

Polydactyly and Related Traits

by Solveig Pflueger, MD, PhD, FACMG

Editor's Note: The following article is included for genetic educational purposes only. The author does not advocate the breeding of cats with radial hypoplasia.

Most cats are born with 18 toes, five on each of the front feet and four on the back. The pollex, or thumb, is smaller than the other digits and is sometimes referred to as a dew claw, especially in dogs. This additional digit is usually absent from the hind feet, hence the lesser number of toes on the rear. However, cats with greater and fewer numbers of toes also exist.

In the scientific literature, the term polydactyly (poly meaning many and dactyl referring to digits) is often used to refer to extra digits. Oligodactyly is the term used when fewer than the usual digits are present. Both conditions have been reported in a variety of mammalian species. In New England it is not uncommon to see cats with extra toes in the household pet classes. Although considered a disqualification in championship competition and not usually bred by cat fanciers (the one exception is the TICA-recognized Pixie-Bob), pet owners tend to find such unusual cats attractive and when a litter is born which includes several big-footed, many-toed kittens, these are often the first ones adopted.

Polydactyly in mammals is classified by embryologists as either pre-axial or post-axial. Axial refers to the folding of the embryonic limb. The thumb side is before the axis, or pre-axial, while the little finger is considered post-axial. When polydactyly is seen in the human, it is usually post-axial. In

other words there is an extra little finger, and there is a dominant gene for polydactyly which is relatively common, especially in, but not limited to, black families.

Most polydactyl cats, on the other hand, have a form of pre-axial polydactyly with the extra digit(s) on the thumb side of the foot instead.

The embryonic hand or paw is paddle like. Separate digits arise as a result of programmed death (apoptosis) of the unneeded cells found in the space between those that will differentiate into the digits. Incomplete apoptosis will result in fusion of digits, or syndactyly.

The form of polydactyly most often seen in cats is the result of a simple autosomal dominant trait. It does not appear to affect the cat adversely and is not known to be associated with other anomalies. Although some owners may argue that the big feet of the polydactyl enable the cat to walk better on the surface of snow, a snowshoe effect, and thus, may enhance survival in New England winters, there is no real evidence that polydactyly has any significant natural selective advantage or disadvantage. However, there may be an element of artificial selection based on people's preferences for unique and unusual cats, a preference that has served to maintain the polydactyly trait in the domestic cat population.

The usual form of feline polydactyly results in duplication of the pollex and it is not unusual to find as many as three digits instead of the usual one, the result resembling almost a second foot. On the back feet, there may be extra toes as well, sometimes resembling normal digits but sometimes also with

a dew claw-like structure higher on the foot. These extra digits do not appear to hamper movement or function and there is no evidence of adverse effects in the homozygote.

However, formation of the embryonic foot is a complex process from the standpoint of the number of processes involved and so it should not be surprising that more than one genetic mutation might lead to extra digits. There have been a number of human conditions associated with polydactyly and it should not be unexpected that more than one form of polydactyly might exist in the cat as well.

There is evidence for a second dominant polydactyly trait in cats which results in different morphology from the usual polydactyly and which has effects extending beyond the foot itself. With this trait the pollex has an extra joint, giving an appearance more like a human finger than the usual rudimentary feline dew claw. This triphalangeal thumb may be duplicated and sometimes the next digit is as well.

Extra digits are usually present on the hind feet, where they may resemble the usual polydactyly. On occasion a rear dew claw is noted.

Although the polydactyly itself is not a problem for the cat, the gene appears to have a second manifestation that affects limb development more adversely. A cat with triphalangeal pollices can produce kittens with hypoplasia (underdevelopment) or aplasia (absence) of the radius, one of the two bones which make up the forearm.

When this occurs, the pollex itself is usually absent as well. The cat may indeed have five toes on the front feet, but these digits will have the appearance of the other toes, not the pollex. The inside of the leg is smooth without evidence of even a vestigial dew claw.

If the radius is absent or markedly smaller than expected, the limb will be foreshortened and will fold inward at the elbow and wrist, often at a 90° angle. The wrist and elbow usually have two forearm bones contributing to formation of these joints. With only one supporting bone, the joint bends toward the missing element. Because of this, the paw pad may deviate inward rather than toward the floor, which makes the limb appear twisted.

The hind limbs are not usually involved and most affected cats are able to ambulate despite their unusual appearance. Splinting of the affected limbs during kittenhood can improve appearance and function and appears to have been noticeably beneficial in two cases known to the author.

This triphalangeal pollex-radial hypoplasia trait is the most likely explanation for the Twisty Cats described in the November 27, 1998 issue of the *Wall Street Journal*. The owners of these cats had been working with polydactyl cats and had unwittingly used a cat with this second polydactyly trait, subsequently producing kittens with radial hypoplasia as well as with polydactyly. Despite their unusual appearance,

the affected cats appear to be healthy. Even so, it is not desirable to deliberately breed cats that have radical hypoplasia.

Although the majority of polydactyl cats have the usual form which results only in extra digits and which does not compromise normal feline movement, cats with the triphalangeal pollex-radial hypoplasia form of polydactyly are not as rare as one might initially suspect. The author has a polydactyl female from Albuquerque who has elongated thumbs and who has produced kittens with radial hypoplasia in litters with two different unrelated males. Her mother was also polydactyl.

Other cats with polydactyly and radial hypoplasia have been found in New York, Massachusetts, Indiana, and California and one occasionally sees polydactyl cats with triphalangeal thumbs in household pet classes in other parts of the country, suggesting that other populations at risk for radial hypoplasia also exist.

The fact that more than one form of polydactyly appears to be present in the cat should serve as a caution for breeders who wish to work with polydactyl cats. Special care should be taken in selecting breeding stock and cats with triphalangeal thumbs should probably be avoided as foundation cats.

The one breed that allows polydactyl cats for competition, the Pixie-Bob, appears to have been fortunate in this regard. The polydactyl gene that contributes so much to the unique look of this breed appears to be a benign trait without effects beyond the extra toes. However, Pixie-Bob breeders who wish to outcross to augment their gene pool should be very careful to avoid incorporating cats that might also produce radial hypoplasia in subsequent generations.

Note: Although closely related individuals, some with increased and some with decreased numbers of digits as a result of the same dominant gene, may seem surprising, this phenomenon is not limited to the cat. Similar traits have been seen in other species as well. In fact, several conditions associated with triphalangeal thumb and radial hypoplasia have been reported in humans. ♣

Solveig Phlueger is a medical doctor, certified by the American Board of Medical Genetics in clinical laboratory genetics and perinatal pathology. She is the Director of Medical Genetics at Baystate Medical Center and an Assistant Professor of Obstetrics and Gynecology at the Tufts School of Medicine. She researches the causes of human pregnancy failure. Solveig has been breeding under the cattery name of Manawyddan since 1969. She has worked with several breeds and currently breeds Munchkins and Ojos Azules, both for show and to study their unique characteristics. She is a TICA Allbreed judge, Chairman of Genetics Committee of TICA and an officer in three local clubs. She lives with her husband and two children in West Suffield Connecticut.

Smiley Cats on the Internet

=^..^= Content Cat >^..^< Happy Cat =^..^< Sleepy cat =^!!^= Mad Cat
(^..^)- Playful Cat {^..^}- Fluffy Cat >^..^< Hungry Cat