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武定中泥盆世早期节甲鱼的新材料

王俊卿
（中国科学院古脊椎动物与古人类研究所）

关键词 云南武定　中泥盆世　节甲鱼类

内　容　提　要

记述了云南武定中泥盆世早期旧城组节甲鱼类一新属新种，并讨论了它与其它一些节甲鱼之间的系统关系。

1981年4—5月间，笔者前往云南武定地区采集化石。云南省武定地校吴宝生老师曾同笔者一起到野外工作。在任教期间，吴老师多次带领学生在武定附近进行野外实习，并采集不少化石。其中有三块较大的、岩性一致的标本，经拼接发现为一较完整的节甲鱼类的头甲。吴老师将该化石赠送给作者以做研究。

化石采于武定县城附近的香水庄。该材料仅为一头甲外模。这一发现不仅丰富了武定地区中泥盆世早期鱼群的内容，同时为进一步讨论短胸节甲鱼类的系统关系提供了新的信息。

对吴宝生老师赠送标本，刘增和张杰两同志分别为本文绘制插图和摄制图版，作者在此一并致谢。

一、化石记述

真节甲鱼目 Euarthrodira Gross, 1932
短胸节甲鱼亚目 Brachthoraci Gross, 1932

香水鱼属(新属) *Xiangshuiosteus* gen. nov.

属型种　吴氏香水鱼(新种) *X. wui* sp. nov.

属的特征　个体较大的真节甲鱼类。头甲呈六边形，宽大于长。头甲前部中间稍下凹，而后部则明显上凸。头甲前缘凸出后缘平直，后侧角靠前。副关节突和后颈突发育。眼孔小，位置靠前，上眼窝发育。中颈片梯形，长度小于头甲长度的1/2。吻片大，形如橄榄。松果片为僧帽形，位于两眶前片之间。松果孔较大，呈肾状，位于松果片的骨化中心。中心片较大呈蝶状。眶前片小于眶后片。边缘片横宽并与中心片相接。纹饰为小的粒状突起。感觉沟为粒骨鱼型。

属名来源　香水为鱼化石产地的名称。

吴氏香水鱼 *Xiangshuiosteus wui* gen. et sp. nov.

(图版 I, 图 1、2; 插图 1)

种的特征 同属的特征。

正型标本 一件保存较完整头甲外模。标本编号 V9758

产地与层位 云南武定香水庄。中泥盆世旧城组。

种名来源: Wu 为化石采集者姓的汉语拼音。

描述与比较 正型标本为一件保存较好的头甲外模。除左侧的眶前片、眶后片、部分边缘片和右侧的眶后片及部分边缘片外，其它各骨片均完整保存。骨片界线和感觉沟均十分清楚。

头甲呈六边形。前缘凸。后缘直，后中突小。前侧缘稍向中线凹，后侧缘则略向外凸。后侧角位置较前。头甲宽大于长，展开后的最大宽度位于后侧角，约 270 毫米，中线处的最大长度为 225 毫米，宽约为长的 1.2 倍。头甲前部中间略向下凹，后半部从中颈片前缘起向后逐渐隆起，最高处位于中颈片的骨化中心。眼孔小而位置靠前。

吻片较大，形如橄榄。没有前后叶之分，与典型的 coccosteids 呈"T"形的吻片明显不同，而与 Homosteidae 科 *Antineosteus* (Leliever, 1984) 则有些相似。该骨片宽大于长，长宽之比为 1:2。骨片明显向背上方凸起，但背叶和前下降叶之间界线不明显。

松果片大，为僧帽状，位于两眶前片之间。骨片的最大宽度为 50 毫米，中线长 30 毫米，两者之比为 1:6。前缘凹后缘凸。骨化中心明显上凸，松果孔刚好在其顶部。松果孔较大，呈肾状，洞穿头甲。

在 Coccosteidae 科里，松果片多为长方形或三角形，如 *Watsonosteus*, *Clarkeosteus* (Denison 1978, 图 57E, F)。在 Buchanosteidae 科里，松果片和吻片愈合成为一个骨片，并位于两眶前片之前 (White 1952, 图 21; Young 1979, 图 1; Denison 1978, 图 49)。因此，新材料的松果片与上述两科所有的属均不同。

中心片较大，两者之间以不规则曲线相接，呈蝶状。两者的最大宽度为 150 毫米，中线长 60 毫米，两者之比为 2.5:1。前缘向后凹，侧缘向外凸，呈半圆形，后缘向前凹入较深。从形状看，该片与 coccosteids 的三叶型中心片明显不同，而与 *Buchanosteus* 的中心片在形状上则很相似。

中心片被较深的中心感觉沟 (csc) 和眶上感觉 (soc) 穿过。通常，这两者在骨化中心处相迁，但也有少数例外，武定材料就是其中之一。中点线沟不发育。后点线沟 (pp) 较长，并与主侧线沟 (lc) 在副颈片上相接。

中颈片呈梯形。前缘向后凹，后缘平直并具一小的后中突。在后中突两侧，中颈片向后下方斜并形成头甲后下降叶。该片长 105 毫米，约为头甲长度的 46%。这一点刚好在 Denison (1978) 对粒骨鱼科 (Coccosteidae) 所限定的中颈片占头甲长度为 34—50% 的范围内，并与 *Buchanosteus* 的 44% 相近似；而与 Homosteidae 科各属的比例不同，在该科里中颈片的长度均超过头甲长度的 50%。骨片最大宽度在后侧角，为 138 毫米，宽大于长，两者之比为 1.3。骨片明显上拱，骨化中心位于最高处。

眶前片小，为不规则的五边形。眶前突不发育。该片外侧明显向上拱起，呈带状并与

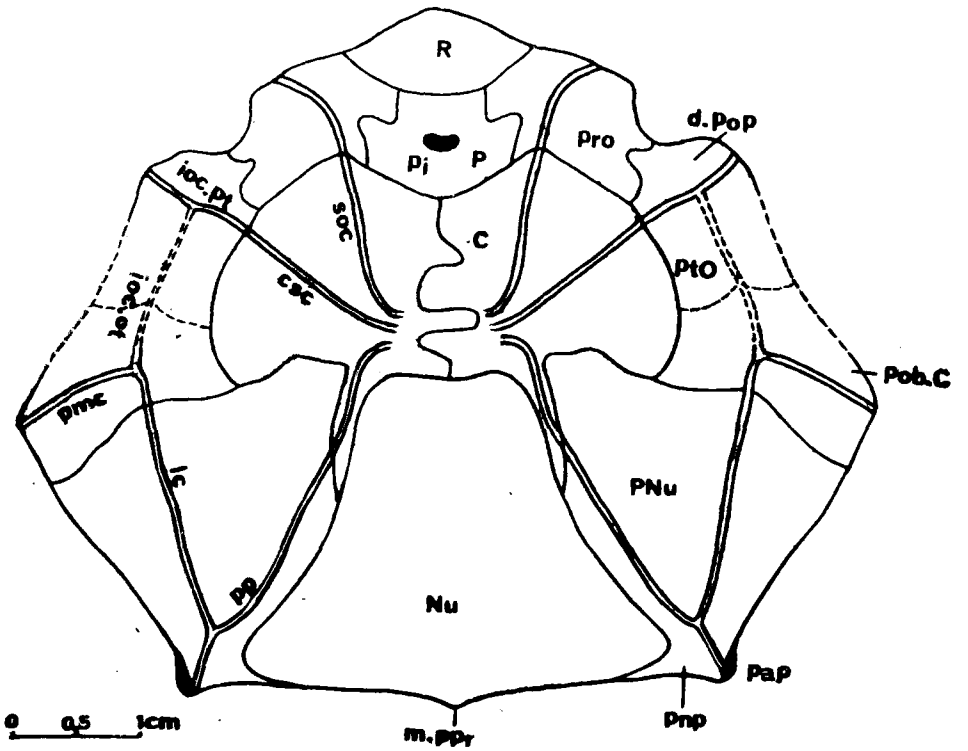

图 1　吴氏香水鱼(新属、新种)头甲复原图。背视。

Fig. 1. *Xiangshuiosteus wui* gen. et sp. nov. Reconstruction of skull-roof in dorsal view based on the Holotype V9756.

C——中心片 (central plate); M——边缘片 (marginal plate); Nu——中颈片 (nuchal plate); P——松果片 (pineal plate); Pi——松果孔 (pineal foramen); PNu——副颈片 (paranuchal plate); PrO——眶前片 (preorbital plate); PtO——眶后片 (postorbital plate); R——吻片 (rostral plate); csc——中心感觉沟 (central sensory canal); d. pop——眶后突 (dermal postorbital process); ioc. ot——眶下沟耳支 (otic branch of ingraorbiyal sensory canal); ioc. pt——眶下沟眶后支 (postorbital branch of infraorbital sensory canal); lc——主侧线沟 (main lateral canal); m. ppr——后中突 (posterior median process); pap——副关节突 (para-articular process); pmc——后缘沟 (postmarginal sensory canal); pnp——后颈突 (postnuchal process); pob. c——头甲后侧角 (posterolateral corner of skull-roof); pp——后点线沟 (posterior pit-line); soc——眶上沟 (supraorbital sensory canal)

眶后片的相应拱起相连，形成明显的上眼窝。两眶前片被松果片左右分开。后外侧缘呈弧形，构成眶孔凹刻的前半部。在短胸节甲类里，除 *Homosteus*, *Heterosteus* 外，眶前片均大于眶后片。武定新材料的眶前片小于眶后片，在这一点上新材料与它们则明显相似。

眶后片保存不全，仅右侧的前半部保存下来。从复原图看，骨片长大于宽，并大于眶前片。骨片为不规则四边形，前缘波状，内侧缘为半圆形。前外侧缘向内凹入构成眶孔凹刻后半部。在眶下感觉沟后支(简称眶后支)(ioc. pt)与该片侧缘相交处向外凸，形成钝圆的眶后突 (d. pop)。骨片前外侧部向上拱，与眶前片相应部分相接形成半圆形拱起，

构成上眶窝。这一点与所有短胸节甲类是相同 (Miles 1969, Young 1981)。中心感觉沟、眶下感觉沟耳支 (ioc. ot) 和眶后支在骨化中心处相遇。

边缘片保存不全,只保存了左侧的后半部。该片大小与眶后片相近,为不规则的四边形,宽大于长。这一点与粒骨鱼科 (Coccosteidae) 各属均相似; 而与 *Buchanosteus* 不同,后者长大于宽。前缘没有保存,后缘前凸; 内侧缘向外凸并与中心片相接。外侧缘构成头甲前侧缘的一部分,明显外凸形成头甲后侧角。主侧线沟贯穿该片,眶下感觉沟耳支和后边缘支 (pmc) 同主侧线在骨片中心相遇。

副颈片大,形状不规则。该骨片内侧较平,外侧明显向腹外侧方弯,因此横向上凸起显著。副关节突 (pap) 和后颈突 (pnp 发育,但前者更明显。前缘短,夹在边缘片和中颈片之间并深入到中心片,向前超过中颈片前缘。这一特征明显地不同于粒骨鱼科各属和 *Buchanosteus*, 而与 *Taemanosteus* (White 1952, 图 30) 相似。主侧线沟与后点线沟在骨化中心处相遇。骨化中心靠近后缘。

感觉沟系统在武定材料里保存较全,除眶下沟耳支因骨片缺失没有保存外,其余均保存而且十分清楚。由于整个头甲是以外模形式保存下来的,因此感觉沟全由高出头甲外模的嵴组成。嵴粗细中等,上下同宽,说明感觉沟较深而且宽度一致。从感觉沟的分布情况看,属典型粒骨鱼型。

纹饰与 Coccosteidae 科各属的纹饰相似,由小的粒状突起构成,基部不呈星状(图版 1, 图 2)。粒状突起分布均匀,但大小不一,无规律性。在 *Buchanosteus* 里,其纹饰呈瘤状,每个瘤的基部均具有放射状的短嵴,使基部呈星状 (White 1952 图版 30, 图 2、3、4)。因此,两者明显不同。

从上面的描述和比较可以看出,武定材料既不同于 Coccosteidae 科的各属,也不同于 *Buchanosteus*, 因此应为一新属、新种,订名为吴氏香水鱼 *Xiangshuiosteus wui* gen. et sp. nov.

二、*Xiangshuiosteus* 的系统关系

上面的详细描述和比较为讨论 *Xiangshuiosteus* 的系统关系提供了可靠的信息。前面的描述和比较,表明 *Xiangshuiosteus* 既具有 Coccosteidae 的某些特征, 如梯形的中颈片,松果片位于两眶前片之间和典型的 Coccosteids 感觉沟系统等; 又具有 Buchanosteidae 科的一些特征,如中心片呈蝶状,眼孔小而前位,头甲后侧角靠前等。这些特点表明 *Xiangshuiosteus* 与 *Coccosteus* 和 *Buchanosteus* 之间的系统关系较近。

Young (1979) 在详细研究了 *Buchanosteus* 的内颅后认为 *Buchanosteus* 内颅的许多特征与长胸节甲类 (Dolichothoraci) 的 *Kujdanowiaspis* 的内颅相似,但是躯甲方面的特征则为典型短胸节甲类型,并由此得出结论,认为 *Buchanosteus* 可能为除 *Gemuendenaspis* (Miles 1962) 外所有短胸节甲类的近祖姐妹群。

Miles (1973) 曾认为, 中颈片后部加宽,腹面有加厚区;副颈片具有后颈突等作为短胸节甲类的共有特征。Young (1979) 认为 Miles 所提的特征在某些长胸节甲类如 *Dicksonosteus*, *Holonema*, *Groenlandaspis* (Goujet 1975, Miles 1971, Ritchie 1975)

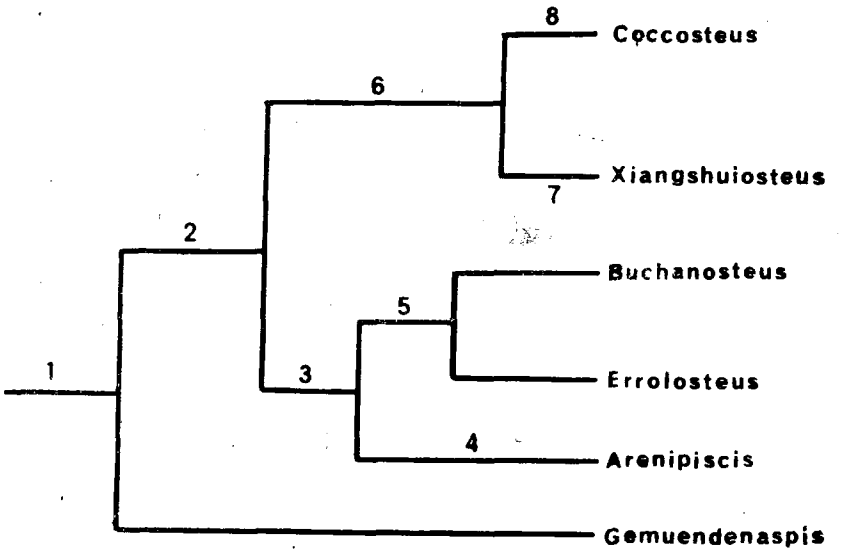

图 2　表示某些真节甲类之间关系的分支图解。

Fig. 2. Cladogram showing interrelationships of some euarthrodiran taxa. Proposed synapomorphies, as discussed here, are listed as follows

1 副边缘片长而窄；中颈片梯形；上迷走神经突和副迷走神经窝缺失；棘片退化；胸窝变大 (elongata submarginal plate; trapezoid nuchal plate; loss of supravagal process and paravagal fossa; reduction of spinal plate; enlarged pectoral fenestra)，2 躯甲短，侧壁退化，中背片具发育的嵴突 (shoetened trunk-shield; madian dorsal plate with carinal process; lateral wall of trunk-shield reduced)，3.松果片和吻片愈合成一个骨片，位于两眶前片之前 (fused rostral and pineal plates; rostropineal plate situated in front of the both preorbital plates)，4.中心感觉沟不达中心片 (supreorbital sensory canal unextending on to the central plate)，5.眶前片短而宽，头甲宽而平 (short and broad preorbital plate; broad and flat skull-roof)，6.松果位于两眶前片之间 (pineal plate situated between preorbital plates)，7.吻片为橄榄形，中心片呈蝶状 (olivary rostral plate; sphenoid central plate)，8.中心片为三叶状 (trilobata central plate)。

里分别存在。因此这些特征并不是令人满意和有效。而他则把长而窄的副边缘片，梯形的中颈片，上迷走神经突和迷走神经窝的缺失，棘片的退化以及长的胸窝等特征，作为短胸节甲类的共近裔性状。笔者认为 Young (1981) 的看法要比 Miles (1973) 的更可取些。

根据 Miles (1971, 1973), Dennis & Miles (1979a. b, 1980), Denison (1978), Young (1979, 1981) 给短胸节甲类所限定的特征和 *Xiangshuiosteus* 的特征，如梯形中颈片；头甲具发育的上眼窝；副颈片具有后颈突等看，*Xiangshuiosteus* 无疑应属短胸节甲类。头甲的外形尤其是头甲前部特征，如中心片不为三叶型，眼孔小而前位，头甲后侧角位置靠前等，明显地与 *Buchanosteus* 相似，表明两者之间有较近的系统关系。但是，在 *Buchanosteus* 里，松果片和吻片愈合成为单一的骨片，并且位于两眶前片之前。这些特征与 *Arenispiscis*, *Errolosteus* (Young 1981) 相似，而与 *Xiangshuiosteus* 则完全不同。这一特征，即松果片和吻片愈合成单一骨片，在以前讨论短胸节甲类的系统关系时没

有被注意到，主要是具有这一特征的属较少的缘故。笔者认为这一特征可能与筛区的内部结构有关，因此这一特征应做为 *Buchanosteus*, *Errolosteus* 和 *Arenispiscis* 的共近裔性状。而中心感觉沟不伸到中心片应为 *Arenispiscis* 的近裔自性，而眶前片短而宽则为 *Buchanosteus* 和 *Errolosteus* 的共近裔性状。Denison (1978), Young (1981)都认为三叶型的中心片这一特征是以 *Coccosteus* 为代表的所有进步短胸节甲类的共近裔性状。*Xiangshuiosteus* 的中心片呈蝶状，这一点明显不同于 *Coccosteus*，但是松果片位于两眶前片之间这一性状是它们所共有的。因此这一性状可能是它们的共近裔性状，从而构成一对姐妹群。

根据上述讨论，可以得出一分支图(图 2)，从中可以看出 *Xiangshuiosteus* 的系统位置。

(1991 年 9 月 14 日收稿)

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NEW DISCOVERY OF EARLY MIDDLE DEVONIAN BRACHYTHORACID (PLACODERM FISH) FROM WUDING REGION OF YUNNAN

Wang Junqing

(Institute of Vertebrate Paleontology and Paleoanthropology, Academia Sinica)

Key words Wuding; Middle Devonian; Euarthrodire

Summary

Order Euarthrodira Gross, 1932

Suborder Brachythoraci Gross, 1932

Genus *Xiangshuiosteus* gen. nov.

Etymology The name of the district where the fossil was collected.

Diagnosis a large brachythoracid, the skull-roof is broad and depressed, it is broader than long, the breadth/length index is about 120. In dorsal view the skull-roof can be regarded as an irregular hexagon with well-developed supraorbital vault. It has a nearly straight posterior margin delimited by the posterolateral angles of paranuchal plates, rostral margin markedly convex between the two orbits, the anterolateral margin is longer than the posterolateral margin. They both are nearly striaght. The posterolateral angle anteriorly placed, the orbits are small and anteriorly placed, not deeply notching the skullroof. Rostral plate olivary in shape, pineal plate larger with a pineal foramen on its centre, which is buddhist-cap shaped. Central plate batterfly-like in shape with a posterolateral process embaying between the nuchal and paranuchal plates. Nuchal trapezoidal, and paranuchal elongate with postnuchal process. Postorbital and marginal plates larger than preorbital plates. Central sensory canals converging to ossification centres of the central plate. Ornament of tubercles densely distributed.

Type species *Xiangshuiosteus wui* sp. nov.

Etymology after Wu Baosheng who send me the specimen.

Holotype V9758 (Fig. 1; Pl I, 1.2), an incomplete skull-roof.

Occurrence Early Middle Devonian, Jiucheng Formation. Wuding region, Yunnan Province.

Diagnosis As for genus.

Description The holotype is an external mould preserved in a more complete piece (Fig 1, Pl I) from which only the both anterolateral part are missing. The configuration of rostral, posterior and posterolateral margins are very clear.

The skull-roof is almost flat in longitudinal section and gently arched transversely. In overall propotion it must have been broad and short, with the orbits anteriorly placed and not deeply notching the skull-roof as in *Coccosteus, Watsonosteus* and *Buchanosteus* (Miles & Westoll 1963, 1968; White 1952; Young 1979). In addition, the posterior margin of skull-roof is nearly straight, the nuchal and paranuchal region is short than *Homostius, Euleptaspis* and

Taemosoteus (Denison 1978, fig 51: White 1978, fig 112). This character is comparable to forms like *Coccosteus, Watsonosteus* and *Plourdosteus* (Denison 1978, fig 57). The posterolateral angle of the skull-roof are well-developed, and evidently situated fairly forward at a level some distance behind the anterior end of the nuchal and paranuchal plates.

The suture lines are very claerly shown on the dorsal surface, and the shape of component bones is very clear too. Anteriorly, there is a large rostral plate, which may be compared with the rostral plate of Coccosteids (Denison 1978, fig 57) but it is olive-shaped, and not divided into two part from these the new form differs from the all genera of Coccosteidae. The shape of pineal plate is very strange, in general the outline of pineal plate is rectangle in Brachythoracids, but in the new form it is "Buddhistcap" shaped, with a large pineal foramen in the centre of the bone, all these are different from the Coccosteids and Buchanosteids.

The preorbital plate (PrO fig 1; Pl I) are broader than long, with irregular shape. It is a fairly flat bone. The supraorbital vaults is very developed and delimited mesially by well marked supraorbital crista, but these are directed ventrolaterally which is very similar to *Arenipiscis* (Young 1981). The dermal preorbital process is not well developed, it is smaller than the postorbital process, in this way the new form is similar to the *Buchanosteus* (White 1952, 1978; Young 1979) and *Errolosteus* (Young 1981) and deffires from others described brachythoracids. The postorbital plate resembles that of Coccosteids in shape and having obvious postorbital process which is very obtuse.

The marginal plate is incomplete, but was probably short and broad. The position of postmarginal canal (pmc, fig 1) is very clear on the dorsal surface of left side of the holotype, the postmarginal plate is incompletely preserved.

The central plate is butterfly-like in shape. The anterior margin is concave and lateral margin is convex, this character is very similar to *Buchanosteus* (White 1952), and *Tityosteus* (Denison 1978, fig 51A) so it is of primitive form in lacking any extensive embayment of its area by preorbital and postorbital plates which doesn't give the central plate of Coccosteids their characteristic trilobed shape (Denison 1978, fig 57), otherwise a long posterolateral process of centrals between nuchal and paranuchal plate is similar to the Coccosteids and differs from *Buchanosteus* (White 1952, 1978; Young 1979).

The paranuchal plate is an elongate bone, which have projected in front of the anterior nuchal margin in holotype. The paranuchal with a distinct postnuchal process, the para-articular process for the dermal neck-joint are preserved on both side (fig 1, Pl I) and appears similar in form to that of *Buchanosteus* (Young 1979, Pl 1 a—b; Denison 1978, fig 49) and Coccosteids (Denison 1978, fig 59) but the lateral articular fossa cannot be seen in holotype.

The nuchal plate is trapezoidal in shape, with a small posterior median process in its posterior margin, its length is 46% of the skull-roof. It quite resembles the nuchal of various forms placed by Denison (1978, fig 51) in the family Coccosteidae and Buchanosteidae (Denison 1978, fig 51, 49), but differs markedly from these in the embayed posterior margin, a feature more typical of pachyosteomorph brachythoracids.

The sensory canal system on the skull-roof of *Xiangshuiosteus wui* is fairly completely known, it is a typical coccosteids. However, the otic-branch of infraorbital sensory canal is uncertian (ioc. ot, fig 1; Pl I, 1) and no trace of middle pit-line was observed on the central plate, a long posterior pit-line is preserved in holotype which differs from the whole genera of Coccosteidae and Buchanosteidae and pachyosteomorph brachythoracids.

Relationship of *Xiangshuiosteus*

Much of information preserved above is of extensive use in assessing relationshipes.

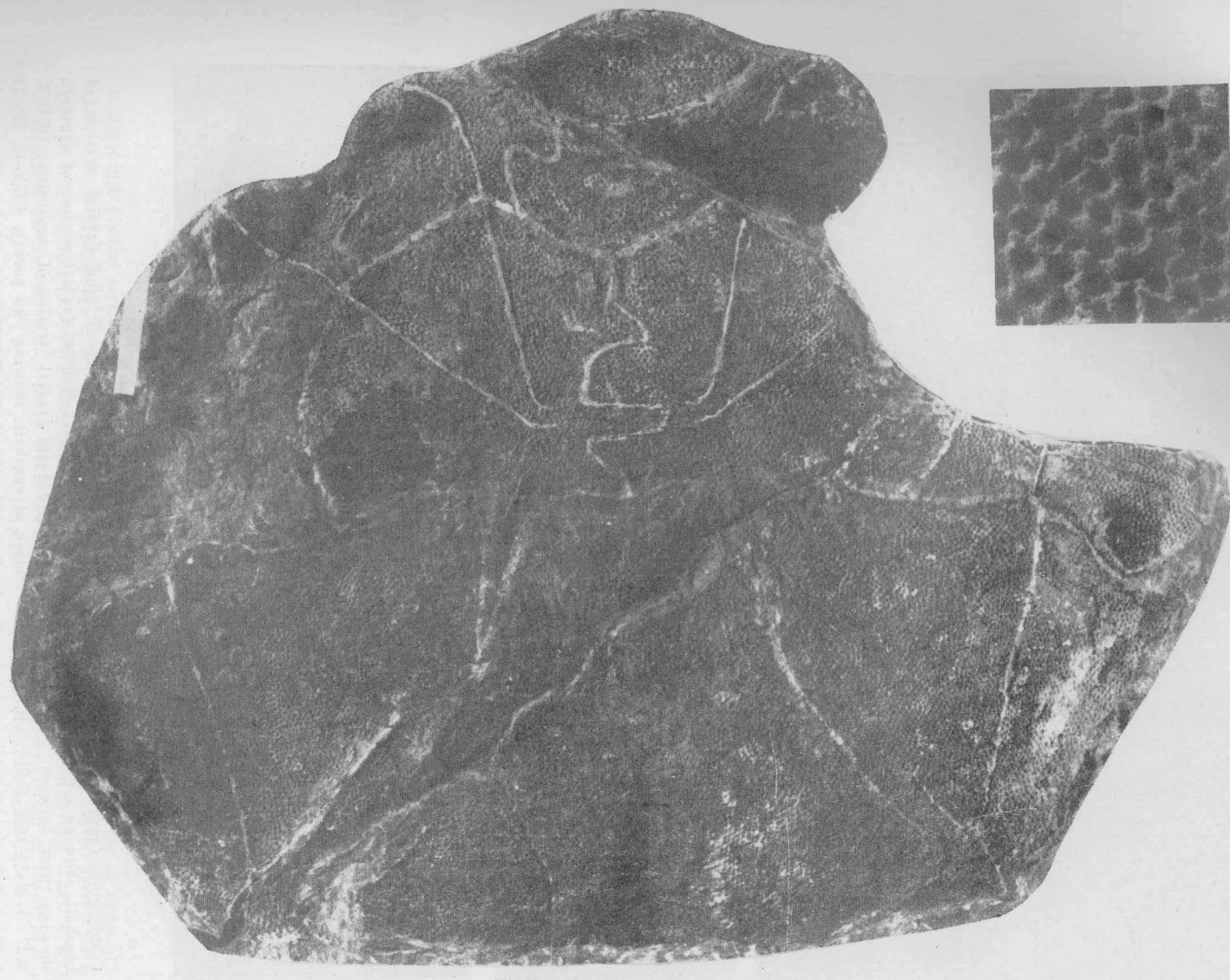
There is no doubt that in many characteristic of its skullroof *Xiangshuiosteus* resembles *Coccosteus*, others is very similar to *Buchanosteus*, these similarities may indicate close phylogenetic relationship between them.

Young (1981) considered that *Buchanosteus* emerges as the plesiomorph sister group of all other Brachythoracids, with the exception of *Gemuendenaspis* base on the detailed stuty of the endocranial structure and other characteristics of the skull-roof and trunk shield.

Miles (1973) lists three characters of the skull-roof and neck-join as specialized for brachythoracids that is the nuchal plate posteriorly expanded; nuchal thickening on visceral surface of skull-roof; postnuchal process of paranuchal plate, but Young (1979) thought some of these feature are also persent in *Dicksonosteus* (Goujet 1975, fig 4), *Holonema* (Miles, 1971, fig 4, 53) and *Groenlandaspis* (Ritchie 1975). So the three characters are clearly an unsatisfactory basis for defining the brachythoracid. At the same time, Young considers that the "brachythoracid families possess along slender submarginal plate lying more or less above the suborbital plate and fused into the suborbital-postsuborbital-palaoquadrate cheek complex and this feature could be related to the loss endocranial supravagal process and paravagal fossa, and it may be regarded as a phylogenetically significant change in the mode of suspension of cheek unit and operation of the operculum" So he proposed it as a synapomorphy difening the Brachythoraci (Young 1979, fig 18).

According to the characters defining the Brachythoraci (Miles 1971, 1973; Denison 1975, 1978; Dennis & Miles 1979 a.b, 1980; Young 1979, 1981) and those described above, the new form, *Xiangshuiosteus*, should be put into Brachythoraci, which resembles the *Coccosteus* in paranuchal plate with postnuchal process, skull-roof with well-developed supreorbital vault, pineal plate situated between preorbital plates. However, the small preorbital plate, no trilobite central plate in skull-roof, the posterolateral angle more forward, these are similar to *Buchanosteus*. But *Buchanosteus* has a larger rostropineal plate which in general form may be compared with that of *Arenipiscis* and *Errolosteus* (Young 1981, fig 5, 10) and in front of both preorbital plates not situated between them. So I think this characters is a synapomorphy of *Buchanosteus*, *Errolosteus* and *Arenipiscis*, and the supraorbital canal terminate anteriorly at the rostropineal ossification centre on either side of the pineal foramen in *Arenipiscis* is an autapomorphy. The preorbital plate short and broad in *Buchanosteus* and *Errolosteus* may be a synapomorphy.

Denison (1978) and Young (1979) agree that the position of the pineal plate between the preorbital plates is the synapomorphy of *Homosteus* and advanced brachythoraci, but in *Homosteus* the nuchal is very long, the paranuchal are drawn out into blunt point anteriorly, the orbits face upward on the dorsal surface of the skull-roof. These are markedly different from the advanced brachythoracids. *Xiangshuiosteus* is very similar to the advanced brachythoracids, with the exception of the shape of central plate. So I think that *Xiangshuiosteus* and *Coccosteus* emerges as the synapomorphy sister group based on the position of pineal plate between the preorbital plate.



吴氏香水鱼 *Xiangshuiosteus Wui* gen. et sp. nov.

1) 一件较完整的头甲 V 8751 背视 ×1/2. a more complete skull-roof in dorsal view. 2) 头甲的一部分，示纹饰 ×1/4 a part of skull-roof, showing the ornament of tubercles.