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大荔颅骨在人类进化中的位置

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摘 要：本文将大荔颅骨的一系列形态特征与中国的直立人、欧洲和非洲的中更新世人、欧洲和亚洲的尼安德特人、中国和欧洲的早期现代人以及现生现代人的数据进行比较，发现可以归纳为几种状况。大荔颅骨：1）与其他中更新世颅骨比较一致，而与早期现代人相去较远；2）与早期和现生现代人一致或接近，显得比其他中更新世人进步；3）在中国早期现代人或现代人变异范围内，也在欧洲中更新世人变异范围内或与之接近，却与中国直立人相距较远；4）处于一般中更新世人与早期现代人之间的中间状态；5）处于中国直立人与中国早期现代人之间的中间位置，而且比较接近欧洲/非洲中更新世人；6）与东亚多数化石人比较一致，而与旧大陆西部中更新世化石人相去较远；7）与中国直立人显然不同，而与欧洲/非洲中更新世人更加接近；8）与非洲中更新世人接近，而与中国直立人和欧洲中更新世人差距较大；9）与大多数中更新世人不同，似乎是自身独有或罕见的。基于这样复杂的状况，作者提出，大荔颅骨既不属于直立人，也不属于海德堡人，表现为兼具东亚的直立人、欧洲和非洲中更新世人的特征，而且是这些共有特征与早期现代人部分特征的镶嵌体，可能比中国的直立人对中国现代人的形成做出过更大的贡献。

关键词：大荔颅骨；人类进化

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1 引 言

古人类学界一直对大荔颅骨在人类进化中的位置存在颇为不同的看法。一般将其归入古老型智人[1-4]，Rightmire[5]、Stringer[6]等认为其应该归属于海德堡人。笔者已经发表了一系列测量数据和非测量特征，并且进行了一些比较研究[1,7,8]，也对这些问题作了一些探讨。本文将结合中国及其他地区中更新世和其他时代人类的更多项目数据进行比较和分析，将大荔颅骨的多项特征归结成几类列举于下，以探讨大荔颅骨在人类进化中扮演的角色和可能起到的作用。必须声明的是，目前许多项目的比较数据十分有限，很可能造成一些假象，从而在一定程度上导致误判。笔者预期，新化石和新数据的出现可能使下述分析有必要进行或大或小的修正。

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2 比较与分析

2.1 大荔颅骨在一系列特征上与已经发现的其他中更新世颅骨比较一致，而与早期现代人相去较远。它们包括：

眉脊粗厚，其眉间部和两侧的眶上部在眉间区互相连续，成为粗壮的眶上圆枕。

前囟点与颅顶点的位置基本上重合。北京和南京的直立人、马坝和 Kabwe 的颅骨也都如此。

正中矢状轮廓在枕骨部呈角状弯曲，与现代型智人、尼人圆钝状过渡的形状显然不同。

颅骨骨壁相当厚，额骨鳞中央、顶骨结节（左侧）、枕骨鳞部中央、颞骨鳞部中央（左侧和右侧）分别为 8.8mm、11.2mm、13.0mm ？和 7.0mm（左侧）和 6.9mm（右侧）[7]，与直立人不相上下。

眶上裂和眶下裂狭窄，接近北京直立人而与现代人的宽度相去较远。

左侧眶下裂的外侧壁向下延展颇深，使得眶腔只能经过垂直向下的通道与颞下窝相通，而不能水平地向外侧通往颞下窝。

蝶骨颞下面位置较眼眶底为低。北京直立人颞下脊稍低于眶脊，而现代人颞下脊与眶脊通常位于同一水平。

全颅高（耳上颅高）在大荔颅骨为 102mm，处于北京直立人变异范围（93.5~107mm，据 Weidenreich[9]）的中上部，比 Kabwe（105mm，据 Weidenreich[9]）稍低；比尼人变异范围（105~122mm，包括欧洲 4 例，亚洲 3 例，据 Weidenreich[9], Suzuki[10]）的下限稍低。大荔的数据比中国早期现代人（108~119mm, 包括柳江据吴汝康 [11]，山顶洞据吴新智 [12]，山顶洞化石已经丢失，本文所引的山顶洞数据均为在模型上测得；丽江据云南省博物馆 [13]，穿洞据吴茂霖 [14]，）短得多。

长高指数 I（ba-b/g-op）在大荔颅骨为 57.1，在非洲上新 / 早更新世人变异范围（50.4~67.5， 其 中 OH 9，KNM-ER 3733 和 3883 据 Kennedy 等 [15]；KNM-ER 1813 据 Rightmire[5]） 和 Dmanisi 人群变异范围（55.4~65.4， 据 de Lumley 等 [16]） 内， 比郧县复原颅骨（55.28，据 de Lumley 等 [16]） 稍高，比北京直立人复原颅骨的（59.9，据 Weidenreich[9] 的数据计算，以下再有类似情况，只注明原始数据来源，不再写“的数据计算”字样）稍低；比 Kabwe 的（60.2，据 Kennedy 等 [15]）低，比欧洲中更新世绝大多数人（58.6~69.9，其中 Petralona，Steinheim，Swanscombe 据 Kennedy 等 [15]；Atapuerca SH 4 号、5 号、6 号据 Arsuaga 等 [17]；Ceprano 据 de Lumley 等 [16]） 都低，只比 Ehringsdorf（55.9，据 Kennedy 等 [15]）高 1 个多单位，比尼人（60.0~66.8，包括欧洲 9 例，亚洲 3 例，据 Suzuki[10] 和 Kennedy 等 [15]）低，比中国的早期现代人（66.7~77.7，包括柳江，据吴汝康 [11]；山顶洞，据吴新智 [12]）和欧洲的早期现代人（65.8~71，包括 6 例，据 Suzuki[10]）都低得多。总之，大荔颅骨的这项指数显示它比大多数中更新世人接近更早的人，也就是更加原始。

长高指数 II（po-b ht/g-op）在大荔颅骨为 49.6，相当于 Dmanisi 变异范围（46.38~53.59，据 de Lumley 等 [16]） 和非洲上新 / 早更新世人变异范围（46.6~53.3，KNMER 3733，

3883 和 OH 9，据 Kennedy 等 [15]）的中部，在北京直立人变异范围（49.0~53.3，据 Weidenreich[9]）内，接近其下限，与和县直立人（50，据吴汝康等 [18]）很接近，比所有欧洲中更新世人（51.0~65.1，包括 Petralona 和 Steinheim 据 Kennedy 等 [15]；Atapuerca SH 据 Arsuaga 等 [17]；Arago 和 Ceprano 据 de Lumley 等 [16]）和尼人（51.5-65.6，包括欧洲 9 例，亚洲 3 例，据 Suzuki[10]）低，比欧洲的早期现代人（58~62.3，包括 6 例，据 Suzuki[10]）和中国早期现代人（57.1~72.5，包括柳江据吴汝康 [11]；山顶洞据吴新智 [12]；丽江据云南省博物馆 [13]；穿洞 2 据吴茂霖 [14]）都低得多。总之，大荔颅骨的这项指数显示它比欧洲中更新世人和部分中国直立人接近更早的人。

颅横曲度指数（au-au/po-b-po）在大荔颅骨为 47.2，比中国的直立人（47.4~54.8，包括北京直立人据 Weidenreich[9]；和县直立人据吴汝康等 [18]；南京直立人 1 号 [以下简称南京直立人] 据吴汝康等 [19]）的最低值稍低，在爪哇直立人（I 号，52.3；II 号，45.6，据 Weidenreich[9]）两件标本之间，比 Kabwe（48.3，据 Weidenreich[9]）稍低，比 Petralona（44.8，据 Suzuki[10]）高，比尼人（41.3~47.4，包括欧洲 5 例，亚洲 2 例，据 Weidenreich[9] 和 Suzuki[10]）上限稍高，比中国的早期现代人（39.2~42.2，包括山顶洞和柳江据笔者 [以下所举山顶洞的数据，除专门说明者外，均为笔者在模型上测得]）和欧洲的早期现代人的（36.5~43.6，包括 3 例，据 Suzuki[10]）高得多。

前囟点星点弦与枕骨宽形成的比值（b-ast / ast-ast）在大荔颅骨为 113.9，在中国的直立人（103.5~119.8，包括北京直立人与和县，据笔者）（此处和以下的北京直立人数据，除另作注明者外，均由笔者在模型上测得）和欧洲中更新世人（97.8~117.5，包括 Atapuerca SH，6 例 10 侧，Petralona，Swanscombe, 均据 Arsuaga 等 [17]）的变异范围内，也在非洲中更新世人的变异范围（107.1~116.3，包括 Eliye Springs 和 Omo 2, 据 Bräuer & Leakey[20]；Kabwe 据 Arsuaga 等 [17]）内，比中国的早期现代人（121.5~132.7，包括山顶洞、柳江、资阳，均据笔者）小得多。

颅后角（angle l-i-o）在大荔颅骨为 105°，接近中国直立人变异范围（98°~106°，包括北京直立人据 Weidenreich[9]；南京直立人为笔者在吴汝康等 [19] 正中矢状轮廓图上测得）的上限，比 Kabwe（99°，据 Suzuki[10]）大。大荔颅骨此角比欧洲中更新世人（107°~129.1°，包括 Ehringsdorf 和 Steinheim, 据 Suzuki[10]）和 Atapuerca (3 例，据 Arsuaga 等 [17] ）的最低值稍小，比除了 Gibraltar 尼人（97°，据 Suzuki[10]）外的欧洲 6 例和亚洲 3 例尼人（113°~127°，据 Suzuki[10]）都小，比现代人的（117°~127.3°，据 Suzuki[10]）显然小得多。

枕骨曲角（angle l-op-o）在大荔颅骨为 98°，比南京直立人（108°，笔者在吴汝康等 [19] 的正中矢状轮廓图上测得）此角小得多，与北京直立人（98°~108°, 据 de Lumley 等 [16]）最低值相等，比 Sangiran（99°~103°，3 例，据 de Lumley 等 [16]）最低值略小。比 Petralona（106°，据 de Lumley 等 [16]）小得多；比现代人（20 例平均值为 133°，变异范围为 128°~138°，据 de Lumley 等 [16]）小得多。

眶间宽与两额宽构成的比值（d-d / fm:a-fm:a）在大荔颅骨为 22.8，在北京直立人 XII 号和南京直立人（分别为 21 和 26，均据笔者在模型上测得的数据计算所得）之间，与 Kabwe（22.6，笔者据模型）很接近，比 Arago（19.0，笔者据模型）大，比 Atapuerca SH 4 和 Atapuerca SH 5（分别是 33.1 和 29.5，据 Arsuaga 等 [17]）和 Petralona（28.7，据

Stringer 等 [21]）都小得多。比中国早期现代人的（15.5-18.6，包括山顶洞和柳江，据笔者）稍大。

2.2 大荔颅骨有一系列特征与现代人一致或接近，显得比其他中更新世人进步。它们包括：

后面观的穹顶轮廓线呈均匀的弧形，颅骨最宽处在颞骨鳞部，而北京直立人的穹顶轮廓线从前面或后面观察都呈两面坡屋顶状， 其最宽处接近颅底。

经过下颌关节窝最外侧点，而且与眼耳平面垂直的直线，通过颅骨内面的颅底与颅骨侧壁交界线的稍外侧处的颅骨壁中。现代人的下颌关节窝完全在颅中窝的下方，经过下颌关节窝最外侧点且与眼耳平面垂直的直线，通过颅骨壁的内侧表面。北京和爪哇直立人下颌关节窝的中心与颅骨壁的内侧表面相对应，大猩猩关节窝的大部在此矢状面的外侧。总起来说，北京和爪哇直立人的下颌关节窝只有内侧半在颅中窝的下方，现代人的下颌窝全部在颅中窝的下方，即向内测方向移动，而大猩猩的下颌关节窝的位置比直立人更加趋于外侧，大荔颅骨与现代人接近。

眉间点枕外隆凸点弦（g-i）上的颅盖高和其与眉间点枕外隆凸点弦（g-i）长形成的指数在大荔颅骨为 50.4，比北京直立人（34.8~41.2，据 Weidenreich[9]）和爪哇直立人（I 号和 II 号分别为 33.3 和 37.4，据 Weidenreich[9]）高得多，比非洲中更新世人 (Jebel Irhoud 为 43.7，Kabwe 为 40.5，Saldanha 为 45.0)，以及 Steinheim(46) 都高（后四者均据 Suzuki[10])，在尼人的变异范围（39.09~53.4，包括欧洲 9 例和亚洲 4 例，据 Suzuki[10]）的上部，甚至进入欧洲早期现代人变异范围（49~61，包括 5 例，据 Suzuki[10]）的下部。

鼻根点枕外隆凸点弧与鼻根点枕外隆凸点弦形成的比值（arc n-i / n-i）在大荔颅骨为 189.9，比尼人（包括欧洲 3 例，亚洲 2 例，145.1~178.1）的大，在 Obercassel 男性（181.2）和女性（203.7）之间，与日本中世纪人骨平均值（200.0）接近（这些外国标本的数据均据 Suzuki[10]）。据此推测大荔在这个方面已经具有现代人的特征。

额骨倾斜角 I（angle b-n-op（i））在大荔颅骨为 54°，比北京直立人（42°~46.5°）、Kabwe（48°）和欧洲和亚洲 5 件尼人标本（变异范围：39°~50°）的最高值都大得多，比欧洲中更新世的 Ehringsdorf（52°）稍大，达到现代人变异范围（45°~59°）的上部，比其平均值（50.8°）大许多（这些比较数据均据 Weidenreich[9]）。

枕骨上鳞与眉间点枕外隆凸点弦形成的夹角（angle g-i-l）在大荔颅骨为 82°，比中国直立人（57°~68°，包括北京直立人，据 Weidenreich[9]；南京直立人，据笔者）、欧洲中更新世人（Ehringsdorf，63°，据 Suzuki[10]）、非洲中更新世人（Kabwe，68°，据 Suzuki[10]）和欧洲尼人（包括 6 例，59°~69°，据 Suzuki[10]）都大很多，比西亚尼人（包括 3 例，74°~81°，据 Suzuki[10]）稍大，相当于现代人变异范围（80.2°~88.6°，据 Suzuki[10]）的下部。

上面宽（fmt-fmt）在大荔颅骨为 121mm，比北京直立人（III，109mm；XI，111mm?，均据 de Lumley 等 [16]），南京的直立人（107mm，南京和以下中国标本均据笔者）与和县（113mm）都长得多，比包括 Arago，Atapuerca SH 5， Petralona，Ceprano 在内的欧洲中更新世人（125~130mm，据 de Lumley 等 [16]）稍短，比非洲中更新世人（包括 Bodo，136mm；Kabwe，139mm，均据 de Lumley 等 [16]）短得多。大荔表现得更接近

欧洲中更新世人，而与中国的直立人差距较大，但是与马坝（126mm），山顶洞 101 号（122mm）很接近，却比山顶洞 102、103 号和柳江（分别是 113、100 和 107mm）长得多。

面颅深度（ba-pr）在大荔复原颅骨为 105mm，比欧洲中更新世人（包括 Atapuerca SH5，115mm，Petralona，119mm，均据 de Lumley 等 [16]）和非洲的中更新世人（包括 Bodo，118mm；Kabwe，117.5mm，均据 de Lumley 等 [16]）的数值都小得多，在中国早期现代人的变异范围（100.0~113.6mm，包括柳江，据吴汝康 [11]；山顶洞据吴新智 [12]）的下部，更接近现代人（60 例平均值，97.2mm，据 de Lumley 等 [16]）。

颅底长与面颅深度的比值（n-ba/ba-pr）在大荔颅骨为 100.5，超出欧洲和非洲中更新世人（Atapuerca SH5，87.8；Petralona，94.8；Bodo，88.4；Kabwe 93.1，均据 de Lumley 等 [16]），比其最高值大得多，在中国早期现代人变异范围（99.3~112.0，包括柳江，据吴汝康 [11]；山顶洞，据吴新智 [12]）内，与现代人 60 例的平均值（101.7，据 de Lumley 等 [16]）很接近。

最小颊高在大荔颅骨为 23mm，比北京直立人 XII（28mm，笔者据模型）、欧洲和非洲的中更新世人（包括 6 例 7 侧，26.7~37.1，据 Arsuaga 等 [17]）都短得多，在中国早期现代人变异范围（包括 4 例 7 侧，21.7-27.2mm，山顶洞模型和柳江据笔者）的最下部。但是大荔比南京直立人（24.3mm，据笔者）和 Zuttiyeh（模型，大约 24mm，据 Arsuaga 等 [17]）分别只短 1.3 和 1mm。不过南京标本的体量比大荔的小得多。所有这些数据表现出东亚和西亚中更新世古人类的最小颊高比欧洲中更新世人较矮。

上齿槽点角 (angle n-pr-ba) 在大荔颅骨为 69.5°，与现代人的平均值（71.4°±3.1°）接近，相差不到一个标准差，比非洲中更新世人（Bodo，59°；Kabwe，62.1°）和欧洲中更新世人（Atapuerca SH5，60.9°；Petralona，62.0°）大得多，也就是说，他们的嘴鼻部比现代人和大荔向前突出得多（Atapuerca SH 据 Arsuaga 等 [17]；Bodo 由笔者根据 Rightmire[23] 的数据计算所得，其余均据 Stringer[24]）。

2.3 大荔颅骨有一些特征在中国早期现代人或现代人变异范围内，也在欧洲中更新世人变异范围内或与之接近，甚至与尼人差距也不明显，却与中国直立人相距较远

笔者无法判断大荔颅骨的这些特征的形成是由于其在演化上比较中国直立人超前，抑或是由于其与欧洲 / 非洲中更新世人在这些特征方面有更近的亲缘关系。这些特征包括：

大荔颅骨没有眶上突，比中国的直立人显得进步，与马坝一致，旧大陆西部有的中更新世标本也没有眶上突。

眉间点颅后点间距（g-op）与眉间点枕外隆凸点间距（g-i）二者在大荔颅骨相差达 16.5mm。中国直立人此二测径相等或差距很小；中国早期现代人此二测径之差在 4mm 和 17.3mm 之间（柳江据吴汝康 [11]；山顶洞据吴新智 [12]；丽江据云南省博物馆 [13]；穿洞 2 据吴茂霖 [14]）。而欧洲 Petralona 此二测径的差距为 18 或 5mm（分别据 Kennedy 等 [15] 和 de Lumley 等 [16]），Steinheim 为 5 或 6mm（分别据 Suzuki[10] 和 Kennedy 等 [15]）；印度 Narmada 的为 9mm（据 Kennedy 等 [15]），Jebel Irhoud 为 8mm（据 Suzuki[10]）；Kabwe 为 1 或 4mm（据 Kennedy 等 [15] 和 de Lumley 等 [16]）。

横额顶指数（ft-ft/eu-eu）在大荔颅骨为 69.6，大于中国直立人（变异范围，

55.9~64.5，包括北京直立人，据 Weidenreich[9] 和邱中郎等 [25]；和县直立人，据吴汝康等 [18]；南京直立人据吴汝康等 [19]）的最高值，落在中国早期现代人的变异范围（66.9~77.1，包括柳江，据吴汝康 [11]；山顶洞据吴新智 [12]；丽江据云南省博物馆 [13]）内，比金牛山古老型智人（最大颅宽 148mm，据吴汝康 [26]；最小额宽 114mm，据吕遵谔 [27]，据之计算得指数为 77.0）低得多。大荔的这个指数比非洲中更新世人（包括 Kabwe，64.3；Salé，57.5，均据 Kennedy 等 [15]）的高，但是没有超出欧洲中更新世人的变异范围（67.0~77.9，包括 Ehringsdorf 和 Steinheim 据 Kennedy 等 [15]；Atapuerca 据 Arsuaga 等 [17]；Arago，Ceprano，Petralona 据 de Lumley 等 [16]）。

颅全矢状弧（arc n-o）在大荔颅骨为 379mm，比北京直立人（321~337mm，据 Weidenreich[9]）与和县直立人（340mm?，据吴汝康等 [18]）都长很多，达到中国早期现代人变异范围（335~388.5mm，包括资阳，据吴汝康 [28]；柳江，据吴汝康 [11]；山顶洞，据吴新智 [12]；丽江，据云南省博物馆 [17]；穿洞 2，据吴茂霖 [18]）的上部，比其上限稍短。而在欧洲中更新世人的变异范围（340~380mm，包括 Ehringsdorf, 据 Weidenreich[9]；Petralona 的数据是笔者据 Stringer 等 [21] 所载额骨、顶骨和枕骨矢状弧相加所得；Atapuerca SH 的颅全矢状弧长数据是笔者据 Arsuaga 等 [17] 所载的额骨、顶骨和枕骨的正中矢状弧长相加所得）内，比其最大值（Ehringsdorf，380mm）只短 1mm。大荔与 Kabwe（372.5mm，据 Weidenreich[9]）接近。

鼻根点枕大孔后缘点弦（n-o）上的颅矢状曲度指数在大荔颅骨为 37.7，比北京直立人（43.2~44.9，据 Weidenreich[9]）和南京直立人（48.8，据笔者）都低得多，比和县直立人（38.5，据吴汝康等 [18]）稍低，在中国早期现代人变异范围（36.4~40.3，包括资阳，据吴汝康 [28]；柳江据吴汝康 [11]；山顶洞据吴新智 [12]）下部，在现代人变异范围（35.2~39.9）内，接近其平均值（36.6）（据 Weidenreich[9]）。大荔与 Kabwe（37.1）很接近，比 Ehringsdorf（40.1）稍小（后两者均据 Weidenreich[9]）。

最大额宽与枕骨宽的比值（co-co / ast-ast）在大荔颅骨为 103.5，比中国的直立人（83.9~99.1?，包括北京直立人据 Weidenriich[9]；南京与和县直立人据笔者）和 Kabwe（90.5，据 Weidenreich[9] 的数据计算）都高，在欧洲中更新世人变异范围（93.6~108.8，包括 Arago，Atapuerca SH 4 号和 5 号，Petralona，Steinheim，Swanscombe，共 6 例，据 Arsuaga 等 [29]）的上部，在中国早期现代人变异范围（100~114，包括山顶洞模型，柳江和资阳均据笔者）的下部，而且与欧洲中石器时代人的平均值（男性，102.9；女性，103.3）和 Sepúlveda 现代人的平均值（男性 103.0，女性 105.6，均据 Arsuaga 等 [29]）十分接近。

最小额宽 (ft-ft) 在大荔颅骨为 104mm，比中国直立人（80.0~93mm，包括北京直立人，据 Weidenreich[9]，和县直立人，据吴汝康等 [18]；南京直立人，据吴汝康等 [19]）长得多，落在中国早期现代人变异范围（83~110mm，包括资阳，据吴汝康 [28]；柳江，据吴汝康 [11]；山顶洞据吴新智 [12]，隆林和马鹿洞，据 Curnoe 等 [30]）内，也落在欧洲早期现代人变异范围（91~111mm，据 Curnoe 等 [30]）以及西亚早期现代人的变异范围（96~110mm，据 Curnoe 等 [30]）内，而且与后两组的平均值（分别为 105±5mm 和 103±5mm）很接近。但是大荔颅骨这个项目也落在欧洲中更新世人的变异范围（102~117mm，包括 Arago

和 Steinheim, 据 Kennedy 等 [15]；Atapuerca, 据 Arsuaga 等 [17]；Ceprano，Petralona, 据 de Lumley 等 [16]）的下部，与 Bodo（103mm，据 de Lumley 等 [16]）接近，而比 Kabwe（96mm，据 de Lumley 等 [16]）长。

最小额宽与最大额宽的比值（ft-ft/co-co）在大荔颅骨为 87.4，比中国直立人（77.8~84.3，包括北京直立人，据 Weidenreich[9]；南京直立人，据吴汝康等 [19]；和县直立人，据笔者）的最大值大，落在欧洲中更新世人（86.1~100，包括 Arago，Petralona 和 Steinheim, 据 Kennedy 等 [15]；Atapuerca, 据 Arsuaga 等 [17]；Ceprano, 据 de Lumley 等 [16]）、非洲中更新世人（78.3~89.6，包括 Bodo，Kabwe 据 de Lumley 等 [16]；Salé 据 Rightmire[31]）和中国早期现代人的变异范围（76.0~90.5，包括马鹿洞，据 Curnoe 等 [30]；山顶洞、柳江和资阳，据笔者）内。

额冠点宽（st-st）在大荔颅骨为 108mm，比中国直立人（78~103mm，包括北京直立人据 Weidenreich[9]；和县直立人据吴汝康等 [18]；南京直立人据吴汝康等 [19]，）长，落在中国早期现代人的变异范围（105~119.5mm，包括山顶洞 101 和 103 号、柳江和资阳，据笔者）内，很接近现代人平均值（110.42mm，据 de Lumley 等 [16]）。但是也落在欧洲中更新世人变异范围（102~130mm， 包括 Atapuerca SH, 据 Arsuaga 等 [17]；Arago，Petralona, Ceprano, 据 de Lumley 等 [16] ）的下部。

颞鳞长高指数在大荔颅骨为 64.6，大荔颅骨的这个指数比中国直立人（45.2~60，包括北京直立人据 Weidenreich[9]；和县直立人据吴汝康等 [18]）的高，比欧洲的 Atapuerca SH（69.3~79.7，5 例，据 Martinez and Arsuaga[32]）的低，在现代人变异范围（49.4~87.5，据 Weidenreich[9]）内，接近现代人的平均值（65.2）。

额骨侧面角（angle m-g-i）在大荔颅骨为 74°，比中国直立人（54°~63°，包括北京直立人据 Weidenreich[9]；和县直立人据吴汝康等 [18]；南京直立人据吴汝康等 [19]）和爪哇的直立人（47.5° 和 55°，据 Weidenreich[9]）以及非洲中更新世人（包括 Kabwe，60° 据 Weidenreich[9]；Jebel Irhoud，67°；Saldanha，61° 均据 Suzuki[10]）都大得很多，十分接近 Ehringsdorf（73.5° 据 Weidenreich[9]），已经进入现代人的变异范围（70°~96°, 据 Weidenreich[9]），但是比其平均值（83.2°）低得多。大荔的这个数值比欧洲尼人（57°~70°，包括 9 例，据 Suzuki[10]）大，比欧洲早期现代人（80°~95°，包括 3 例，据 Suzuki[10]）小。

2.4 大荔颅骨有一些特征处于一般中更新世人与早期现代人之间的中间状态。它们包括：

有前囟区隆起，但是不太强。

颅骨额鳞中部偏下处，有约呈梭形的正中矢状隆起，比北京直立人的短而且弱。

额结节两侧皆不甚明显，似有似无。

枕骨圆枕实际上为一菱形丘状隆起，向两侧尖缩。

颅后点在枕骨枕面与项面过渡地带与枕面的分界处，这样的位置介于直立人与现代人之间，而较偏于前者。

蝶骨大翼颞面与颞下面之间缓缓过渡，此处的特征介于北京直立人和现代人之间。其间没有明显的颞下脊。

鼓板厚度介于北京直立人与现代人之间。

颅骨内面脑膜中动脉的分支形式与北京直立人最晚的颅骨 V 号比较相似。整体看来，大荔颅骨脑膜中动脉分支的印迹比北京直立人的丰富。

颅骨左侧外面有角圆枕，但是颅骨内面没有与之对应的圆枕。北京直立人内外两面都有圆枕，现代人一般没有角圆枕，早期现代人有少数例外。

枕骨大脑窝与小脑窝面积之比大约为 3:2，介于北京直立人与现代人之间。北京直立人的这个比例大约为 2:1；现代人的则大约是 1:2。

枕内隆凸点与枕外隆凸中心的距离是 11mm，介于直立人与现代人之间。

左侧横窦沟外侧段沿着顶乳缝走行，右侧横窦沟外侧段经过顶骨。这样的情况介于尼人和包括北京直立人在内的其他非现代人与现代人之间，而比较接近现代人。前者的横窦沟倾向于由枕骨直接连到颞骨上的乙状窦沟，而不经过顶骨，后者经过顶骨的后下角。

颅骨宽度在乳突上脊处与在颞骨鳞部几乎相等（149.5mm）。中国直立人颅骨最宽处都在乳突上脊水平，上新 / 早更新世和其他中更新世颅骨最大宽一般也在乳突上脊水平，而现代人颅骨最宽位置高得多，一般在顶骨或颞骨鳞部。

泪腺窝的洼陷程度介于直立人与现代人之间。

颅横曲度指数（au-au/arc po-b-po）在大荔颅骨为 47.2，比较资料见于第一组的特征。

2.5 大荔颅骨有些特征介于中国直立人与中国早期现代人之间的中间位置，而且比较接近欧洲 / 非洲中更新世人。它们包括：

鼻枕长与颅全矢状弧形成的颅矢状曲度指数（n-op/arc n-o）在大荔颅骨为 51.8，远小于北京直立人（55.7~57.3，据 Weidenreich[9]），稍小于和县的直立人（52.9，据笔者），比中国早期现代人（变异范围，47.2~51.0，包括山顶洞、柳江和资阳，均据笔者）的最高值稍大。在欧洲中更新世人的变异范围（49.5~54.4，包括 Ehringsdorf 据 Weidenreich[9]；Petralona 据 Stringer 等[21]；Atapuerca 据 Arsuaga 等[17]，颅全矢状弧由笔者将该文所载额骨弧，顶骨弧和枕骨弧相加而得）的中部。Kabwe（54.2，据 Weidenreich[9]）接近欧洲中更新世人的最高值。

最大额宽与颅宽的比值（co-co/eu-eu）在大荔颅骨为 79.3，介于中国的直立人（68.5~76.9，包括北京直立人，据 Weidenreich[9]；南京与和县据笔者）与中国早期现代人（79.7~93.1，包括山顶洞模型、柳江和资阳，据笔者）之间，虽然不在两者的变异范围之内，却比较接近早期现代人，而且在欧洲中更新世人变异范围（包括 6 例，75.0~87.9，平均值 79.7，据 Arsuaga 等[17]）中部，很接近其平均值（6 例平均值 79.7），也在欧洲尼人（包括 11 例，75.5~83.4，平均值 80.6±2.6，据 Arsuaga 等[29]）的变异范围内，也很接近其平均值（包括 11 例平均值，80.6）而比欧洲旧石器时代晚期人的平均值（男，87.9；女 85.2，据 Arsuaga 等[29]，转引自 Frayer，1980）都小得多，在 Sepúlveda 人的变异范围（男，41 例，72.9~90.1；女，57 例，77.7~90.8，据 Arsuaga 等[29]）内。

2.6 大荔颅骨有一些特征与东亚的多数化石人比较一致，而与旧大陆西部中更新世化石人相去较远。它们包括：

泪腺窝浅，与北京直立人相近，而 Arago 21、Steinheim、Petralona、和 Kabwe 的眶顶也都呈穹隆，泪腺窝都比大荔的明显。

额鳞中部偏下处，有呈脊状的正中矢状隆起。中国中更新世化石除南京 2 号外一般都呈脊状，底面较狭，而欧洲和非洲标本这个隆起的底面宽，相比之下隆起的程度较弱。

左侧顶骨与枕骨之间有一块缝间骨残片。高度和宽度均约 2 厘米，可能是一块印加骨的残余。印加骨在北京直立人中有相当高的出现率，许家窑、丁村顶骨后上角的形态都显示很可能具有印加骨，在欧洲和非洲发现的中更新世人类化石中除了 Petralona 颅骨在顶骨和枕骨之间有一块宽约 3cm 呈不规则形的缝间骨以外鲜有类似的情形。这些资料提示，可能印加骨或比较大的缝间骨在中国中更新世人群有比旧大陆西部较高的出现率，后来由于遗传漂变，具有较高印加骨出现率的一股人去了美洲，从东亚起源的人群如北极区美洲印第安人和西藏 / 尼泊尔人中也有相对地较高的出现率。

额骨正中矢状弦鼻根点区段与额骨正中矢状弦的比值（nasion subtense fraction of n-b / n-b）在大荔颅骨为 43.5，指示额骨正中矢状弧最突出点在此轮廓线的下半，比北京直立人（45.3~48.7，据 de Lumley 等 [16]）稍小、比南京直立人（42.4，据笔者）稍大、比马坝（47.4，据笔者）小、在中国早期现代人变异范围（43.0~46.0，包括山顶洞和柳江，据笔者）内而与其下限很接近。与之形成对比的是，大荔比欧洲中更新世人（包括 Petralona，50.0，据 de Lumley 等 [16]；Arago，49.6，其 M29 和 M29c 均据 de Lumley 等 [16]）的低得多，比非洲中更新世人（ 44.9~54.1，包括 Laetoli OH18，Eliye Springs，Omo 1，Jebel Ithoud 1 和 2 号，和 Singa，据吴新智等 [3]）最低值稍小。总之，大荔颅骨的这个指数与中国的无论是中更新世人还是早期现代人相比，都在其变异范围内，却超出旧大陆西部中更新世人的变异范围，特别是比欧洲标本的低得多。

枕骨角在大荔颅骨为 96°，在中国直立人变异范围（95°~108°，北京和南京的直立人均由笔者按照 Howells[33] 的方法分别在 Weidenreich[9] 和吴汝康等 [19] 的正中矢状图上测量）内，接近其下端，比 Atapuerca SH（106.5°~126.1°，据 Arsuaga 等 [17]）最低值小得多。两组人的变异范围只有极小幅度的重叠。特别值得注意的是，大荔的枕骨角甚至比非洲上新 / 早更新世人（101°~114°?， 包括 KNM-ER 3733, 3883, 1813），Dmanisi（115.6° 和 108°?）以及 Sangiran（105° 和 100°）小（这三组数据均据 Rightmire[34]）。

眶间前宽（mf-mf）在大荔颅骨为 21.5mm，与中国早期现代人（19.1~21.2mm，包括山顶洞模型和柳江，据笔者）。与北京直立人 XII 号（22.5mm）、南京直立人（19mm）和欧洲的早期现代人（包括 7 例，23.4±2.9mm）都很接近，比欧洲，非洲和西亚中更新世人（包括 5 例，29.5±2.2mm）短得多，比尼人（包括 5 例，24.2±7.5mm）也短（以上三组数据均据 Sládek 等 [22]）。

大荔复原颅骨的上面高指数（n-pr/zy-zy）为 53.2，接近金牛山的人类化石（50.1，据吴汝康 [26]）和南京直立人（49.9，据吴汝康等 [19]）和北京直立人 XII 号复原头骨（54.5，模型据笔者），比欧洲中更新世人（56.0~59.0，包括 Petralona，Steinheim 据 Suzuki[10]；Atapuerca SH, 据 Arsuaga 等 [17]）和非洲中更新世人（54.2~64.7，包括 Jebel Irhoud，Kabwe，据 Suzuki[10]；Bodo 据 Conroy 等 [35]）低，在中国早期现代人的变异范围（48.5~53.8，包括柳江，据吴汝康 [11]；山顶洞，据吴新智 [12]）内。

右侧眶下孔与眼眶下缘的距离在大荔颅骨为 8.3mm，与南京直立人眶下孔距眶缘的 7.5mm（据笔者）相近，与 Atapuerca SH（14.1~17.7mm，据 Arsuaga 等 [17]）及 Petralona（16.4mm，

据 Arsuaga 等 [17]）相差颇大。

此外，大荔颅骨眶间宽与两额宽构成的比值（d-d/fm:a-fm:a）也与中国化石人类接近，与欧洲中更新世人相距较远，不过与 Kabwe 也接近（详见第一组特征）。

2.7 大荔颅骨有一些特征与中国直立人显然不同，而与欧洲 / 非洲中更新世人更加接近。

它们包括：

非洲、欧洲中更新世人类眶上突的存在与否有变异，中国直立人一般都有眶上突，而大荔和马坝没有眶上突，这可能暗示中国和旧大陆西部中更新世人类之间的基因交流的结果。

眉脊上缘轮廓的内侧段与外侧段相交成角状，两侧眉脊都是中部最厚，与 Petralona，Bodo，Kabwe 等相似，而与中国其他化石眉脊上缘的轮廓呈比较均匀的弧形很不相同。

梨状孔和眼眶之间的骨面隆起，与 Petralona，Bodo，Kabwe 等相似，而中国的化石人类都没有表现这样的隆起。

顶骨后缘弦长（l-ast, 以参照人字缝基本走向所确定的下位的人字点为测量标志）在大荔颅骨为 94mm，与欧洲中更新世人（74.5~95.6mm，包括 Atapuerca SH，10 例，17 侧，据 Arsuaga 等 [17]；Petralona, 据 Stringer 等 [21]）接近，比中国直立人（77~87mm，包括北京直立人据 Weidenreich[9]；和县据笔者）长。

两额宽（fm:a-fm:a）在大荔颅骨为 114mm，比北京直立人（XII 号模型，104mm）、和县直立人（101mm）、南京直立人模型（96mm）和马坝（100mm）（均据笔者）都长得多，而与欧洲、非洲和西亚中更新世人（6 例平均值 ± 标准差，114.7±8.5，据 Sládek 等 [22]）接近。

Rightmire[36] 根据大荔颅骨的眼眶高和脑量估计其 EQ 为 5.30。他估计非洲和欧洲中更新世人的 EQ 为 5.3±1.29，北京直立人 XI 和 XII 的平均值估计为 4.6，显示大荔颅骨的 EQ 与非洲和欧洲中更新世人相当接近，而与北京直立人不同。

2.8 大荔颅骨有特征与非洲中更新世人接近，而与中国直立人和欧洲中更新世人差距较大

额骨眉间点前囟点弦的眉间点区段与眉间点前囟点弦形成的比值（glabella subtense fraction of g-b/g-b）在大荔颅骨为 43.4，指示额骨正中矢状弧最突出点在此轮廓线的下半部，比北京直立人（47~50.9，III 号的数据为笔者在 Black[37] 的图上测得，其余数据为笔者在 Weidenreich[9] 各该头骨的左侧观图版上测得）、南京直立人（49.7，据笔者）都小，而比欧洲中更新世人（包括 Arago，51，其 M29d 和 M29f 据模型和 Spitery[38] 附图；Ceprano，60.8，据 Ascenzi 等 [39] 附图测量和换算）小得多；在非洲中更新世人（42.6~58.5，包括 Florisbad, Jebel Irhoud, Kabwe, Laetoli, Omo 1 和 Saldanha, 据吴新智等 [3]）变异范围的最下端。另一方面，大荔没有超出中国早期现代人的变异范围（41~48.5，包括山顶洞、柳江、资阳，据笔者；黄龙据王令红等 [40]），与马坝（45.1，据笔者）也接近。

2.9 大荔颅骨有一些特征与大多数中更新世人不同，似乎是自身独有或少见的，它们包括:

从颞鳞前上部向前伸出一个长约 10mm，高约 7mm 的长方形突出部，插入顶骨与蝶骨之间，而与额骨相接，导致翼区呈斜置的Π形。

鸡冠不高，横径颇大，不像现代人那样近似薄片状。而北京直立人和 Ngandong 的化

石都没有这个结构。

枕骨下鳞与 g-i 夹角（angle g-i-o）在大荔颅骨特别小，只有 21°，比中国的直立人（包括北京直立人，37°~ 44°，据 Weidenreich[9]；南京直立人模型，49°，据笔者）、欧洲和亚洲的尼人（包括 7 例，31°~ 54°，据 Suzuki[10]）和现代人（31°~ 40°，据 Suzuki[10]）都小很多。

3 讨 论

本文分析的大量特征属于第一组，凸显大荔颅骨中更新世的时代特质，第二组的特征显示它代表同时代人类中比较接近现代人的群体。第二、三、四、五组的部分特征提示大荔所代表的群体对现代人这些特征的形成可能作出过比中国的直立人，乃至旧大陆西部的中更新世人较大的贡献。第一组和第二组特征以及其他组的部分特征表明大荔颅骨是一个集原始与进步特征于一体的镶嵌体。第六组和第一、二、三、五组的部分特征指示大荔与东亚人群可能有比较密切的关系。第二、三、七、八、九组和第四、五组的部分特征都指示大荔颅骨很可能代表一个不属于直立人的独特的群体。第三、五、七、八组和第四组的部分特征则提示其与旧大陆西部人群可能有一定程度的遗传联系。考虑到地缘的因素和这件化石与第一模式的石器伴存，比较合理的推论似乎应该是，大荔的根很可能在东亚，其前辈原本比东亚直立人更与欧洲人群亲近或在其进化过程中接受过从西方来的基因。

关于中更新世和更晚的人类之间的关系 Rightmire[41] 曾经提出过四种假说。其第一种假说将尼人列为与近代人关系最近者，其次为海德堡人，最远者为亚洲古老型人；第二种假说也将尼人列为与近代人关系最近者，其次是亚洲古老型人，最远者是海德堡人；第三种假说将亚洲古老型人列为与近代人关系最远者；第四种假说是，共同祖先分为两支，一支发展出近代人和亚洲古老型人；另一支发展成海德堡人和尼人，即将亚洲古老型人列为与近代人关系最近者。三年后他发表了一篇关于中更新世人类进化的论文，在讨论郧县、大荔和金牛山的人类化石后写道“如果认同中国这些个体（包括郧县？）不是直立人，则将之归属于海德堡人是必须探索的一个选项”[5]。在该文所载的图中，他将亚洲早于 10 万年前的人类画在一个绝灭旁支中，末端缀以问号，同时在文字中援引 Harding 等（1997）的论文说，比较分子生物学研究对亚洲古老型人向现代人基因库做过贡献的可能性问题持开放态度。Stringer[6] 发表的图中将大荔与马坝、金牛山放在以 Narmada 开端的一个绝灭旁支中，将周口店与和县一起放在以 Sangiran 开端的另一绝灭旁支中。本文所显示的形态比较的大量资料显然不能支持 Stringer 这样的主张和 Rightmire[5] 于 1998 年的推测，却比较有利于 Rightmire[41] 于 1995 年提出的第四种假说。可能是他们被本文分析的大荔颅骨与欧洲、非洲中更新世人比较接近的特征所吸引，在没有能进行比较全面分析的基础上过分重视这些片面的信息便做出了上述的推测和判断。

在我们的比较中还可以看出，大荔有不少特征与欧洲中更新世人接近而与非洲的不同，有的特征与非洲的接近而与欧洲的不同，显示出在中更新世，欧洲和非洲的人类之间有明显的差异，因此欧洲的和非洲的中更新世人可否归并于一个物种——海德堡人，还是一个需要研究的问题。总之，将大荔归属于海德堡人这个界限还很不明朗的古生物种似乎

是过于草率了。

大荔颅骨的复杂形态学表现和上述的各种信息，使我们不得不思考：人类进化，特别是中国这一地区的人类进化，远不是迄今以为的那样简单。中国和西方在中更新世时很可能生存着一个物种内若干区别明显而又互有联系的，够不上亚种级别的人类支系，或许可以称之为形态类型（Morph）。就目前已有的化石而言，可以包括：以大荔为代表的大荔类型（还可能分解出金牛山亚型、马坝亚型和曲远河口亚型）；以北京直立人为代表的直立人类型（还可能分解出周口店亚型与和县亚型）；分布于欧洲的海德堡类型（还可能分解出 Arago 亚型和 Atapuerca 亚型等），和分布于非洲的罗德西亚类型等。更多的新化石和新研究还可能分出更多的类型和 / 或亚型。虽然目前限于资料的不足很难冒然做出很准确的判断，许多比较残缺的化石暂时还难以归类，但是笔者还是愿意将这个时间段的人类进化设想为总体上呈河网状的结构 [42]。

4 结 论

大荔颅骨表现为中更新世晚期人类共有特征和早期现代人部分特征的镶嵌体，并且兼具东亚的直立人和旧大陆西部中更新世人的特征， 它既不属于直立人，也不属于海德堡人。在此基础上可能设想的历史场景是一百多万年前直立人进入东亚后分为两大支，一支发展成以北京直立人为代表的和以和县直立人为代表的类型；另外一支原本就与旧大陆西部人类比较亲近或者后来吸收了来自旧大陆西部的基因，形成了以大荔颅骨为代表的类型。中国早 / 中更新世的，除直立人以外的其他人类化石可能属于这个类型，也可能是属于这一支脉的单独类型。这一支脉既有直立人的部分特征，也有旧大陆西部（主要来自欧洲）的部分特征。大荔颅骨的不少特征比中国的直立人，乃至旧大陆西部中更新世人进步，指示大荔颅骨所代表的人类进化世系可能在中国早期现代人的形成过程中作出过比中国的直立人、非洲的中更新世人，甚至可能比欧洲的中更新世人更大的贡献。

以上只是笔者在目前掌握的有限资料的基础上进行比较、分析与归纳的结果，其中不少项目对比资料不多，或者在某些方面还存在缺陷，如对差距不能做统计学检验等，说服力不够强，但是笔者相信它能在一定程度上反映大荔颅骨在人类进化中的位置和扮演的角色。因此还是愿意陈之于此以待未来更多标本的检验。总之，这只是试探性的结论，需要等待将来更多新化石和有关资料出现时进行印证，补充或修订以达到新的比较正确的认识。

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The Place of Dali Cranium in Human Evolution

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This paper presents a comprehensive comparative study between Dali cranium and other human fossils of Middle Pleistocene and those of later time.The non-metric and metrical features are classified into 9 categories as follows:

1.The features of Dali which are similar to other Middle Pleistocene humans(MPH) and quite different from those of early modern humans(EMH).

The brow ridges are robust and connect each other in glabellar region.

The bregma and vertex coincide in position.

There is angular turn on the occipital portion of mid-sagittal contour.

The cranial wall is thick.

The lacrimal fossa is shallow.

The left infraorbital fissure communicates with the infratemporal fossa through a downward passage instead of a horizontal one.

The infratemporal surface of sphenoid bone locates at a lower level than the orbital floor.

The auricular height of Dali cranium is 102mm. It falls within the variation range (v.r.) of *Homo erectus* (*H.e.*) from Zhoukoudian (ZKD) (93.5mm~107mm)[9] and shorter than that of Kabwe

(105mm) [9] and Neanderthals (103-122 mm, totally including 7 cases, the sites from which the fossils were enearthed can be checked in the references cited, similarly hereinafter) [9-10]and EMH of China (108~119 mm, including Liujiang, Lijiang, Chuandong and Upper Cave) [11-14].

The length-height index I (ba-b/g-op) of Dali cranium is 57.1. It falls within the v.r. of Plio/Pleistocene humans of Africa (50.4~67.5, including KNM-ER1813; OH 9, KNM-ER 3733, 3883) [5, 15] and that of Dmanisi (55.4~65.4) [16]. The value of Dali is slightly higher than that of the recontructed skull of Yunxian 55.8[16], and lower than that of the reconstructed skull of *H.e.* from ZKD (59.9)[9] and that of Kabwe (60.2) [15] as well as that of most of MPH of Europe (58.6~69.9, including Petralona, Steinheim, Swanscombe; Ceprano; Atapuerca SH 4,5,6) [15-17] except Ehringsdorf (the index is 55.9)[15]. It is much lower than that of EMH of China (66.7~77.7, including Liujiang and Upper Cave) [11,12] and Europe (65.8~71, including 6 cases) [10].

The length-height index II (po-b ht/g-op) of Dali is 49.6. It falls within the v.r. of that of Dmanisi (46.38~53.59[16]) and Plio/Pleistocene humans of Africa (46.6~53.3, including OH 9, KNM-ER 3733, 3883) [15]. The value of Dali is close to the lower limit of *H.e.* from ZKD (49.0~53.3) [9]. It is lower than that of *H.e.* from Hexian (50) [18] and close to the lower limit of the v.r. of MPH of Europe (51.0~65.1, including Petralona, Steinheim; Arago, Ceprano; Atapuerca SH) [15,16,17]. The index of Dali is much lower than that of EMH of China (57.1~72.5, including Liujiang, Upper Cave, Lijiang and Chuandong) [11,12,13,14] and Europe (58~62.3, including 6 cases) [10].

Transverse cranial curvature (au-au/po-b-po) of Dali cranium is 47.2. It is lower than that of *H.e.* of China (47.4~54.8) [9,18,19] and is between two specimens of Pithecanthropus from Trinil (I, 52.3 and II, 45.6) [9]. It is lower than that of Kabwe (48.3) [9] and higher than that of Petralona (44.8) [10]. The value of Dali is much higher than that of EMH of China (39.2~42.2, measured by the author on Liujiang and casts of Upper Cave) and Europe (36.5~43.6, including 3 cases) [10].

The ratio of b-ast to occipital breadth (ast-ast) of Dali cranium is 113.9. It is within the v.r. of *H.e.* of China (103.5~119.8, including those of Hexian and cast of ZKD which are all measured by the author) and MPH of Europe (97.8~117.5, including Atapuerca SH, Petralona and Swanscombe) [17]as well as that of MPH of Africa (107.1~116.3, including Kabwe; Eliye Springs, Omo 2)[17, 20]. It is much lower than those in EMH of China (121.5~132.7, including those of Liujiang, Ziyang and casts of Upper Cave which are all measured by the author).

The angle, l-i-o of Dali is 105°. It is close to the highest value of the v.r. of *H.e.* of China (98°~106°, those of ZKD are according to Weidenreich 1943[9]; that of Nanjing is measured by the author) and lowest value of that of MPH of Europe (107°~129.1°, including Ehringsdorf, Steinheim ; Atapuerca SH) [10, 17]. It is much lower than that of modern humans (117°~127.3°) [10].

Angle l-op-o of Dali cranium is 98°. It equals the lowest value of the v.r. of *H.e.* of China (98°~108°, including ZKD and Nanjing) [16, 19], much lower than that of Petralona (106°)[16] and much lower than that of modern humans (128°~138°) [16].

The ratio of d-d to fm: a-fm: a of Dali cranium is 22.8. It is between the values of *H.e.* from ZKD XII (21) and Nanjing (26)(those of ZKD and Nanjing are measured and calculated by the author) and very close to that of Kabwe (22.6, measured by the author on cast). The value of Dali is much lower than that of Petralona(28.7) [21]and Atapuerca SH 4 and 5 (33.1 and 29.5 respectively) [17] and higher than that in EMH of China (15.5~18.6, measured by the author on fossil from Liujiang and casts of the fossils from Upper Cave).

2. Features similar or close to that in modern humans

The contour in hind view appears as an even curve with the broadest part locating at the temporal squama.

The vertical line passing the most lateral point of mandibular fossa passes through the lateral cranial wall lateral to the joining point between the inner surface of cranial base and lateral cranial wall.

The ratio of calvarium height above g-i chord to g-i chord of Dali cranium is 50.4. It is much higher than those in *H.e.* from ZKD(34.8~41.2)[9], Pithecanthropus from Trinil(33.3~37.4)[9] that of Kabwe (40.5) [10], Saldanha (45.0) [10] and Jebel Irhoud (43.7) [10], and higher of that of Steinheim (46) [10]. The value of Dali falls into the v.r. of EMH of Europe (49-61, including 5 cases) [10].

The ratio of arc n-i to n-i chord of Dali cranium is 189.9. It is higher than that of Neanderthals (5 cases, 145.1~178.1) [10], between that of male (181.2) and female (203.7) of Obercassel[10]. Dali's value is close to the average of Middle Age Japanese (200.0) [10].

Angle b-n-op (i) of Dali is 54°. It is much higher than that of *H.e.* from ZKD (42°~46.5°) [9], Kabwe(48°) [9] and Neanderthals (including 5 cases, 39°~50°) [9]. It is higher than that of Ehringsdorf (52°)[9] and falls into the v.r. of modern humans (45°~59°)[9].

Angle g-i-l of Dali cranium is 82°. It is much higher than that of *H.e.* of China (57°~68°)(those of ZKD are from Weidenrech[9]; that of Nanjing is measured by the author), Ehringsdorf (63°) [10], Kabwe (68°) [10], and Neanderthals of Europe (including 7 cases, 59°~69°) [10]. Dali's value falls within the v.r. of modern humans (80.2°~88.6°) [10].

Upper facial height (fmt-fmt) of Dali cranium is 121mm. It is much longer than those of *H.e.* from ZKD(III, 109mm; XI, 111mm?)[16] and Nanjing (107mm,measured by the author) and Hexian (113mm). Dali's value is very close to that of Maba(126mm) and Upper Cave 101(122mm), and much longer than those in Upper Cave 102 and 103 (113mm and 100mm respectively) as well as that in Liujiang(107mm)(All specimens of China except those from ZKD are measured by the author). Dali's value is shorter than MPH of Europe(125~130mm, including Arago, Atapuerca SH5, Petralona and Ceprano)[16], and much shorter than those from Bodo(136mm) [16]and Kabwe(139mm)[16].

The depth of facial bones (ba-pr) is 105mm. It is much shorter than that of Atapuerca SH 5 (115mm) [16], Petralona (119 mm) [16], Bodo (118 mm) [16] and Kabwe (117.5mm) [16]. Dali's value falls within the v.r. of EMH of China (100~113.6 mm, including Liujiang and Upper Cave) [11, 12] and is close to the average of that of modern humans (including 60 cases, 97.2 mm) [16].

The ratio n-ba/ba-pr of Dali cranium is 100.5. It is much higher than that in Bodo (88.4) [16]; Kabwe (93.1) [16], Atapuerca SH 5(87.8) [16] and Petralona (94.8) [16]. It falls within the v.r. of EMH of China (99.3~112.0 , including Liujiang and Upper Cave) [11, 12] and is close to the average of modern humans (101.7) [16].

Cheek height(WMH) of Dali cranium is 23mm. It is within the v.r. of early modern humans of China(21.7~27.2mm, including 7 sides of 4 cases of Upper Cave and Liujiang, measured by the author). Dali's value is shorter than that in *H.e.* from ZKD(XII, 28mm, measured by the author), and those in MPH of Europe(26.7~37.1mm, including 7 sides of 6 cases) [17]. It is close to the *H.e*. from Nanjing(24.3mm, measured by the author) and Zuttiyeh(24mm)[17], but the dimensions of *H.e*. from Nanjing are generally shorter than *H.e*. from ZKD.

The prosthion angle (n-pr-ba) of Dali cranium is 69.5°. It is very close to the average of that of modern humans (71.4°±3.1°) [24] and much higher than that in Kabwe (62.1°) [24], Bodo(59°, calculated by the author based on the data in Rightmire, 1996[23]), Atapuerca SH 5 (60.9°) [17] and Petralona (62.0°) [24].

3. Features far from that in *H.e.* of China and within the v.r. of that in EMH of China and / or modern humans. These features are also close to that in MPH of Europe and/or Africa

Dali cranium has no supraorbital process.

The maximum cranial length (g-op) is 16.5 mm longer than glabella-inion length (g-i) in Dali cranium. The difference between these two measurements is very short or none in *H.e.* of China and is between 4 mm and 17 mm in EMH of China (including Liujiang[11] ,Upper Cave[12], Lijiang[13] and Chuandong 2[14]). The difference is larger than 5 mm in Petralona[15], Steinheim[15], Jebel Irhoud [10] and Narmada[15].

Transverse fronto-parietal index (100 x ft-ft/eu-eu) is 69.6 in Dali cranium. It is higher than that of *H.e.* of China (55.9~64.5, including ZKD, Hexian, and Nanjing) [9, 18, 19, 25] and falls in the v.r. of EMH of China (66.9~77.1, including Liujiang , Upper Cave and Lijiang)[11, 12, 13]. Dali's value is higher than that of Kabwe(64.3) [15] and Salé (57.5) [15]. It is within the v.r. of MPH of Europe (67.0~77.9, including Ehringsdorf, Steinheim; Arago, Ceprano, Petralona; Atapuerca SH) [15,16,17].

The total cranial arc (n-o arc) is 379 mm in Dali cranium. It is much longer than those in *H.e*. from ZKD (321 mm~337 mm)[9] and *H.e.* from Hexian (340 mm?) [18]. It falls within the v.r. of EMH of Chna (335 mm~388.5 mm, including Liujiang, Upper Cave, Lijiang, Chuandong and Ziyang) [11-14, 28] and that of MPH of Europe and Africa (340 mm~380 mm , including

Ehringsdorf [9]Atapuerca SH, Petralona, and Kabwe [9]) (the values of Atapuerca SH and Petralona are calculated by the author based on the data presented in Arsuaga et al. [17] and Stringer et al. [21], respectively).

The cranial curvature on the n-o chord is 37.7 in Dali cranium. It is lower than that of *H.e.* from ZKD (43.2-44.9) [9], Nanjing (48.8) (by the author)and Hexian (38.5) [18]. It falls within the v.r. of EMH of China (36.4~40.3, including Liujiang , Upper Cave and Ziyang) [11, 12, 28] and v.r. of modern humans (35.2~39.9) [9]. Dali's value is close to the average of that of modern humans (36.6) [9], Kabwe (37.1) [9]and slightly lower than that of Ehringsdorf (40.1) [9].

The ratio of maximum frontal breadth to occipital breadth (co-co/ast-ast) is 103.5 in Dali cranium. It is much higher than those of *H.e.* of China (including ZKD, Nanjing and Hexian: 83.9~99.1?)(ZKD is from Weidenreich, 1943[9], Nanjing and Hexian are by the author) and that of Kabwe(90.5, calculated by the author based on Weidenreich, 1943[9]). Dali's value falls within the v.r. of MPH of Europe (93.6~108.8, including Arago, Atapuerca SH 4 and 5, Petralona, Steinheim and Swanscombe) [29]. Dali's value falls within the v.r. of EMH of China (including Upper Cave, Liujiang and Ziyang: 100~114, by the author) and is close to the average of Mesolithic humans of Europe (male, 102.9; female, 103.3) and Sepúlveda population (male, 103.0; female, 105.6)[29].

The minimum frontal breadth of Dali cranium is 104 mm. It is much longer than those of *H.e.* of China (80.0 mm~93 mm including ZKD, Hexian and Nanjing) [9, 18, 19] and falls within the v.r. of EMH of China (83 mm~110 mm , including Upper Cave, Liujiang, Ziyang, Longlin and Maludong) [1, 12, 28, 30]. It falls also in the v.r. of EMH of Europe (91 mm~111 mm) [30] and West Asia (96 mm~110 mm) [30]. The mean values of last two groups are 105±5mm and 103±5 mm respectively). Dali's value falls also in the v.r. of MPH of Europe (102 mm~117 mm , including Arago, Steinheim; Ceprano, Petralona ; Atapuerca SH) [15, 16, 17]and is close to that of Bodo (103 mm) [16] , but is longer than that of Kabwe (96) [16].

The ratio of minimum frontal breadth to maximum frontal breadth (ft-ft/co-co) is 87.4. It is higher than those of *H.e.* of China (77.8~84.3, including ZKD [9], Nanjing [19] and Hexian which is measured and calculated by the author)and falls within the v.r. of MPH of Europe (86.1~100, including Arago, Petralona, Steinheim; Ceprano , Atapuerca SH,) [15, 16, 17] and that of African MPH (78.3~89.6, including Bodo, Kabwe and Salé) [16, 31]. It falls also within the v.r. of EMH of China (76.0~90.5, including Upper Cave, Liujiang, Ziyang, and Maludong which is from Curnoe et al., 2012[30]; U.C., Liujiang and Ziyang are measured and calculated by the author) .

The bistaphanic breadth (st-st) of Dali cranium is 108 mm. It is longer than those of *H.e.* of China (78mm~103mm , including ZKD [9], Nanjing and Hexian, latter two are measured by the author), and falls within the v.r. of EMH of Chian(105~119.5, including Upper Cave 101, 103, Liujiang and Ziyang, all of these are measured by the author). The mean value of modern humans (110.42mm) [16] is close to that of Dali's value which falls also within the v.r. of MPH of Europe

(102mm~130mm, including Arago, Petralona, Ceprano; Atapuerca SH) [16, 17].

Length-height index of temporal squama is 64.6 in Dali cranium. It is higher than those in *H.e.* of China (45.2~60, including ZKD and Hexian) [9, 18], and slightly lower than those in Atapuerca SH (including 5 cases, 69.3~79.7) [32]. Dali's value is close to the average of that of modern man (65.2) and well within his v.r. (49.4~87.5). [9]

The frontal profile (angle m-g-i) of Dali cranium is 74°. It is much larger than those of *H.e.* of China (56°~63°,including ZKD, Hexian, and Nanjing) [9, 18, 19], Pithecanthropus from Trinil (47° and 55°) [9] and MPH of Africa (including Jebel Irhoud, 67°[10]; Saldanha, 61°[10]; Kabwe, 60°[9]). Dali's value is very close to that of Ehringsdorf (73.5°) [9] and falls in the v.r. of mordern man (70°~96°)[9].

4. Features intermediate between MPH and EMH

Dali cranium has a weak bregmatic eminence, a fusiform median sagittal ridge at the middle part of frontal bone, and a tympanic plate the thickness of which is intermediate between that of *H.e.* from ZKD and modern man.

An angular torus presents at the outer surface of parietal bone.

Tranverse cranial curvature (au-au / arc po-b-po) of Dali cranium is 47.2. The comparsions between Dali cramium and other specimens have been persented among the features of Group 1.

5. Features intermediate between *H.e.* and EMH of China and close to those in MPH of Europe and/or Africa

The cranial curvature above chord n-op of Dali cranium is 51.8. It is much lower than those in *H.e.* from ZKD (55.7~57.3) [9], slightly lower than that in *H.e.* from Hexian (52.9, measured by the author). It is slightly higher than the upper limit of the v.r. of EMH of China (including Upper Cave, Liujiang, and Ziyang, 47.2~51.0, by the author) and is well within the v.r. of MPH of Europe (49.5~54.4, including Ehringsdorf[9], Atapuerca SH[17] and Petralona[21]). That of Kabwe (54.2) [9] is also within the v.r. of MPH of Europe.

The ratio of maximum frontal breadth to maximum cranial breadth (co-co/eu-eu) is 79.3 in Dali cranium. It is intermediate between those in *H.e.* of China (68.5~76.9, including ZKD [9], Nanjing and Hexian which are measured and calculated by the author) and those in EMH of China (79.7~93.1, including Upper Cave, Liujiang and Ziyang, measured by the author). It falls in the v.r. of MPH of Europe (Atapuerca SH: 75.0~87.9) [17] and v.r. of Neanderthals of Europe(including 11 cases, 75.5~83.4) [29]. It is much lower than the averages of early Upper Paleolithic man of Europe (male: 87.9; female: 85.2) [29]and within the v.r. of Sepúlveda population (male, 41 cases: 72.9~90.1; female, 57 cases: 77.7~90.8) [29].

6. Features close to those in fossil humans of East Asia and distant to those of MPH of

Europe and / or Africa

The median sagittal ridge of frontal bone is higher and has narrower base than those in MPH of Europe and Africa.

The ratio of nasion subtense fraction of n-b chord to n-b chord is 43.5 in Dali cranium. It is slightly lower than those in *H.e.* from ZKD(45.3~48.7) [16] and slightly higher than that of *H.e* from Nanjing(42.4, by the author). It falls in the v.r. of EMH of China (43.0~46.0, including Upper Cave and Liujiang, all are measured and calculated by the author). On the contrary, Dali's value is much lower than those in MPH of Europe (including Petralona, 50.0[16]; Arago, 49.6, based on the data presented by de Lumley[16]) and is lower than those in MPH of Africa (44.9~54.1, including Laetoli OH18, Eliye Springs , Omo 1, Jebel Ithoud 1 and 2 and Singa) [3].

The occipital angle of Dali cranium is 96°. It is within the v.r. of *H.e.* of China (including ZKD and Nanjing, 95°~108°, measured on the Figures in Weidenreich[9] and Wu et al. [19] respectively) and is much lower than those of Atapuerca SH (106.5°~126.1°) [17]. Dali's value is also much lower than those of Plio/Pleistocene huamns of Africa(101°~114°?, including KNM-ER 3883, 3733, 1813?) [34], Dmanisi (115.6° and 108°?) [34] and Sangiran (105° and 100°) [34].

The anterior interorbital breadth (mf-mf) of Dali cranium is 21.5 mm. It is close to that in EMH of China (including Upper Cave and Liujiang: 19.1mm~21.2mm, by the author), *H.e.* from ZKD(No.XII, 22.5mm), Nanjing(19mm) and slightly shorter than that of EMH of Europe (including 7 cases: 23.4±2.9 mm) [22]. Dali's value is much shorter than that in MPH of Europe, Africa and West Asia (including 5 cases, 29.5±2.2 mm) [22].

The upper facial index (n-pr/zy-zy) of Dali cranium is 53.2. It is close to that of Jinniushan(50.1)[26], *H.e.* of Nanjing (49.9) [19] and ZKD XII (54.5, measured by the author on cast). Dali's value is within the v.r. of EMH of China(48.5~53.8) [11, 12] , but is lower than those in MPH of Europe (56.0~59.0, including Petralona, Steinheim; Atapuerca SH) [10, 17] and Africa (54.2~64.7, including Jebel Irhoud, Kabwe; Bodo) [10, 35].

The distance between infraorbital foramen and inferior border of orbit is 8.3 in Dali cranium. It is close to that in *H.e.* of Nanjing (7.5 mm, measured by the author) and much shorter than those in Atapuerca SH (14.1 mm~17.7 mm) [17] and Petralona (16.4 mm) [17].

The ratio d-d to fm:a of Dali cranium is 22.8 mm. The comparisons between Dali cranium and other specimens have been presented among the features of Group 1.

7. Features quite different from those in *H.e.* of China and are close to those in MPH of Europe and/or Africa

In Dali cranium supraorbital process is absent, the middle part of the supraorbital torus is much thicker than the medial and lateral part, and there is a bulge between the orbit and pyriform aperture.

The l-ast chord of Dali cranium is 94 mm. It is within the v.r. of MPH of Europe (74.5 mm~95.6 mm , including 10 cases, 17 sides of Atapuerca SH and Petralona) [17, 21] and much longer than those in *H.e.* of China (77 mm~87 mm, including ZKD[9] and Hexian which is measured by the author).

The bifrontal breadth (fm: a-fm: a) of Dali cranium is 114 mm. It is much longer than the MPH of China (96 mm~104 mm, inluding *H.e.* from ZKD, Nanjing and Hexian, Maba , all of these are measured by the author) and close to those in MPH of Europe, Africa and West Asia (mean value of 6 cases: 114.7±8.5) [22].

The EQ of Dali cranium, average of *H.e.* from ZKD and MPH of Europe and Africa are 5.30, 4.6 and 5.3±1.29 respectively, as estimated by Rightmire[36].

8. Feature close to those in MPH of Africa and distant from other MPH of China and Europe

The ratio of glabella subtense fraction of g-b chord to g-b chord is 43.4 in Dali cranium. It is lower than those of *H.e.* from ZKD (47~50.9, measured and calculated by the author based on the figures in Black[37] and Weidenreich[9]), Nanjing (49.7, by the author) and Maba (45.1, by the author). But it is within the v.r. of EMH of China (41~48.5, including Huanglong[40], Upper Cave, Liujiang and Ziyang, that of the latter three are made by the author) , Dali's value is within the v.r. of MPH of Africa (42.6~58.5, including Florisbad, Jebel Irhoud, Kabwe, Laetoli, Omo 1 and Saldanha) [3]. But it is much lower than those in Arago (51, calculated by the author based on the cast and the data presented in Spitery [38]), and Ceprano (60.8, measured and calculated by the author based on the figure presented in Ascenzi et al [39]).

9. Features rarely seen in other MPH or uniquely seen in Dali

A quadrangular shaped process of the size of 10×7 mm, extending from the antero-superior part of temporal squama and connects with frontal bone. This makes the sutures in pteryon region obliquely posited ∏ shape.

The crista galli is thin and low with a large transverse diameter.

The angle g-i-o of Dali is 21°. It is much smaller than those in *H. e.* from ZKD (37°~44°,measured by the author on the figures presented in Weidenreich [9]) and Nanjing (49°, measured by the author on cast) , Neanderthals of Europe and Asia (31°~54°, including 7 cases) [10] and modern man (31°~40°) [10].

Discussion and conclusion

The features including in Group 1 confirm the position of Dali cranium in Middle Pleistocene. Features of Group 2 show that this cranium is one of the specimens closer to EMH than *H.e.* if not also MPH of Europe and Africa. Part of the features of Group 2, 3, 4 and 5 suggest that the population represented by Dali cranium provides more contribution to the formation of modern man than *H.e.* of China, if not also the MPH of west part of Old World. The features of Groups 1 and 2 and some features of other Groups indicate that Dali cranium represents a mosaic with primitive and progressive characters. Features of Group 6 and part features in Group 1, 2, 3 and 5 suggest close relation of Dali cranium to populations of East Asia. Many features presented in Groups 2, 3, 4, 5, 7, 8 and 9 indicate that Dali cranium probably belong to a population different from *H.e.* The features of Group 3, 5, 7, 8 and part of Group 4 suggest that Dali may have close relation with the populations in the western part of Old World. So Dali cranium is a mosaic joining some features of *H.e.* of China, MPH of Europe and Africa as well as some modern features. This cranium belongs to neither *H.e.,* nor *H.heidelbergensis*. The population represented by Dali cranium have made more contribution in the formation of EMH of China than *H.e.* of China and MPH of Africa. Considering the geographical factor and the association with the Paleoliths of Mode I of Dali cranium, more reasonable inference may be that the root of the population represented by Dali cranium is in East Asia and the antecessors of this population originally had higher affinity with the populations of Europe or had absorbed the gene flow from the West before evolving to Dali population.

With regards to the relation between the humans of Middle and Late Pleistocene Rightmire (1995)[41] has proposed four hypotheses, the evidence exhibited in the present paper are more favourable to the fourth hypothesis of him, namely the recent humans are most closely related with Archaic Asians.

In spite of the limitation of the data for comparison the present author would like to say that the complexity of the morphology shown in Dali cranium suggeats that the human evolution in East Asia is not as simple as we thought until present. The Middle Pleistocene humans may be classified into several morphs: Dali morph, erectus morph, Narmada morph, Zuttiye morph, Rhodesia morph (for Africa), Heidelberg morph (for Europe) etc. Hexian specimens may represent a submorph of erectus morph, Jinniushan, Maba and Quyuan River Mouth may represent separate submorphs of Dali morph or separate morphs for themselves. Atapuerca SH and Arago may represent separate submorphs. The model of human evolution in Middle Pleistocene is like a river network.

The above mentioned comparisons are based on limited information available. The author looks forward to the accumulation of new data to renew the preliminary conclusion based on this study.

Keywords: Dali cranium; Human evolution

（The References are listed above after the Chinese text of this article）