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Histological Structure of Hair in the *Gliridae* (*Rodentia*)

[Pp. 1—12 and pls. I—XII]

Budowa histologiczna włosów u przedstawicieli rodziny *Gliridae* (*Rodentia*)

Abstract. The paper contains a histological description of the hair of Polish and exotic representatives of the family *Gliridae* and the key to the identification of species within this family, based on the structure of the medulla, the cuticular scale patterns and the shape of the cross-sections. Six genera have been described out of which four are known in Poland: *Eliomys*, *Dryomys*, *Glis* and *Muscardinus*. The remaining two genera are the *Glirulus* known from Japan, and *Myomimus* found in Central Asia and South East Europe.

CONTENTS

I. INTRODUCTION

In the Polish literature some notice has been given to the study of the hair of small mammals but mainly from the point of view of gross morphology. HAITLINGER (1967, 1968a, b) was interested in the histological structure of the

hair of mammals and described the hair of the representatives of the genus *Apodemus*. DZIURDZIK (1973) tries to identify Polish species of mammals on the basis of the histological structure of their hair; in other papers KUBIAK and DZIURDZIK (1973) and DZIURDZIK (1977) describe the histological structure of the hair of contemporary and fossil rhinoceros, and the structure of the hair of the hybrid of the European Wisent × domestic cattle.

In the foreign literature available to the author there is no detailed description of the histological structure of the hair of mammals from the family *Gliridae*, apart from a few references to the subject made by DAY (1966) and SOKOLOV (1973).

II. MATERIAL AND METHOD

The examined hair was obtained from preserved skins, thus it was dead hair. Hair samples were taken from different parts of the body, mainly though from the back and sides. DAY'S (1966) method of examining was used. It has been already used with small modifications and described by the author (DZIURDZIK 1973).

The specimens were embedded partly in crystal-cement, partly in Canada balsam. The casts of hairs were made in crystal-cement and the cross-sections were obtained by cutting hairs fixed by gelatine in the core of the elder. There was no need for the hair to be lightened for the medulla was always seen quite clearly. Photographs were taken partly under the Amplival (Carl Zeiss) microscope with K4:1 oculars for photographs and lenses 16/0.40 and 40/0.95, partly under a scanning microscope. Hair measurements (width and length) were made with the help of a measuring microscopic ocular.

III. GENERAL DESCRIPTION OF HAIR OF THE *GLIRIDAE*

We can distinguish three types of hairs:

a. Guard hair, the longest and thickest. It is straight, spindleshaped, in its distal part usually there is no medulla. Its shield is clearly defined. In this category of hair the cuticular scale patterns and the type of medulla present are the most constant features. Due to this the structure of these hairs has been considered as the most characteristic quality of a given species.

b. Coarse hair, shorter and thinner, lanceolate shaped, with a defined shield, without a clearly marked construction.

c. Fine hair, the shortest and the thinnest. It has no medulla and usually is curled.

Some authors distinguish another type which is intermediate between guard and coarse hairs (SOKOLOV 1973). Both guard and coarse hairs usually

have a medulla consisting of a single row of cells placed along the hair. Such a medulla is described as a uniseriate ladder medulla (DAY 1966). Sometimes however, in the case of thicker hairs there can be in places two cells to the hair width. The medullary cells can be lumpy rounded or narrow, rectangular. They are loosely packed in the hairs' cortex. The intercellular spaces are filled with air or pigment which accumulates in a characteristic way on the walls of the medullary cells (Plate III, 6, 7).

Light rays are refracted by intercellular air giving a false picture of the medulla, which is an artefact. The size of the intercellular spaces and also the angle at which the rays are refracted determines the hue of the hairs (SOKOLOV 1973). The medulla is mainly continuous, but e. g. in the case of *Glis glis* it can be discontinuous, fragmental especially in the distal part of the hair. The cortex is thin, especially of *Glirulus japonicus*, where the medulla occupies nearly the whole width of a hair. The thickest cortex has been found in the hair of *G. glis*.

All *Gliridae* have non-constricted hair only *Myomimus personatus* has hair that is constricted. There can be two constrictions to the hair length.

The cuticular scales usually adhere to the surface of the hair, sometimes they are protruding e. g. in *Dryomys nitedula*. They form various types of mosaics e. g. in *G. glis* and *Eliomys quercinus* (Plate II, fig. 3, Pl. VI, fig. 14), or a diamond petal pattern, sometimes a lanceolate pattern. Frequently one pattern merges into another one in the same hair. There are two forms of the diamond petal pattern. The typical diamond petal pattern e. g. in *D. nitedula* (Pl. V, fig. 11) with rather wide rounded scales (sometimes two scales to the hair width) or a diamond petal pattern with wide petals enclosing capsule-like the whole stem of a hair, e. g. in *E. quercinus* (Pl. II, fig. 5, Pl. XII, A). The mosaic pattern also varies according to species (Pl. XII, B); e. g. in *G. glis* (Pl. VI, fig. 14) we find a very fine mosaic composed of a number of „petals" which have rugged, irregular edges. Mosaics found in *M. avellanarius* and *M. personatus* are completely different. The line of the mosaic is more even, the edges of the cuticular petals are smooth (Pl. XI, fig. 24, Pl. III, fig. 7). The mosaic pattern of the cuticular of *E. quercinus* (Pl. II, fig. 3) is different again. This mosaic has completely even edges. The scales include the hair's stem. This pattern usually merges into a diamond petal pattern as in *E. quercinus* (Pl. II, fig. 5). A diamond petal pattern can in some parts become a lanceolate pattern as mentioned above (Pl. XI, fig. 23). The scales become narrower and longer, with sharp ends. The following cross-sections of the hairs of mammals from this family are round, slightly oval, bean-shaped and kidney-shaped. The longest hairs are found in *G. japonicus* (15 mm) and in *G. glis* (14 mm). The thickest are in *E. quercinus* (42 μ) and in *G. glis* (40 μ). The most delicate and the thinnest hairs have *M. personatus*: length about 11 mm and about 18 μ thick.

The *Gliridae* form from the point of view of the histological structure of hair a distinctive group among other mammals. Not single qualities have decided about that but a set of qualities. The most similar structure of hair,

to the hair of *Gliridae (Eliomys* and *Dryomys)* has, within the rodents, *Pitymys*. There are some differences in the shape of the cross-sections. Among the insectivores the mole *Talpa europaea* has histologically similar hair, but its hair differs from that of *Gliridae* in its morphological structure and the structure of the medulla. The mole can have a multiseriate medulla apart from a uniseriate medulla. Besides, the insectivores have another common feature with *Gliridae* (mentioned already above) that is, constricted hair. Within the *Gliridae*, the most similar structure of hair have genera *Eliomys* and *Dryomys*. Apart from that there are some similarities between the hair of *Myomimus* and *Muscardinus*, as well as *Glirulus* and *Eliomys*. As a rule though, these genera have a distinct character of their own. The hair of *G. glis* is distinctively different among the whole family *Gliridae*.

IV. KEY TO THE IDENTIFICATION OF SPECIES FROM THE FAMILY *GLIRIDAE* BASED ON HAIR STRUCTURE

1. All hairs have a ladder medulla through the whole hair length. The medulla is exclusively uniseriate, continuous or fragmental . . . . . 2.
—. Some of the hairs have a uniseriate ladder medulla through the whole hair length, in some hairs parts have a multiseriate medulla (2—3 cells to the hair width). Medulla solely continuous . . . . . 4.
2. Cuticular scale patterns mainly mosaic very fine, with a strongly undulating pattern line as if rugged (Pl. VI, fig. 14), in a few hairs it merges into a pattern intermediate between a diamond petal and lanceolate pattern. Cross-sections kidney-shaped, and medulla in the distal of the hair fragmental . . . . . *Glis glis*
—. Cuticular scale pattern lanceolate or diamond petal. If there is a mosaic pattern present its lines are even nearly parallel. Cross-sections round or kidney-shaped, but the medulla is continuous throughout the whole hair length . . . . . 3.
3. Cuticular scale pattern is lanceolate or diamond petal with long petals. Cross-sections kidney-shaped . . . . . *Muscardinus avellanarius*
—. Cuticular scale pattern mosaic merging into a diamond petal pattern with short petals. Cross sections round or slightly oval . . . . . *Glirulus japonicus*
4. Hair mainly non-constricted. Cuticular scales either adhere to the surface of the hair or protrude in equal degree along the whole surface of the hair. Cuticular scale pattern is mosaic, sometimes merging into a diamond petal pattern, with short capsule-like overlapping petals. There can also be a diamond petal pattern with long petals, merging into a simple lanceolate pattern. Cross-sections exclusively round . . . . . 5.
—. Most of the hairs, especially the coarse ones are constricted. The cuticular scales protrude more to one side, alternatively after each constriction.

Cuticular scale pattern is diamond petal with long petals, merging in parts into a pattern similar to a compound lanceolate pattern (two scales to the hair width). Cross-sections round, oval or bean-shaped . . . . . *Myomimus personatus*

5. Cuticular scales adhere to the surface of the hair. On some of the hair the cuticular scale pattern is mosaic with parallel lines of the pattern, in others diamond petal (Pl. II, fig. 5), or diamond petal with elongated petals (Pl. II, fig. 4) . . . . . *Eliomys quercinus*

—. Protruding scales (more on thin hairs). Cuticular scale pattern mosaic with „cross over" lines of the pattern, merging into a diamond petal pattern which is sometimes composite (two petals to the width of hair). This pattern can in turn merge into a lanceolate pattern (Pl. V, fig. 11) . . . . . *Dryomys nitedula*

V. HISTOLOGICAL STRUCTURE OF HAIRS IN THE PARTICULAR SPECIES OF *GLIRIDAE*

Eliomys WAGNER, 1840

Garden dormouse, *Eliomys quercinus* (LINNAEUS, 1766)

The guard hairs are about 12 mm long and about 42 μ thick. There is no medulla in the tip of the hair. The medulla is ladder (Pl. I, fig. 1, 2), uniseriate. In a few cases it has been found that in the thickest hairs there are two cells to the hair width. The medullary cells are loosely placed in the cortex, and they do not adhere to oneanother. The intercellular spaces are filled with air. The pigment is accumulated in a characteristic way (Pl. I, fig. 1) giving a picture of the medulla composed of spherical, oval cells, whereas in reality the cells are more rectangular. In the case of light hair with little pigment the picture is completely different (Pl. I, fig. 2); one can see a distinct „ladder" built of narrow, rectangular cells.

The cross-section is round.

The cuticular scales in guard hairs are adhering and form in some of the hairs a mosaic pattern and in others the mosaic pattern merges into a diamond petal pattern (Pl. II, fig. 3, 4). There have also been found hairs with only a diamond petal pattern. The mosaic on the hairs of *E. quercinus* is a simple pattern; the lines of it are nearly parallel, rarely adjoining (Pl. II, fig. 3). This pattern merges into a diamond petal- capsule pattern (Pl. II, fig. 5). The cuticular petals are wide enfolding capsule-like the stem of the hair. There can also be a diamond petal pattern in a form similar to the one shown in Pl. II, fig. 4. The proportion of the length of a scale to its width is completely different here. The scales are more slender, more sharply finished. Such a diamond petal pattern usually is the only one that is present in a given hair. The coarse hairs are shorter, of an average length 11 mm and 30 μ width. Fine hairs have not been measured and they have not been taken into consideration in the analysis because of their simplified structure.

Dryomys THOMAS, 1906

Forest dormouse, *Dryomys nitedula* (PALLAS, 1779)

Guard hairs are straight, with no medulla in the tip. Their medium length is 12 mm and width 33 μ. The medulla is ladder (Pl. III, fig. 6, 7), built of narrow, rectangular cells (Pl. III, fig. 6, 7, Pl. IV, fig. 10). In a few places there can be two cells to the hair width (Pl. IV, fig. 8). In thinner guard hairs and in coarse hairs the medulla is built of rounded cells. There have been found protruding cuticular scales on thin hairs. The cuticular is built of cells of thick hairs with a mosaic pattern, or a mosaic pattern merging into a diamond petal pattern (sometimes two petals to the hair width). In places the diamond petal pattern may merge into a lanceolate pattern (2—3 cells to the hair width). In coarse hairs or thinner guard hairs, the diamond petal pattern is more frequent (Pl. V, fig. 11). There are cases of hairs having a cuticular pattern intermediate between a diamond petal and a lanceolate one. The cross-section is round. Coarse hairs have an average length of 10 mm, and 22 μ width.

Glis BRISSON, 1762

Fat dormouse, *Glis glis* (LINNAEUS, 1766)

The guard hairs are long, their medium length is 14 mm and their average width is 40 μ. The medulla is ladder uniseriate (Pl. V, fig. 12, 13), often fragmental, built of two types of cells:

1. narrow, rectangular and 2. oval, spherical. The second type is more frequent; it is found both in guard and coarse hairs. It can occur that the medulla changes throughout the hair's length; in its proximal part and in the shaft it is built of cells irregularly shaped. In the distal part the cells become more typical, spindle shaped or rectangular. The tip of the hair has no medulla. The cuticula is built of cells which form on the surface of guard hairs mainly a mosaic pattern, but there are also hairs in which the mosaic merges into a diamond petal pattern or one intermediate between a diamond petal pattern and a lanceolate pattern (Pl. VI, fig. 15). The mosaic is very small, the line of the pattern is strongly undulated, as if rugged (Pl. VI, fig. 14). The cross-section is kidney-shaped. The coarse hairs are about 12 mm long and about 32 μ wide.

Muscardinus KAUP, 1829

Common dormouse, *Muscardinus avellanarius* (LINNAEUS, 1758)

The guard hairs are straight. They are 10 mm long and have an average width of 35 μ. The tip has no medulla, it is rather long. The medulla is ladder, uniseriate and continuous. In some of the hairs the medullary cells are rectangular, but lumpy and rounded, in others, narrow, rectangular. They are pigmented in a characteristic way on both sides along the cells. Sometimes (e. g. in coarse hairs) the medullary cells are further away from each other than normally which gives an effect of a „bead-like" medulla (Pl. VII, fig. 16). The cuticula is built of cells which form a lanceolate or diamond petal pattern. One pattern may

merge into another in the same hair (Pl. VIII, fig. 18). In the shaft part of the hair there may be a mosaic (Pl. VIII, fig. 17).
The cross-section is kidney-shaped. The coarse hairs are very similar to the guard ones but they have a shorter tip. They are 8.5 mm long and 24 μ wide.

Glirulus SCHINZ, 1845

Japanese dormouse, *Glirulus japonicus* SCHINZ, 1845

Hairs thinner and more delicate than that of the remaining *Gliridae*. Guard hairs are 15 mm long and 20 μ wide. The medulla is ladder, uniseriate (Pl. IX, fig. 19, 20), it occupies nearly the whole width of a hair. It is built of big, rectangular cells, often bi-concave; pigment accumulates in a characteristic way in the concaves which gives a picture of a continuous medulla built of adhering lumpy elements. In hairs which are less pigmented the cells lie at some distance apart from each other. In such a case one can clearly see drops of pigment gathering in the concave parts of the cells. The tip of the guard hairs is long, it has no medulla and often has no pigment. The cuticula is built of cells which form a mosaic pattern which merges into a diamond petal pattern (Pl. X, fig. 21) typically shaped. In coarse hairs the diamond petal pattern may merge into a lanceolate pattern.
Cross-section are round or slightly oval.

Myomimus OGNEV, 1924

Mouse-like dormouse, *Myomimus personatus* OGNEV, 1924.

The guard hairs are of an average length 11 mm and 18 μ width. The medulla is ladder uniseriate (Pl. X, fig. 22). In a few hairs two cells to the hair width were present. The medullary cells, as in the case of all *Gliridae*, are rectangular, rounded to a greater or lesser degree, pigmented in a characteristic manner. In the thickest hairs in places where two cells to the hair width are present — they are slightly different in shape, narrower, without a marked concavity. Sometimes the cells pass each other. The cuticula is built of cells which form on some of the hairs a diamond petal pattern, which can merge into a pattern similar to a lanceolate one (in thick hairs there can be two scales to the hair width -(Pl. XI, fig. 23)- or in other hairs a mosaic pattern (Pl. XI, fig. 24), or mosaic merging into a diamond petal pattern. Coarse hairs may be constricted. There can be two constrictions throughout the hair length. This feature is considered to be characteristic of the hairs of insectivores (DAY, 1964). Protruding cuticula scales have been found in coarse hairs; as in the case of insectivores, the scales protrude more on one side which changes after a constriction i. e. if before the constriction the scales protruded more to the right side than after the constriction they will protrude more to the left. The cross-sections are round, slightly oval or nearing a bean-shape.

VI. DISCUSSION

Gliridae are a very distinct group as regards the histological structure of hair, especially the shape of the cuticular scale patterns. Some of the species from this family have already been considered in other authors' studies e. g. DAY (1966) gives a description of the hair *M. avellanarius* and *G. glis*. According to DAY the hair of *M. avellanarius* has a ladder uniseriate medulla, the arrangement of the cuticular scales is lanceolate or diamond petal, and the cross-section kidney-shaped. The author mentions that delicate (fine) hair can be constricted.

G. glis on the other hand has a uniseriate, ladder — fragmental medulla, the arrangement of the cuticular scales is mosaic. DAY does not give the cross-section. On the basis of the material consulted for this paper, it has been found that in the hairs of *M. avellanarius* there is a mosaic pattern apart from the lanceolate and diamond petal pattern mentioned by DAY. Constricted hairs, not only fine hairs as DAY suggests, but also guard hairs are sporadically present in all species from the family *Gliridae*. Most of the guard hairs of *M. personatus* have constrictions which is considered to be a characteristic feature of the species. This feature has been up till now (DAY, 1966) considered as a characteristic feature of the hairs of insectivores. It has been found that as in the case of insectivores, though in a smaller degree, the cuticular scales protrude more to one side alternatively after each constriction in the hair of *M. personatus*. However, the hairs of *G. glis* apart from having the mosaic pattern mentioned by DAY, have also a diamond petal pattern, or diamond petal merging into a lanceolate. The cross-sections of the hair of the fat dormouse are kidney-shaped. As far as the structure of the medulla in the hair of *G. glis* is concerned then apart from a ladder fragmental medulla there is also a continuous medulla. A fragmental, discontinuous medulla is most frequently found in the distal part of the hair.

Genera belonging to the *Gliridae* which are found in Poland, that is: *Dryomys*, *Eliomys*, *Glis* and *Muscardinus* have already been initially described by the author (DZIURDZIK, 1973); however, it is only this paper that contains a wide, detailed description of the histological structure of the hair of *Glires*, supported by photographical material. Previously the author did not succeed in identifying two species on the basis of hair structure, namely: *E. quercinus* and *D. nitedula*. Now this has proved to be possible. Data concerning the width and length of the hair of *Glires*, their division into particular categories (guard, coarse, fine and the like) — can be found in SOKOLOV'S paper (1973). In comparison with the measurements of the hair of *Gliridae* given by SOKOLOV the hair of the representatives of this family in Poland is usually shorter and thinner. This is illustrated in the following Table I. This table concerns only guard hairs. The measurements of coarse hairs and fine hairs have not been taken into consideration in this paper, as they are not needed for the identification of species.

SOKOLOV also gives the number of hairs in 1 cm^2 of skin of a given species.

Table I

Measurements of guard hairs

Name of species	Sokolov (1973)		Dziurdzik	
	length in mm	width in μ	length in mm	width in μ
Eliomys quercinus	13.4	47	12	42
Dryomys nitedula	13.5	35	12	33
Glis glis	14.7	45	14	40
Muscardinus avellanarius	10.9	36	10	35
Myomimus personatus	—	—	11	18
Glirulus japonicus	—	—	15	20

For *G. glis* and *D. nitedula* this number is 22 300, and for *E. quercinus* — 17 660 hairs. However, there is no data concerning the structure of the medulla or cuticular scale patterns.

From observation it appears that:

1. The hair of all *Gliridae* has a ladder uniseriate medulla. The occassional occurrence of a multiseriate medulla (two cells to the hair width) is not connected with the type of hair but with hair width.

2. All guard hair of *Gliridae* has the same cuticular scale patterns no matter which part of the animal's body it comes from.

3. The cuticular scale patterns, the structure of the medulla, and the shape of the cross-sections can be used in the case of *Gliridae* for taxonomic purposes.

4. It has been found that constricted hairs are present in the fur of *Gliridae*. Up till now this feature was considered to be a limited to insectivores.

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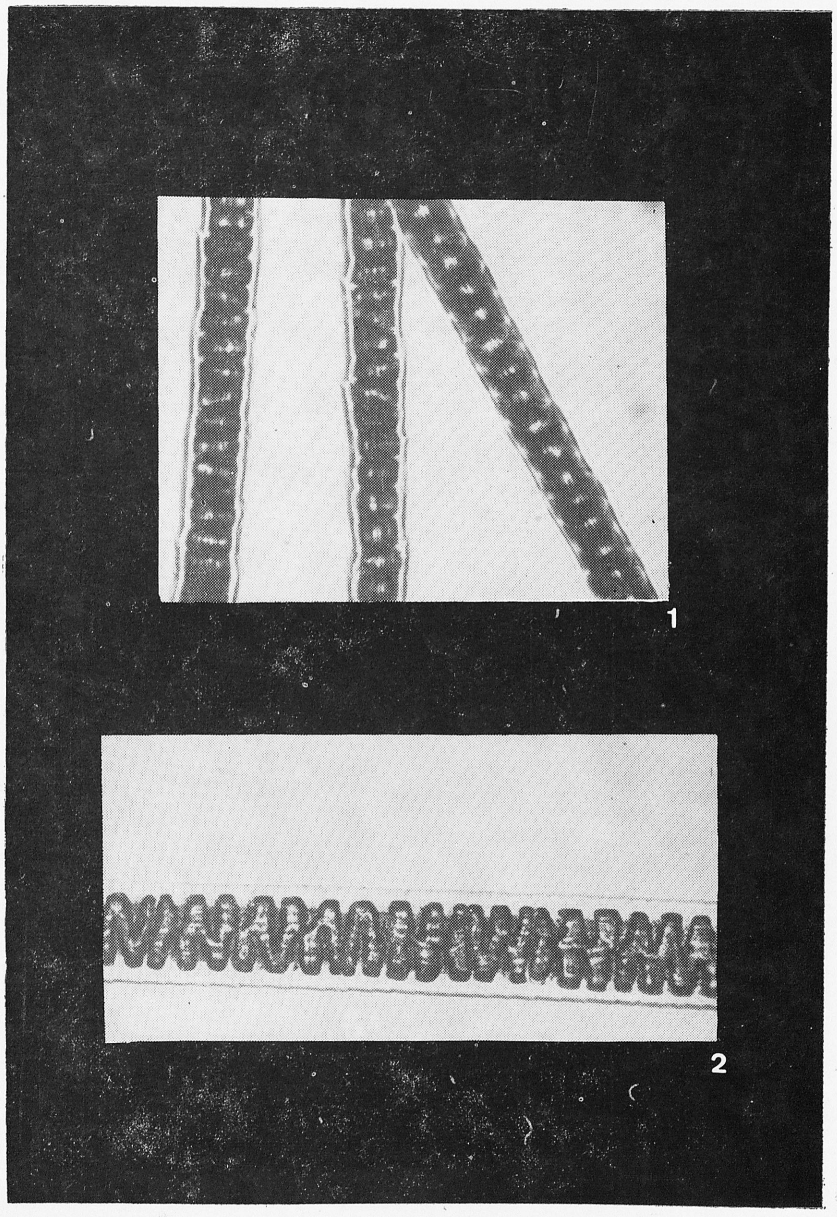
STRESZCZENIE

Praca zawiera opracowanie histologiczne włosów polskich i egzotycznych przedstawicieli rodziny *Gliridae* oraz klucz do oznaczania gatunków w obrębie tej rodziny, na podstawie budowy rdzenia, wzoru łusek kutikuli oraz kształtu przekroju poprzecznego. Opracowano 6 rodzajów, z czego 4 występują w Polsce: *Eliomys*, *Dryomys*, *Glis* i *Muscardinus*. Pozostałe 2 rodzaje to: *Glirulus* znany z Japonii, oraz *Myomimus*, występujący w Azji Środkowej i Europie południowo-wschodniej. Z obserwacji wynika, że: 1. u wszystkich *Gliridae* włosy mają rdzeń drabinowy, jednoseryjny. Występująca sporadycznie wieloseryjność (2 komórki na szerokość włosa) związana jest nie z typem włosa, lecz z jego szerokością. 2. Włosy przewodnie *Gliridae* mają ten sam wzór łusek kutikuli, niezależnie od miejsca usytuowania na ciele zwierzęcia. 3. Wzór łusek kutikuli, budowa rdzenia oraz kształt przekroju poprzecznego mogą służyć w przypadku *Gliridae* celom taksonomicznym. 4. Stwierdzono u *Gliridae* występowanie włosów przewężanych, którą to cechę przypisywano do tej pory jedynie włosom ssaków owadożernych.

PLATES

Plate I

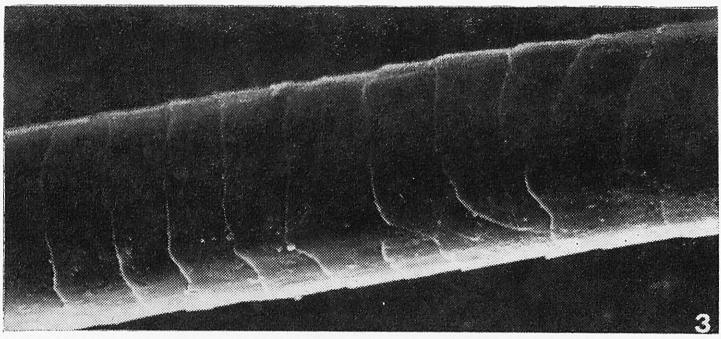
Types of medullary cells present in the hair of *E. quercinus*. 1 — medullary cells pigmented in a characteristic way, 2 — a hair partly without pigment; a clearly visible „ladder" of narrow, rectangular cells. The picture is slightly deformed by the presence of intercellular air



B. Dziurdzik

Plate II

Types of cuticular scales found in the hair of *E. quercinus*. 3 — a mosaic pattern, 4 — a diamond petal pattern. Enlargement 1500 ×, 5 — diamond petal pattern. The cuticular scales are wide, enclosing capsule-like the hair's stem. Enlargement 6000 ×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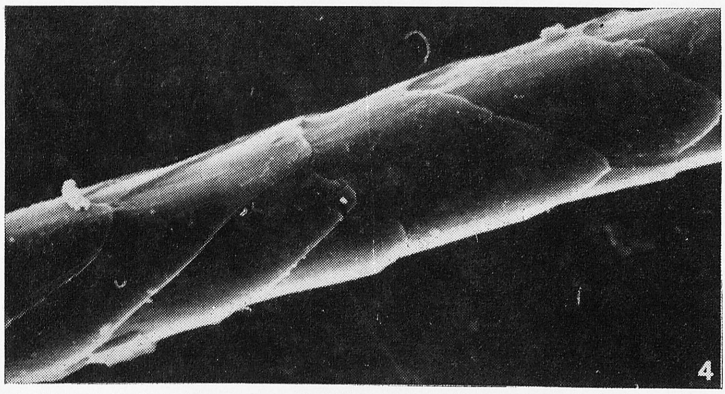
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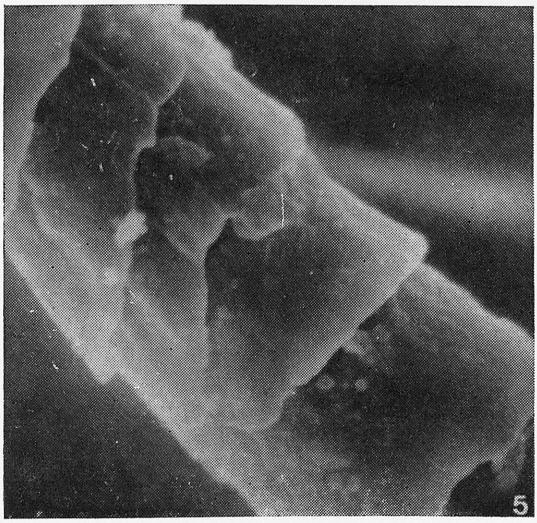

5

Plate III

Types of medulla present in the hair of *D. nitedula*. 6 — biconcave cells are visible with pigment accumulated in a characteristic way, 7 — a hair with visible protruding cuticular scaes and a hair with lighter parts, with a visible structure of medulla

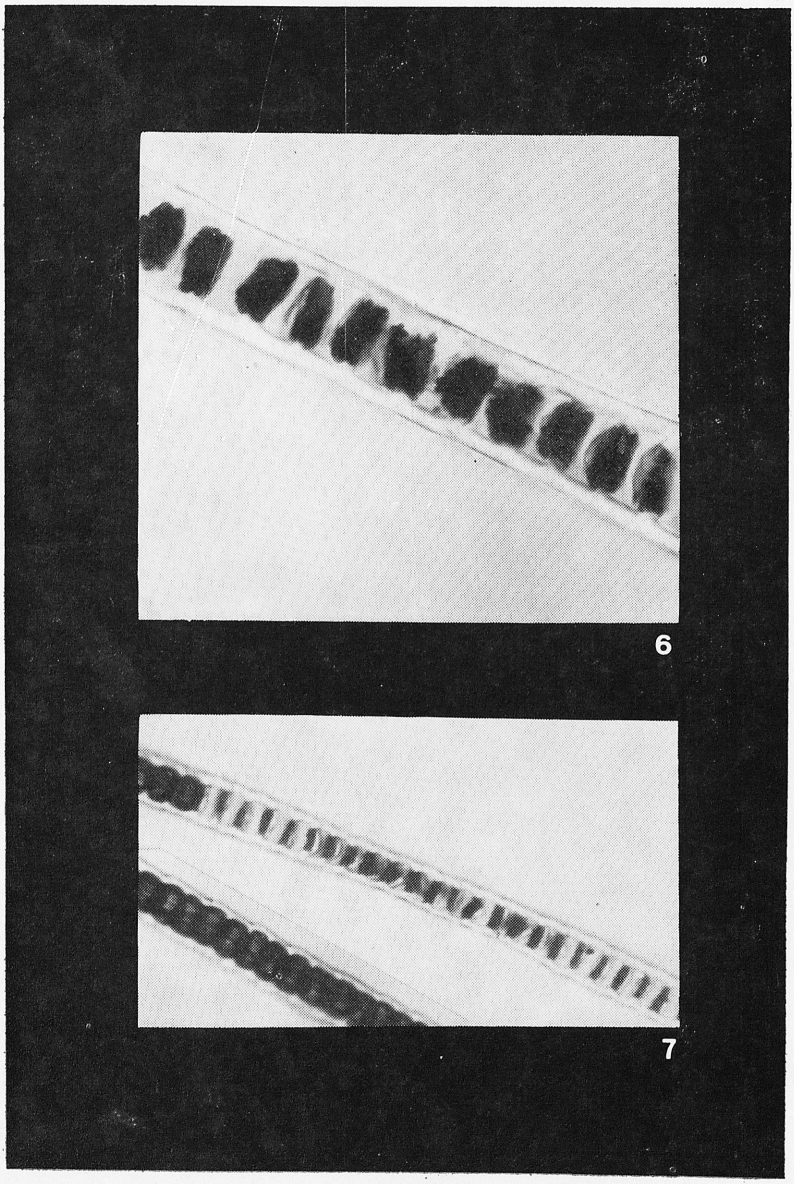
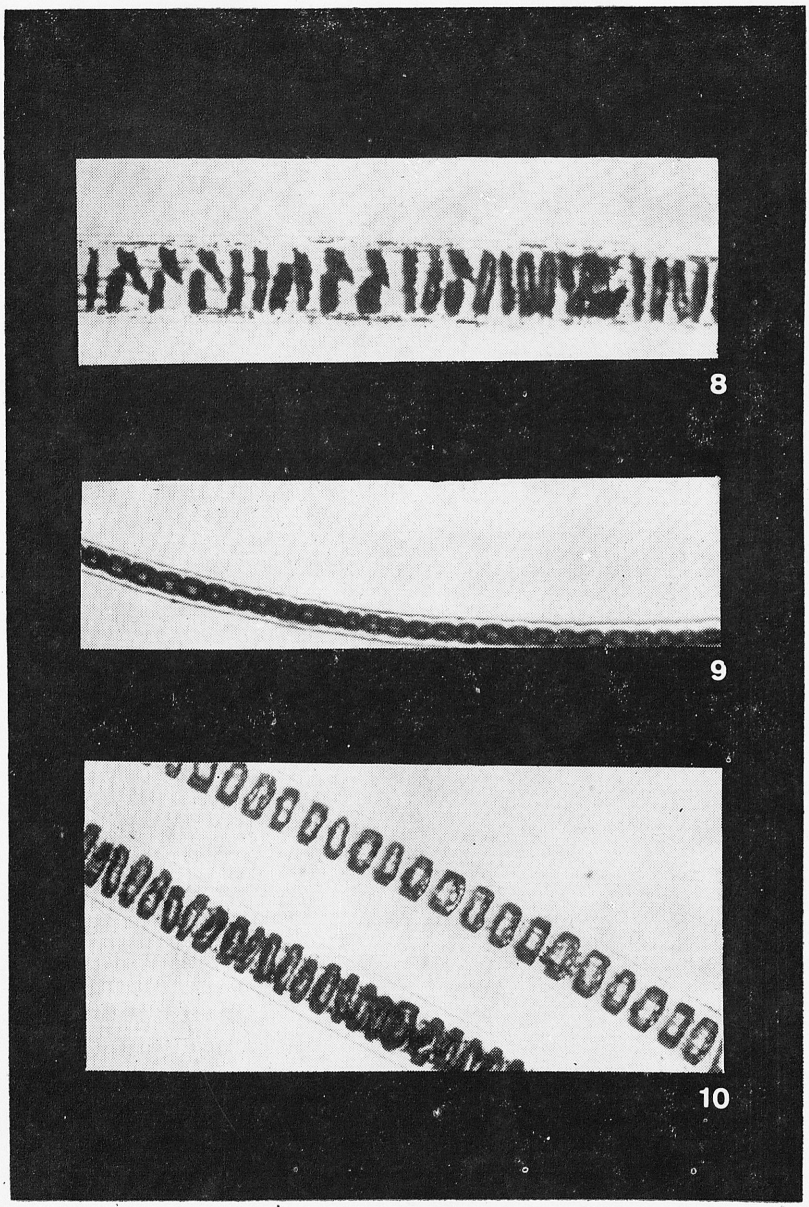

6
7
0.01mm

Plate IV

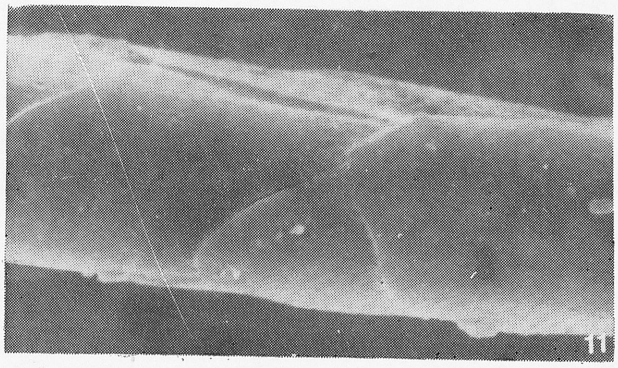
Types of medulla in the hair of *D. nitedula*, 8 — a fragment of a hair with two medulary cells to the hair width, 9 — a coarse hair, 10 — typical medullary cells; on the left side of the hair visible traces of pigment

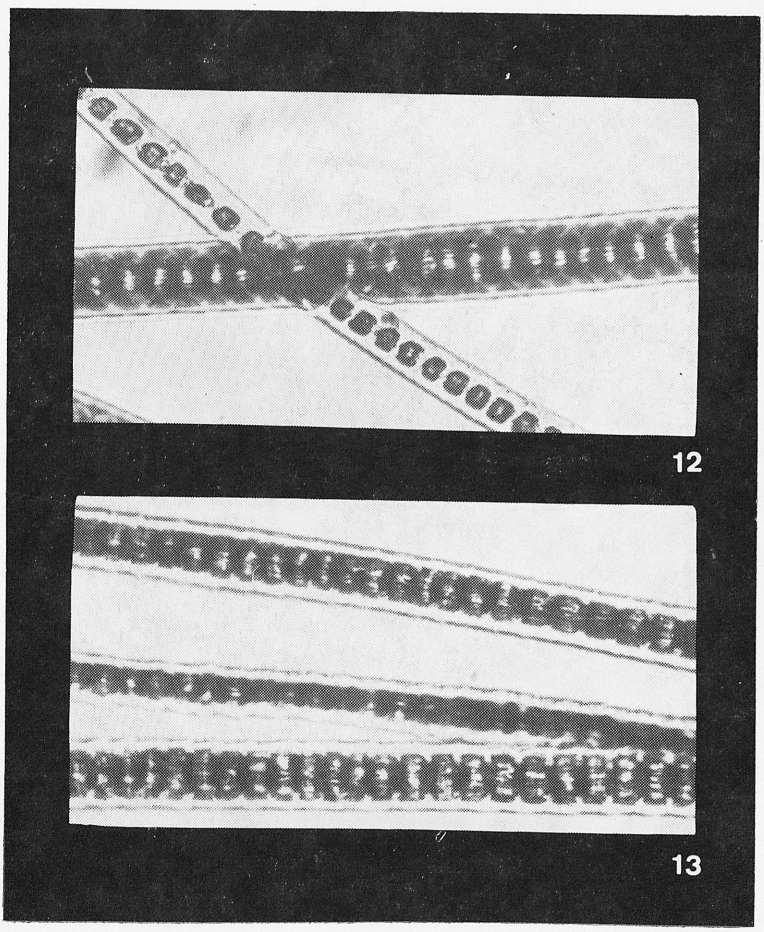


B. Dziurdzik

Plate V

A diamond petal pattern on a hair of *D. nitedula* (11). Enlargement 3000 ×. Types of medullary cells in the hair of *G. glis*. 12 — a lighter hair, with rounded medullary cells, 13 — hairs with rectangular medullae cells



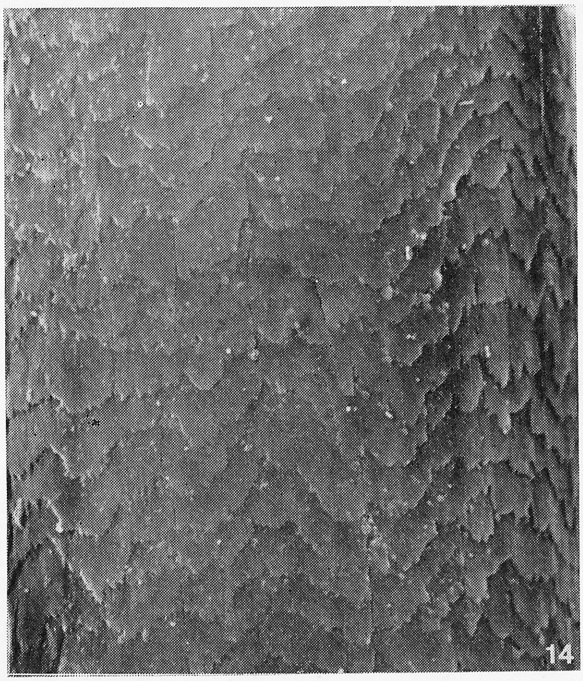


0.01mm

B. Dziurdzik

Plate VI

A mosaic cuticular scale pattern in a hair of *G. glis*; the mosaic is very fine, the line of the pattern very undulating (14). Enlargement 6000 ×. A cuticular scale pattern intermediate between a diamond petal and a lanceolate pattern of *G. glis* (15). Enlargement 3000 ×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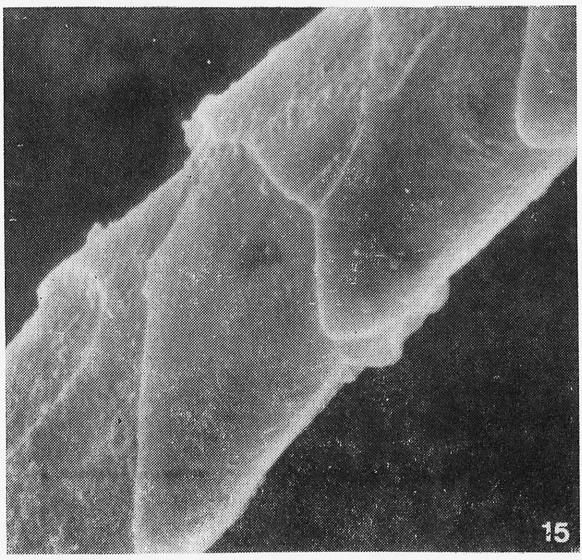

15

Plate VII

A bundle of hairs of *M. avellanarius*; medullary cells visible (16)

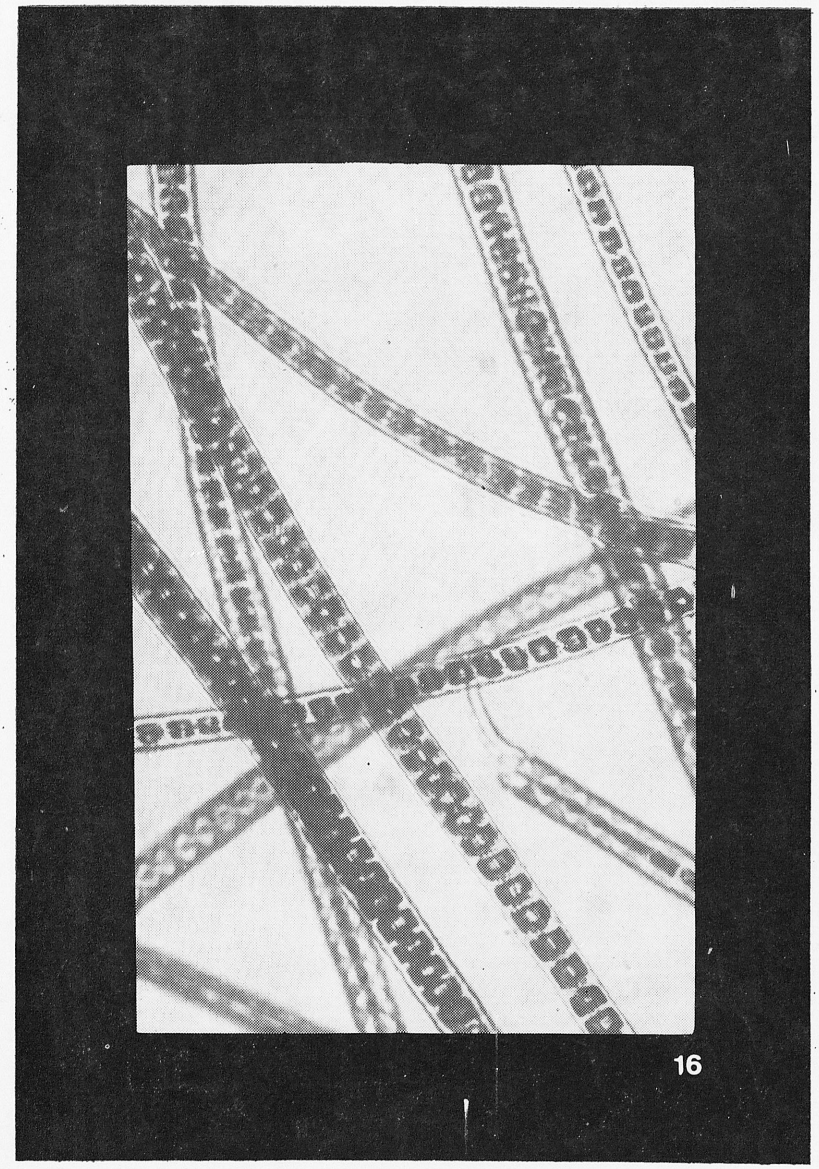
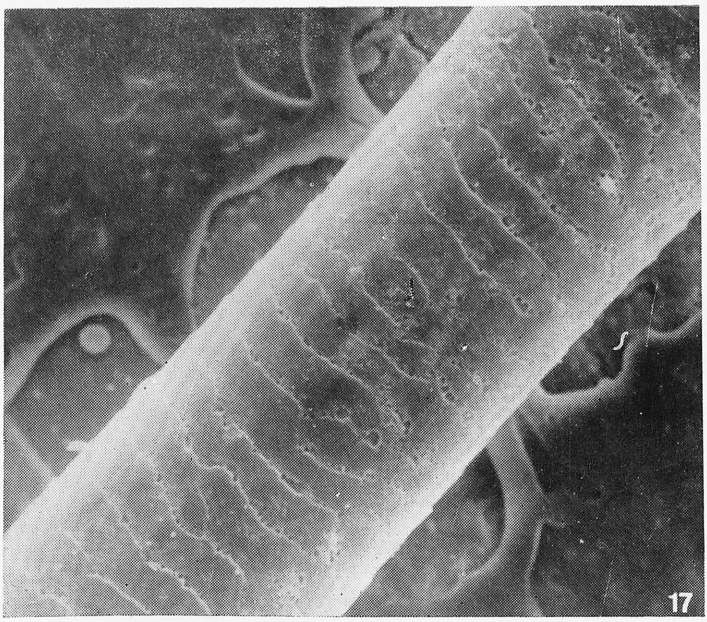

16
0.01 mm

Plate VIII

Cuticular scale patterns of the hair of *M. avellanarius*. 17 — a mosaic pattern, 18 — the change of a diamond petal pattern into a lanceolate within the same hair. Enlargement: fig. 17—1500 ×, fig. 18—1000 ×


17

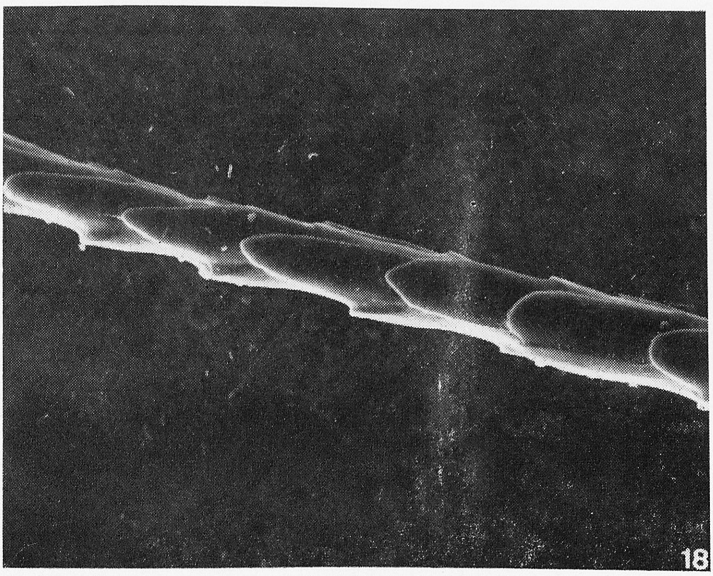
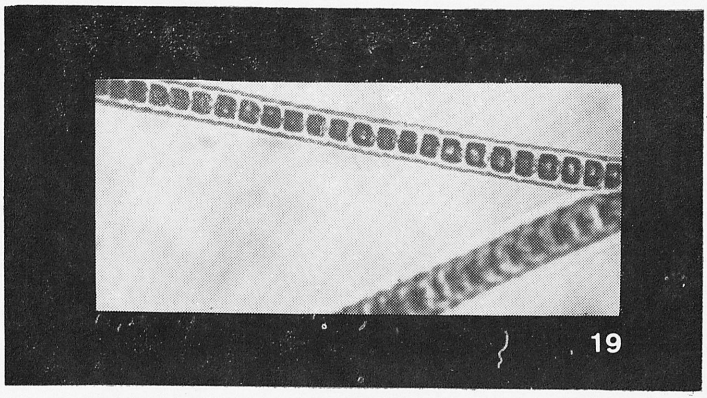
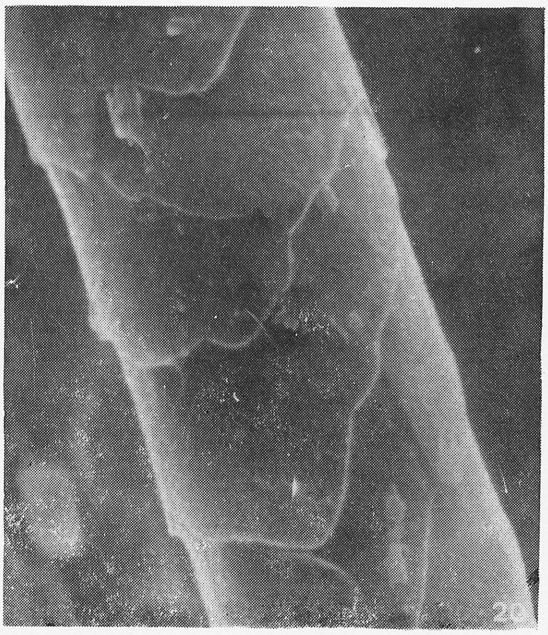

18

Plate IX

Types of medulla in the hair of *G. japonicus* (19) A diamond petal pattern of the cuticula on the hair of *G. japonicus* (20). Enlargement 3000 ×



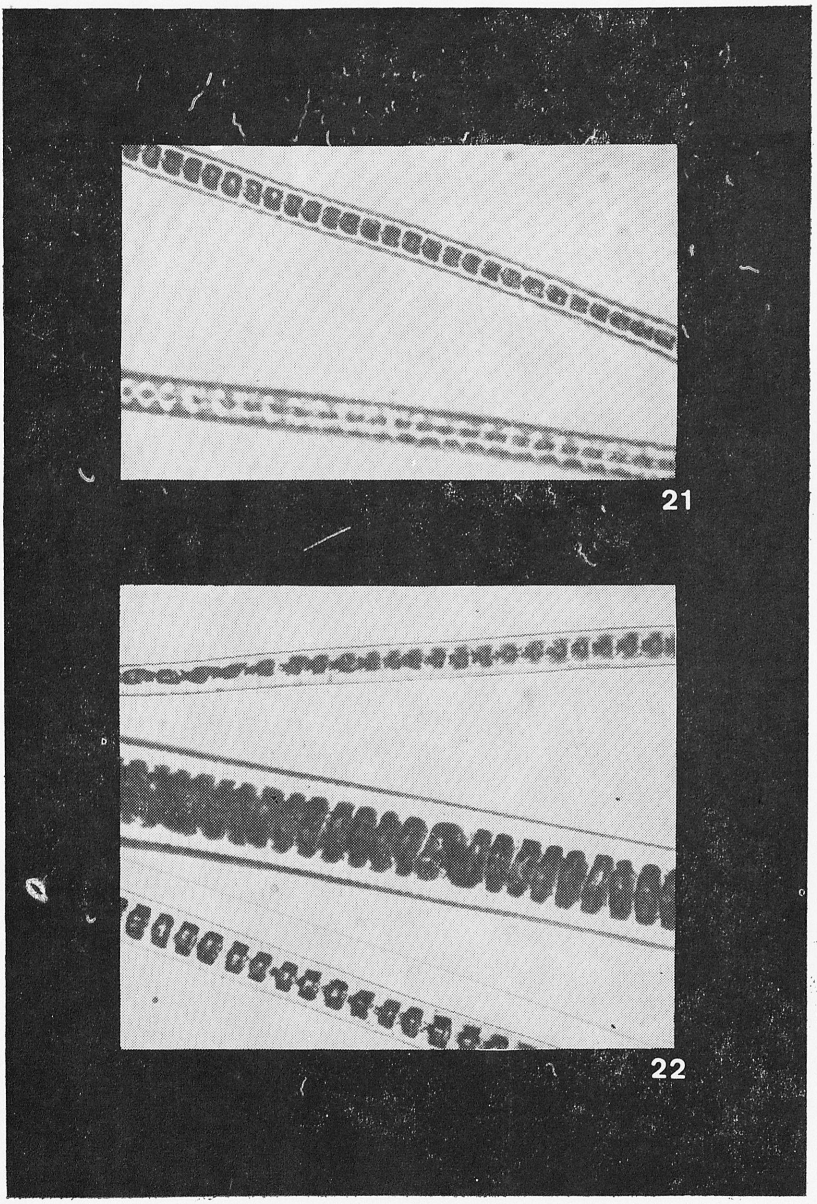
0.01 mm



B. Dziurdzik

Plate X

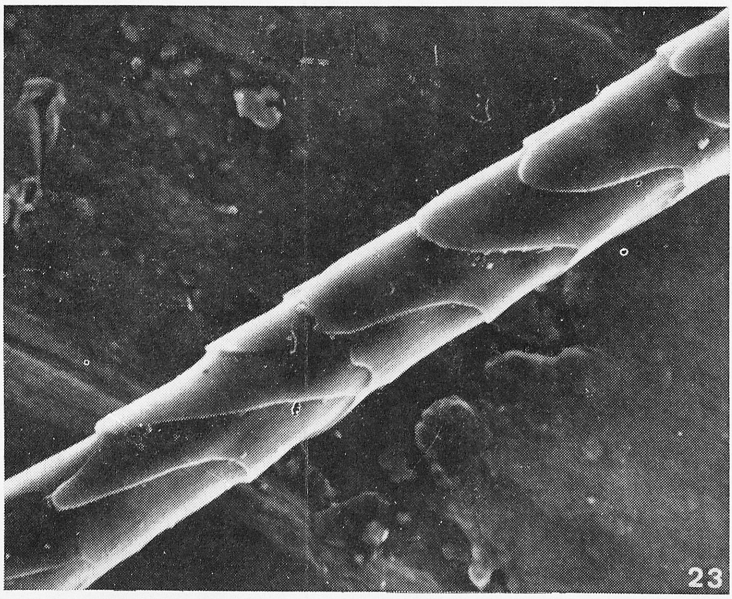
A bundle of hair of *M. personatus* (21—22)



B. Dziurdzik

Plate XI

Cuticular scale patterns on the hair of *M. personatus*. 23 — a diamond petal pattern merging into a lanceolate, 24 — a mosaic pattern. Enlargement 1500 ×


23

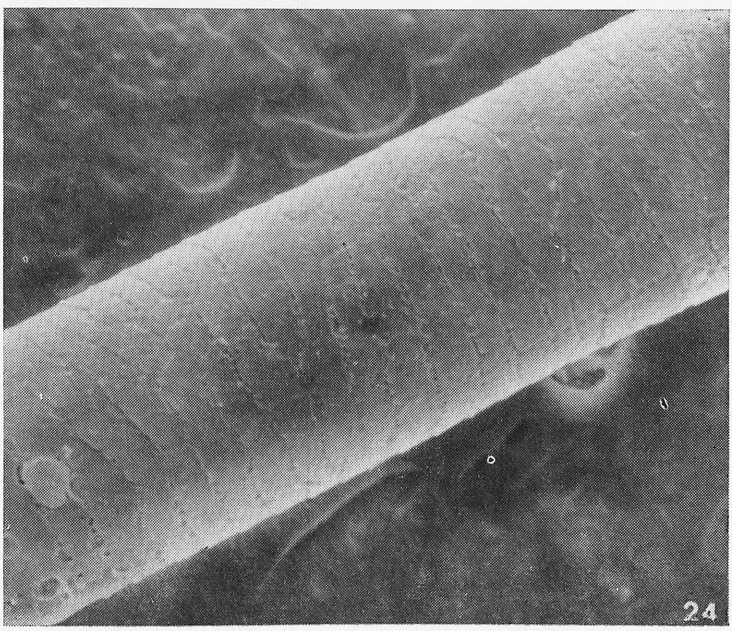
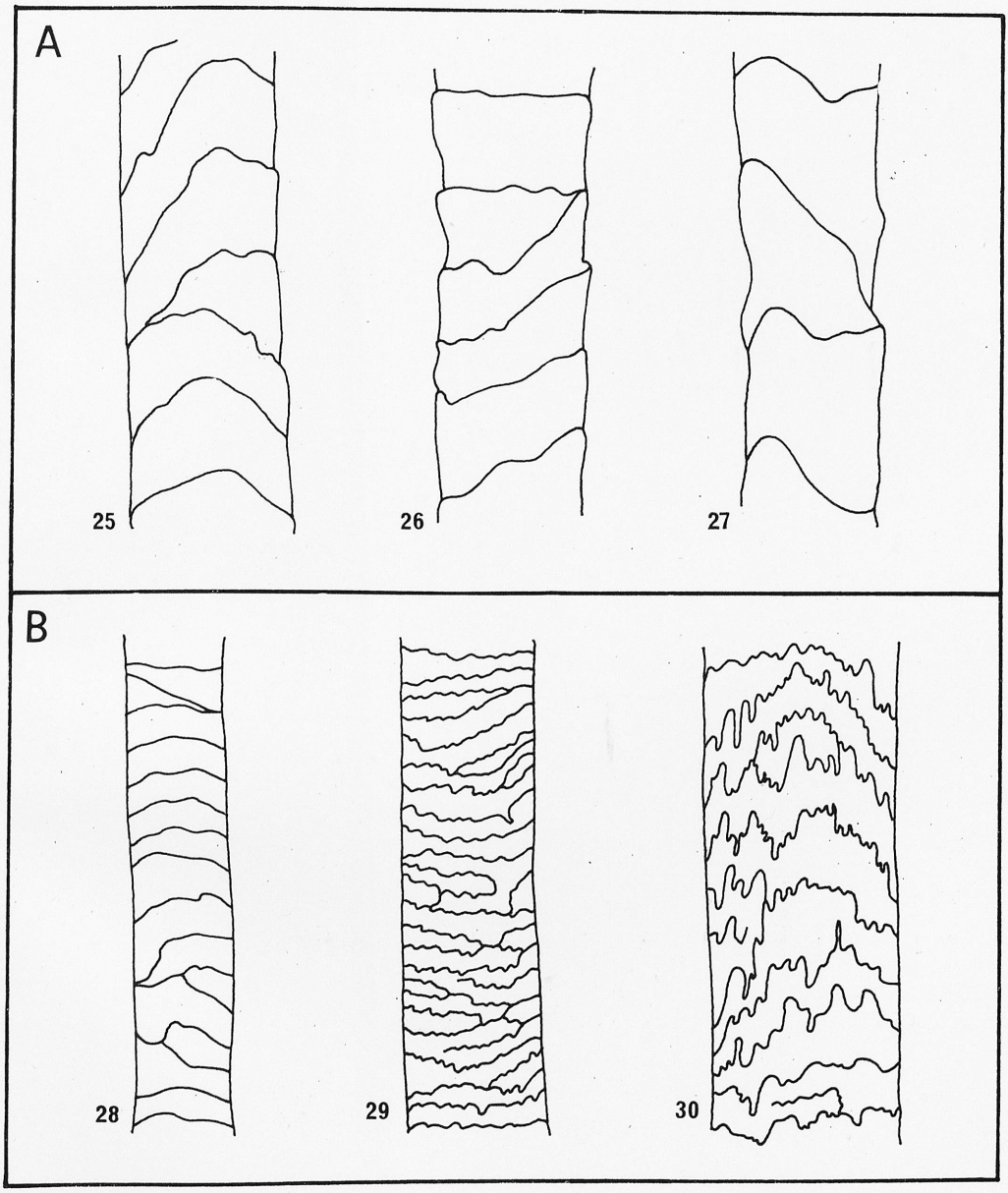

24

Plate XII

Changeability within the same type of cuticular scale patterns. A — figure 25, 26, 27 — different occurrences of the diamond petal pattern; B — figure 28, 29, 30 — different types of mosaics


A
25
26
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B
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