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The histological structure of hairs of the giant panda, *Ailuropoda melanoleuca* (DAVID, 1869), and the lesser panda, *Ailurus fulgens* (F. CUVIER, 1825), and the systematic position of these species

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Abstract. This paper presents a study of the histological structure of hairs of the giant panda, *Ailuropoda melanoleuca* (DAVID, 1869), and the lesser panda, *Ailurus fulgens* (F. CUVIER, 1825), documented with photomicrographs taken in a scanning microscope (structure of hair cuticle) and in a light microscope (structure of hair medulla). The structure of hairs, especially the cuticular scale pattern, indicates the similarity of the giant panda to the *Ursidae* and the lesser panda to the *Procyonidae*.

Key words: hair, histological structure, *Ailuropoda melanoleuca*, *Ailurus fulgens*.

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I. INTRODUCTION

The systematic position of the giant panda, *Ailuropoda melanoleuca* (DAVID, 1869), is controversial. At first it was included together with the lesser panda, *Ailurus fulgens* (F. CUVIER, 1824), in the family *Procyonidae* (GREGORY 1936, MORRIS 1965). Recently, it has been more and more often recognized as a member of the family *Ursidae* (HENDEY 1980, O'BRIEN et al. 1985, WANG et al. 1988). According to some authors (CHU 1974, SCHALLER et al. 1985), the problem of the systematic status of the giant panda is still open. SCHALLER et al. (1985) and GINSBURG (1982) are doubtful also about the systematic position of the lesser panda, *Ailurus fulgens* (F. CUVIER, 1825). The substantial literature dealing with both pandas contains no study on the structure of hairs, which, as has been

pointed out many a time, may be of taxonomic importance (DZIURDZIK 1973, 1978b, KELLER 1981).

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II. MATERIAL AND METHOD

Hairs of the giant panda were investigated on the material obtained from the Zoological Garden in Pyongyang, North Korea. The hairs of the lesser panda came from the individuals born in freedom in Szechwan in China in 1983 and were taken in Warsaw Zoological Garden. Ten guard hairs and ten fine hairs of either panda species were examined by the method presented by DAY (1966) and applied with certain modifications by DZIURDZIK (1973, 1978b). A light microscope was used to study the medulla structure and a scanning microscope for the hair surface (cuticular scale pattern) and cross sections.

The photomicrographs of hair medullae were prepared from sections under the light microscope at a magnification of 200x, whereas the hair cuticle structure and cross sections were photographed in the scanning microscope at magnifications 200x, and 640x. The photomicrographs of hairs of the bear and racoon were from DEBROT's (1982) paper.

III. HAIR STRUCTURE

Giant panda, *Ailuropoda melanoleuca* (DAVID, 1869)

Fig. 1, 2, 3, 4a

Two types of hairs were found present in the sample under study:

1. guard hairs, 8.0-8.5 cm long, 0.26 mm thick (in the broadest place),

2. fine hairs, 7.5-8.0 cm long, 0.19 mm thick, unpigmented, wavy.

The cuticular scales of both types of hairs form a mosaic pattern, composed of fine waves; it is more distinct on guard hairs (Fig. 1.a-f, Fig. 2. a-d).

The hair medulla appears above the shield. It is heavily pigmented, of a poorly seen structure and sometimes fragmentary. It is a ladder-type medulla (Fig. 3.a-e).

The cross-section of hairs is oval (Fig. 4.a), that of fine hairs round.

Lesser panda, *Ailurus fulgens* (F. CUVIER, 1825)

Fig. 5a-i

Three types of hairs occur in the pelage of the lesser panda:

1. guard hairs, the longest, 5.6 cm long, 0.30 mm thick, strongly pigmented, almost black;

2. coarse hairs, brown, slightly wavy, 4 cm long, 0.27 mm thick;

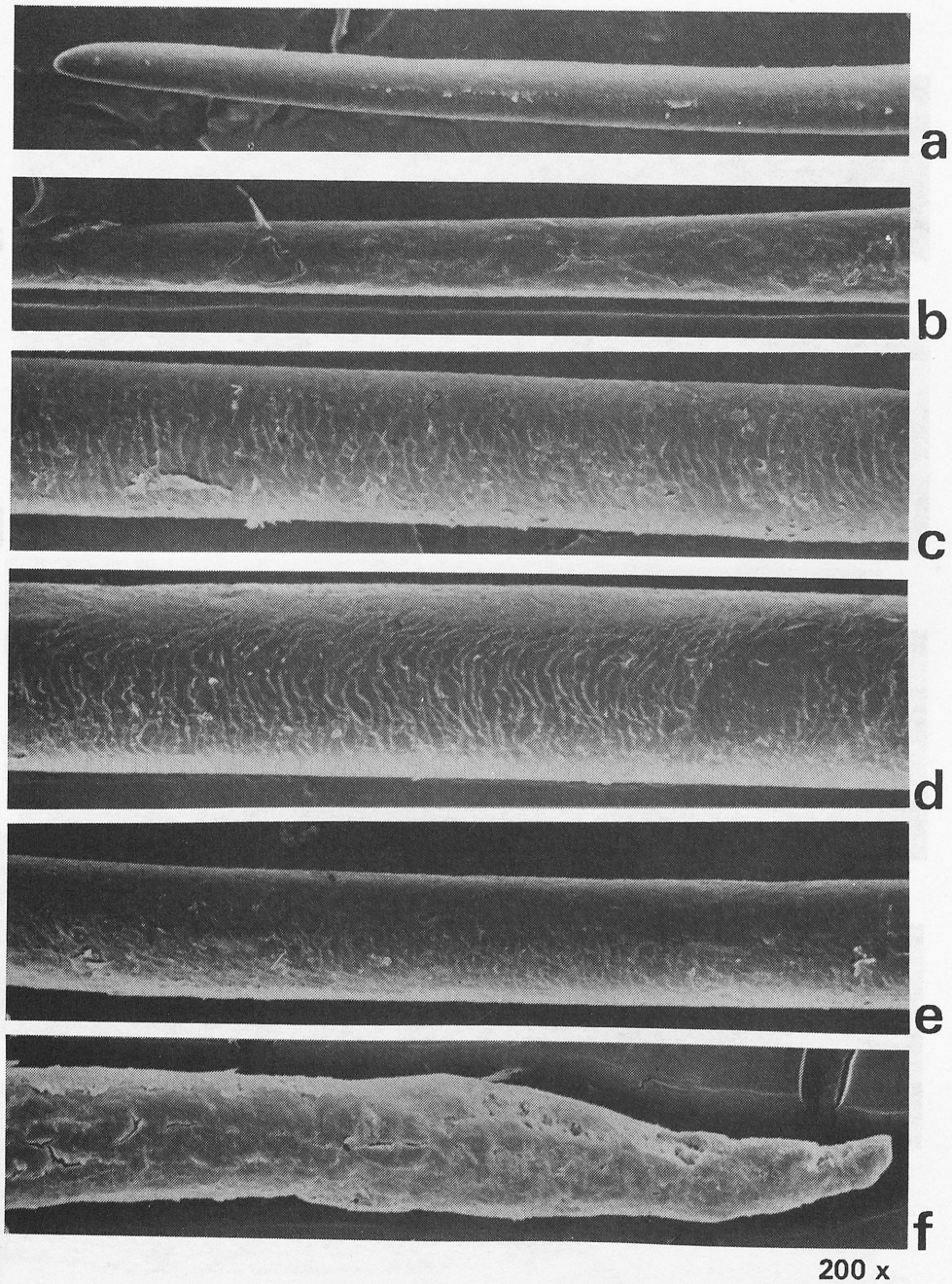


Fig. 1. Mosaic pattern of cuticular scales on a guard hair of the giant panda, *Ailuropoda melanoleuca*: a - hair tip, b - fragment of hair below the tip, c - fragment of hair above the shield, d - shield, e - fragment of hair below the shield, f - hair bulb.

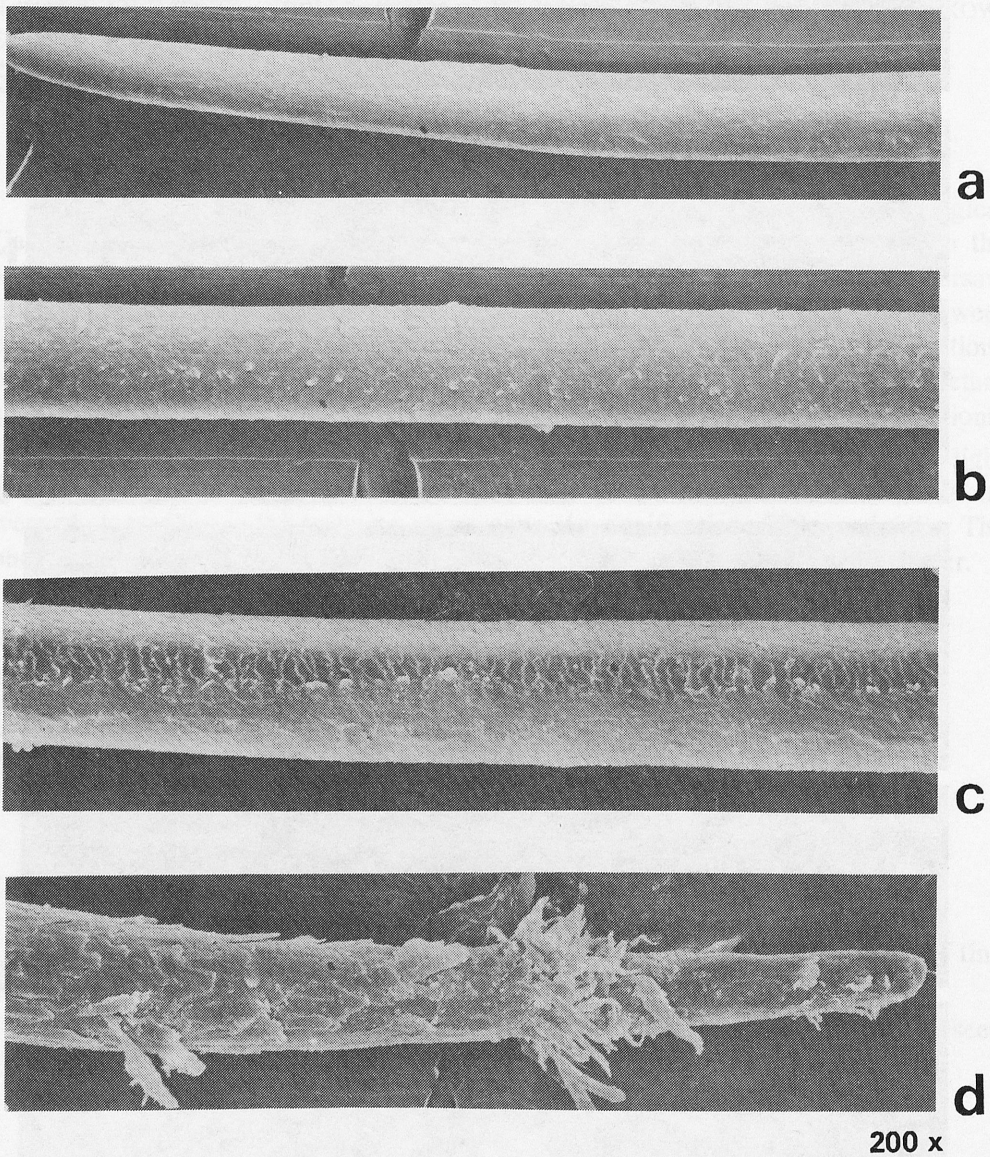


Fig. 2. Mosaic pattern of cuticle on a fine hair of the giant panda, *Ailuropoda melanoleuca*: a - hair typ, b - below the tip, c - hair shield, d - hair bulb.

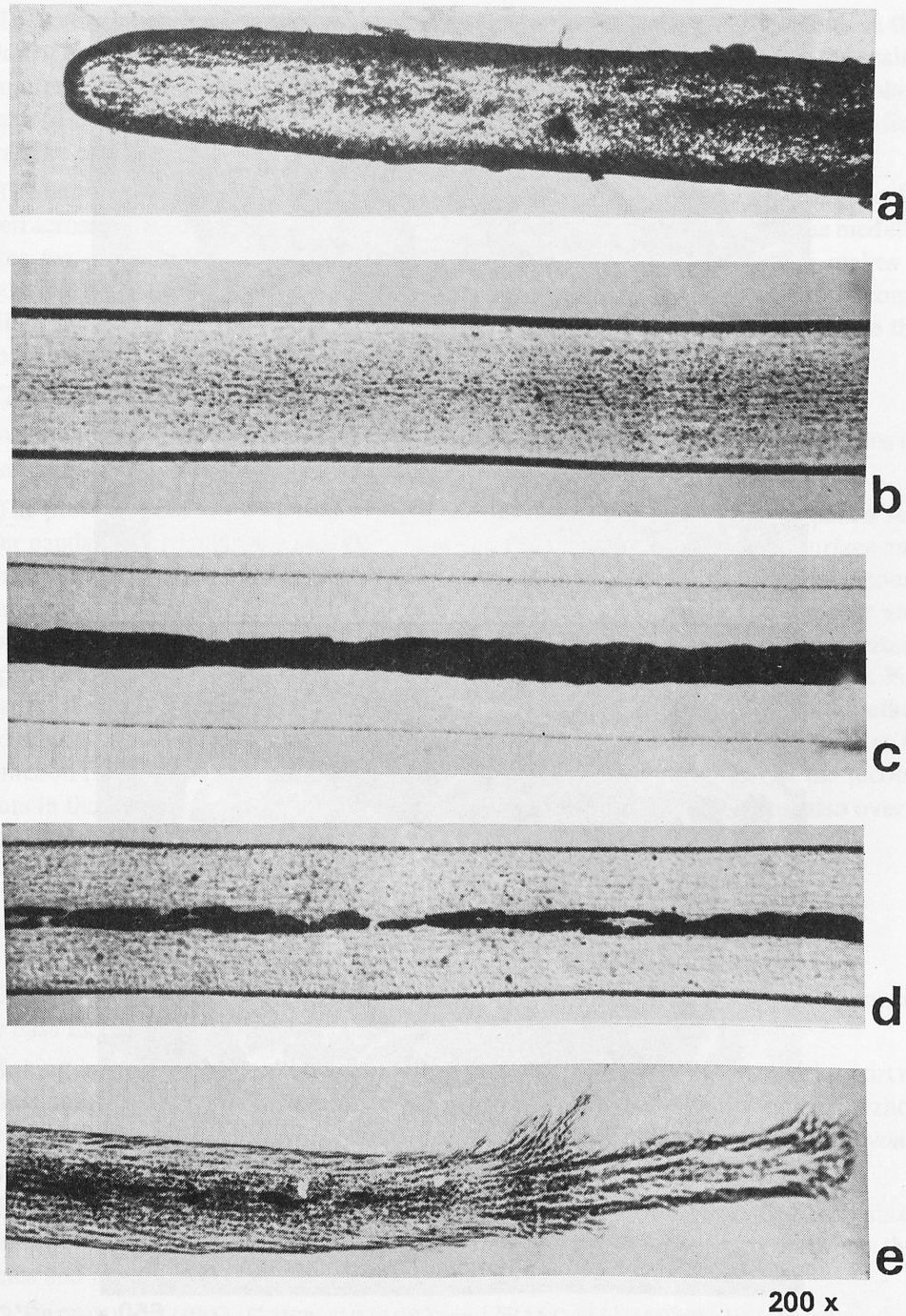
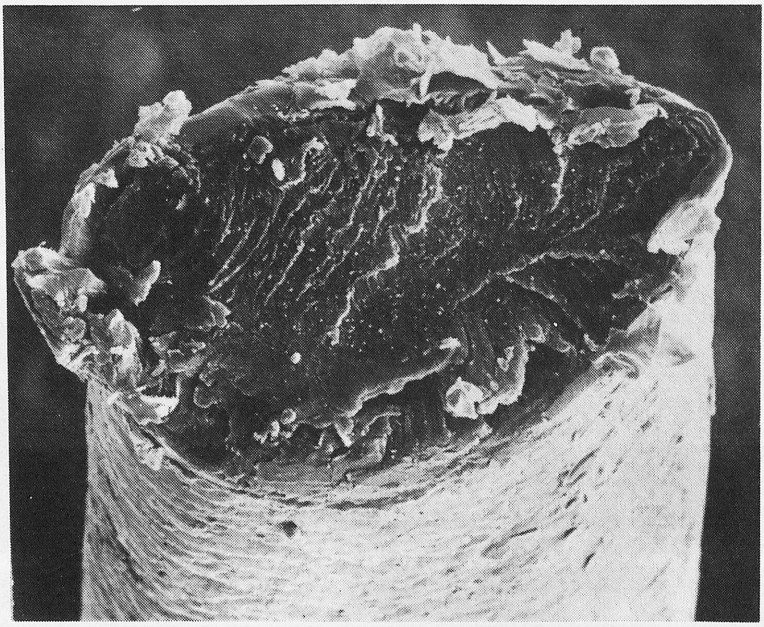


Fig. 3. The structure of guard hair medulla in the giant panda: a - tip, b - fragment of hair above the shield, no medulla, c, d - hair medulla visible, e - hair bulb.



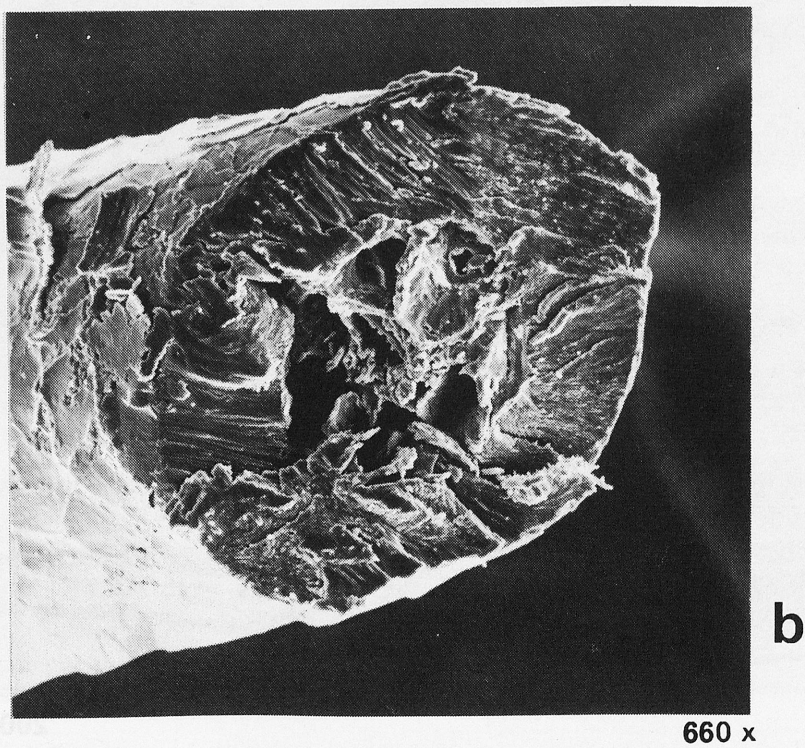


Fig. 4. Cross-section of a guard hair: a - giant panda, b - lesser panda.

3. fine hairs, white, wavy, 3-5 cm long, 0.2 mm thick.

The cuticular scale pattern of guard hairs is mosaic and shows very fine waves in the region of the hair tip and that adjoining the bulb, while in the part called "shield" the scales form a reversed pectinate pattern, which in places merges into a composed lanceolate pattern (4-5 scales across the hair). A similar situation was observed on a coarse and fine hairs. The change in the cuticular scale pattern along the hair is shown in Fig. 5.a-i.

The hair medulla appears close bellow the tip as a ladder medulla, built of single cells (1 cell across the medulla). The cells increase in height and in the shield region the medulla makes two-thirds of the hair thickness: it is very heavily pigmented, which makes it impossible to examine its structure exactly. In the part adjoining the bulb the cells become smaller, the medulla narrows again and its ladder structure becomes visible. Above the bulb the medulla becomes fragmentary.

The cross-sections of hairs are round and oval.

All the types of hairs were examined in both panda species, but only the structures of guard hairs, mainly the cuticular scale patterns, are of taxonomic significance.

The present observations on the histological structure of hairs of the giant panda and lesser panda, in particular, the analysis of cuticular scale patterns on the hair surface and their comparison with the corresponding structures on hairs of the brown bear and racoon, point clearly at a similarity in hair structure between the giant panda and the bear and between the lesser panda and the racoon. The hairs of the giant panda show certain simplifications in the cuticular scale patterns in comparison with those of the bear. For instance, there was no diamond petal pattern in the giant panda (Fig. 6.c). On the other hand, the cuticular scale pattern on the hairs of the lesser panda was nearly the same as in the racoon (cf. Figs. 5. and 6.d-f). The reversed pectinate pattern typical of the racoon occurs in the lesser panda in its classical form not only on the hair shield but also over a long section of the hair below the shield.

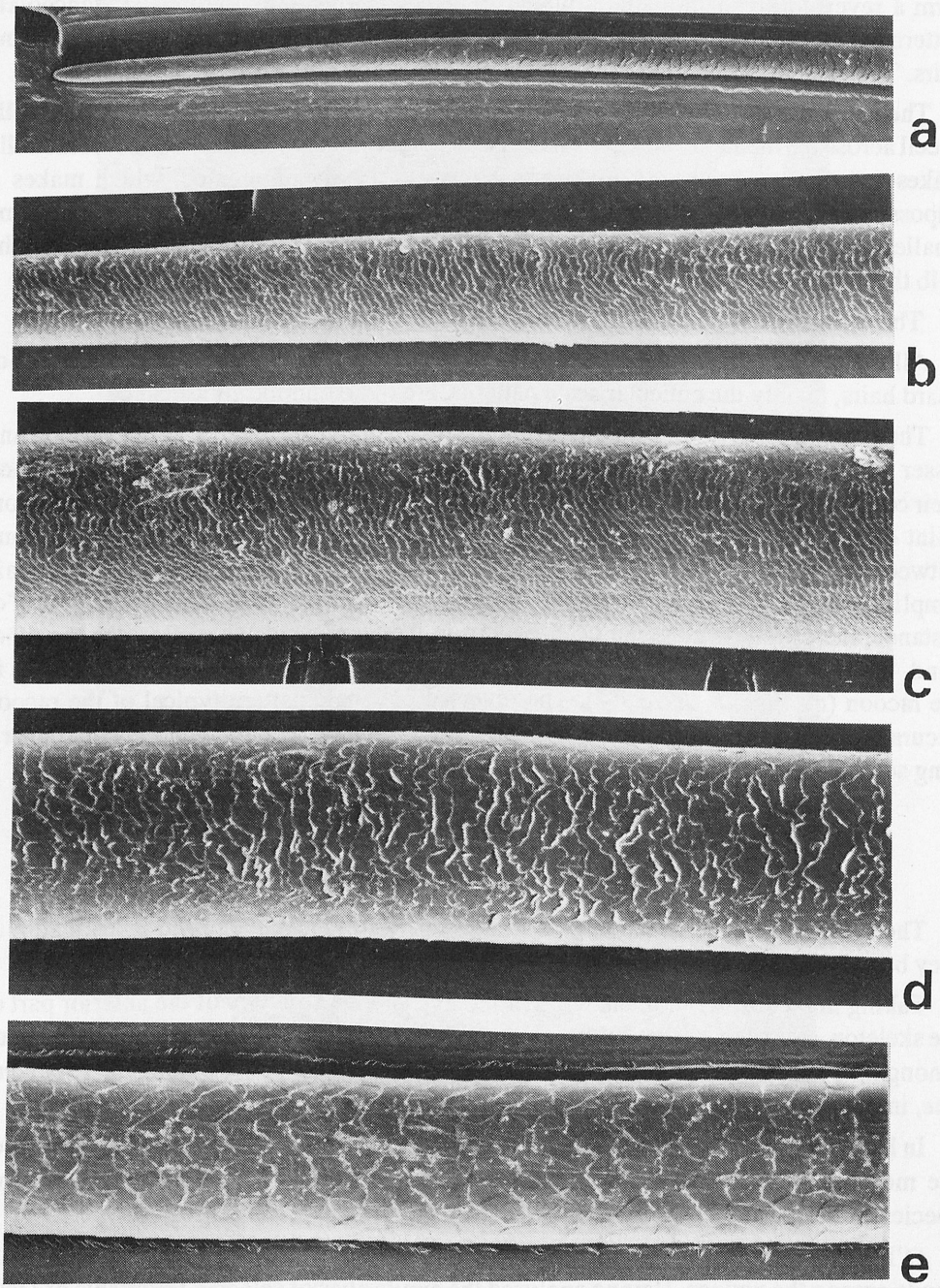
DISCUSSION

The systematic position of the giant panda varies from investigator to investigator, as they base themselves on different characters of this species.

Taking into consideration the ways of feeding and the structure of the anterior part of the skeleton, skull and teeth resulting from it, GREGORY (1936) numbered the giant panda among the *Procyonidae*. MORRIS (1965) also placed the giant panda among the *Procyonidae*, in the subfamily *Ailurinae*.

In his monograph of the giant panda DAVIS (1964) states on the basis of an analysis of the morphological and anatomic features that there is a great similarity between this species and the members of the family *Ursidae*, referring it to this last family.

O'BRIEN et al. (1985), GINSBURG (1982) and WANG et al. (1988) also place the giant panda among the ursines. Having analysed the similarities of selected fragments of DNA (DNA hybridization), O'BRIEN et al. (1985) erected a new subfamily, *Ailuropodinae*,


a
b
c
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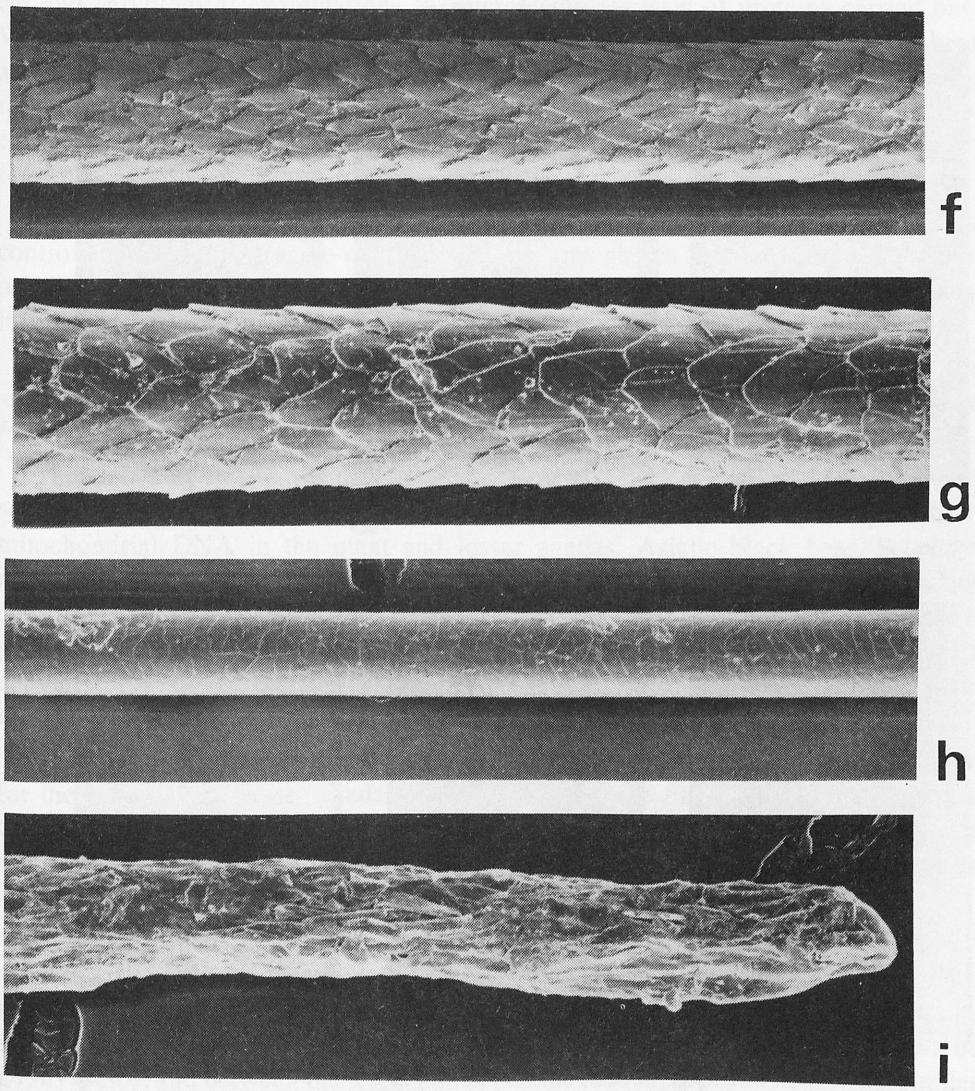

Fig. 5. Variation in cuticular scale pattern along a guard hair of the lesser panda, *Ailurus fulgens*: a - tip, b - below the tip, c,d,e - hair shield, f - below the shield, lanceolate pattern, g - reversed pectinate pattern, h - hair fragment above the bulb, mosaic pattern, i - bulb.

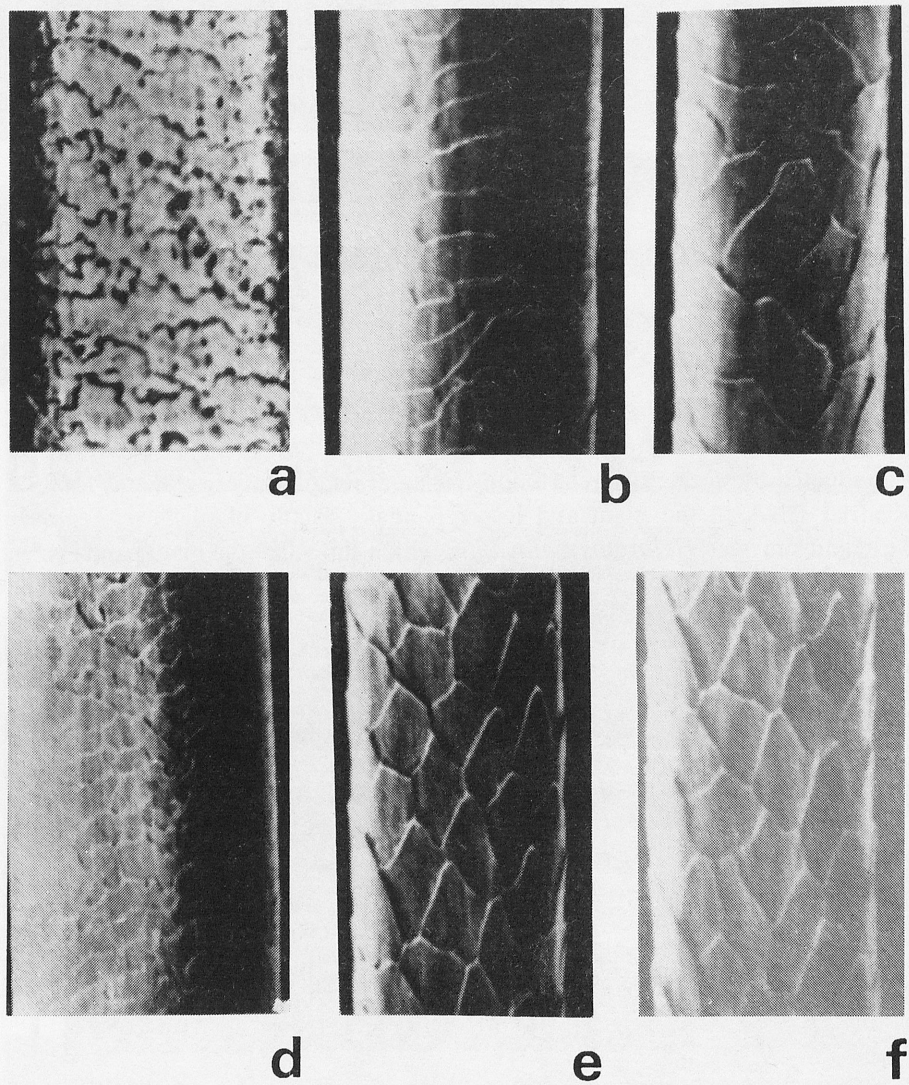

Fig. 6. a,b,c - cuticular scale patterns on a guard hair of the bear, *Ursus arctos*, from DEBROT (1982), d, e, f - cuticular scale patterns on a guard hair of the racoon, *Procyon lotor*, from DEBROT (1982).

within the family *Ursidae* for the giant panda. O'BRIEN claims that the giant panda stands closer to the bear than to any other genus, which has been confirmed also by other methods, more classical and reliable than DNA hybridization, i.e. by electrophoretic, immunological and caryological examinations. A microelectrophoresis of proteins carried out by WANG et al. (1988) also suggests the closest relationship of the giant panda to the bear of all the *Carnivora* examined in this respect. CHORN and HOFFMAN (1978) hold the opinion that the giant panda belongs to the subfamily *Agrotheriinae*, commonly thought to be extinct. WANG TSIANG-KE (1974) and THENIUS (1979) include the giant panda in the family *Ailuropodidae* related to the *Ursidae*.

CHU (1974) thinks that although the systematic position of the giant panda is still controversial, "the aggregate of biological features shows that the giant panda should occupy a special position in the *Arctoidea* and should be placed in a monotypic family of its own, *Ailuropodidae*".

On the other hand, SCHALLER et al. (1985) arrived at the conclusion that the two pandas are very similar to each other and differ to an equal degree from both the *Ursidae* and *Procyonidae*. Therefore, they propose to erect a separate family for them.

The similarity of the two pandas is also indicated by YA-PING and LI-MING (1991) studies conducted by the RFLP (restriction-fragment length polymorphism) method on mitochondrial DNA in the giant and lesser pandas, Asiatic black bear, *Selenarctos thibetanus*, and sun bear, *Helarctos malayanus*, which show that the giant panda is "more closely related to the lesser panda than to the bears". Their results indicate that "the two pandas are closely related on mitochondrial DNA RFLP, but it may not be the result of convergent evolution. So, it is certainly a fascinating evolutionary problem to determine the cause of these similarities".

The controversy on systematic position concerns, for the most part, the giant panda, for the status of the lesser panda, numbered among the *Procyonidae*, is not generally questioned, though, e.g. GINSBURG (1982) puts forward his view that the lesser panda is more closely related to the *Ursidae* than to the *Procyonidae*, in which family it has been included.

Examinations of the structure of hairs carried out in the present study show big differences in it between the giant panda and the lesser panda. These differences take place mainly in the structure and shape of cuticular scales on guard hairs. At the same time a great similarity was found in hair structure between the giant panda and the brown bear, *Ursus arctos*, and between the lesser panda and the racoon, *Procyon lotor*. This similarity of hair structure may indicate the affinity of these species, and so the membership of the giant panda in the family *Ursidae* and the lesser panda in the family *Procyonidae*.

Despite this, and the fact that many authors who in their investigations used both classical methods based on anatomy and morphology and modern biochemical and genetic methods are inclined to include the giant panda in the family *Ursidae*, the problem is still questionable.

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