CHAPTER I

INTRODUCTION

Literature review

Hair is the integumentary structure that covers almost the entire body of mammals (Frandson, 1981). It has protective,sensory and important thermoregulatory function (Benedict, 1957 ; Homan & Genoways, 1978). Several workers have studied the morphological structures of mammalian hair. Many characters of hair have taxonomic value which can used as a tool for identification (Hausmam, 1920 ; Mathiak, 1938 ; Mayer, 1952 ; Benedict, 1957 ; Appleyard, 1960 ; Spence, 1963 ;Adorjan & Kolenosky, 1969 ; Howden, 1973 ; Brunner & Coman, 1974 ; Hepworth, 1974 ; Short, 1978 ; Kondo , Araki and Ohsuqi, 1985 ; Brain, 1987). In mammals, the main morphological characters including shape, length of filament and width of the shafts,type of medulla, pigment distribution and cuticular scale pattern are used as the determinative characters for identification.

Hair structures

The internal structure of hair are consist of three layers of keratin material : the central core or medulla, a layer of cortex surrounding the medulla, and the outermost layer called the cuticle or scale layers (figure 1). All three layers are composed of dead cells (Benedict, 1957 ; Brunner & Coman, 1974 ; Hepworth, 1974).

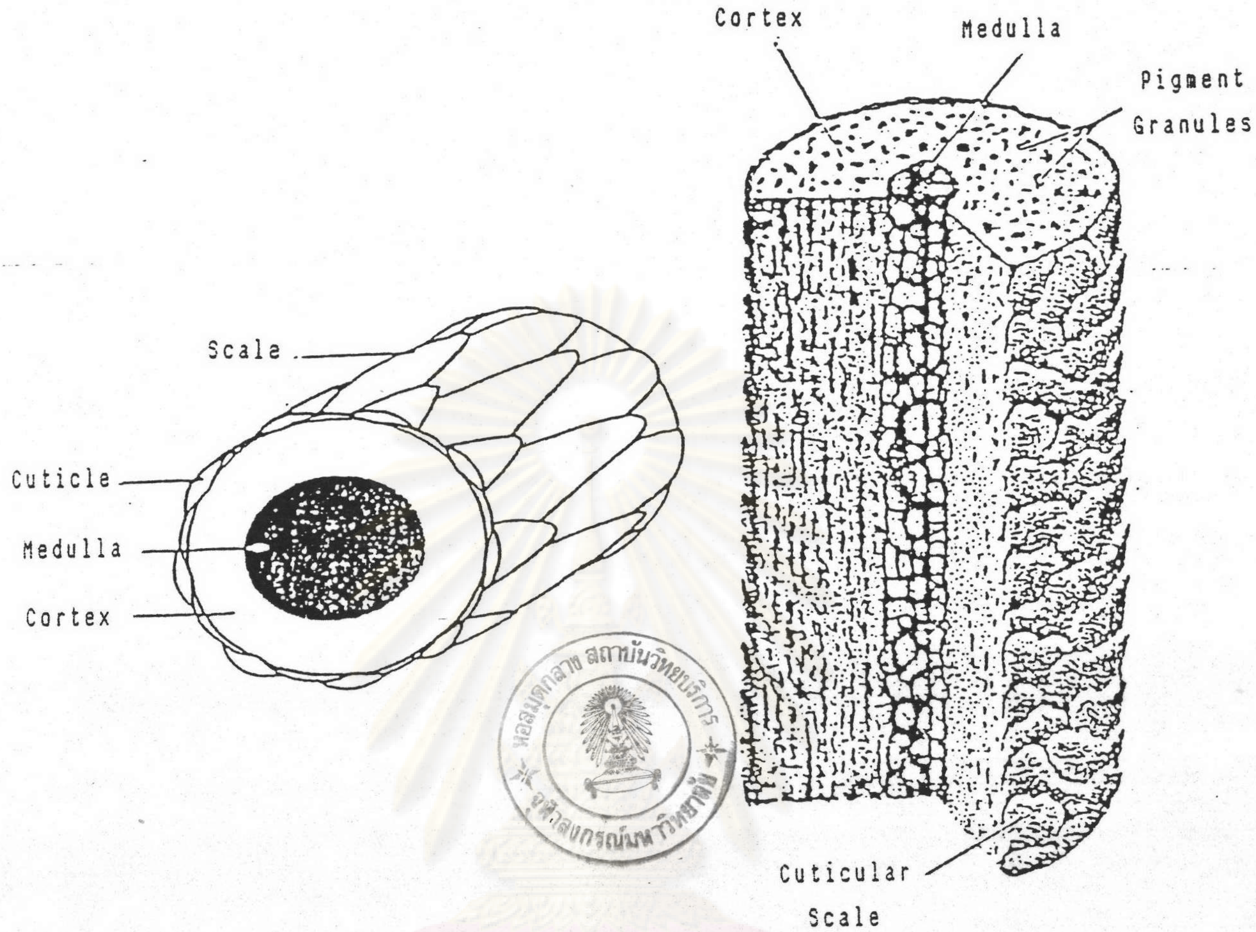

Figure 1 Diagrams of internal structure of hair.
(after Brunner & Coman, 1974, and Hepworth, 1974)

1. <u>The inner layer</u>, medulla

The medulla is composed of shrunken, loosely arranged of dead cells of irregular shape , together with their component air spaces or vacuoles (Benedict, 1957). Air spaces appear as obvious dark areas under the light microscope. These dark spaces can obscure the actual structure of the medulla (Brunner & Coman, 1974). The pattern and arrangement of both air spaces and medullary material are defined by Brunner & Coman (1974), into four main types as follow :

1.1 *Unbroken medullae*

These types consist of a continuous central axis of a regular or irregular diameter which can range from narrow to very wide medullary area. Several types are classified :

1.1.1 *Medulla lattice* The shrunken medullary cells form a network or lattice and enclose air spaces of various shape. It may be classified as narrow (figure 2A) or wide (figure 2B) medulla lattice.

1.1.2 *Aeriform lattice* The air spaces appear as a network or lattice , enclosing aggregations of shrunken medullary cell. The aeriform lattice may be classified as narrow (figure 2C) or wide (figure 2D). In many mammals , the lattice type medullae are found only in the wider parts of hairs.

1.1.3 *Simple* The medulla area has no obvious medullary structure , it may be relatively narrow or wide along the column of the fiber (figure 2E). Hairs with a simple medulla are found in association with hairs having a lattice type of medulla. It should be pointed out that damaged hairs (e.g. from faecal samples) often show an apparent simple medulla due to the destruction of medullary networks by the digestive processes.

1.2 *Broken medullae*

The medulla is not continuous along the length of the hair, but is interrupted by sections of cortical material. Two types may be recognized :

1.2.1 *Interrupted* Short sections of cortical material interrupt the medullary column along its length (figure 2F).

1.2.2 *Fragmental* Long sections of cortical material interrupt the medullary column along its length (figure 2G).

1.3 *Ladder medullae*

These medullae have one or more rows of air spaces. Two types can be classified :

1.3.1 *Uniserial ladder* The medulla has a single row of air spaces and these can be angular, rounded, flattened or cup-shaped (figure 2H).

1.3.2 *Multiserial ladder* The medulla has two or more rows of uniform air spaces (figure 2I.)

1.4 *Miscellaneous medullae*

These are generally uncommon medulla. The following types may be recognized.

1.4.1 *Globular* This type has an aggregation of globular air spaces (figure 2J).

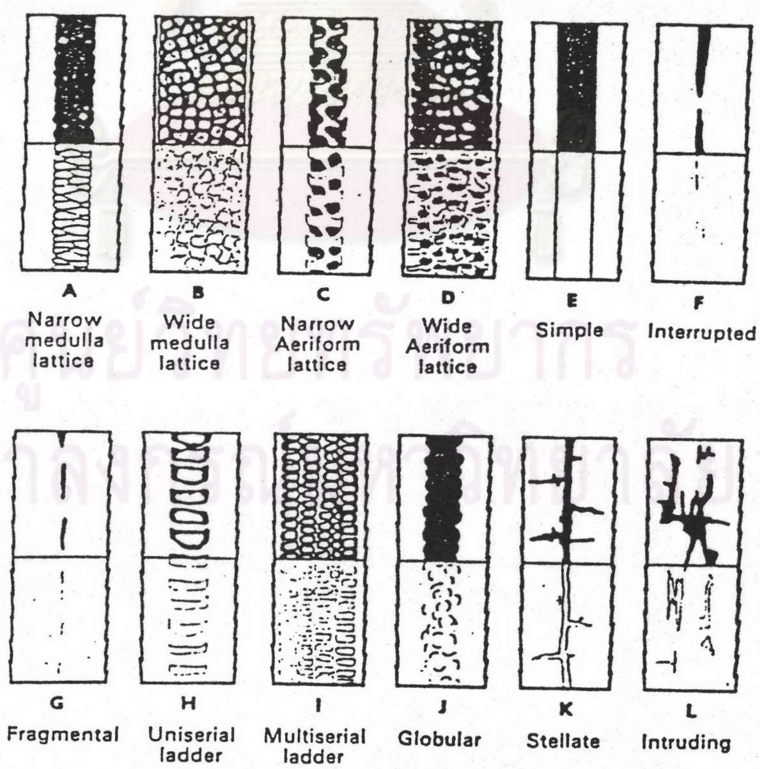

Figure 2 Diagram of medulla types.

(after Brunner & Coman, 1974)

1.4.2 *Stellate* This type has finger-like projections radiating out into the cortex (figure 2K).

1.4.3 *Intruding* This type has narrow and irregular placed air spaces projecting into the cortex. The spaces may project in several directions and are not necessary found in the center of the hair (figure 2L).

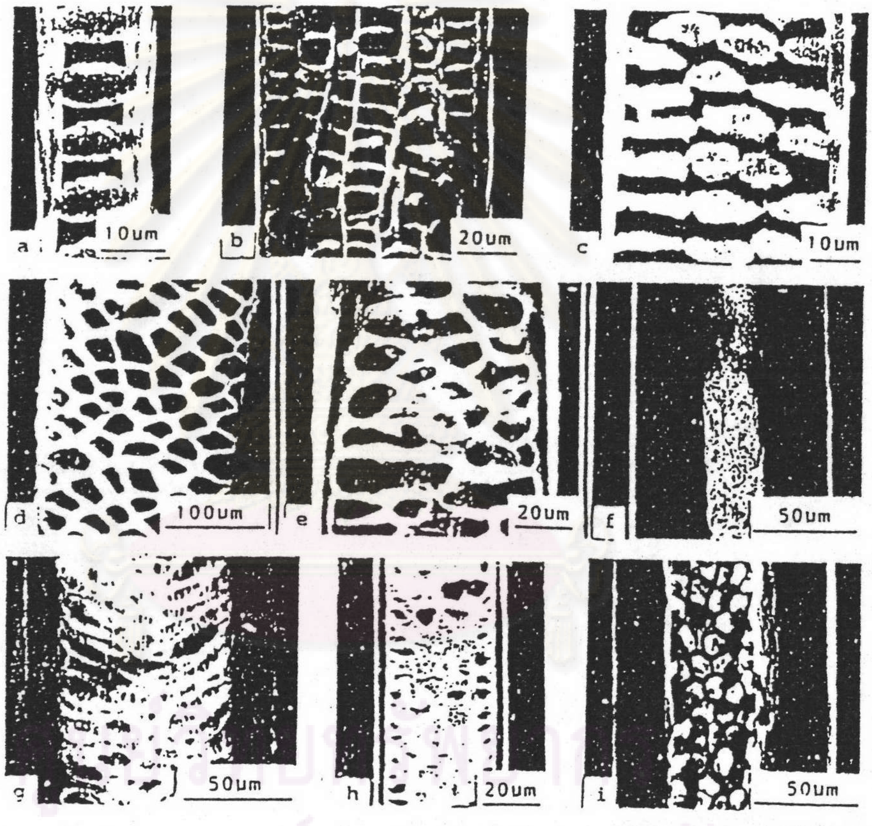

Figure 3 Photomicrographs of medulla types.

(a) ladder type-A, (b) ladder type-B,

(c) ladder type-C, (d) lattice type-A,

(e) lattice type-B, (f) Network type-A,

(g) Network type-B, (h) Network type-C,

(i) Reversed latice type

(after Kondo, et al., 1985)

After the development of the scanning electron microscope , Kondo, et al. (1985), has revealed on the basis of the wall shape bounding the air spaces, that the morphological structures of the medulla in various mammalian hairs can be classified into nine different types (figure 3), while only three types can be identified in light microscope. Simple unbroken type from light microscopy were classified into three types with SEM, i.e. Net work type-A,B and C. It was also shown that the guard hairs of animals belonging to the same family share the same medulla type. The presence of medullary cells has been used to distinguish various kinds of hair (Benedict, 1957 ; Brunner & Coman, 1974 ; Day, 1966 ; Hausman, 1920 ; Hepworth , 1974 ; Homan & Genoways, 1978 ; Kondo ,et al., 1985).

2. The middle layer, cortex

The cortex, the middle layer of hair shaft, is composed of fusiform or spindle-shaped cells, which interdigitate with each other along the long axis of the shaft (Homan & Genoways, 1978). The cortex cells are usually not visible under the light microscope since they are packed into a rigid and almost homogenous hyalin mass (Hausman, 1932 ; Brunner & Coman , 1974). Due to a high degree of cornification, the cortex has a low refractive index and, in the absence of pigment, is translucent. Because the cortex lacks discernible structure, under the light microscope,it is of little value for identification purposes. However, in those hairs where the cortex is pigmented, the size and arrangement of pigment granules may be an important diagnostic criterion (Benedict, 1957 ; Brunner & Coman, 1974 ; Mathiak, 1938). Very often, the ratio of cortex width to medulla width (shown in cross-section) can be of use in the identification process (Brunner & Coman, 1974) (figure 4).

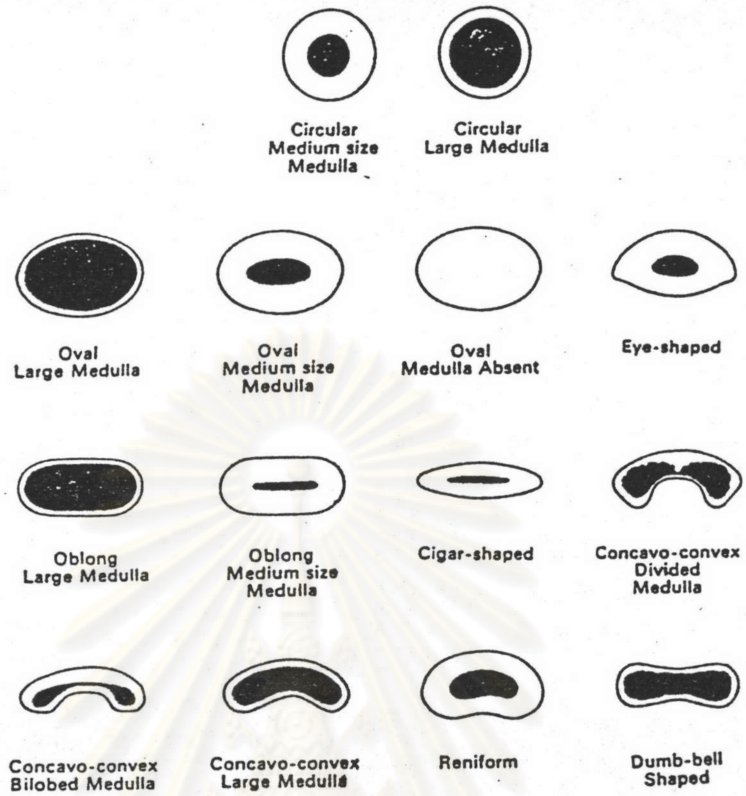

Figure 4 Shapes of cross-section
(after Brunner & Coman, 1974)

3. <u>The outer layer</u>, cuticle

The cuticle, the outermost layer of the shaft , is composed of regular or irregular shrinkle-like, clear cells of various configuration. Scales have free edges pointing towards the hair tip. The size and shape of scales, and their pattern of arrangement around the hair, are useful criteria for identification purposes (Brunner & Coman, 1974). The measurement of scale size has been used by Hausman (1930) and Mayer (1952). Size can be defined as the ratio of the length of scale to the width of filament (cited by Brunner & Coman, 1974).

The classification of cuticular scale shown below is based on the following main features :

1. Terms descriptive of the general scale pattern.
2. Terms which describe the form of scale margin.
3. Terms which describe the distance between the external margins of scales.

A. Scale patterns

According to Benedict (1957), the cuticular scales are classified into two main categories. Imbricate scales overlap each other, and there are always two or more scales encircling the shaft. Coronal scales are in the form of rings, and a single scale completely encircles the shaft ; giving the appearance of a group of stack cups. Within each category there are further subdivisions as shown in figure 5.

B. Scale margins

The scale margin may be defined as the free distal edge of an individual scale. It can be classified into various characters (figure 6).

Smooth margins are without indentations and appear as a smooth line (figure 6A).

Crenate margins have shallow but relatively pointed indentations (figure 6B).

Rippled margins have deeper indentations but the profile is generally rounded (figure 6C).

Scalloped margins consist of a series of curves with generally rounded peaks and pointed troughs (figure 6D).

Dentate margins have large tooth-like projections and are found only on coronal scales (figure 6E).

Denticulate margins have small tooth-like projections and also found on coronal scales (figure 5) (Benedict, 1957).

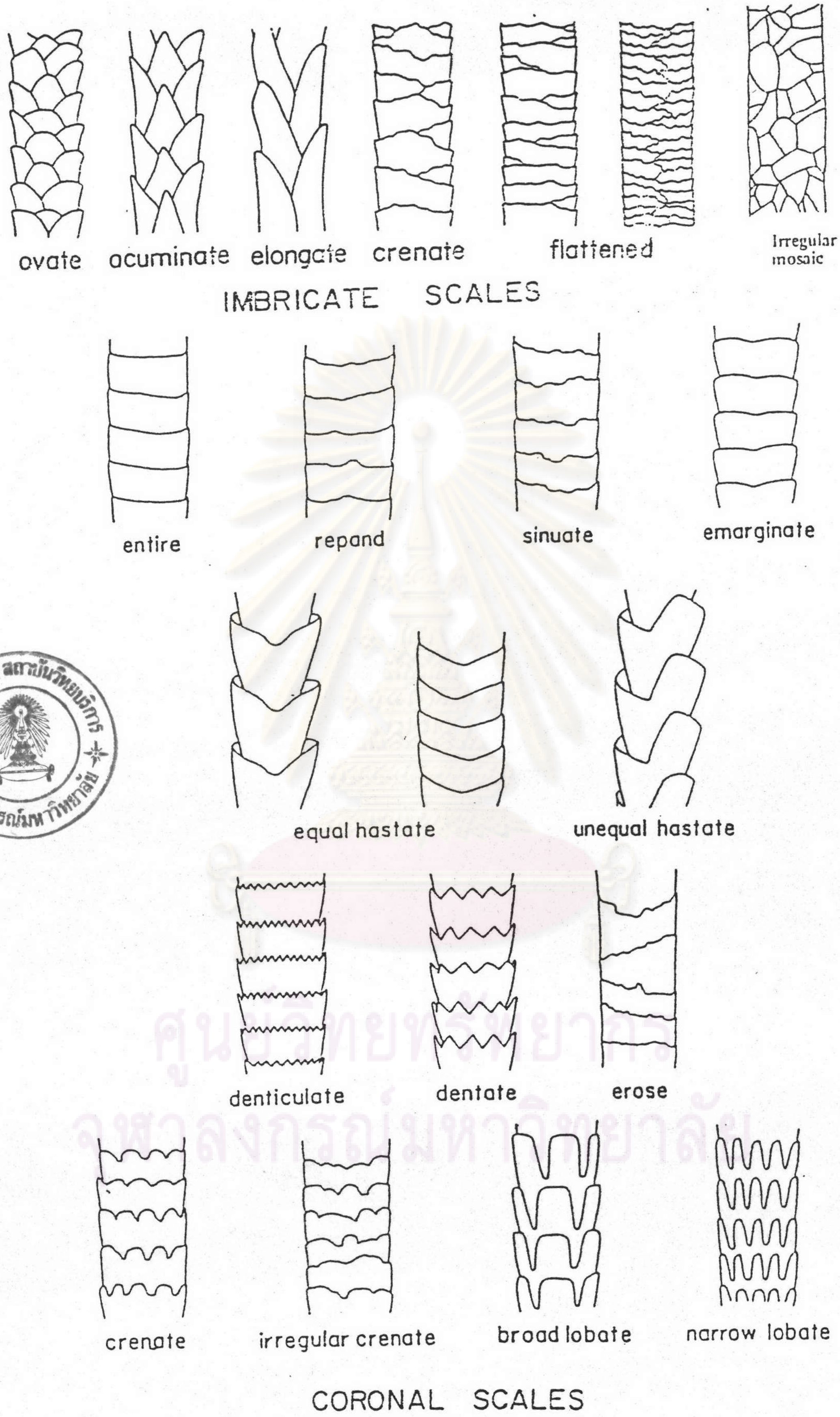

Figure 5 Types of scale. (after Benedict, 1957 and Hepworth, 1974)

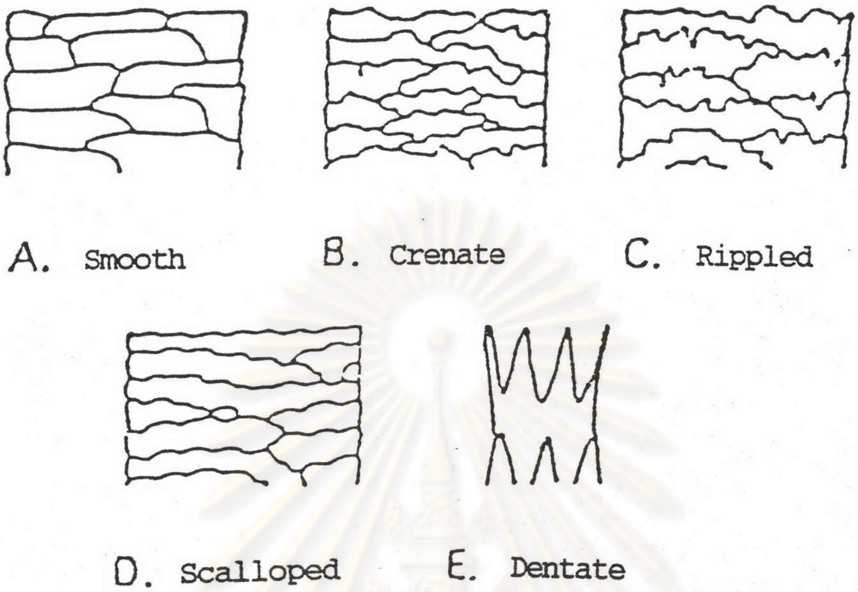

Figure 6 Types of scale margin (after Brunner & Coman, 1974)

C. Distance between margins.

In describing the arrangement of cuticular scales, it may be desirable to indicate whether the free edge of one scale and that of adjacent scales above and below are close together or well separated. The *distant* type are those where the visible width of the scale is not more than three times the visible length (i.e. the distance between one free distal scale margin and the next). In *near* types, the ratio of width to length might be from 3 to about 8, and in *close* types it is greater than about 8 (Brunner & Coman, 1974). The ratio is termed as scale index.

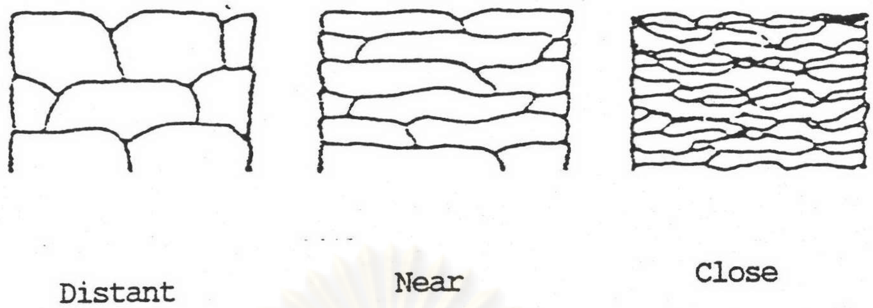

Figure 7 Distance between margin of scale

(after Brunner & Coman, 1974)

Various types of scale encircling the shaft in the different form of appress, divergent and divaricate (figure 8) are of diagnostic value.

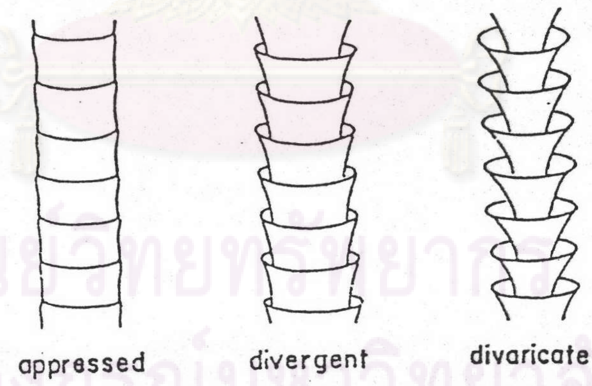

Figure 8 Divergence of scale from filament

(after Benedict, 1957)

Pigment distribution: Pigment may be present in the cortex or medulla or both regions of a hair. There are isolate occasions when cuticular scales may be pigmented (Benedict, 1957). An important aspect is the way in which the pigment is distributed along the length of an individual hair. Many mammalian hairs present a banded appearance. Both Stains (1958) and Mayer (1952) have utilized aspects of colour banding in their keys to the identification of hairs. Again the location of pigments in hair cross-sections may be of importance. Day (1966) has produced a detailed classification of pigment distribution based on an appropriation of cross-sections. Two pigment types are known to occur in mammalian hair: eumelanin and pheomelanin. Eumelanin results in brown or black hair, whilst pheomelanin gives a yellow or reddish colour. Despite this, hairs may display a variety of colour hues, with black, brown and yellow being the most common or basic colours. Due to the problem of bleaching in old or alcohol preserved specimens, colour of hair does not involve in this study.

Objective

Morphological structures of hair are very important for hair identification. The studies on morphology of hair of several kinds of mammal including some bats have been investigated for many decades (Benedict, 1957 ; Brunner & Coman, 1974 ; Cole, 1942 ; Homan & Genoway, 1978 ; Mile, 1965 ; Nason, 1984). None of such research has been done on bats found in Thailand (Songsakdi Yenbutra, 1987). The present study aims to reveal the morphological structures of hair including shape, size, type of medulla, pigment distribution, pattern and arrangement of scale. This work will fullfill the informations about hair of bats in Thailand.