

指间区纹在灵长类动物中的进化

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摘要: 各种灵长类动物的指间区纹有很大差异。树鼯到原猴是由原始多垫指间区纹变为各区发育均匀的单垫纹。新大陆猴发展出两侧发达中部退化的类型。旧大陆猴的指间区纹最发达, 疣猴多为箕纹但各区不均匀, 猴类为各区均匀的斗纹。类人猿的指间区纹极退化, 长臂猿丧失了指间区纹。对照各种灵长类动物的生活习性, 发现树栖类型指间各区发育不均匀, 地栖类型则均匀, 使用多则指间区纹发达, 反之则退化。人类因为握持工具而次生出了环指侧花纹。各种灵长类动物的各区指间区纹并不同源, 这暗示着它们的祖先分化得很早。

关键词: 指间区纹; 灵长类; 进化

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人类手掌各区域指间区纹分几种不同的类型, 由不同位置的不同性质的基因所控制, 这在前文^[1]已较详尽地说明。区 和 区 a, d 三叉点上的小花纹是独立遗传的, 由不完全显性或隐性基因控制, C 三叉点上的 区 小花纹也是由隐性基因控制。环指根部 、 区的复杂花纹呈现出一种表型多样的镶嵌显性遗传方式。灵长类的指间区纹与人类不同, 研究和比较各种灵长类动物指区间纹, 有助于了解指间区纹进化的过程和因素。

Ayer^[2]于 1948 年首先开始了灵长类肤纹的研究。灵长类肤纹的分类法也早已大致确定^[3-5]。之后各国学者对各种灵长动物的肤纹作了大量的研究和比较^[6-13]。但对各种肤纹在整个灵长类中演化过程的研究十分少见。人类指间区纹的遗传机理研究得较清晰后, 各种灵长动物的指间区纹的观察比较就更易进行了。本文利用各种文献资料和采自上海动物园的样品, 对灵长类各分支的指间区纹作了系统的比较分析, 以研究其进化。

1 材料与方法

1.1 研究对象

种类

树鼯科 Tupaiidae

树鼯 *Tupaia belangeri chinensis*^[11]

地树鼯 *Tupaia tana*^[14]

马来树鼯 *T. Lacemata lacemata*^[15]

笔尾树鼯 *Ptilo cercus Lowii*^[14]

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眼镜猴科 Tarsiidae

眼镜猴 *Tarsius*^[16]

狐猴科 Lemuridae

斑狐猴 *Lemur variegatus* 上海动物园

懒猴科 Lorisidae

蜂猴 *Nycticebus coucang* 上海动物园

卷尾猴科 Cebidae

蜘蛛猴 *Ateles atar* 上海动物园

松鼠猴 *Saimiri sciureus* 上海动物园

狨科 Callithricidae

黑面狨 *Tamarin midas*^[17]

秃狨 *Marikina bicolor*^[17]

狮面狨 *Leontocebus rosalia*^[17]

阿根廷倭狨 *Mico argentatus*^[17]

疣猴科 Colobiade

叶猴 *Semnopithecus*^[21]

黑叶猴 *Presbytis francoisi*^[12]

菲氏叶猴 *P. phayrei*^[12]

川金丝猴 *Rhinopithecus roxellanae*^[10]

滇金丝猴 *R. berlichii*^[10]

猴科 Cercopithecidae

猕猴 *Macaca mulatta*^[9]

藏猴 *M. thibetana*^[13]

恒河猴 *Crocidura coerulea*^[6]

长臂猿科 Hylobatidae

白手长臂猿 *Hylobates lar*^[4]

猩猩科 Pongidae

黑猩猩 *Pan satyrus* 上海动物园

猩猩 *Pongo pygmaeus*^[16]

人科 Hominidae

智人 *Homo sapiens*^[1]

1.2 采样方法 石墨粉玻璃胶带粘贴法^[11]。

1.3 研究方法 在灵长类进化树上考察各种指间区纹的分布。

2 结 果

2.1 树鼩的原始多垫式指间区纹

树鼩是刚刚脱胎于食虫动物的最原始的灵长类动物。它也有了灵长类所独有的特征——肤纹。灵长类的共同祖先群的肤纹可能与树鼩的十分相似。树鼩的肤纹并没有布满整个掌面,而是分散地存在于几个区域。4个指间区是其肤纹分布的主要位置。树鼩的各指间区纹明显由3至4块掌垫拼成。各块掌垫上的嵴纹走向不同,每3块掌垫交界的地方,嵴线组成1个指根三叉,在以后的灵长掌纹中演变成三叉点。其它三叉点也是由各掌垫交

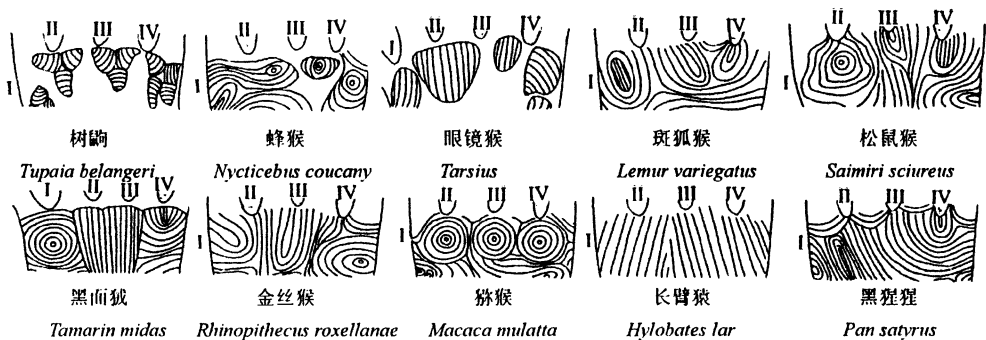


图 1 各类灵长动物的指间区纹

Interdigital patterns of primates

界形成的, 树栖的指间区掌垫花纹基本都是弓型纹, 各掌垫也难以区分发育上的主次。总体来说, 在现存灵长类中, 树栖的指间区纹是最原始的。

2.2 原猴均匀发育的指间区纹

树栖每个指间区有 3—4 个掌垫, 行使一个掌垫的功能, 十分不经济。在原猴中, 每区仅 1 个掌垫充分发育, 其它掌垫挤压得退化或消失。包括眼镜猴、狐猴、懒猴这三类, 各区保留的一个掌垫发育程度都是较均匀的, 与新大陆猴不同。眼镜猴的指间垫嵴纹仍是简单的弓型纹, 狐猴是原始型花纹, 懒猴则是较小的斗型纹。从残留的三叉点痕迹和嵴线走向来看, 眼镜猴保留的是 IV 区桡近侧垫, 狐猴是 IV 区桡远侧垫, 懒猴 IV 区是尺近侧垫。其它区的保留都是一致的: I 区是尺近侧垫, II 区是尺远侧垫, III 区是桡远侧垫。

2.3 新大陆猴两侧发达中间退化的指间区纹

新大陆猴的指间区纹特点与原猴全然不同。靠侧的指间区发育程度高, 形成箕型或斗型纹, 中部的指间区则只有开放型的花纹。卷尾猴中发达的是 I、II 区纹, 而狨猴多为 I、IV 区纹。卷尾猴中的蜘蛛猴甚至第一指消失, 松鼠猴的第一指也不发达。松鼠猴指间 III 区仍有较小的箕型纹。狨猴指间 I、II 区虽都是开放纹, 但仍有明显界线, III 区纹往往是不典型的箕型纹。

2.4 旧大陆猴极发达的指间区纹

旧大陆猴的指间区纹是灵长类中最发达的。几乎全部种类各指间区都总有高级花纹。指间区纹至此进化到了一个顶峰。疣猴和猴类又有明显的区别。疣猴的花纹多是箕纹, III 区尺侧垫发育。而猴类的指间 II、III 区有极显眼的斗型纹, 这些斗型纹虽可分更细的类型并有不同的分布, 但几乎 100% 的个体都全部有斗型纹。这些斗型纹与类人猿的指间区纹是由不同的掌垫发育而来的。

2.5 类人猿极退化的指间区纹

长臂猿指间区不组成任何花纹, 是灵长类中最退化的类型。估计其祖先上新猿也是无纹类型。猩猩类指间区纹也非常退化, 猩猩 I、II 区有拉长的箕型纹; 黑猩猩 I、II 区有较小的箕型纹, III 区有时有近侧小箕型纹。这些箕型纹又不是每个个体都存在。所以旧大陆猴指间区纹未出现无纹基因, 而类人猿中则有大量无纹基因, 且有纹基因的显性地位也动摇了。

2.6 人类的痕迹指间区纹和次生的环指侧镶嵌纹

人类与其它灵长类同源的指间区纹比其它类人猿更为退化。只在指间 I、II 区极偶然地出现相当小的箕型纹, 位于三叉点上, 且可能都是不完全显性甚至是隐性的, 这些从灵长类传来的指间区纹已经走到了进化的末路, 只作为痕迹地存在。在人类环指侧产生了一种新的指间区纹。这是非人灵长类所没有的, 是一种次生的花纹。这种纹的多样类型和独特的镶嵌显性遗传已在原文^[1]有专门论述。

3 讨 论

3.1 树栖、地栖习性对指间区纹发育均匀性的影响

各种灵长类的指间区纹发育的均匀性与其树栖、地栖习性体现出较明显的相关性。树栖只是偶尔上树, 狐猴也树栖性不强(图 2), 所以各指间区纹都较均匀。而懒猴的指间区纹均匀性明显不如狐猴, 因其树栖。但由于懒猴不多运动, 所以又较新大陆猴均匀。新大陆猴

几乎完全树栖,且极好动(图 2),故出现两侧发达中部退化的极不均匀的指间区纹型。猴科的均匀性最强,而疣猴科不太均匀,因为疣猴科多树栖而猴科则地栖倾向较大。地栖需要掌面全面平整地着地,所以各区花纹发育均匀;树栖则抓握攀爬时多用手掌两侧夹持,故两侧花纹发达。这可能是这种相关性出现的原因。

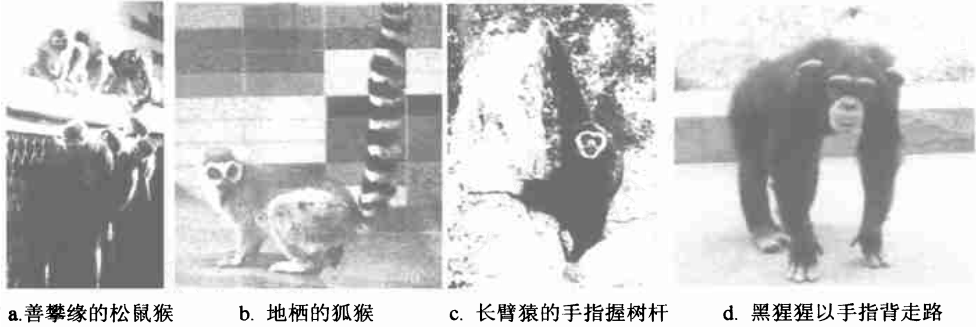


图 2 几种灵长动物的生活习性
Behaviors of several primates

3.2 类人猿指间区纹退化的原因

类人猿指间区纹退化的原因可能是指间区不接触物体。长臂猿攀缘时用的是前端的指节,指间区几乎完全不接触物体,从不使用,故而退化没有了花纹。猩猩科走路时指节背面对着地,只抓握物体时才用指间区,因而指间区纹也较退化。这一状态在腊玛猿中就可能出现了。因而人类虽然因为劳动而多用指间区,也改变不了这些花纹退化的趋势。

3.3 人类环指侧次生花纹的原因

类人猿退化的指间区纹对人类劳动的需要已经不适应,而次生的花纹则应运而生。这种花纹可能由其它指间区纹的基因突变而来。环指(第四指)根部是指掌交界处最常用的部位。人类拇指按手掌时总是按在该部位。抓握物品时,该部位也是对应拇指或大鱼际的受力中心(如图 3^[18])。因此该部位需要最大的摩擦力和最强的触觉,而人类在进化中产生了强壮的大鱼际肌肉,次生出了环指侧多样的镶嵌纹,以适应这一需要。

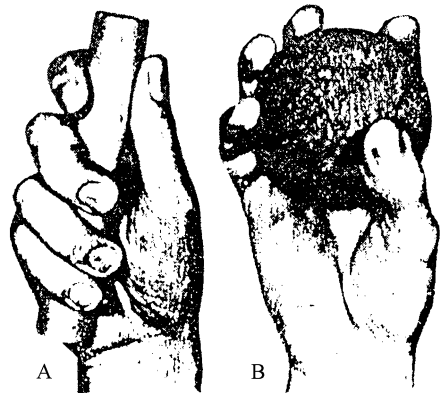


图 3 人手的两种握持方式
(环指根总在受力中心)
Two grips of human hand

3.4 各灵长类动物指间区纹的不同源性

树鼩的指间区有许多掌垫,以后的灵长类动物指间区纹由不同的掌垫发育而来,是不同源的。这暗示着各科灵长动物虽然可能有共同的祖先,但很早就分道扬镳。而各科中的种属可能较晚分离,如类人猿和人类。各科分化后在很长一段时间内可能并没有产生太大的区别。

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EVOLUTION OF INTERDIGITAL PATTERNS AMONG PRIMATES

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Abstract: As the interdigital patterns of primates are different from that of human being, the studies and the comparisons of them will result in the clarification of the course and factors of interdigital patterns evolution.

1 Origin of Interdigital Patterns

General opinion about how dermatoglyphy comes into being is that primates need to enhance the frictional force and sense of the palms and soles for tree-inhabiting lives. Interdigital pattern is one of the earliest dermatoglyphies. When interdigital patterns have just taken shape, those in different area did not contact each other. There were still large fur areas between dermatoglyphy areas. On palms of *Tupaia*, there are always 3 to 4 muscle pads, fairly close to each other, opposite to each finger, with simple arch patterns on each pad. Ridge trends are different from one pad to another. During latter primates' development, some of these pads expand, and others get narrowed. Neighboring pads contact each other. Dermatoglyphies are distributed all over the palm. There is a tripartite point left at the demarcation of each three pads. On the pads, appear more complicated patterns.

2 Evolutionary course of Interdigital Patterns

Commonly speaking, there is only one biggest pad in each interdigital area of those species higher to *Tupaia*. Analyzing the ridge trends and the positions of tripartite points, we find that primates have reserved different pads according to *Tupaia*, which suggests some big categories split up quite more earlier than we think. So the evolutionary pattern of primates is bush-like.

There are mainly 5 evolution branches out of *Tupaia*. *Tarsidae*. There is only one pad in each interdigital area, and fairly big space between pads. On the pads, there is only simple arch pattern.

Lemur and *Loisidae*, one pad in each area, too, small gap between pads. On the pads, equally develop out primitive pattern, loop or small whorl. New World monkey. Side interdigital areas are developed while central areas are retrograde. In *Cebidae* interdigital area II is a big whorl, and in area IV is a loop. In *Hapalidae* area I is a big whorl, area IV also loop. Interdigital areas have completely connected.

Old World monkey. The interdigital patterns of Old World monkey are the most developed. There are loops in different sizes in *Colobidae*. In *Macaca* area II, III and IV are all big obvious whorls. Human-like ape. Their interdigital patterns are quite retrograde. Gibbons have no interdigital patterns. Chimpanzees occasionally have some little loops. Humankind has developed out of ape. So the original interdigital patterns are also degenerate. But opposite to the third finger, appears a new various pattern.

3 Evolution Factors of Interdigital Patterns

Comparing the categories of primates, we find interdigital areas of tree-inhabiting primates developed rather unequally, while ground-inhabiting ones are on the contrary. Equality of interdigital patterns is directly proportional to the ground-inhabited tendency. It is possibly because palms of whom that is ground-inhabiting need to touch ground equally, but while living on tree, palms must press the branch from both sides. So interdigital areas of tree-inhabiting primates are side developed and central retrograde. Pattern intensity is also directly proportional to the rate of utilization. This is reflected very well in human-like apes. Gibbons use fingers to seize hold branches, and seldom use interdigital area (so that to be nimble when seize or release). Then there are no patterns in their interdigital areas. When chimpanzees are walking, they let fingers back to touch ground. Only when they hold something occasionally, they will use interdigital patterns. So their interdigital patterns are very degenerate. Only few individuals have small loop in their interdigital areas.

Interdigital patterns of humankind, corresponding to those of human-like apes, are also very degenerate. They are all imperfectible dominant or recessive small loops. It does not fit the high frequency and intensive use of interdigital areas when we are laboring. So the force focus of human palm when seizing something, opposite to the third finger, appears a new pattern. This kind of new pattern is various and inheriting distinctively.

Key words: Interdigital patterns; Primates; Evolution