Vol XI (3—4) 1974

SKIN PIGMENTATION IN BUFFALOES

M. A. Majeed, M. D. Ahmad and M. A. Toor*

An objective method for the numerical evaluation of cutaneous pigmentation in buffaloes was described and a reference skin pigmentation rate (SPR) scale proposed and illustrated.

Black and brown skin colours of Nili-Ravi buffalo-heifers were primarily because of black and light-brown shades of the pigment. The skin colour corresponded with the colour of the hair. In white skin patches of *Panj-Kalyan* specimens even the hooves were of white colour. Of the 8 locations studied maximum SPR (2.2) was recorded at back, and minimum (0.8) at brisket as well as lower abdomen locations. The thickest skinned forehead location had (a) the thickest epidermis, (b) the best developed dermal papillae, (c) and the most upright hair follicles. The contour of skin at the relatively thinner ventral locations was not straight but marked with epidermal folds, furrows or both. The giant follicles were about two times as deep as the ordinary hair follicles.

INTRODUCTION

Among other characteristics of skin, rate of cutaneous pigmentation has been suggested to influence the adaptability of different breeds of cattle to the tropical heat (Brody, 1948; Findlay, 1950). Exposure to direct sunlight was suggested to affect the quantity of this pigment as the skin of the Zebus was shown to be much more heavily pigmented than the skin of Ayrshire cattle, and the dorsal areas of the body were found to show the greatest density of the pigment (Yang, 1952; Goldsberry and Calhoun, 1959).

Advancement in age darkened the skin of the buffalo (MacGregor, 1941). Much of the skin pigmentation was on the other hand lost when the animal was kept away from direct sunlight (Badreldin and Ghany, 1952). White and brown coloured buffaloes may with age, become progressively spotted or freckled (Cockrill, 1968). In this species of the large

*Faculty of Veterinary Science, University of Agriculture, Lyallpur.

domestic ruminants also, the largest concentration of melanin pigment was found to be localized on the comparatively better exposed dorsal regions of the body (Hafez *et al.*, 1955; Chandra and Bharadwaj, 1969). Yet very little work has so far been done in assessing the rate of cutaneous pigmentation in Pakistani buffalo, much less the factors which influence its rate. The present study is undertaken to investigate the rate of cutaneous pigmentation at eight equidistant locations of the main body in brown[1] as well as black coloured buffalo heifers of the Nili-Ravi breed.

MATERIAL AND METHODS

Eight whole skins were obtained in July and August from 2-4 years old slaughtered buffalo heifers of Nili-Ravi breed. Four of these skins were black and four brown in colour; two of either colour showing white markings of the much preferred *Panj-Kalyan*[2] pattern. Duplicate samples were respectively taken from left and right sides at forehead (L_1, L_{11}), back (L_2, L_{12}), mid-neck (L_3, L_{13}), shoulder (L_4, L_{14}), mid-flank (L_5, L_{15}), lateral thigh (L_6, L_{16}), brisket (L_7, L_{17}), and lower abdomen (L_8, L_{18}) locations. Samples were not taken from the white skin patches.

Sampling, fixation and processing were done strictly in accordance with the techniques as detailed by Majeed, *et al.* (1973). A minimum of 10 vertical serial skin sections of 25 u thickness were cut from each paraffin embedded sample by a graduated rotary microtome and taken on Mayer's albumen applied glass slides. All these sections were decerated in three changes of xylene and mounted without staining in canada balsam (Goldsberry and Calhoun, 1959).

The rate of pigmentation was assessed by visual inspection of the mounted sections under an ordinary light microscope, always using a 10X eye-piece and a low power (3.5 X) objective. In the preliminary trials it was observed that consistent use of artificial light and blue filter improved the repeatability of the findings. Any five first encountered intact section of skin per sample were thus examined and matched against a pre-set and handy scale of skin pigmentation rates (SPR) illustrated in Plate 1. Any whole number of the scale, i. e., 0, 1, 2 or 3, to which a large part of the

1 Skin and hair of light brown colour: locally called *Khuri*. Not an albino.

2 Showing white at the forehead, white at all the four feet for variable lengths and white switch of the tail. May or may not have wall eyes.

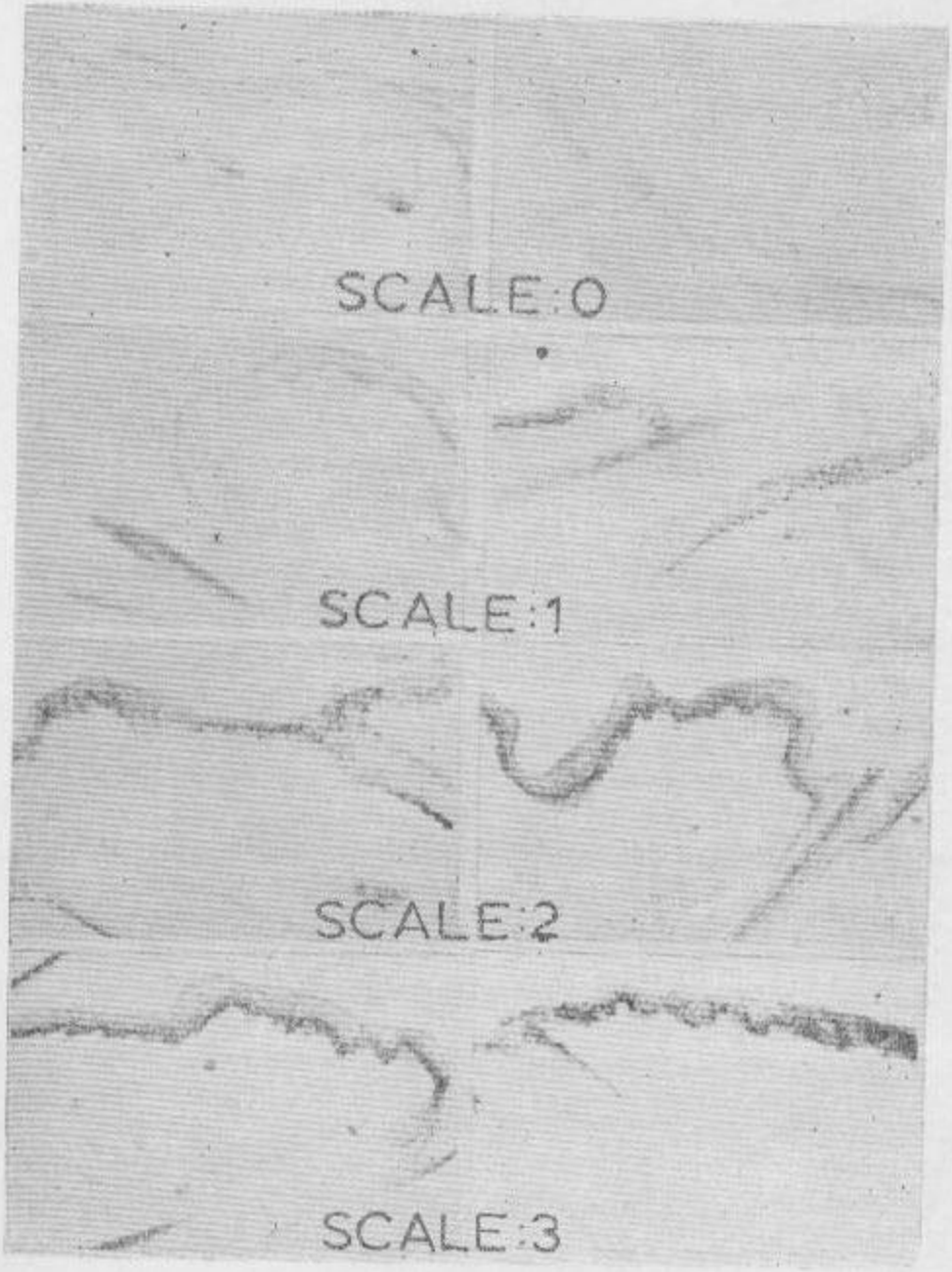

Plate No. I

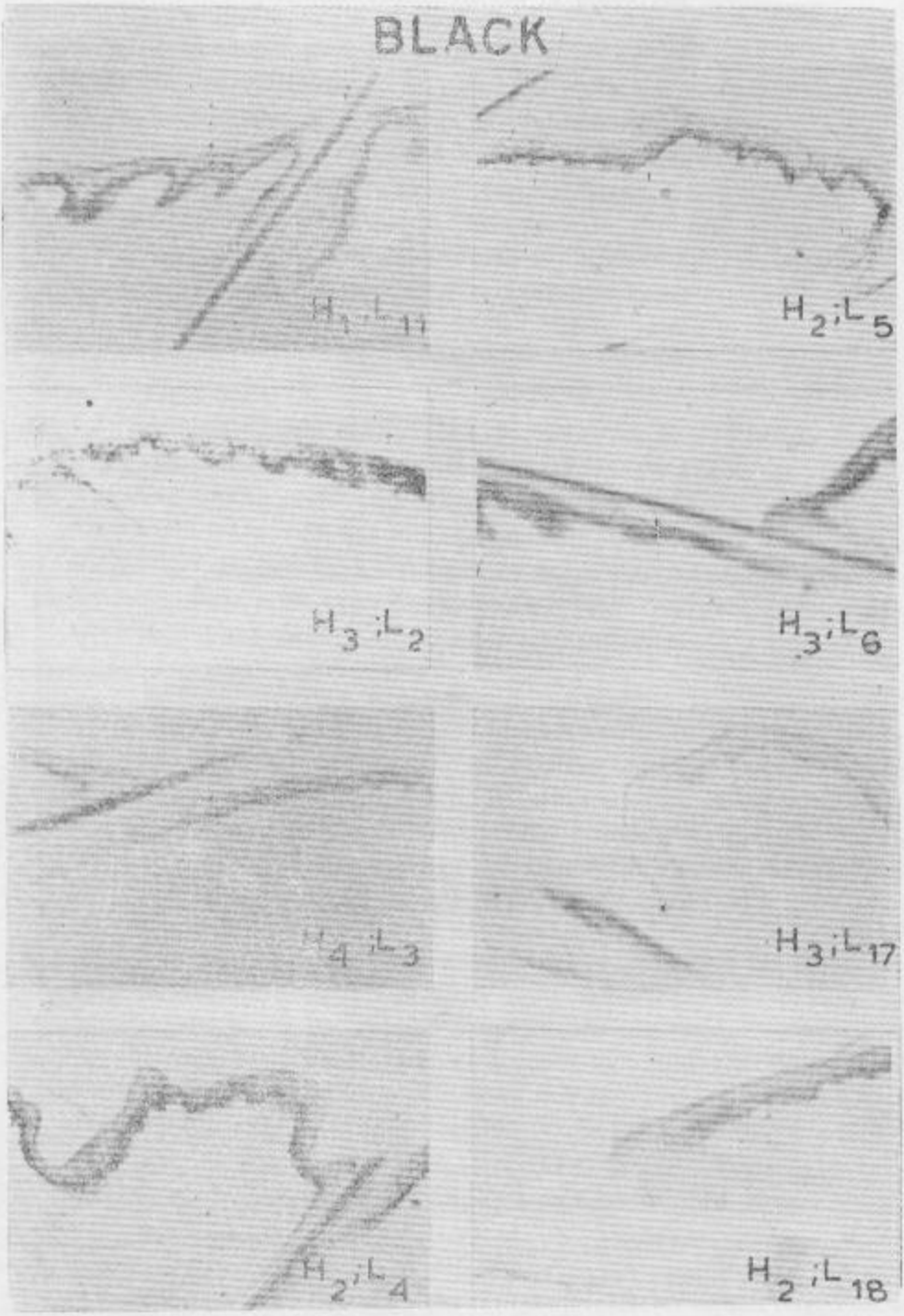

Plate No. II

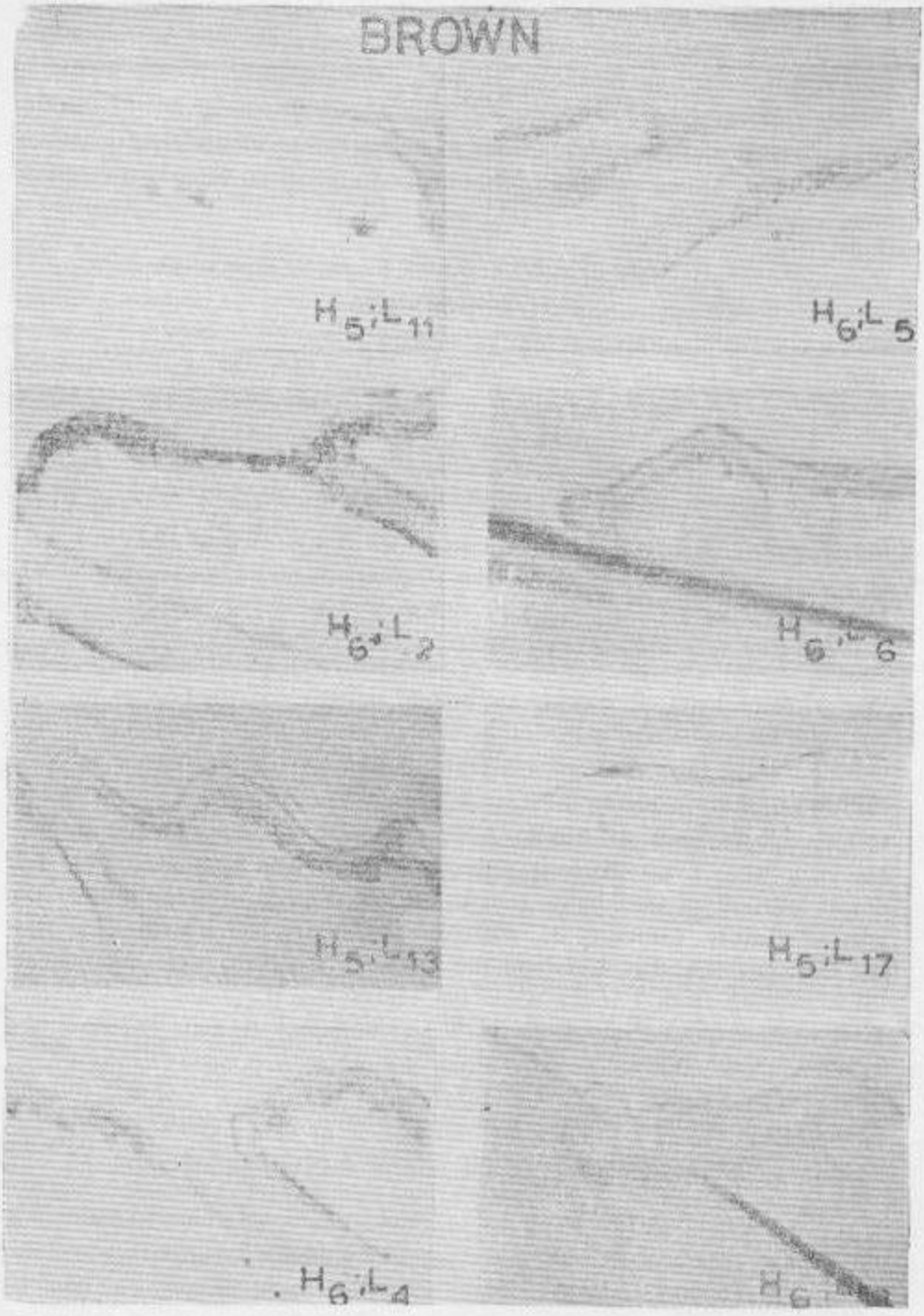

Plate No. III

majority of these sections matched or nearly matched was recorded. Sample readings were never taken in fractions.

RESULTS

Average degree of cutaneous pigmentation at all the eight locations in black and brown skinned buffalo-heifers is given in Table I and illustrated in Plates II and III.

TABLE I *Mean Skin Pigmentation Rates (SPR) at all the eight locations studied*

Skin Colour	LOCATION								Overall Mean
	$L_{1,11}$	$L_{2,12}$	$L_{3,13}$	$L_{4,14}$	$L_{5,15}$	$L_{6,16}$	$L_{7,17}$	$L_{8,18}$	
Black	1.7	2.3	1.7	1.8	1.9	1.6	0.9	0.9	1.6
Brown	0.9	2.1	1.3	1.6	1.7	1.2	0.6	0.7	1.3
Mean	1.3	1.2	1.5	1.7	1.8	1.4	0.8	0 8	

Irrespective of colour or colour pattern, distribution of the skin pigment was obviously comparable at the various locations studied. The overall average rate of cutaneous pigmentation was slightly higher in black (SPR = 1.6) than in brown (SPR = 1.3) skins. The back (L_2, L_{12}) was found to be the best pigmented (SPR = 2.2) and brisket (L_7, L_{17}) as well as lower abdomen (L_8, L_{18}) the least pigmented (SPR = 0.8) locations. The only dorsal location of the body (L_2, L_{12}) studied on an average showed the greatest density (SPR < 2) of the pigment; all the lateral areas (L_3, L_{13}; L_4, L_{14}; L_5, L_{15}; L_6, L_{16}) and the forehead (L_1, L_{11}) were intermediate (SPR ranging from 1 to 2), while the ventral (L_8, L_{18}) and auxillary (L_7, L_{17}) regions showed the least (SPR > 1) amount. It may, however, be mentioned that the colour of the hair always corresponded to the colour of the skin. Brown coloured skins carried brown hair and black skins having black hair. Futhermore, the colour of hair and hooves was also white at all the white patches of the skin in the *Panj-Kalyan* specimens.

It seemed that the difference in black and brown coloured skins was not that of intensity or size of the pigment granules but primarily of type. Whether fine and scattered, or coarse and coalescent, the pigment granules

in black skins were always of black colour and those of brown skins were of brown colour. The pigment granules appeared to be well distributed throughout the cytoplasm, at places forming clear cut congregations termed nuclear caps (Chandra and Bharadwaj, 1969). At the deepest layer of the dark epidermis, the much larger pigment granules seemed to oblitrate the cell boundaries.

A closer examination of Plates II and III shows pigmented epidermis against a contrasting background of almost transparent dermis. This brings the relative thickness and overall contour of the epidermis out at the different locations studied. As the magnification employed in all these microphotographs was the same, following observations can be made :

(i) The epidermis was the thickest at the forehead (L_1. L_{11}) location where the epidermal pegs were also the deepeet.

(ii) At a large majority of the locations studied the dermal papillae were well developsd.

(iii) The angle of slope of the hair follicles was maximum at the forehead (L_1, L_{11}) location.

(iv) At all the lateral and ventral locations of the body (except L_2, L_{12}) the epidermis was thrown into distinct epidermal folds, epidermal furrows or both.

(v) The giant hair follicles were about twice as thick and two time as deep as the ordinary hair follicles.

DISCUSSION

A simple method for numerical evaluation of cutaneous pigmentation in cattle was developed by Yang (1952) in which frozen 25 u thick, unstained, vertical sections of skin were examined under the low power of an ordinary light microscope and matched against a pre-set gradient scale. Comparisons between different locations and individuals thus became possible. Goldsberry and Calhoun (1959) instead employed poraffin embedded samples. They proposed mentioning of gross hair-coat colour, e.g. B for black and R for red in Aberdeen Angus and Herford cattle along with the numbers respresenting the quantity of the epidermal pigment. Following these leads, decerated 25 u thick unstained vertical sections of buffalo-heifer skin were studied under an ordinary light microscope and the rate of cutaneous pigmenation

recorded in whole numerals after matching against the scale shown in Plate 1. Methods and materials were further standardised by the constant use of :

(a) A built-in artificial light and a blue filter.

(b) A 10x eye-piece and a 3.5x objective.

(c) A tri-X black and white film for photomicrography. All prints were magnified two times on No. 3 glossy paper.

(d) A handy available scale (Plate I) facilitated actual cross matching which in turn minimized the individual variation.

Epidermal folds and furrows on the free skin surface have also been observed in the stained samples (Majeed *et al.*, 1975). In the relatively naked yet glossy skin of the buffalo such depressions could possibly detain some moisture at the time of wallowing or during showers subsequent evaporation of which may act as an adjuvant to the scanty sweat secretion.

True albinism is relatively rare in buffalo but white skinned albinoid specimens with black eyes, black horns, black hooves and yellow hair are not uncommon among the marsh buffaloes of the Far East (Cockrill, 1968). In Nili, Ravi, Kundi and Surti breeds of water buffalo on the other hand a light brown skin colour, locally called *Bhuri* is not infrequent. The colour of the hairs in all the four specimens studied was yellowish brown but their horns were all black and their eyes were either black or wall. In all the four *Panj-Kalyan* specimens of the present study the hair and the hooves in white skinned areas were also white. It may be noted that the brown skin colour in the brown coloured Nili-Ravi buffalo heifer was primarily because of a yellow tinge of the pigment.

Sunlight appeared to influence the quantity of the pigment both in black and brown coloured skins, as profuse, moderate and light degree of cutaneous pigmentation was recorded at the dorsal, lateral and ventral locations of the body, respectively. This is in line with the findings of Hafez *et. al.*, (1955) and Chandra and Bharadwaj (1969).

Bonsma (1949) suggested that dark pigmented cattle skin with hairs of light colour may be the ideal colour combination for resisting the ill effects of long and short wave radiation which is so intense in tropical countries. This was largely because the black skin was shown to facilitate the absorption of infra-red rays which resulted in enhanced body tempera-

ture. However, such generalizations have not held the test of time especially in the very complex heat tolerance mechanism otherwise the white skinned albinoid specimens of the marsh buffalo in China, Thailand, Philippines and Indonesia or the brown *Bhuri*, variety of the water buffalo in Pakistan and India would have proven to be the best heat tolerant buffaloes of the world.

Badreldin and Ghani (1952) on the other hand argued that whereas the black pigmented buffalo skin limited her adaptability to exposure to direct sunlight, in shade it helped in more efficient dissipation of heat. T is perhaps explains why buffaloes :

(i) become darker with advancement in age (MacGregor, 1941)

(ii) show a more substantial and quicker cooling of their bodies with summer showers (Minett, 1947)

(iii) are said to have a relatively better cooling mechanism in shade (Mullick and Kehar, 1951)

(iv) lose cutaneous pigmentation when kept away from direct sunlight (Badreldin and Ghany, 1952)

(v) show relatively darker dorsal locations of the body (Hafez et al., 1955 ; Chandra and Bharadwaj, 1969), and

(vi) show improvements in their work capacity, milk production and fertility when kept in shade (Roy et al.; 1964).

LITERATURE CITED

1. Badreldin, A.L, and M.A. Ghany 1952. Adaptive mechanism of buffaloes to ambient temperature. Nature, Lond., 170 (4324) : 457-458.

2. Bonsma, J.C. 1949. Breeding cattle for increased adaptability to tropical and subtropical environments. J. Agric. Sci. Camb; 39 (2) : 204—221.

3. Brody, S. 1948. Environmental physiology with special reference to domestic animals. I. Physiological backgrounds. Res. Bull. Mo. Agric. Exp. Sta. No. 423.

4. Chandra, G., and M.B. Bharadwaj 1969 Epidermal pigment distribution in buffaloes (*Bos bubalis*). J. Agric. Sci. Camb., 72 (1) : 149-153.

5. Cockrill, W.R. 1968 Observations on skin colour and markings of the water buffalo (*Bubalus bubalis*). Veterinarian, 5: 29-32.

6. Findlay, J.D. 1950 The effects of temperature, humidity, air movement and solar radiation on the behaviour and physiology of cattle and other farm animals; a review of existing knowledge. Bull. Hannah Dairy Inst. No. 9.

7. Goldsberry, S., and M.L. Calhoun. 1959 The comparative histology of the skin of Herford and Aberdeen Angus cattle. Am. J. Vet. Res.. 20 (74) : 61—68.

8. Hafez, E.S.E., A.L. Badreldin, and M.M. Shafei. 1955 Skin structure of Egyptian buffaloes and cattle with particular reference to sweat glands. J. Agri. Sci., Camb., 46 (1): 19-30.

9. MacGregor, R. 1941 The domestic buffalo. Vet. Rec., 53: 442-450.

10. Majeed, M.A., M.D. Ahmad, M.B. Sial, and M. Ajmal. 1973 A method for the quantitative study of skin structures in the buffalo. Pak. J. Agri. Sci. 10 (1—4); 167-176.

11. Majeed, M.A., M.B. Sial; M.D. Ahmad, and M. Ajmal 1975 The buffalo heifer skin (in press).

12. Minett, F.C. 1947 Effect of artificial showers, natural rain and wallowing on the body temperature of animals. J. Ani. Sci., 6 (1): 35—49.

13. Mullick, D.N., and N.D. Kehar 1951 Comparative heat tolerance test in cattle and buffaloes. J. Ani. Sci. 10: 1078—1079.

14. Roy, A., B.P. Sen Gupta, and M.S. Misra 1964 Effect of varying environment on semen quality, cardiorespiratory activity, milk production and female fertility of buffalo. Arid Zone Research XXIV. Environemental Physiology and Psychology in Arid Conditions. Proc. Lucknow Symp., UNESCO.

15. Yang, S.H. 1952 A method of assessing cutaneous pigmentation in Bovine skin: J. Agri. Sci., Camb., 42 (4); 465—467.