鹿化石订了7个属种，后来又把它们归并为3个属，即：柄杯鹿(*Lagomeryx*)，原古鹿(*Palaeomeryx*)和皇冠鹿(*Stephanocemas*)，在山旺发现的众多鹿化石中，柄杯鹿的数量最多，虽然它们牙齿的构造十分相近，但角的类型却相去甚远，是种内变异，还是种间区别?尚需进一步研究敲定。

关于*Palaeomeryx*的分类，是近百年来古哺乳动物学中颇为引人注目的争论点之一。

最近的研究表明，*Palaeomeryx*是长颈鹿中最早分出的一个旁支，它和鹿科有较近的亲缘关系，而和牛科的关系较远。

杨钟健(1937)研究的*Stephanocemas colberti*既不是皇冠鹿，也不是典型的柄杯鹿，一般柄杯鹿的角都是属于没有角节的非脱换型，皇冠鹿的角节则是圆而平坦的，*Stephanocemas colberti*角上的角节参差不齐且不太显著，这与欧洲从中中新世开始出现的一种鹿(*Heterroprox*)很相近。这种由非脱换性角向脱换性鹿角发展的过渡类型。在欧洲仅出现于中中新世。目前我们姑且把*Stephanocemas colberti*保留其种名，放在柄杯鹿(*Lagomeryx*)属中。

胡长康1957年研究报道的*Stephanocemas* cf. *thomsoni*仅保存了角的掌状分叉的两个分枝，角的中心部分缺失。角之近端无论是背面或腹面都比较粗糙，腹面尤甚，可能这就是与角干接触的边缘部分。

*Stephanocemas*是欧洲中中新世的典型属，胡长康研究的材料应属*Stephanocems*，但是否汤氏种，有待进一步研究确定。

古鹿(*Palaeomeryx*)首先发现在欧洲，并且分布广泛，我国发现却不多，由于完整的材料很少，长期以来，人们无法肯定古鹿是否有角。山旺材料的发现证明，原古鹿仅雄性有角，雌性则无。它的角在生长方式上接近长颈鹿的角，由皮下一骨化中心形成，仅在老年个体此骨化中心才和头骨完全愈合，"角"的表面粗糙，表明它可能和长颈鹿的一样，由皮毛覆盖。

Fossil Cervidae in Shanwang

The fossil Cirvidae is the maximum amount in the fossil mammals from Shanwang, the well-preserved skeltons are more than 60 up till now. In the past 40 years, the researchers classified the fossil Cervidae into 7 species but merged them into 3 genera afterwards, that are *Lagomeryx*, *Paleomeryx* and *Stephanocemas*.

The classificatiom of the Palaomeryx is one of the contention of mammalian paleontology in the near century.

Although some similarities between the *Palaeomeryx* and Giraffidae had caused attention (O.Hefmann,1870; M.Schosser,1903; Teilhard de Chardin, 1939; G.plign,1941), the former was all along classified in the Cervidae or Cervoidea.

A viewpoint was born out of repeated study that the *Stephanocemas colberti* described by C.C.Young (1937) neither *Stephanocemas* nor typical *Lagomeryx*. Generally, the antler of *Lagomeryx* is non-deciduous,a nd that of the *Stephanocemas* is round and smooth, the pedicles uneven and not striking, it is very like the *Heterroprox* that begun to appear in middle Miocene in Europe. We included the *Stephanocemas colberti* into *Lagomeryx* at present.

The *Stephanocemas* cf.*thomsoni* reported by Hu Changkang(1957), only two fragments of antlers preserved, wholly absent of central area.

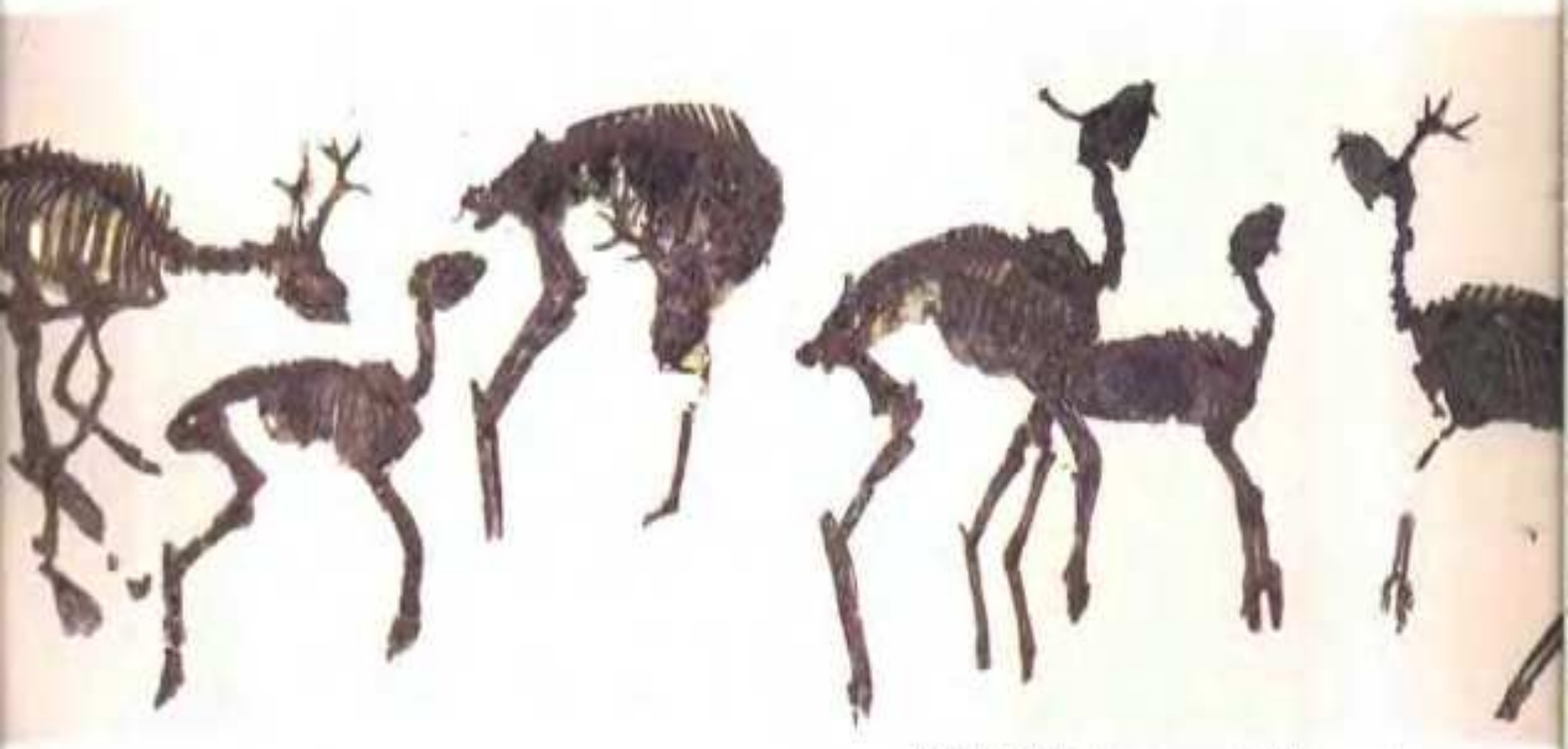
The *Stephanocemas* is a typical genus of the middle Miocene in Europe, the specimen studied by Hu should belongs to *Stephanocemas* but it remains to be solved whether it is a part of the *S.thomsoni* or not.

The *Palaeomeryx* found in Europe first of all, and are widely dispersed over there, a few of them were discovered in China. Because The complete skelunton is very few at all, it is unable to determine whether the Palaomery had antler, the material found from Shanwang shows that the male *Palaeomeryx* with antlers and the female without it.



▲柯氏柄杯鹿角





柯氏柄杯鹿群 *Lagomeryx* skeleton mural

▼三角原古鹿 (*Palaeomeryx tricornis*)

特征：雄性在眼眶上方有一对短粗侧扁的“皮骨角”，角的前缘向后倾斜，角的顶端稍有膨大，角表面粗糙。枕部顶端向后上方延伸，末端膨大，形成“锤形”角状突起。

简记：虽然*Palaeomeryx*和长颈鹿之间的某些相似性早就引起了人们的注意，但是它还是一直被人们习惯地放在鹿超科或鹿科里。1966年法国古生物学家才第一次明确地提出把*Palaeomeryx*放在长颈鹿超科。

*Palaeomeryx tricornis*为 *Palaeomeryx*的分类提出了新的证据。角的着生位置，表面形态，内部构造以及与头骨的关系(以骨缝相接)等与现生长颈鹿完全一致。

The males have a pair of short and stout cortical antlers above the orbits, the apex of antlers slightly expanded and the antler surface roughly.

Although some similarities between the *Palaeomeryx* and the Giraffe caused the researchers' attention, the *Palaeomeryx* put in the Cervidae in 1966 but it had been merged into Giraffidae.

The *Palaeomryx tricornis* provided a new evidence for the classification of the *Palaeomeryx*.



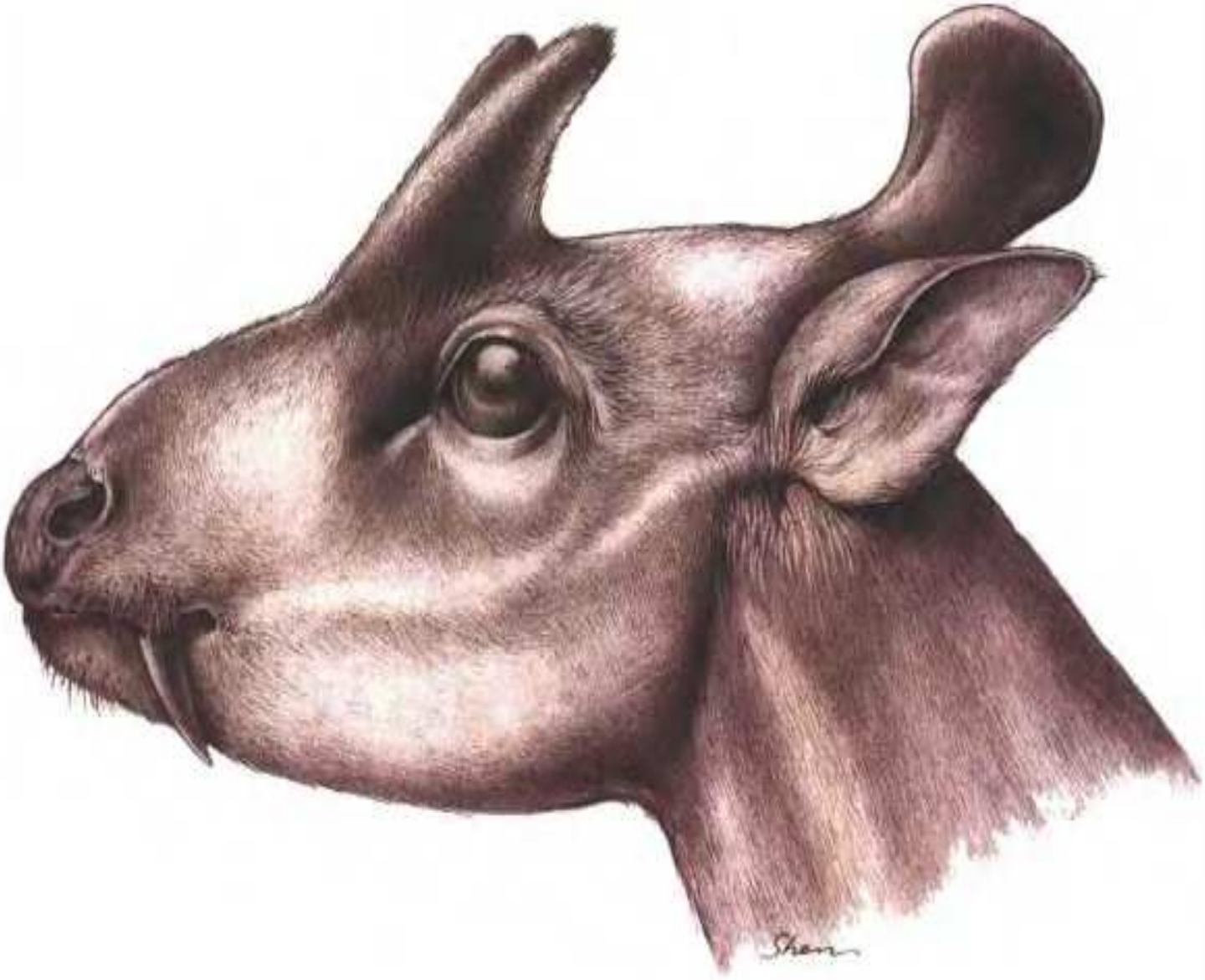


▲柯氏柄杯鹿(*Lagomeryx colberti*)

柄杯鹿是已绝灭的鹿类。雄性有角，末端分岔，但这种角是不脱落的，而且可能是终生由皮肤覆盖的，雄性有大的上犬齿。雌性既无角，也无大的犬齿。雌雄前后肢都保留有较发育的侧趾，这些都表明这是一类构造原始的鹿类。过去根据角的分叉情况曾定过几个种，现在看来，它们很可能是种内变异。

Lagomeryx colberti

It was a extincted Cervidae.The males with antlers and large upper canine, in neither cases did the females posses s. In the past, it had been described into several species based on the fork-form antlers, it seems that probably a phenomenon of species variation.



三角原古鹿(*Palaeomeryx tricornis*)头骨复原图

肉食目

肉食目，是以“食肉”为其特征的一类动物，它们的身材灵巧，牙齿和四肢明显表现出适应吃肉和捕捉其它动物，如犬齿发达，门齿齐全，还有一对上、下臼齿特化形成而成的，适合切割功能的“裂齿”，一般在趾尖有尖锐的爪，如猫、狗等……。有趣的是迄今在山旺发现的肉食类大概都属于熊科的成员。

Carnivora

The Carnivora is characterized as meat-eating, they generally have stout canines and sharp carnassial teeth. Among them, some genera of it changed to omnivorous even to plant-eating animals such as bears and pandas. It is interesting that the fossil Carnivora found from Shanwang are all belong to Ursidae.



东方祖熊 *(Ursavus orientalis)*

一种小型食肉动物，大小接近现生灵猫，四肢纤长，后肢比前肢长，腰部形成较大的弧度，具长尾，动作灵巧，但牙齿已明显为“熊”式，即已有大大加长的裂齿和后臼齿，属强烈“杂食性”。它可能代表了现今熊类早期的一个旁支。

祖熊是欧洲中新世常见的动物，它对确定地层年代很有用，在欧洲的二十多个化石点均有发现，在北美和亚洲的地层中也有过记录，遗憾的是，所有发现的祖熊化石都很破碎。由于人们从未发现过祖熊的骨架，致使许多古生物学家对祖熊的体态几乎是一无所知。东方祖熊化石是迄今世界上保存最好的完整骨架，对于我们研究祖熊起源和进化具有很重要的意义。

特征：个体最小的*Ursavus*，前臼齿相对更小，裂齿及其后颊齿齿冠低，各尖分化弱，M^1外侧后根在前部近端有一纵沟，M^2小于M^1，跟座小，M_1跟座特别宽，M_2跟座较长，比三角座更偏向舌侧。

简记：*Ursavus* 属共包括七个种，其中出现的时代最早，个体最小和构造最原始的是*U. elmensis*，*U. orientalis* 比它还小，在构造上，除了个别的进化性状外，在总的进化水平上大体与它相当，而比其它种要原始，个体也小。

Small size. Meat-eating. The size like the modern civet, limbs slender, and the posterior limbs being longer than the anterior limbs. Long tail. It is probably a early collateral family of the present bears.

Ursavus was a common animal in Miocene in Europe. It is very beneficial to determine the stratigraphic horizon. It also had been found in N.America and Asia, but the fossils are all fragmentary. The *Ursavus orientalis* is the most well-preserved fossil skeleton in the world till now. This specimen is the smallest of the genus.Premorlars very small and low, the molars all very low-crowned, with weakly individualized cusps.

So far seven species of *Ursavus* have been described, among which *U.elmensis* is the smallest, the most primitive and the earliest in geological age. According to the general evolutionary level and the size,the *U.orientalis* is closest to *U.elmensis*.



Ursavus orientalis 左上P^2—M^1顶面观



Ursavus orientalis 左下M_1—M_3顶面观



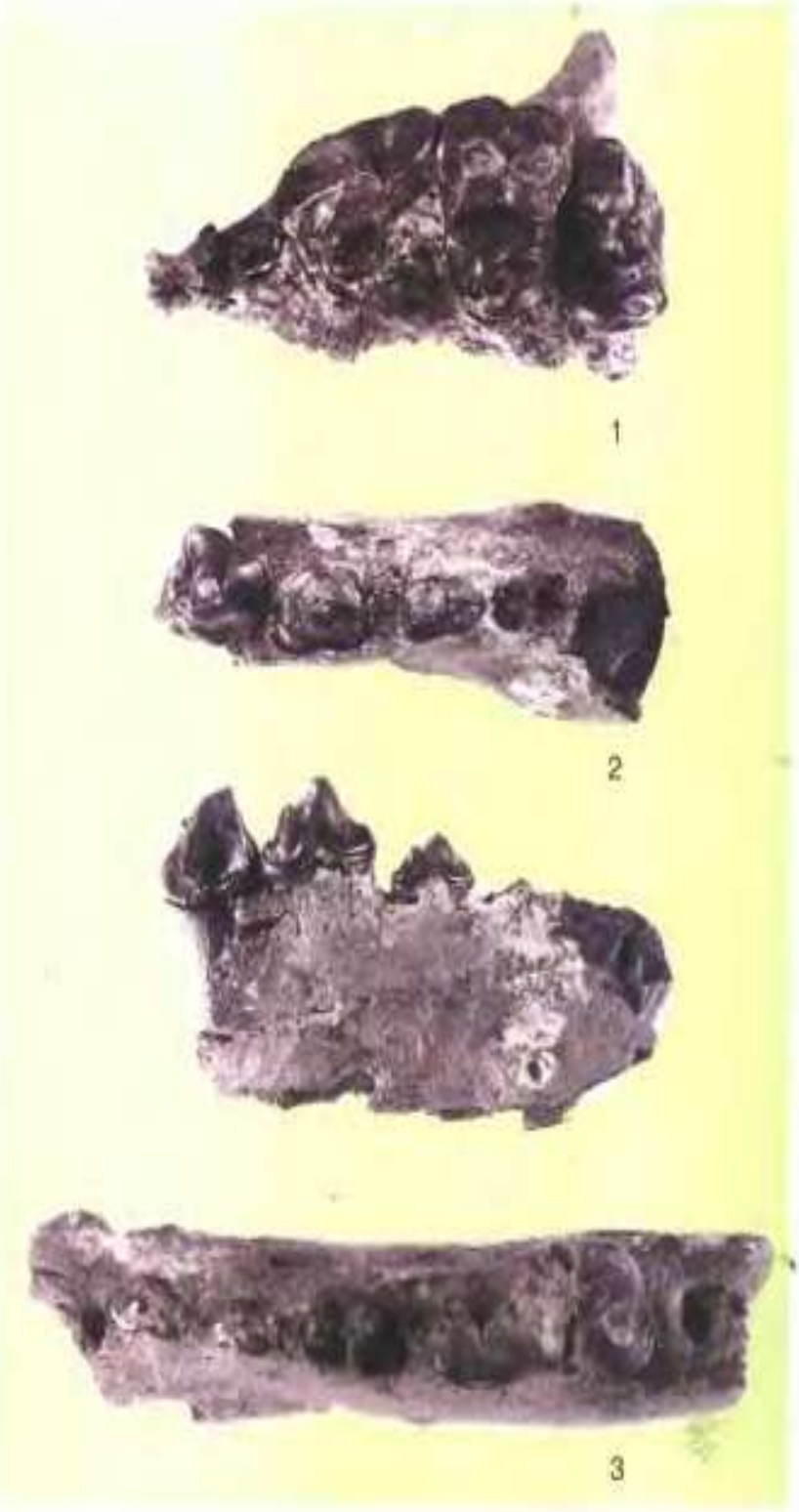
杨氏半熊 *(Hemicyon (P.) youngi)*头骨



杨氏半熊 *Hemicyon (Phoberocyon) youngi*

特征(增订)：主尖后的附尖(Postmetaconid)巨大，前尖高大，其前缘向后上方倾斜，跟座的外后角向后外方突出；具有下前尖。

The P_4 is proportionally much larger than the preceding premolars. Its posterior accessary cusp is also much enlarged. The paraconid of the P_4 bulges on the base of its anterior edge, making the anterior edge rather strongly sloping backward. The M_1 possesses a paraconid, which is separated from the metaconid by a shallow groove; the trigonid is large in comparison with the talonid.



杨氏半熊 *Hemicyon (P.) youngi*

1. 不完整左上颌 顶面观
2. 不完整右下颌 顶面观及唇侧观
3. 不完整左下颌 顶面观





孔子犬熊 (*Amphicyon confucianus*)

这是一类大型肉食动物，体态如熊，有长尾，行动亦如熊敏捷，有很粗壮的颊齿，可以切割兽肉，也可以咬碎骨头，是当时最大的，也可能是最凶猛的野兽。

特征：是犬熊属较大的一种，下颌水平支深厚，下颏孔大，在P_1与P_2之间；P_2—P_3之间齿缺较长，P_3以后牙齿排列紧，P_3低，简单，无前、后附尖；M_1侧扁较其它种长而窄，下前尖短，下原尖高，下后尖小，跟座有明显下内尖，下次尖钝而粗壮。

简记：过去*Amphicyon*连同一大批和它相近的肉食类一直被视为犬科的早期成员，近年来越来越多的古生物学家都同意 J. R. Hough 1948年的意见，根据头骨基部的特征把*Amphicyon*归入熊科。

它们的牙齿构造确实具有和犬科动物相似的特征。因此把*Amphicyon*译为犬熊更为贴切。

A large-sized, meat-eating animal, the body like bear with long tail. Judging from the general characters of the jaw, there is no doubt that this fossil represents a large and violent *Amphicyon*.

犀类的进化

犀是奇蹄目(Perissodactyla)中十分庞杂的一类，是新第三纪和第四纪地层中常见的哺乳动物化石之一。最早的犀类化石发现于北美、亚洲和欧洲的始新世地层中。始新世晚期到渐新世曾是犀类的鼎盛时代。中新世以后，大部分种类趋于绝灭，仅有真犀科(Rhinocerotidae)的一些属种延续到更新世。目前只剩下印度犀(*Rhinoceros unicornis*)、爪哇犀 (*Rhinoceros sondaicus*)、苏门答腊犀(*Dicerorhinus sumentrensis*)、黑犀(*Diceros bicornis*)和白犀(*Diceros simus*)五个子遗种。前两种在鼻骨上各有一个角亦称独角犀，后三种除了生有鼻端角外，还长有一个额端角，因此又有双角犀之称。现在它们仅分布在亚洲和非洲的热带森林和疏林边缘地区。

关于犀类的起源和进化。目前还不十分清楚，分类上也还存在许多问题，一般将犀类(Rhinocerotidea)分成跑犀科(Hyracodontidae)、两栖犀科(Amynodontidae)和真犀科(Rhinocerotidae)。近来有的古生物学家认为，真犀科是晚始新世，由具有四趾，原始的蹄齿犀(Hyracodontidae)分化出来的。

一般早期的犀类个体都比较小，而且无角，但很快地向个体大的方向发展，渐新世及以后的犀类一般都体高身大，有的发展成陆生最大哺乳动物——巨犀。

犀类大都生活在热带的沼泽地区，草食性，只有个别的晚期种类，如更新世的披毛犀生活在寒冷的地区。

山旺盆地共发现过三种不同的犀类(*Brachpotherium*、*Plesiaceratherium* 和*Diaceratherium*),它们皆属于无角犀亚科(Aceratheriinae)，无角犀亚科是由真犀科演化出来的一个支系，它们生活的时代仅限于中新世。

*Brachpotherium*短头型，无角，上门齿大，牙齿白垩质比较发育，下颊齿外壁沟浅，四肢粗短，是中新世比较常见的一种犀。

*Plesiaceratherium*四肢较长，前足四趾，无角，是一种较为原始的犀类。

*Diaceratherium*的四肢较为粗短，头骨属短头型，鼻骨末端有一个不大的角。至于为什么山旺盆地中一个不大的生态环境内，竟生活着三种截然不同的犀类，这倒是古生物学家十分感兴趣的问题了。

EVOLUTION OF THE RHINOCERAS

Rhinoceras is a very numerous category of the perissodactyla, and one of the common fossil mammals in Neogene and Quaternary systems. The earliest fossil rhinoceras found in the Eocene system in N.America, Asia and Europe. It was the prime of rhinoceras from Eocene to Oligocene. Most of them were extincted after Miocene, and only some genera lasted to Pleistocene. At present, only five species remain: the *Rhinoceros unicornis, R.sodaicus, Dicerorhinus sumentrensis, Diceros bicornis* and *Diceros simus*. The first two species respectively possessed a horn over the nasal bone, so namely single-horn rhinoceros, the last three species with the exception of this have a frontal horn, and called double-horn rhinoceras. They are only distributed in the tropical forests and the borders of sparsed forests in Africa and Asia now.

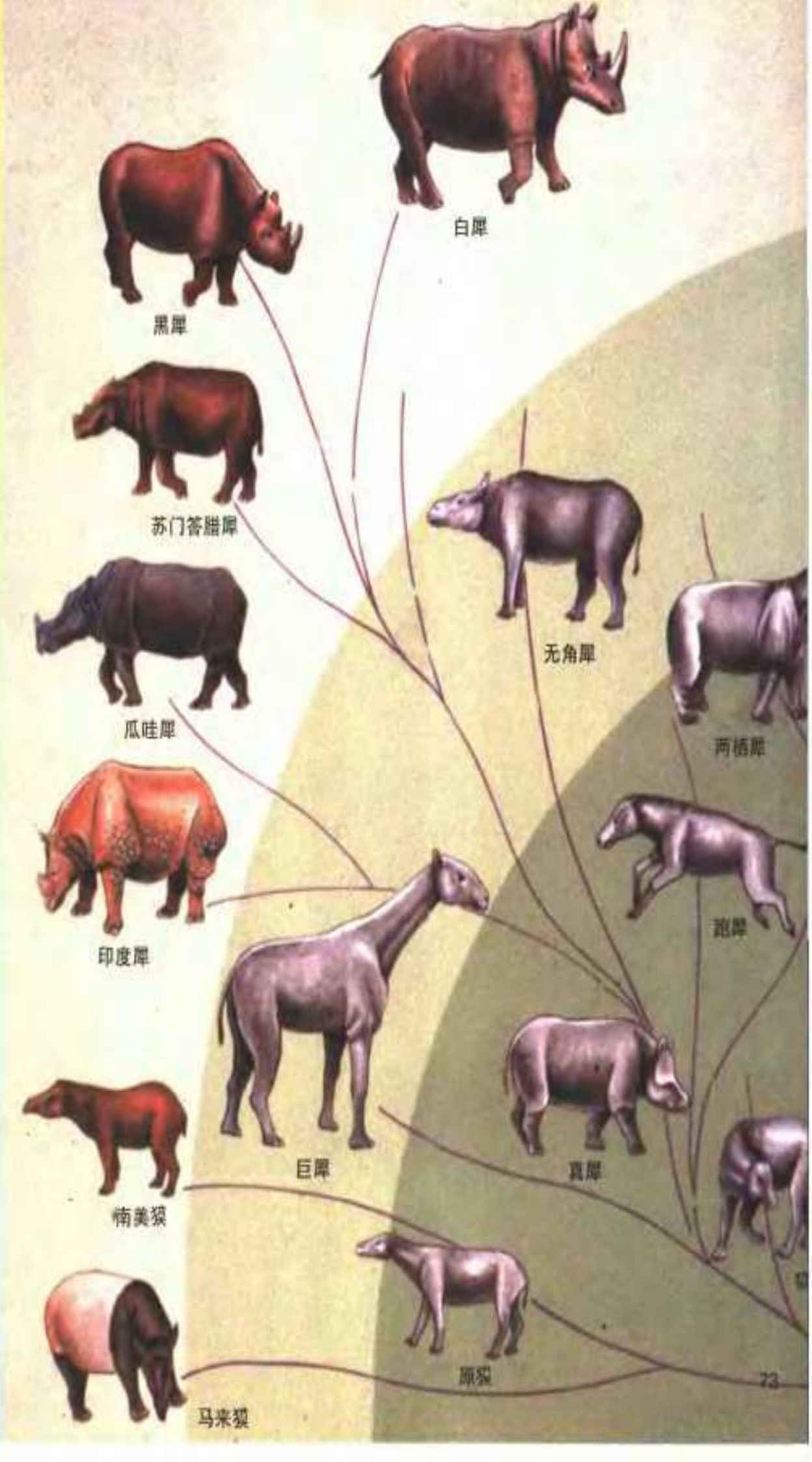
We do not know clearly about the origin and evolution of the rhinoceras, and there are many problems in their classification.Generally,it is divided into Hyracodontidae, Amynodontidae and Rhinocerotidae, some paleontologists recently considered that the Rhinocerotidae was differetiated from the primitive Hyracodontidae in late Eocene.

The rhinoceras in early stage generally were small-sized without horns, but they developed to large bodies very soon, the rhinoceras in Oligocene and from then on were large-sized, and some became the largest mammals, the Indricotherium.

Most of the rhinoceras lived in the marshland in the tropics and plant-eating, only specific late species as the Coelodonta antiquitatis lived in the frigid areas.

There are two rhinoceras, *Plesiaceratherium* and *Diaceratherium*, found from Shanwang, they all belong to the Aceratheriinae, and they were confined to Miocene.

EVOLUTION OF RHINOCERAS



展览大厅一隅












山旺古生物化石学术讨论会


POSIUM ON PACIFIC NEOG


太平洋地区晚第三纪海陆事件国际学术讨论会
INTERNATIONAL SYMPOSIUM ON PACIFIC NEOGENE CONTINENTAL AND MARINE EVENTS

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