

Histological Structure of the Hair in Hybrids of European Bison and Domestic Cattle

Bogumiła DZIURDZIK

Dziurdzik B., 1978: Histological structure of the hair in hybrids of European bison and domestic cattle. *Acta theriol.*, 23, 16: 277—284 [With 1 Table & Plates XIV—XVIII].

The paper contains a histological study of the hair of 19 hybrids obtained by cross-breeding F_1 , B_1 and B_2 generations of European bison with domestic cattle of two breeds — red Polish (*pr*) and black-and-white lowland (*bw*). The hair of domestic cattle and European bison differ in the structure of the medulla. In the three hybrids of generation F_1 examined, hair of the cattle type or mixed hair occurred (*i.e.* both of the cattle type and European bison type in the same individual), with a ratio of 1:2. In generation B_1 hybrids had hair of the bison or cattle type or mixed, with a ration of 1:3:3, and in generation B_2 , bison type or mixed hair occurred with a ratio of 3:3. In the generations B_1 and B_2 a new character, namely absence of a medulla in the guard hairs appeared, which does not occur in the initial forms.

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1. INTRODUCTION

The numerous studies made on hybridization of European bison with domestic cattle do not deal with the hair covering, and in particular its histological structure. Pietrzykowski & Krasieńska (1971) made a detailed study of the skin of hybrids of European bison and cattle, and an evaluation of its suitability for tanning, technical and food purposes without, however, taking into consideration the hair covering.

The studies made previously on the hair structure in mammals (Dziurdzik, 1973; Kubiak & Dziurdzik, 1973) and the differences found in the histological structure of hair in European bison and domestic cattle encouraged the author to carry out a similar analysis in respect of hybrids of the foregoing species.

The present paper contains the results of a detailed study of the hair of hybrids derived from various versions of cross-breeding of domestic cattle and European bison.

2. MATERIAL AND METHODS

The material used for the studies consisted of samples of hair from 19 hybrids obtained from the Mammals Research Institute, Polish Academy of Sciences, at

Białowieża. Observations were made of the hair of F_1 generation hybrids obtained from cross-breeding two breeds of domestic cattle, namely: red Polish (*pr*) and black-and-white lowland (*bw*) with European bison, and hybrids of back-crossed generations B_1 ($1/4$ bison and $3/4$ domestic cattle) and B_2 ($1/8$ bison and $7/8$ domestic cattle) (Table 1).

Observations were made on the guard hair, *i.e.* the longest and thickest hair, since woolly hair has a simplified histological structure. The method given by Day (1966), and applied previously by the author (Dziurdzik, 1973), was used in the present studies. Examination was made of the medulla of the hair, the arrangement of scales of the cuticle, the shape of cross-sections and the number of free margins of cuticular scales per 1 mm of length of hair.

Preparations from hairs were made by fixing the hair on a slide using clear cement. After drying, part of the hairs were pulled off using a pair of pincers: the imprint of the hair remained on the slide, showing the pattern of cuticular scales quite clearly. Observations of structure of the medulla were made on the other hairs. Part of the imprints of the hair cortex were obtained by crushing a bundle of hairs placed between two celluloid plates, by means of two metal cylinders. The cross-sections were made by using a razor blade to cut hairs fixed in gelatine in elder pith. The hairs were photographed under a microscope with magnification $40\times$. The nomenclature used by Day (1966) has been adhered to in this paper.

Since earlier studies made by the author show that the hair of European bison and domestic cattle differ chiefly in respect of structure of the medulla, this characteristic was taken as the basis for dividing the material into groups. The definitions used below — »bison type« or »cattle type« — indicate respectively a medulla similar in structure to the hair medulla of the European bison or domestic cattle.

3. RESULTS

The hybrids examined were divided into 4 groups according to the structure of the hair medulla.

The first group included hybrids with bison type hair (Plate XIV, Figs. 3, 4) or with predominance of bison type hair (Table 1).

The hair from the B_1 hybrid does not contain a medulla in its proximal part (near the hair bulb), although there is a fragmental lattice medulla similar in places to the bison type, in the region of the papilla. Four hairs without a medulla and with rufous pigmentation were found, the hairs being finer than the rest, but not woolly.

Two B_2 hybrids had bison type hair from both the morphological and histological aspects. There was usually no medulla in the proximal part of the hair; near the papilla there was a lattice ladder continuous or fragmental medulla with small sections lacking a medulla. Pigmentation was mostly intense, making observations difficult; completely white hair also occurred. Out of approximately 15 hairs examined one had no medulla. The hair of the third B_2 hybrid had a continuous lattice medulla

in the proximal part, passing into a fragmental medulla in the region of the papilla and in the distal part, very similar in appearance to a medulla of the bison type. Large sections of the hair were found to possess no medulla.

The second group included hybrids with cattle type hair (Plate XIV, Figs. 1, 2), or with predominance of cattle type hair (Table 1).

Hybrid F_1 and the two hybrids B_1 had very darkly pigmented hair, making examination of the medulla structure impossible in some parts. In places where the pigmentation was less intense, a fragmental lattice medulla could be seen. The sections in which there was no medulla were short. In the hybrid F_1 a few short sections of medulla slightly similar to the bison medulla were found in some of the hairs, but hairs with the cattle type medulla predominate. The third hybrid B_1 had hairs with

Table 1

Comparison of kinds of hybrids, types of hair occurring and number of hybrids used for observations.

Kind of hybrid, father × mother	Generation	Bison type of hair	Cattle type of hair	Mixed type of hair	Hair without medulla	Number of individuals
bison × <i>bw</i>	F_1			1		1
<i>bw</i> × female bison	F_1			1		1
<i>pr</i> × female bison	F_1		1			1
<i>bw</i> × F_1	B_1	1	3	3	1	8
<i>bw</i> × B_1	B_2	3		3	2	8
Total		4	4	8	3	19

a fragmental lattice medulla, but the sections without a medulla were long, not infrequently very long. In such hairs the medulla appears to be rudimentary only.

The third group, which was the most numerous, consists of hybrids in which mixed hairs of both the bison and cattle type were found, also hairs without a medulla, although there was no distinct predominance of any of the hair types (Table 1).

Hybrids obtained from crossbreeding *bw* × female bison had mixed hair, of the cattle, bison and also medulla-less types.

The only hybrid obtained from crossbreeding bison × *bw* had very intensely pigmented hair, making accurate examination of the medullary structure impossible. In places in which it proved possible to depigment the hair a lattice medulla could be seen. The remaining hairs possessed no medulla.

B_1 hybrids most often had hair with the following structure: in the

part near the bulb there was no medulla over a considerable section, then a fragmental lattice medulla appeared in the region of the papilla, similar in appearance to the bison medulla, but disappearing again in the distal part of the hair.

The second kind of hair occurring in this group is hair with a fragmental lattice medulla, more similar to the cattle type, and not possessing a medulla in both the proximal and distal part.

The third type of hair are hairs without a medulla or with traces only of a fragmental lattice medulla.

The following types of hair were found to occur in B_2 hybrids of this group: (1) white, unpigmented hairs with a fragmental lattice medulla very similar to a bison medulla; (2) white, unpigmented hairs, with a fragmental lattice medulla of the cattle type: the sections with and without a medulla were long; (3) hairs with intense pigmentation, rufous — with a fragmental lattice medulla of the cattle type, with long sections of the hair in which there was no medulla; (4) hair with dark pigmentation, with medulla similar in places to bison medulla: large sections without medulla; (5) hairs with intense pigmentation, without medulla.

The fourth group — hybrids with medulla-less hairs (Plate XV, Figs. 5, 6) or with predominance of medulla-less hairs. This group comprises hybrids B_1 and B_2 (Table 1).

Hybrid B_2 — had both pigmented and light hairs, without a medulla. One hair had a fragmental lattice medulla, similar in places to the bison type, with long sections without a medulla. Fragmental lattice medulla of the cattle type occurred in the distal part.

Two kinds of hairs occurred in B_2 hybrids, namely: very intensely pigmented, difficult to depigment, which made it impossible to discern the medulla, and light hairs, which were clearly devoid of a medulla. No medulla was found in the hairs which proved possible to depigment. In one of the hybrids, in addition to a predominant number of hair without a medulla, a few hairs were observed in which there were traces of a lattice medulla (Plate XV, Fig. 7).

In the case of hairs without a medulla the possibility of complete depigmentation during preparation was taken into consideration, but this possibility was rejected, since in such cases the presence of intercellular air would have made it possible to observe the medulla, which not infrequently was the case during the observations made. The pattern of the scales of the hair sheath in hybrids is of a mosaic character, exhibiting both cattle and bison characteristic, without persistence of any regularity (Plate XVI, Figs. 8—11 & Plate XVII, Figs. 16, 17).

4. DISCUSSION

Hairs of domestic cattle differ histologically from those of European bison in respect of the medullary structure. The pattern of scales of the hair sheath is mosaic in character (Plate XVII, Figs. 12, 13), while the cross-section is round in both species.

The hair medulla in the bison (Plate XVII, Fig. 15) is of the lattice type, but similar in appearance to a ladder medulla, due to the occurrence of intercellular air. This kind of medulla has been defined as intermediate between lattice and ladder (Dziurdzik, 1973).

Air, as stated by Šulc (1930), occurs only in dead hairs, but on account of the frequent use of dead hairs for observations and also the fact that the presence of air would appear to be a constant characteristic, it was decided to accept the medulla deformed in this way as characteristic of the European bison.

The medulla of cattle hairs (Plate XVII, Fig. 14) is mostly lattice and fragmental (Dziurdzik, 1973). Hair sometimes occur in which parts of the medulla are similar in structure to the hair medulla of the bison. In addition the width of the hair medulla in relation to thickness of hair in the bison is far greater than in cattle.

The number of free margins of the scales forming the sheath per 1 mm of hair length has been taken by certain authors (Myczkowski, 1964) as a characteristic feature of the given species, being from 40—80 for the European bison, from 50—80 and less often to 90 in cattle.

From the morphological aspect the hair of European bison and cattle differs primarily in respect of length and thickness. The thickness of cattle hair is from 0.1—0.2 mm, but from 0.23—0.37 mm in the European bison. Approximate length of cattle hair was from 3—5 cm, and bison hair from 4—12 cm (the majority of the hairs used for the studies had been cut off, so that it was impossible to speak of the absolute length of hair).

The studies made by Krasieńska (1963) show that the *bw* breed transmit cattle character to a greater degree than the *pr* breed. The results of examination of material taken as a basis in this paper do not point to this kind of conclusion. It is true that in one hybrid *pr* × female bison — the hair was of the cattle type, which would indicate that the fragmental lattice medulla is a dominating characteristic. Unfortunately no large number of hybrids from this form of cross-breeding were available, so that it was impossible to arrive at any more general conclusions. It is also difficult to draw conclusions, on the basis of the study material, as to the influence of the father or mother on transmission of characters in the hair structure, for instance with crossbreed-

ing European bison \times *bw* cattle, F_1 hybrids had mixed hair, irrespective of the way in which the experiment had been conducted (Table 1).

In backcross generations hybrids B_1 and B_2 all four types of hair occur, cattle hair and mixed hair predominating in B_1 hybrids, and bison hair and mixed hair in B_2 (Table 1). The certain degree of regularity observable in the type of hair obtained leads to the assumption that only a small number of genes provides this character.

Among the results obtained in this study the appearance of a new character, that is, the absence of a medulla in certain of the guard hairs, is remarkable. Both cattle, regardless of the breed, and also European bison, have guard hairs containing a medulla, but differing in their histological structure, which provided the author with a basis for differentiating between these species (Dziurdzik, 1973). According to Sokolov (1962) and Myczkowski (1964) woolly hair in cattle has no medulla, but these hairs were not included in our studies.

The absence of a medulla in guard hairs occurred in too large a number of individuals (in the latter case as many as in two out of the eight examined) to rule out the possibility of a new mutation having been created. It is probable that it is the result of the co-action of different genotypes, since we were dealing with interspecies hybrids.

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Bogumiła DZIURDZIK

BUDOWA HISTOLOGICZNA WŁOSÓW HYBRYDÓW ŻUBRA
Z BYDŁEM DOMOWYM

Streszczenie

Praca zawiera histologiczne opracowanie włosów 19 mieszańców pokolenia F_1 , B_1 i B_2 , żubra z bydłem domowym dwu ras: czerwonej polskiej (*pr*) i nizinnej czarno-białej (*bw*). Ponieważ włosy żubra i bydła domowego różnią się głównie budową rdzenia (Pl. XXX, Figs. 14, 15), na tę więc cechę zwrócono szczególną uwagę u mieszańców i przyjęto ją za kryterium podziału mieszańców na grupy: (1) o włosach typu żubrowego, (2) o włosach typu bydłowego, (3) o włosach mieszanych, tzn. zarówno bydłowych jak i żubrowych, oraz bezrdzeniowych, występujących bez wyraźnie zaznaczonej przewagi któregoś z typów włosów, (4) o włosach bezrdzeniowych. U 3 badanych mieszańców pokolenia F_1 wystąpiły włosy typu bydłowego albo mieszane, w stosunku 1:2. W pokoleniu B_1 mieszańce miały włosy typu żubrowego, bydłowego lub mieszane, w stosunku 1:3:3, a w pokoleniu B_2 — wystąpiły włosy typu żubrowego oraz mieszane, w stosunku 3:3 (Tabela 1).

W pokoleniach B_1 i B_2 pojawia się nowa cecha, mianowicie bezrdzeniowość włosów przewodnich, nie występująca u form wyjściowych. Prawdopodobnie, cecha ta jest wynikiem interferencji genotypów, jako że mieliśmy do czynienia z krzyżówkami międzygatunkowymi.

EXPLANATION OF PLATES

Plate XIV

Hairs of hybrids with cattle type of medulla:

Fig. 1. Fragmentary reticular medulla.

Fig. 2. Centinuous reticular medulla.

Figs. 3—4. Hairs of hybrids with bison type of medulla.

Plate XV

Hairs of hybrids without medulla:

Figs. 5, 6. Visible accumulation of pigment on margins of cuticular scales.

Fig. 7. Hair of hybrid with trace of rudimentary medulla.

Plate XVI

Different types of mosaic pattern of sheath scales on hairs of hybrids:

Fig. 8, 9. With bison medulla.

Figs. 10, 11. With cattle medulla.

Differences in thickness of hairs are due to different magnification and also to using different parts of the hair for the photographs.

Plate XVII

Patterns of scales of the hair sheath:

Fig. 12. Cattle.

Fig. 13. Bison, and types of hair medulla.

Fig. 14. Fragmentary reticular medulla (cattle).

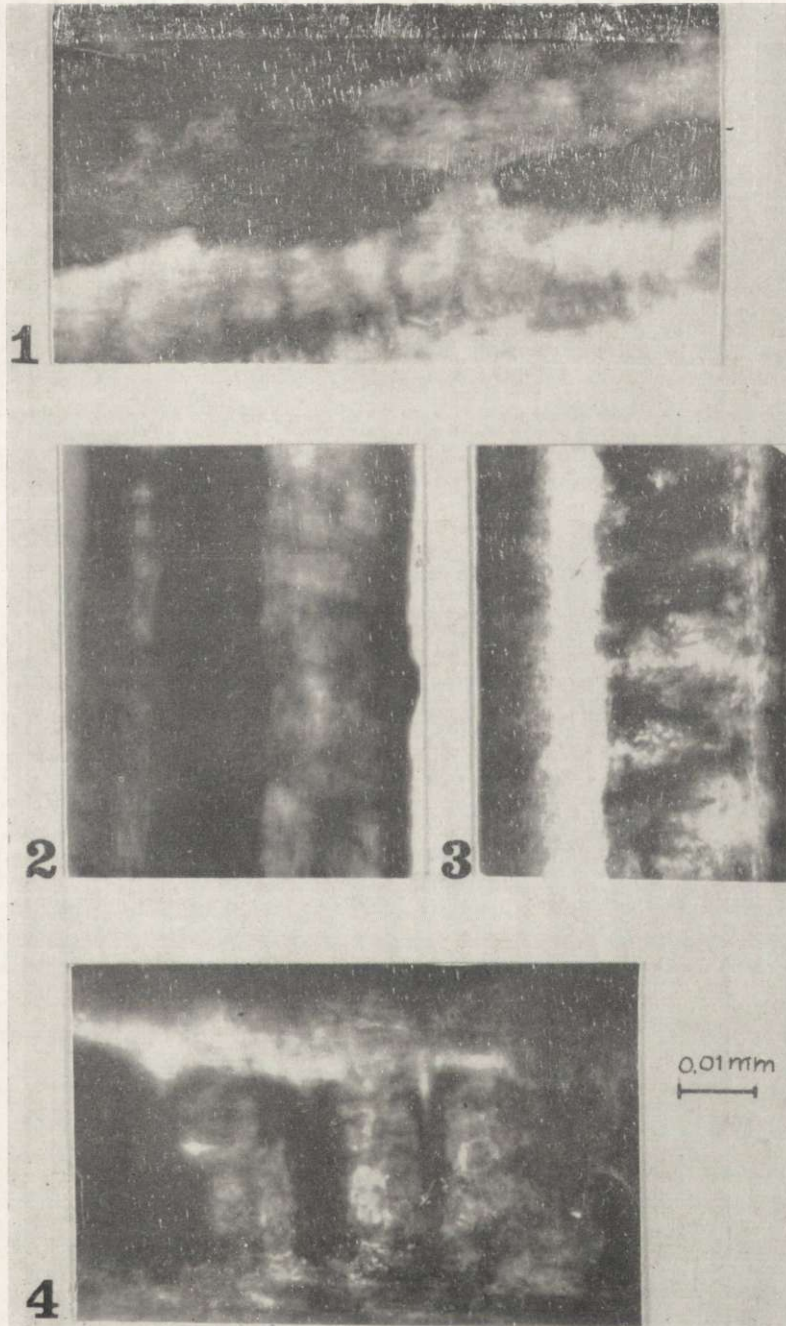
Fig. 15. Bulbous medulla, with air visible between cells (bison).

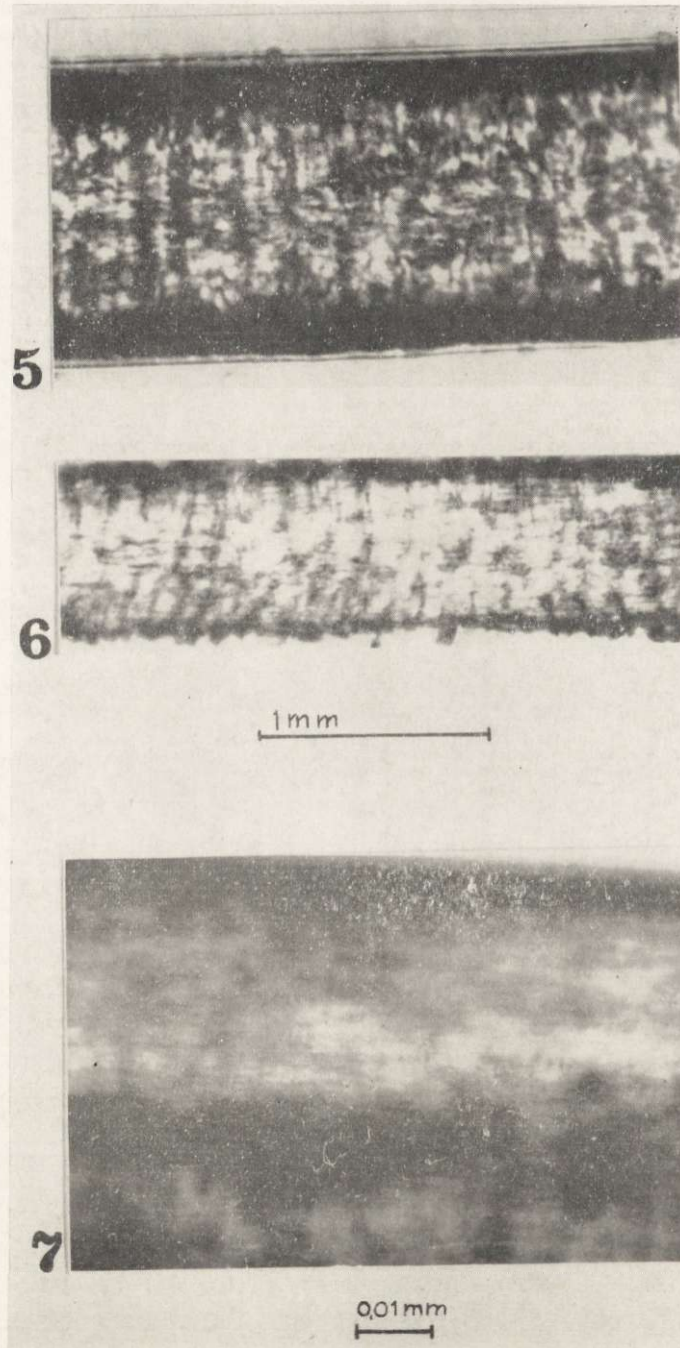
Plate XVIII

Different kinds of mosaic pattern on the same hair in a hybrid with cattle medulla.

Fig. 16. In proximal part of hair.

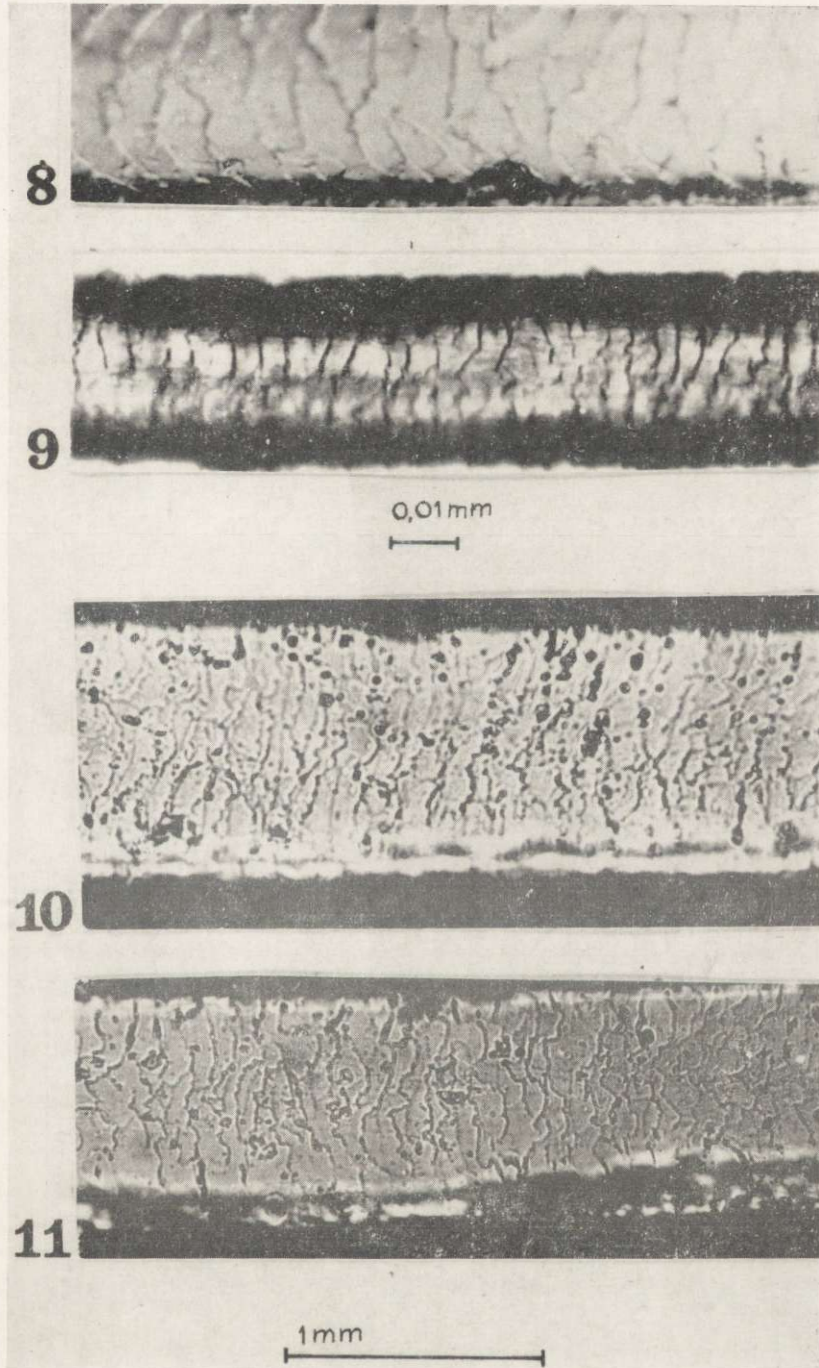
Fig. 17. In distal part of hair.

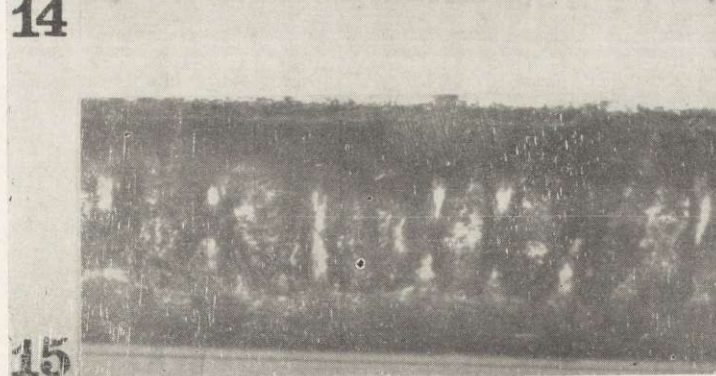
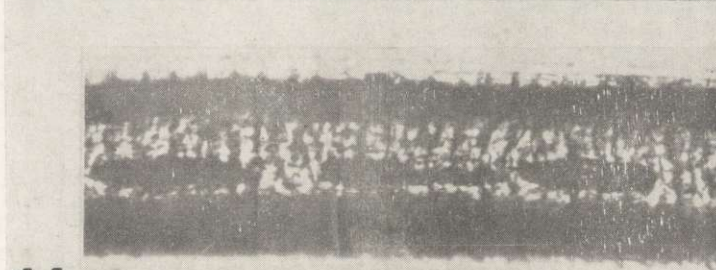
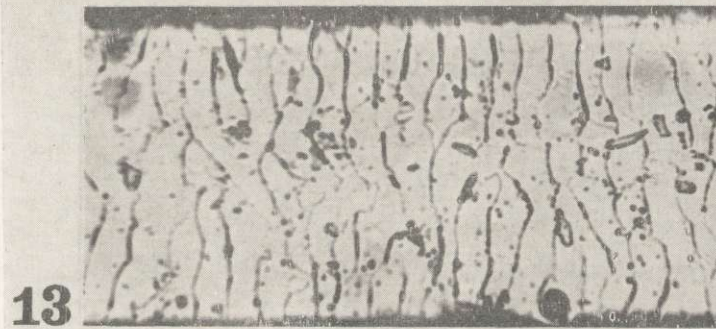




B. Dziurdzik

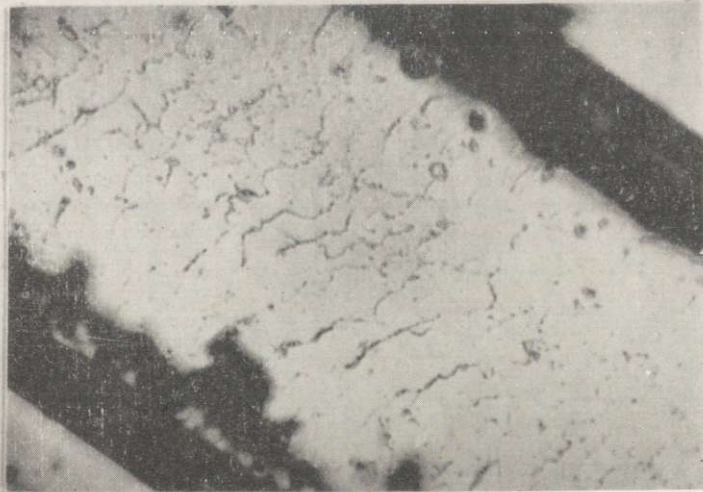
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