

鄂尔多斯中华弓鳍鱼的发现 及其在地层上的意义

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近几年来在陕西、甘肃、宁夏及内蒙古诸地相继发现了中华弓鳍鱼化石。首先西安地质调查处106队(1956)在内蒙古桌子山东麓苦节儿头的灰黄色砂岩中发现了这类鱼化石,依该队记载,含鱼的层位是属于“新召层”,即相当于涇川层。此后,该处的野外队(1957)又在甘肃环县合道川的灰白色砂岩中发现了大量的同一类鱼化石,共生的还有龟化石。地质部鄂尔多斯普查大队(1957, 1958)在内蒙古德里丁、哈达图河、宁夏固原白杨城,以及甘肃省地质局在临洮馮家湾等地也都找到了该类鱼化石。刘东生(1956)在陕甘一带调查黄土时,在陕西吴旗白于山北坡的浅紫红色细砂岩中也发现了这类鱼化石(图1)。著者对上述各地点的标本进行了观察比较,认为它们是中华弓鳍鱼(*Sinamia*),并与山东蒙阴的为同一种。这些新化石地点的发现与标本的增多,不仅对了解该类鱼的形态特征、地理分布等有所补充,更重要的是为我国中生代后期地层的对比,提供了较多的鱼化

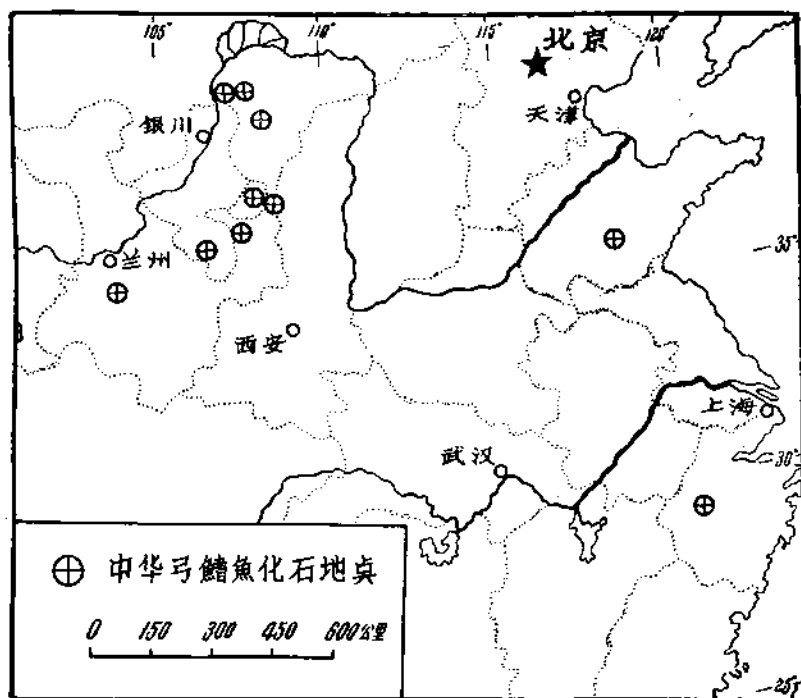


图1 中华弓鳍鱼化石产地分布图

石依据。

研究历史

中华弓鳍鱼为史天秀(E. A. Stensiö)研究我国山东蒙阴群中的鱼化石时(1935)建立的一个新属,标本为谭锡畴和师丹斯基(O. Zdansky)在1923年采自山东蒙阴宁家沟西北40里的灰绿色细砂岩中。当时所获得的标本,据史氏文章的记载是:“标本共十八,身首俱全者六,首部完整者一,身部完全者十一”。由此可知,当时所采获的标本显然缺少首尾俱全的个体,因而他原来的形态描述是不完全的;在系统位置方面,只将它列为一新属,并未归科。著者现今观察了在上述各地点采获的新材料,参考了叶祥奎(1960)自正型标本产地采集的补充材料后,除对该种鱼的形态特征加以补充外,并认为中华弓鳍鱼不仅代表一个新属,且由于它与弓鳍鱼科(Amiidae),以及其他有关的科均有显著的区别,同意贝尔格(L. Berg, 1940)氏的意见,把它列为一独立新科,即中华弓鳍鱼科(Sinamiidae)。

标本记述

今根据对大量新标本的观察将科、属特征综述如下:

弓鳍鱼目 Amioidea

中华弓鳍鱼科 Sinamiidae

特征: 顶骨愈合成一块。板骨(tabulars)数目多。具有眶上骨。舌颌骨无通过舌颌神经的孔。内头盖骨骨化部分较弓鳍鱼(*Amia*)的为强。鳞片菱形或近长椭圆形,被有硬鳞质层。无棘鳞。头上若干膜质骨或多或少地被有硬鳞质层。无上枕骨。吻骨单一,有眶下感觉沟穿过。其他感觉沟分布似古鳐目。背鳍基长或中等长。尾半歪型,后缘凸圆,尾鳍除具有主鳍条外,还具有副鳍条。生活在淡水中。包括:中华弓鳍鱼属,中国,晚侏罗世;伊克昭弓鳍鱼属(*Ikechaoamia*)中国北部,晚侏罗世至早白垩世。

中华弓鳍鱼属 *Sinamia*, Stensiö 1935

特征: 体呈长梭形,稍侧扁。头低平,中等大。全长约为头长的4—5倍上下。头长颇大于头高,也大于体高,为体高的2倍。板骨数目多,通常每侧多至4块,相邻者常愈合一起。顶骨的前缘突伸,插入额骨间。额骨长大。吻骨宽V字形。眶上骨5—6块;眼眶后有两块较小的长方形眶后骨,不十分向后延伸,致使该骨与前鳃盖骨之间存有较大的空隙。辅上颌骨一块,窄长。鳃条骨数目多,其前方有一大的咽板骨(gular plate)。上下颌均生有一列大的锥形齿。成年个体的椎体骨化完善。背鳍基长,其起点在腹鳍之前。鳍条疏而短。臀鳍基短,颇小于背鳍。背鳍条和臀鳍条的远端分节分叉。尾鳍半歪型,鳞叶甚短缩,后缘凸圆,鳍条粗壮,数目少而排列稀疏,具有纤细的副鳍条,分节密,两者表面均有规则的硬鳞质饰纹。鳞片菱形,长大于高,复嵌相接,非为一般的关节相接型。鳞片硬鳞质层厚,每一鳞片的骨质层以一纵脊与上复硬鳞质层嵌合。躯干部的鳞片(除背部鳞片外)后下缘有若干锯齿。

师氏中华弓鳍鱼 *Sinamia zdanskyi* Stensjö

(插图 2—5, 图版 I—VIII)

1935 *Sinamia zdanskyi*, Stensjö, *Palaeontologia Sinica*, Ser. C, Vol. 3, fasc. 1.

标本: 本文中用以观察的标本不少于 70 个体, 以产地的不同编号为 V. 1106—1113 号, 其中以 1106 及 1109 号包括的个体较多, 且有 11 条较为完整(图版 I, II, VIII), 其余各号中的标本多是鱼体的一部分, 有头部、躯干或尾部, 以及部分鳍及鳞片。

产地及时代: 内蒙古桌子山东麓苦节儿头 (V. 1108), 德里丁 (V. 1111), 哈达图河 (V. 1112); 宁夏固原白杨城官院沟 (V. 1110); 陕西吴旗白于山北坡 (V. 1106), 吴旗陈家砭 (V. 1107); 甘肃环县合道川鞞家洼沟 (V. 1109), 临洮中铺馮家湾 (V. 1113)。晚侏罗世。

关于中华弓鳍鱼的体形及各部的形态结构, 史天秀已作过较详细的描述, 这里不再重述。不过由于他所依据的标本, 保存的不够完好, 故在身体各部的比例上, 鳍条数目以及尾鳍形态等, 均未记述或记述得不够确切。为了对该类鱼有一整体的概念, 著者在本文中也给以扼要的记述, 并对史氏未曾描述的部分加以补充。

标本描述: 体呈长梭形, 体长为体高的 5—6 倍, 头长的 3.5—4.5 倍。头长为体高的 1.2—1.4 倍。尾柄长为其高的 1.5—1.7 倍(表 1)。

表 1 师氏中华弓鳍鱼的身体测量及其各部比例表

各部 位测量(毫 米)及其比例	标本号 产地	V. 1106.4	V. 1106.6	V. 1109.1	V. 1109.3	V. 1109.4	V. 1114.1
		陕西吴旗白于山北坡		甘肃环县合道川鞞家洼沟			山东蒙阴 宁家沟
全长	长	219.00	200.00	153.00	166.00(约)	194.00(约)	437.00(约)
体长	长	188.00	165.00	135.00	145.00	169.00	386.00
体高	高	—	30.00	26.00	24.00	32.00	68.00
头长	长	52.00	38.00	34.50	34.00	37.00	102.00
头高	高	—	19.00	19.00	22.00	24.00	47.00
尾柄长	长	—	24.00	—	27.00	—	59.00
尾柄高	高	—	15.50	—	15.50	—	38.00
全长与头长比		4.20	5.20	4.40	4.80	5.20	4.30
体长与头长比		3.60	4.30	3.90	4.20	4.50	3.80
体长与体高比		—	5.50	5.30	6.00	5.20	5.60
头长与体高比		—	1.26	1.33	1.40	1.20	1.40
尾柄长与尾柄高比		—	1.50	—	1.70	—	1.50

头长大, 前部窄, 后部略宽, 侧面略呈三角形。额骨一对, 颇为长大; 前端与后端较宽, 中部略有收缩; 后缘向后突伸, 与顶骨连接; 前外角和前内角均向前突伸, 尤以前内角为显著; 额骨表面具有自中心向周围放射的硬鳞质条状纹饰; 两块额骨之间的骨缝略弯曲(图 2)。顶骨愈合成一块, 略呈四方形; 前端中部向前伸突, 插入额骨后部中间; 后缘几乎平直, 仅后缘中部稍向后突伸, 后缘与居于中央的板骨连接; 侧缘与上一间颞骨(supratemporo-intertemporal)连接, 侧缘的中后部略向外侧扩张, 插入上一间颞骨内缘的缺刻处; 顶骨表面亦布有与额骨上相似的硬鳞质条状纹饰。板骨数目多, 通常每边有 4 块, 但常常彼此愈合, 故其数目有变化, 如在 V. 1106.2 和 1106.5 号标本上, 每边均为 4 块; 在 V. 1106.1 号

标本上,右边为3块,而左边为4块;在 V. 1106.4, 1106.10 号标本上,右边为4块而左边为3块;在 V. 1106.9 号标本上,每边均为3块;在 V. 1108.1 号标本上,中央两块彼此愈合成一块。这些骨板的形状,除了每边最外侧的一块由于后外角向后伸展,略呈三角形外,其余的均呈四边形。未愈合的板骨,其长大于宽;这些板骨的表面具有硬鳞质疣突(tubercles)或连续成层状。上-间颞骨大,长而窄;后缘与第2至4块板骨连接;内缘与顶骨毗邻;前缘与额骨、膜质蝶耳骨连接;其表面亦布有与额骨上相似的硬鳞质条状纹饰。膜质蝶耳骨(dermosphenotic)较小,位于上-间颞骨之前,其内缘与额骨相接。鼻骨一对,略呈四边形,前部较后部为宽(V. 1106.4),在其前侧缘可观察到前鼻孔的开口(V. 1108.1)。

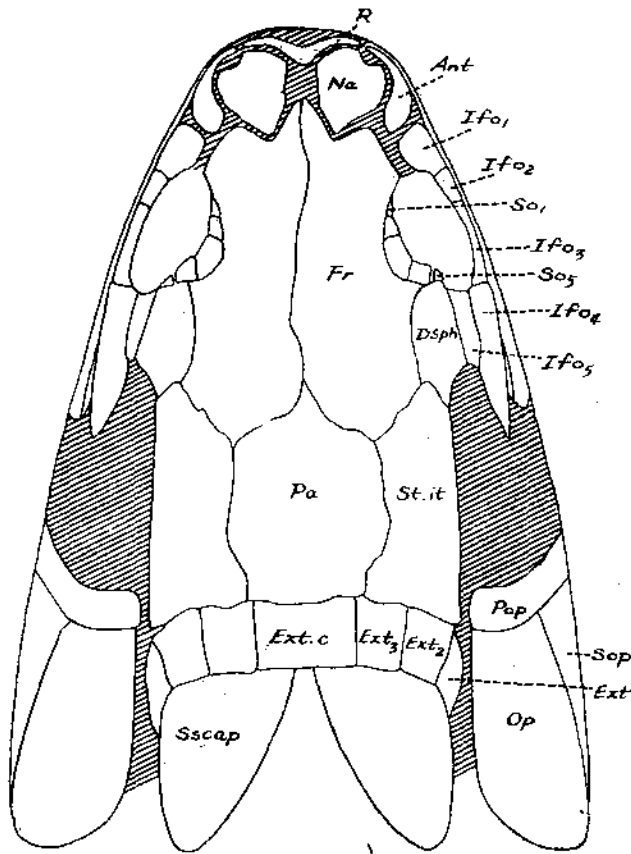


图2 师氏中华弓鳍鱼(*Sinamia zdanskyi* Stensiö)头骨复原图(背面视),放大(依 Stensiö, 加以修改)

Ant—眶前骨, Dsph—齿-夹板骨, Ext. c, Ext₁, Ext₂, Ext₃—板骨(额外肩胛骨), Fr—额骨, Ifo₁-Ifo₅—眶下骨, Na—鼻骨, Op—鳃盖骨, Pa—顶骨, Pop—前鳃盖骨, R—吻骨, So—眶上骨, Sop—下鳃盖骨, Sscap—上肩胛骨, St. it—上间颞骨。

吻骨(Rostal)不成对,呈宽“V”字形(V. 1108.1)。眶前骨(antorbital)狭窄,呈弧形,前部尖细,后部宽大,前端与吻骨相接(V. 1108.1)。眶上骨小,数目多,约5—6块(V. 1108.8, 1106.5)。眶下骨(infraorbital series)保存不佳,但尚可辨识,共有5块(V. 1106.4, 1109.9),包括下列各骨:眶前骨或称泪骨(preorbital or lachrymal)一块(ifo₁),略呈四边形。眶下骨(suborbitals)较窄,共两块(ifo₂-ifo₃)组成眼眶下缘,前边的一块略宽大,它的前缘与眶前骨邻接;后一块的后缘与腹面一块眶后骨连接。眶后骨(postorbitals)两块(ifo₄-ifo₅),上面的一块很小,略呈长方形;下面的一块较大,呈不规则四边形(V. 1106.10),其长约约为上面那一块长的2倍,后缘延伸较长,但与前鳃盖骨之间,仍存有较大的间隙(图2)。

前上颌骨(premaxillum)较狭长,组成上口缘的前一半(V. 1106.6),背部附着于脑盖上。

上颌骨长,前部窄,与前上颌骨的宽度几相等,后部显著加宽,并向后伸长(V. 1108.3, 1109.2)。辅上颌骨(supramaxillum)一块,长而窄,两端更窄(V. 1106.2),位于上颌骨后部的上方。膜质腭骨(dermopalatine)小,略呈四边形,其长稍大于宽(V. 1108.3)。外翼骨长而窄,下缘加厚;背面中部与内翼骨相接;后部与后翼骨连接;后端与方骨连接(V. 1107.2)。

内翼骨较大, 后部加宽; 侧缘与外翼骨邻接; 后缘与后翼骨邻接(V. 1107.2, 1108.3)。后翼骨大, 其上缘有一深而宽的缺刻, 由这个缺刻把后翼骨的背部分成为基突(basal process)和耳突(otic process); 前者略呈弯曲的柄状; 后者长而低, 近于直立(V. 1107.2)。方骨呈三角形, 其背缘与后翼骨连接, 前缘与外翼骨连接; 前腹面有一关节髁与下颚骨联结(V. 1107.2)。舌颚骨高而扁, 其前缘有一深的缺刻, 后缘的中部有一宽的骨突, 无通过舌颚神经的孔。颌骨小, 位于舌颚骨的前腹角前方, 附着于方骨的腹缘后部(V. 1107.2)。角舌骨(ceratohyal)未完全显露, 其背部较腹部宽, 且弯曲(V. 1106.3, 1108.3)。

齿-夹板骨(dentalo-splenia)保存的较为完好, 前部低, 后部特别高(V. 1106.3, 1107.2, 1108.3, 1112.2)。隅骨较大, 构成下颚骨的后部(V. 1107.2)。上隅骨保存不完全, 但尚可辨认, 比隅骨小(V. 1112.2)。

鳃盖系统完全。鳃盖骨大, 呈四边形, 其宽略大于高; 背缘短, 较平直或略拱曲; 后缘最长, 并显著地向后凸出; 腹缘较长, 几呈平直; 前缘短于后缘, 略向内凹(V. 1106.4, 1107.2, 1108.1, 1109.9)。下鳃盖骨小于鳃盖骨, 呈不规则四边形, 其后背缘与鳃盖骨的腹缘连接; 其腹缘为最长的一边, 显著地凸出; 以前缘为最短, 与前鳃盖骨的后下缘联接(V. 1106.4, 1109.9)。前鳃盖骨狭长, 略呈新月形, 上、下部的宽度相同(V. 1106.4, 1109.2)。间鳃盖骨小, 呈三角形(V. 1106.9)。鳃条骨14对, 较粗壮, 它们自前向后递次加宽, 以最后的鳃条骨最长, 位于间鳃盖骨及下鳃盖骨的下方(V. 1106.3, 1108.4)。

在 V. 1106.3 号标本上可观察到保存较完好的咽板骨, 它的前端尖, 后端宽, 呈一等腰三角形, 两后角圆钝, 且略向侧方突伸(图3)。在 V. 1108.3 号标本中, 有保存完好的副蝶骨和锄骨, 副蝶骨后部较前部宽大, 具有高大的升突(processus ascendens)。锄骨前宽后窄, 副蝶骨前端插于两锄骨后端中间。

牙齿呈圆锥形, 尖锐; 前上颚骨、上颚骨及齿-夹板骨各有一列大的牙齿, 齿尖稍向内弯曲并被有珐琅质(V. 1112.2, 1106.6); 下颚的冠状骨上有小而钝的牙齿; 膜质腭骨与外翼骨的前侧部的牙齿保存不佳。

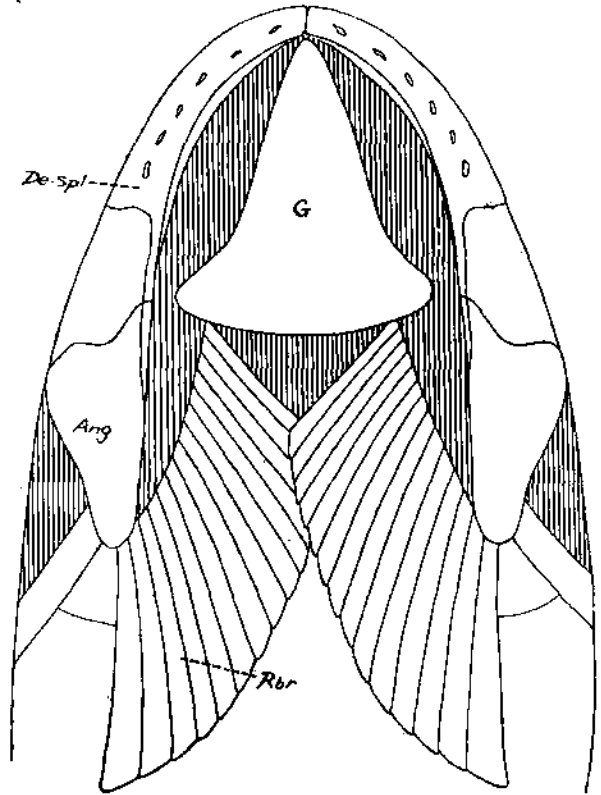


图3 师氏中华弓鳍鱼 (*Sinamia zdanskyi* Stensjö)

头骨复原图(腹面观), 放大

Ang——隅骨, De.spl——齿-夹板骨,
G——咽板骨, Rbr——鳃条骨。

感觉沟系统：头部感觉沟系统的详细分布情况，史天秀(1935)曾作过较详细的描述，在这里给以扼要的描述：眶上感觉沟(supraorbital canal)前端起自鼻骨的后腹角，经过鼻骨的前背部，转折向后延伸，通过额骨，止于额骨的后侧角处(V. 1106.1, 1108.1)。眶下感觉沟(infraorbital canal)的前端起自吻骨，向后延伸，经过眶前骨、眶下骨、膜质蝶耳骨至上-间颞骨的前部(V.1106.2, 1106.4)。侧线的头区部分(cephalic division of main lateral line)，前端在上-间颞骨的后部与眶下感觉沟联结，向后伸展到板骨(V. 1106.1)。前鳃盖感觉沟(preopercular canal)，背端连接眶下感觉沟及头区主侧线，沿着前鳃盖骨的前侧缘伸向下端(V. 1106.6)。下颚感觉沟(mandibular canal)起自隅骨后上部，沿着齿-夹板骨的腹部向前延伸(V. 1108.3)。

脊柱未完全显露，仅躯干前部的一部分外露；脊椎骨化较完好，椎体高大于长(V. 1108.3, 1109.7)。在躯干前部的椎体上可见到一部分髓棘与肋骨，髓棘远端残破，从其近端来看，似较细小；肋骨较细长，未伸达腹缘(V. 1107.1)。

在肩带部仅能观察到上肩胛骨(suprascapula)，上匙骨、匙骨及后匙骨。上肩胛骨较大，略呈三角形，其表面具有硬鳞质条状纹饰[至少存在于前部和后侧部(V. 1106.4, 1108.1, 1109.2)]。上匙骨较长，上部较下部略宽，稍弯曲，其表面亦有硬鳞质条状纹饰(V. 1106.5, 1109.2)。匙骨较狭长，下部较上部为宽(V. 1106.3, 1106.6, 1109.2)。后匙骨位于上

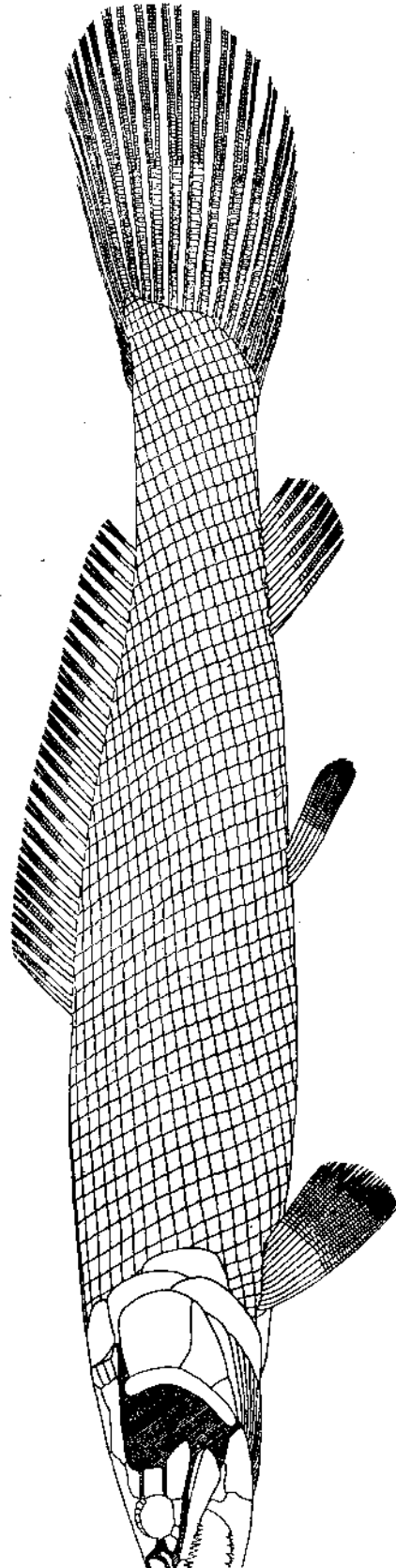


图5 师氏中华弓鳍鱼的复原象(Restoration of *Sinamia zdanskyi*)

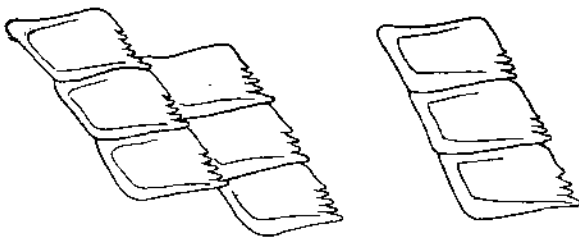


图4 师氏中华弓鳍鱼(*Sinamia zdanskyi* Stensjö)的鳞片,左、腹部,右、尾部,均放大

匙骨下部和匙骨的后方,上部较下部为窄(V. 1106.10, 1109.2)。胸鳍鳍条较长,约有 2 根不分叉鳍条和 8—10 根分叉鳍条,在远端的 4/7 分节,分节密,节距长小于宽。

腹鳍较小,约有 6 根鳍条,其远端分节部分约占鳍条全长的 2/3,分节密;腹鳍起点距臀鳍较距胸鳍为近(V. 1106.6, 1107.1, 1109.8)。

背鳍基颇长,其起点居于腹鳍之前,终点与臀鳍的终点近于相对,鳍条 27 根,远端分节分叉(V. 1106.4, 1107.1, 1111.2)。

臀鳍基较短,鳍条 6—9 根(V. 1107.1, 1109.3),其远端 1/2 分节,分节密,节距宽大于长。

尾鳍为半歪型尾,鳞叶很萎缩,尾鳍后缘呈凸圆形,约有 11—13 根长鳍条(不包括上、下边缘的细小鳍条),尾鳍条几乎全部分节,仅靠近基部的一段(在 V. 1112.1 标本略长),不分节,节距短,于 1/2 处开始分叉。此外,在靠近每根粗鳍条的上方还有一根小而不分叉的副鳍条,其分节部分的长度与粗鳍条的相似,节距长宽相等(V. 1106.4, 1108.2)。

鳞片菱形,其外露部分均被有硬鳞质,鳞片长大于高(图 4),体侧鳞片较背、腹部的略高,除了靠近肩带后少数鳞片复压较多外,其他鳞片复压较少,鳞片前背角稍向前突伸,尤以体前部的鳞片显著,无关节突(articular peg)和关节窝(articular socket),中嵴(medial ridge)发育;躯干部鳞片(背部鳞片除外)的后缘有锯齿,靠近边缘具有少许浅的同心纹。自肩带至尾基共约 46—48 列鳞片;在肩带后方自腹缘至背缘约有 14 列;自腹鳍基至背鳍基间约有 22—23 列;自尾柄腹缘至背缘约有 14 列。

在 V. 1107.1 号标本的躯干部保存有一段侧线,约沿着第 10 列(由腹缘至背缘计算)鳞片向后延伸,达至尾柄。有些侧线鳞片表面呈现有侧线穿孔(图 5)。

讨 论

中华弓鳍鱼的系统位置

中华弓鳍鱼(*Sinamia*)与弓鳍鱼(*Amia*)颇为相似,史天秀曾对这两类鱼作了较详细的比较,同时也指出两者在某些特征上显然不同,如中华弓鳍鱼的顶骨为一块(后者为两块),板骨块数多等,并指出中华弓鳍鱼具有以下一些较原始性质:内头颞骨的骨化程度较强,有眶上骨、有菱形的硬鳞,头部的一些膜质骨和全部鳞片均被有硬鳞质层。现从当前标本的尾部来看,尾鳍仍残留着部分鳞叶(scaly-lobe),这也是较弓鳍鱼原始的性质。

弓鳍鱼的地史记录,在欧洲是由古新世至中新世;北美是由始新世一直到现代,*Amia calva* 仍生存于北美的河湖中。

中华弓鳍鱼与伊克昭弓鳍鱼(*Ikechaoamia*)(刘宪亭, 1961)在头盖骨骨片形状与排列上非常相似,但后者的鳞列有减退现象,鳞片略呈长椭圆形,虽仍被有硬鳞质层,但已介于硬鳞与原始圆鳞之间,与中华弓鳍鱼的鳞片关系是密切的。

由中华弓鳍鱼的头盖骨的骨片关系、鳃盖及鳞片的排列、鳍的位置等特点看来,中华弓鳍鱼应属于 Furid (Eugnathoid) 类型。Brough (1939) 研究 *Heterolepidotus* 时,曾认为 *Heterolepidotus* 与 *Furos* 很近似,*Amia* 又与 *Heterolepidotus* 很相似,从而他认为 *Amia* 是 Furid 这一类的后代。由中华弓鳍鱼的特征来看,与 *Amia* 颇为近似,所不同的是

中华弓鳍鱼具有若干原始性质,从各方面看,中华弓鳍鱼应属于 Furid (Eugnathid) 组中,是无疑的。

另外,由中华弓鳍鱼的某些特征,如单一的顶骨、有眶上骨、菱形的硬鳞等,不应归属于弓鳍科(Amiidae),当时史天秀(1935)建立了新属,未曾归科,大概也考虑到这一情况了。后来贝尔格(1940)在他的“现代和化石鱼形动物及鱼类分类学”一书中把它单独列为一科即中华弓鳍鱼科(Sinamiidae)。罗美尔(Romer)在1955年仍把它列入弓鳍鱼科。著者根据较多材料的分析,认为它应独立成为一科。中华弓鳍鱼科代表着较弓鳍鱼科为原始的,繁盛于晚侏罗世的一个类群。至目前止,无疑可归于该科的有两个属即 *Sinamia* 和 *Ikechaoamia*。

属的检索表

Synopsis of genera

- | | |
|--|------------------------|
| 1. 背鳍基长,鳞列发达,鳞片菱形 | (中华弓鳍鱼) |
| Base of dorsal fin long, scale rhombic | (<i>Sinamia</i>) |
| 2. 背鳍基略短,鳞列减退,鳞片近长椭圆形 | (伊克昭弓鳍鱼) |
| Base of dorsal fin somewhat short, scale nearly elliptical | (<i>Ikechaoamia</i>) |

在鄂尔多斯地区这些新材料的发现,对追溯弓鳍鱼类的起源与分布很有意义,就现有资料看,更证明了弓鳍鱼这一类群是起源于欧亚大陆,以后才扩展到新大陆的看法(刘,1961)是有道理的。

含中华弓鳍鱼地层的时代

中华弓鳍鱼化石,过去仅知产于山东蒙阴群的中下部,现今又在鄂尔多斯地区的保安群的华池环河组与涇川组中发现,扩大了该种鱼的分布范围。保安群的地层层序自下而上为:宜君组、洛河组、华池环河组、罗汉洞组及涇川组。它主要为一套红色砂质及粉砂质岩层,夹有灰绿色、蓝灰色泥质及粉砂质岩层,总的呈杂色。所以在鱼化石本身所附的岩石颜色也呈现不同的色斑。根据在当地工作的有关地质队的研究,认为上述这一套岩层属于内陆湖泊相与河漫滩相沉积,且基本为连续沉积。从中华弓鳍鱼体形特征上,如扁平的头部与身体腹面较平,强大胸鳍等,也表明它们是适于河川或急流的水域中生活的。

由于在上述各地点所产的鱼化石均为同属同种,即师氏中华弓鳍鱼(*Sinamia zdanskyi* Stensio),除个体大小方面略有不同外,尚无其他显著区别。从鱼化石本身论,上述各地区含鱼地层可以对比;又鄂尔多斯地区的含鱼地层与山东蒙阴的,在岩性上有些类似,均为砂质和泥质岩层,说明在沉积环境上有其共同性。再加上古生物方面的证据,著者认为上述各地区含鱼地层的沉积时代应大致相当。

山东蒙阴群的地质时代,过去葛利普(A. W. Grabau, 1923)根据软体动物、昆虫等化石,订为早白垩世。维曼(C. Wiman, 1929)根据爬行动物化石也订为早白垩世。近年来许多人在该地区进行工作,多认为它属于晚侏罗世。顾知微(1960)研究了该地层中所产的软体动物化石,也认为是属于侏罗纪。杨鍾健(1958)认为盘足龙(*Helopus*)可以生存于比白垩纪的早些时候。

史天秀研究山东蒙阴鱼化石时,是以地层时代已确定为早白垩世为前提的,故对地层时代未加深入讨论,只提到在下白垩统中产有相当原始性的弓鳍鱼类,与现生的 *Amia* 有

一定的差别,推証早在白垩纪以前,中华弓鳍鱼和弓鳍鱼就已分为不同的演化途径了。

现根据鱼化石本身的特征与有关这类鱼的生存历史分析,著者认为,具有一定原始性的中华弓鳍鱼的生存时代不会晚于侏罗纪。

此外,更有意义的是,产有中华弓鳍鱼的一些地点,如山东蒙阴宁家沟、内蒙哈达图河以及宁夏固原官院沟的同层位中也产有狼鳍鱼(*Lycoptera*)化石。后者为晚侏罗世分布于东亚一带的特有鱼类,分布中心也在我国北部(刘宪亭等, 1963,印刷中)。又中华弓鳍鱼与狼鳍鱼在其所属类群中,均为具有相当原始性的分子之一,著者认为含有狼鳍鱼-中华弓鳍鱼群(*Sinamia-Lycoptera fauna*)的地层时代为晚侏罗世,尚属合理。

从这些中华弓鳍鱼化石新地点的发现与对鱼化石的研究,可以初步将我国西北的保安群、六盘山群和山东的蒙阴群,以及华北的产有狼鳍鱼的热河群等的时代加以对比(表 2)。

表 2 中国北部狼鳍鱼-中华弓鳍鱼群的地史分布
The geological distribution of *Lycoptera-Sinamia* fauna in Northern China

狼鳍鱼化石带 Lycopterid zone	山东半岛 Shantung Peninsula		燕山东部 East Yenshan Region		六盘山和鄂尔多斯区 Liupanshan and Ordos Plateau		中华弓鳍鱼化石带 Sinamid zone	地质时代 Geological ge	
	莱阳盆地 Laiyang basin	蒙阴盆地 Mengyin basin	西区 West	东区 East	六盘山 Liupanshan	鄂尔多斯 Ordos			
	青山组 Tsingshan formation			泉头组 Chuantou F.				白垩纪 Cretaceous	
<i>L. woodwardi</i> and <i>L. kansuensis</i>		蒙阴群 Mengyin Group <i>S. zdanskyi, L. woodwardi</i>	热河群 Jehol Group <i>L. longicephalus, L. davidi</i> etc.		乃家河组 Naichiuho F. <i>L. woodw.</i> etc.	Paoan Group	涇川组 Tsingchuan F. <i>S. zdanskyi</i>	<i>Ikechaoamia</i>	晚 Late
					马郡山组 Matushan F. <i>L. woodw.</i> etc.		罗汉洞组 Lohantung F.		
<i>L. longicephalus</i> and <i>L. davidi</i> zone				阜新组 Fuhsin F.	李洼峽组 Liwahsia F.		华池环河组 Hwachih-Huanho F. <i>S. zdanskyi</i>	<i>S. zdanskyi</i>	中 Middle
				沙海组 Shahai F. <i>L. davidi</i>	和尚铺组 Hoshangpu F.		洛河组 Loho F.		
<i>L. sinensis</i>	莱阳组 Laiyang F. <i>L. sinensis</i>			金刚山组 Chinkan-shan F. <i>L. muroii</i>	三桥组 Sanchao F.		宜君组 Ichuan F.		早 Early
				义县组 Ihsien F.					

F. = Formation

最近(1962),张弥曼同志在浙江寿昌城南的寿昌组中也发现了该类鱼化石,经初步观察,归属于中华弓鳍鱼科是没有问题的。

中华弓鳍鱼在多处地发现不仅有助于解决我国北部中生代地层的大面积对比和发育历史问题,同时由于该类鱼化石在浙江寿昌组中的发现,又为了解我国北部沿海地区和东南沿海一带中生代后期地层之间的关系,提供了线索。由于中华弓鳍鱼的广泛分布,证明当时上述各地区的水系有着联系。

参 考 文 献

- 刘宪亭, 1961: 内蒙古伊克昭盟白堊系中弓鳍鱼科一新属。古脊椎动物与古人类 5, 2, 122—129。
 刘宪亭等, 1963: 华北的狼鳍鱼化石(印刷中)。
 谭锡畴, 1923: 山东中生代及旧第三纪地层。地质汇报, 第五号, 第二册。
 Allis, F. PH., 1919: On certain features of the otic region of *Lepidosteus*. London. Zool. Soc., Proc. Part. 3—4, 245—265.
 Berg, I. S. 1940: Classification of fishes both recent and fossil. Trav. Inst. Zool. Acad. Sci. URSS. 5, 197—207 (Russian and English).
 Brough, J. 1939: The Triassic fishes of Besano, Lombardy. Brit. Mus. (Nat. Hist.), London.
 Dechaseaux, C. 1937: Le genre *Amia*, son histoire Palaeontologique, Ann. pal., 26, 3—36, 10 figs. 1 pl.
 Goodrich, E. S. 1907: On the scales of fish, living and extinct, and their importance in classification. London. Zool. Soc., Proc. 751—774.
 Grabau, A. W., 1923: Cretaceous Fossils from Shantung. Geol. Surv. of China Bull. 5, 2, 143—181.
 Nielsen, E. 1936: Some few preliminary remarks on Triassic fishes from East Greenland. Medd. Grønland, 112, 3, 1—35.
 Priem, F. 1908. Etude sur le genre *Lepidotus*, Ann. Pal. 3, 1—19.
 Rayner, D. H. 1941: The structure and evolution of the holostean fishes. Biol. Rev., 16, 218—237.
 Regan, C. T. 1923: The skeleton of *Lepidosteus*, with remarks on the origin and evolution of the lower Neopterygian fishes. London. Zool. Soc., Proc. 2, 445—461.
 Schaeffer, B. 1960: The Cretaceous Holostean fish *Macrepistius*. Amer. Mus. Novitates, No. 2011.
 Stensiö, E. A. 1932: Triassic fishes from East Greenland. Medd. Grønland 83, 3, 225—227.
 Stensiö, E. A. 1935: *Sinamia zdanskyi*, a new Amioid from the Lower Cretaceous of Shantung, China. Paleont. Sinica, C, 3, fasc. 1.
 Traquair, R. H. 1910: Les Poisson Wealdiens de Bernissart, Mém. Mus. Roy. Hist. Nat. Belg., VI, 37—43. Pls. 2.
 Woodward, A. S., 1895. Catalogue of the Fossil Fishes in the British Mus. (Nat. Hist.) III, 360—373.
 Woodward, A. S. 1902. On an Amioid fish (*Megalurus mawsoni*, sp. nov.) from the Cretaceous of Bahia. Brazil. Ann. Mag. Nat. Hist. (7), 9, 87—89.
 Woodward, A. S. 1916: The fossil fishes of the English Wealden and Purbeck formations, Part II, Palaeontogr. Soc. LXIX.

THE DISCOVERY OF *SINAMIA ZDANSKYI* FROM THE ORDOS REGION AND ITS STRATIGRAPHICAL SIGNIFICANCE

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Sinamia zdanskyi was first described by Stensiö (1935) based on materials collected by Tan and Zdansky from Mengyin Series in 1923. Since then, no information of this fish has ever been reported up to the present time.

Recently, a great number of well preserved *Sinamia zdanskyi* has been collected from different localities in Kansu, Shensi, Ninghsia and Inner Mongolia autonomous Region

around the Ordos Plateau. Therefore it is worth while to give a brief note about this fish. Since this fish has completely described by Stensiö already, the authors confine their description mainly to those parts which were not described by Stensiö due to lack of well preserved materials.

In the past ten years researches on Mesozoic stratigraphy had greatly advanced in China, and the geological age of the Mengyin Series which yield *Sinamia zdanskyi* has to be restudied also. Therefore a brief discussion on the distribution and stratigraphical age of this fish is also given below.

Genus *Sinamia* Stensiö, 1935

Diagnosis: Body slenderly fusiform, slightly compressed. Head depressed and moderate in size. Head length with opercular apparatus about $1/4$ to $1/5$ of the total length of the fish, and 1.4 times to the maximum depth of the trunk. Tabulars (extrascapular) four on each side, but usually some of them fused with each other. Parietal unique, large and nearly square in shape, produced anteriorly. Frontals long. Supraorbitals present, about 5—6 in number. Most anteriorly on the snout there is a broad V-shaped rostral. The postorbitally situated bones of the infraorbital series two in number, fairly small, not extending much backwards and therefore leaving a wide gap between themselves and the preoperculum. One supramaxillum, low. Branchiostegal rays 14 pairs. A large triangular gular plate present. Teeth long and conical. Dorsal fin rather long, beginning further forwards than the ventral fins and extending backwards to a point opposited the posterior part of the anal fin; anal fin short-based; ventral fins short-based, but rather long. Caudal fin-tays rather short scaly-lobe, and convexed hinder border. Lepidotrichia of the dorsal and anal fins robust. Each of them situated fairly far apart from one another, and jointed only in the distal parts. Caudal fin with few and rather far apart situated lepidotrichia which were jointed throughout their length, except for a rather short proximal portion. Fulcra absent on all fins. Scales rhombic, somewhat lower than long, without peg and socket articulation in transversal rows. All scales coated with a thick layer of ganoine on the whole exposed area. External dermal bones of head with an ornamentation of ganoine-striate.

Type species: *Sinamia zdanskyi* Stensiö.

Remarks: The genus *Sinamia* contains only one species, *S. zdanskyi*. Stensiö (1935) described it completely, and discussed the relationship with *Amia calva* mainly on the general resemblance of the shape of the endocranium and the number, shape and extent of the substitution bones of the endocranium etc.

Brough (1939) has pointed out that *Sinamia* might related with Furid (Eugnathid). Berg (1940) has erected a new family Sinamiidae. Romer (1955) placed *Sinamia* in Amiidae. It is quite possible that *Sinamia* with its large unpaired parietal, a character not usually observed in the Amiidae, its stronger ossification of the endoskeleton of the head, presence of the supraorbitals and thick ganoine covering on the external dermal bones and rhombic scales etc., representing an independent family as Berg anticipated.

Sinamia zdanskyi Stensiö

(Text figs. 2—5; Plates I—VIII)

1935. *Sinamia zdanskyi*, Stensiö, Palaeontologia Sinica, Ser. C, Vol. 3, fasc. 1.

Holotypes: The specimens figured by Stensiö (1935, Pl. V, fig. 2, Pl. VII, fig. 2,

& Pl. VIII) from Mengyin Group.

Pleisotypes: The specimens figured by the present authors (Pls. I—VIII) from Tsinchuan and Hwachih-Huanho formations.

Diagnosis: As for genus, and those given by Stensiö.

Materials: This species is represented by no less than 70 specimens from nine localities in the Ordos region and Shantung Peninsula. Of these there are about eleven complete individuals which preserved in two large pieces of reddish sandstone collected from Wuchi, Shensi and Huanhsien, Kansu. Whereas the remainders are fragmentary, being either parts of the head, and the trunk or isolated parts of fins and scales.

Horizon and Locality: Upper Jurassic. K'utschert'ou, Chotzesan (V.1108), Hatanuho (V.1112) and Teliting (V.1111), Inner Mongolia; Kuanyüankou, Kuyuan (V.1110), Ninghsia; Hotaochuan, Huanhsien (V.1109) and Fengchiawan, Lint'ao (V.1113), Kansu; Paiyüshan (V.1106) and Chenchiapien (V.1107), Shensi; Ningchiakou (V.1114), Mengyin, Shantung.

Description: The specific characters of this fish has been completely described by Stensiö. Only minor differences could be found from specimens on hand. Therefore detail descriptions are omitted here, only characteristics supplementing Stensiö's description are given below. Measurements of complete specimens from different localities are given in Table 1 (see page 3).

Head, trunk, axial skeleton, girdles and paired fins

Characteristics of these portions observable from specimens on hand are essentially similar to that of the holotype from Mengyin, Shantung (Cf. Stensiö 1935, pp. 6—42).

Unpaired fins

Dorsal fin: The dorsal fin is rather long which occupies more than one half the length of the back. Its origin is inserted in advance of that of the ventral, and ends opposing to the posterior part of the anal fin. The lepidotrichia observed in V.1107, are 27 in number, and each of them situated from one another fairly far apart. They were jointed and branched distal (Pl. IV, 1).

Anal fin: The anal fin is short based and high, with its anterior half situated opposing to the most posterior part of the dorsal fin. Its lepidotrichia, only 7—9 in number, are branched and jointed in the distal end.

The lepidotrichia of both dorsal and anal fins are destitute of ganoine.

Caudal fin: The abbreviate hemi-heterocercal shaped caudal fin is convex on hinder border and with about 13 long lepidotrichia. Below each essential lepidotrichia there existed a slender accessory one, which is separated from the essential ones at the base and has a length as long as the latter. The lepidotrichia are stout, closely articulated nearly throughout their whole length, the short proximal parts are unjointed. These unjointed portion shows no distinct traces of articulations superficially, but in its interior very distinct vestiges of articulations can be observed. All of the lepidotrichia (including essential and accessory ones) are ornamented with longitudinal striae of ganoine. (fig. 5; Pls. II, VI, VII, 2)

Squamation

The scales are rhombic and coated with thick ganoine on their exposed area. All

the scales are lower than they are long, with a somewhat produced antero-dorsal corner. The anterior overlapped area is narrow. A very pronounced medial ridge is developed on the upper surface of the bony layer, which interlocks with the thick ganoine layer firmly. The inner side of the scale is plain.

The scales inlay each other in each transverse row, not with peg-and-socket articulation. The total number of transverse scale rows are about 46—48. Each row is composed of 14—15 scales behind the occiput, of about 22—23 scales in the abdominal region and of about 14 scales in the hindmost part of the caudal region.

The exposed area of the scales is nearly smooth. The posterior margin of scale from the dorsal region are smooth, and with few (1—2, 3—5) denticles in those of the abdominal and caudal regions (fig. 4). Some scales on the lateral line are usually pierced by an oval foramen near the centre (fig. 4, Pls. II, IV, 1; VII, 2—3).

Based on the well preserved specimens a reconstruction of this fish was made (fig. 5).

DISCUSSION

Since its first discovery by Tan and Zdansky from Mengyin, Shantung in 1923, *Sinamia zdanskyi* has never been reported elsewhere up to the present time. The discovery of well preserved specimens of it from the Paoan Group of the Ordos Plateau and also from the Chienteh Group of Chekiang in southeastern China is of great interest to the study of the palaeogeography and stratigraphy in China.

Mengyin Group is a continental deposit first studied by Tan (1923). On account of its stratigraphical position and lithological characters Tan correlated this Group with the Laiyang formation, which yield *Lycoptera sinensis* and other fossils. A. W. Grabau after studying the mollusca (1923), insects (1923) and *Lycoptera* (1928) from the Laiyang formation and related formations from western Laoning, and eastern Kansu, advocated a view that the *Lycoptera*, *Ephemeropsis* bearing beds is Lower Cretaceous in age. Since then most authors dealing with the Mesozoic stratigraphy in China agreed with Grabau and considered the *Lycoptera* and *Ephemeropsis* bearing formation as Lower Cretaceous in age also.

From the Mengyin Series together with *Sinamia*, remains of a Sauropod, *Helopus zdanskyi*, different forms of land turtles, *Sinemys lens*, *Sinochelys applanata* and *Scutemys tecta* have also been found by Tan and Zdansky. All these forms are new to record and were studied by Wiman (1929). Their age were considered by Wiman as Lower Cretaceous also.

Recently based on new palaeontological finds and also from a critical study on the previously described fauna and flora, most students on this problem found out that these previously nominated Lower Cretaceous beds, turns to be Upper Jurassic of even older in age.

Young (1958), from a study on the new materials of Sauropods from China has pointed out that the geological age represented by *Helopus zdanskyi* is Upper Jurassic probably.

On account of the presence of typical Jurassic forms *Ferganoconcha*, *Tetoria* and *Corbicula* from the *Lycoptera* horizons Ku (1960) vigorously argued that these mollusca bearing formations, formerly assigned as Lower Cretaceous by Grabau is Upper Jurassic

图 版 I 說 明

1. 斯氏中华弓鳍魚(*Sinamia xidanskyi* Stensib)
一羣魚(15 个个体), $\times 1/3$, 标本登記号 V. 1106.
A school of fish (15 individuals), $\times 1/3$.



1

