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Atlas of the Microscopic Hair Structure of Southern African Shrews, Hedgehogs, Golden Moles and Elephant-shrews (Mammalia)

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Abstract. A hair atlas of 41 southern African Macroscelididae, Soricidae, Erinaceidae and Chrysochloridae species is presented and a simple key to identifying those species on the basis of hair characteristics is compiled. Light and electron microscopic hair analyses revealed diagnostic species characteristics such as medullary structure, cross sectional shape and cuticular scale patterns. Additional characteristics like hair colouration, diameter and length as well as geographical distribution have been considered. Hairs of all examined species of golden moles and elephant-shrews show sufficient specific characteristics to allow an unequivocal identification of the species. Shrew hairs, however, lack specific features and in most cases only a definite identification to generic level is possible. The diagnostic criteria of similar keys by other authors as well as limitations of the key are discussed.

Key words. hair fine structure, identification key, hair atlas, small mammals

1. INTRODUCTION

Microscopic analyses of mammalian hair find practical applications in law enforcement and forensic sciences (DE BOOM & DREYER 1953), epidemiology (KEOGH 1979), taxonomy (KEOGH 1975; DUCOMMUN et al. 1994), ecological studies (e.g. DAY 1966; BRUNNER & WALLIS 1986), species conservation, fur and textile industry (WILDMAN 1954) and are also relevant for the identification of food contaminations (KEOGH 1979).

The examination of hairs extracted from regurgitated pellets of birds of prey (MÄRZ 1987) and scats provide information on dietary habits of the respective predators and the existence of mammalian prey (e.g. DAY 1966; GILBERT & NANCEKIVELL 1982; BRUNNER & WALLIS 1986). Since hairs suffer lesser degradation from mastication and digestion than skulls and bones, hairs retain valuable characteristics and are often the only usable remains of an ingested prey species for identification (DAY 1966; BRUNNER & COMAN 1974).

Hairs are usually composed of a cuticula with a layer of scales, the cortex containing pigmentary granules and the medulla (BRUNNER & COMAN 1974). The variations in shape, arrangement and type of these structures as well as characteristics such as hair diameter, distal tip tapering, size ratio between medulla and cortex, etc. are specific for certain taxonomic groups and thus allow the identification of the genus or species from a hair sample when compared to a reference system based on microscopic hair structure such as a hair atlas or an identification key (BRUNNER & COMAN 1974). Certain types of body hairs such as overhairs are of particular diagnostic importance because of the presence of such specific characteristics and structures.

Comprehensive photographic referencc systems and identification keys were developed for many mammal species, e. g. of Australia (LYNE & MCMAHON 1951; BRUNNER & COMAN 1974), Asia (AMERASINGHE 1986), northern America (MATHIAK 1938; MAYER 1952; ADORJAN & KOLENOSKY 1969) and Europe (DAY 1966; DZIURDZIK 1973, DEBROT et al. 1982; TEERINK 1991). These also exist for most southern African Bovidae (DREYER 1966; KEOGH 1983), Muridae and Cricetidae (KEOGH 1985) and mammals of the Andries Vosloo Kudu Reserve, South Africa (PERRIN & CAMPBELL 1980).

However, photographic reference systems do not exist for small prey species such as shrews and elephant-shrews as well for most rodent families of southern Africa. The objectivc of the present study is to compile an atlas of the characteristics and structure of hairs of southern African Macroscelididae, Soricidae, Erinaceidae and Chrysochloridae species as well as a key for their identification based on hair characteristics.

2. MATERIALS AND METHODS

2.1. Collection of reference hair specimens for identification

Hairs were taken from dried skins of the Natural History Museum (MNH), Maputo, Mozambique, the collection of Scientific Services (NKW, KNP), Kruger National Park, Skukuza, South Africa and the Transvaal Museum

(TM), Pretoria, South Africa. Origin and specimen numbers are stated in the Hair Atlas. By means of examination of the teeth, only adult individuals with fully developed pelage were chosen for hair sampling. Hair samples were taken from behind the neck on the back, from the flanks and the belly of the animal. In order to obtain entire unfragmented hairs, a tuft of hairs was clasped with forceps at the base and carefully pulled against the direction of the undisturbed hair. Hair samples were transferred on transparent sticky tape to maintain the original hair orientation and removed for examination by applying a drop of 70% ethanol on the hair sample.

Forty-one species of southern African Macroscelididae (7 spp.), Soricidae (20 spp.), Erinaceidae (1 sp.), and Chrysochloridae (13 spp.) were examined. Hair samples of *Chrysochloris visagiei*, *Chryptochloris zyli* (Chrysochloridae) and *Elephantulus fuscus* (Macroscelididae) were not available from the three collections and therefore not examined.

Taxonomic classification and data on distribution are based on HUTTERER (1993), SCHLITTER (1993), BRONNER (1995) and BOITANI et al. (1999).

2.2. Microscopic analysis of hair samples

Length measurement, description of hair profile and colour was made with the help of a stereo microscope (Wild 195040, Germany) and an electronic calliper (Mitutoyo Digimatic CD-6 CS, Japan). Whole mounts, cross sections and scale casts of hairs were prepared as described in great detail e. g. by BRUNNER & COMAN (1974) and KEOGH (1983, 1985) and examined using a microscope (Olympus T 041, Japan) with phase contrast condenser (Olympus ULW CD 0.30) and phase contrast objectives (Olympus S Plan 10x PL, LWD CD Plan 20x PL, LWD CD Plan 40x PL).

Prior to examination, hair samples were cleaned in 70% ethanol and dried between absorbent tissue paper. For the study of medulla types and pigmentation, temporary mounts were made. Sample hairs were mounted in paraffin oil on cover slip (76 mm x 26 mm x 1 mm) and examined in phase contrast.

Cross sections of the hairs were obtained by the plate method using a stainless steel slide (76 mm x 25 mm x 0.5 mm) with holes of 0.8 mm in diameter. A loop of nylon thread was pushed through a hole and several threads of bright cellulose acetate yarn (335 DTEX, Bembergcell S.P.A., Italy) inserted into the loop as packing material. The nylon thread was pulled through the hole until the cellulose acetate yarn formed a funnel-like structure. A hair sample was inserted into the centre of the "funnel" and pulled into the hole. The protruding parts of the hairs and packing material were cut off on both sides of the slide with a razor blade held at an angle of about 35°. Paraffin oil and a cover slip were placed on the side upon which the second cut was made and the obtained cross section was examined in phase contrast in order to study the shape of cross sections and medulla.

Cuticular scale casts were prepared in order to study cuticular scale patterns. Individual hairs were placed on a thin layer of transparent nail polish on a glass slide. After drying, hairs were removed with forceps and the resulting casts examined in bright field.

Cuticular scale patterns were also examined by the use of a scanning electron microscope. Hair samples were mounted on stubs, coated with gold for two minutes using a sputter coater (Edwards S 150, Germany) at 20 mA and 2.0 x 10^{-3} Pa and scanned with an electron microscope (Zeiss DSM 940A, Germany) at 15.0 KV.

2.3. Measurement of hair diameter and angle of distal hair tip

Photographs of the square compartments (1/400 mm²) of a counting chamber (Neubauer Lumicyte, Germany) were taken to produce 50 µm scales for all magnifications used in microscopic analyses. The respective scales were used to measure the diameters of hairs on photographs.

For the trigonometric determination of the angle of the distal tip of golden mole hairs, a right-angled triangle was drawn from the respective photographs, measuring 200 µm from the tip of the hair (or the extrapolated point of intersection for hairs with blunt tip) to the right angle.

2.4. Documentation of results

The results were documented with an analogous still camera (Olympus OM-2, Japan) attached to the microscope using colour negative film rated at 100 ISO. The aperture was chosen to obtain relatively long exposure times of about 10 seconds. Thus blurring due to vibrations caused by setting off the shutter could be minimized. During the study of whole mounts and cross sections, additional drawings of hair profiles, medulla types and cross sections shapes were made. For the description and classification of hair characteristics, a simplified scheme was used based on WILLIAMS (1938), BRUNNER & COMAN (1974), PERRIN & CAMPBELL (1980) and KEOGH (1985).

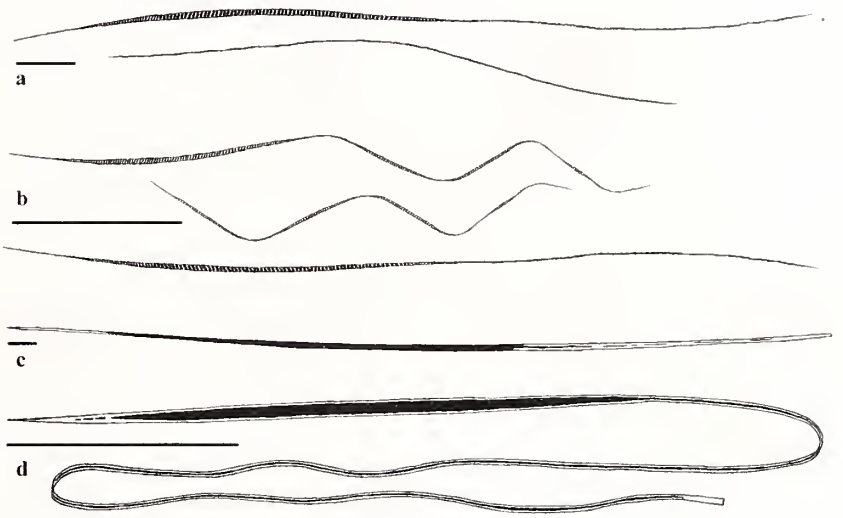

Fig. 1. Basic hair profiles of elephant-shrews (a), shrews (b), hedgehogs (c) and golden moles (d); bars equivalent to 1 mm.

2.5. Hair profiles

Hair profiles were classified according Figure 1 and as suggested i. a. by WILLIAMS (1938) and DREYER (1966). Heavy overhairs are usually long and stiff. Curly overhairs also referred to as shield hairs (BRUNNER & COMAN 1974) or intermediate hairs (PERRIN & CAMPBELL 1980), possess a distally enlarged "shield" region, which is grooved in the case of shrews, golden moles and many Rodent species. The "shield" region often bears specific characteristics and is therefore of diagnostic importance. Furhairs, also referred to as underhairs (BRUNNER & COMAN 1974; PERRIN & CAMPBELL 1980), are shorter, softer and more abundant than overhairs and lack specific features. Other hair types like whiskers were not considered. Unless otherwise stated, the results refer to overhairs having a "shield" region.

2.6. Medulla types

The medulla is the central part of a hair and is embedded in the cortex. The cortical cells, visible only with an electron microscope, grow faster than medullar cells, resulting in medullar air spaces (KEOGH 1983). These air spaces are intransparent for transmission light and thus appear dark, unless "infiltrated", i. e. the contained gas or air is substituted with a suitable medium. Medulla types were studied from whole mounts of hair and classified according to BRUNNER & COMAN (1974), shown in Figure 2. The following medulla types characterize the species examined in the present study:

Wide medulla lattice: This type is the common medulla type of the wider, distal part of golden mole hairs and of some elephant-shrews. The network or lattice is composed of shrunken medulla cells and mostly small, but in the case of a few golden mole species, larger enclosed air spaces. The lattice stretches across the entire diameter of the hair.

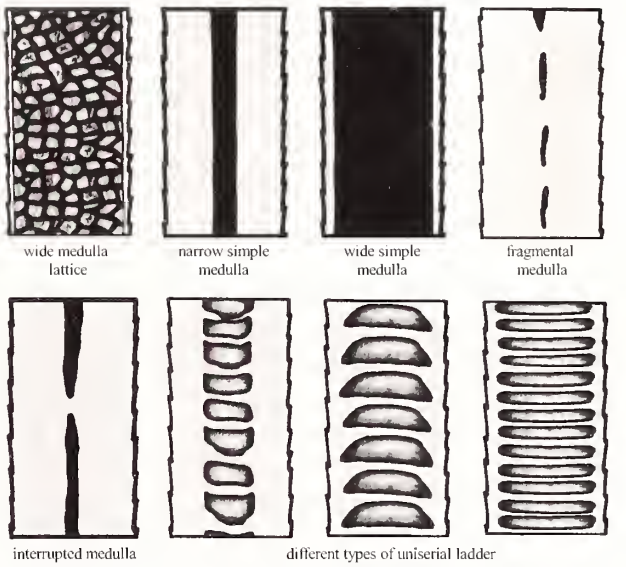

Fig. 2. Medulla types in longitudinal view.

Simple medulla: The medulla lacks an obvious structure and can be narrow or wide. This type is common in hairs of hedgehogs and might be found at the base and tip of shrew hairs.

Fragmental: In this type, the usually simple medulla is repeatedly interrupted by longer sections of cortical material. A fragmental medullary column can be often found at the base of hairs.

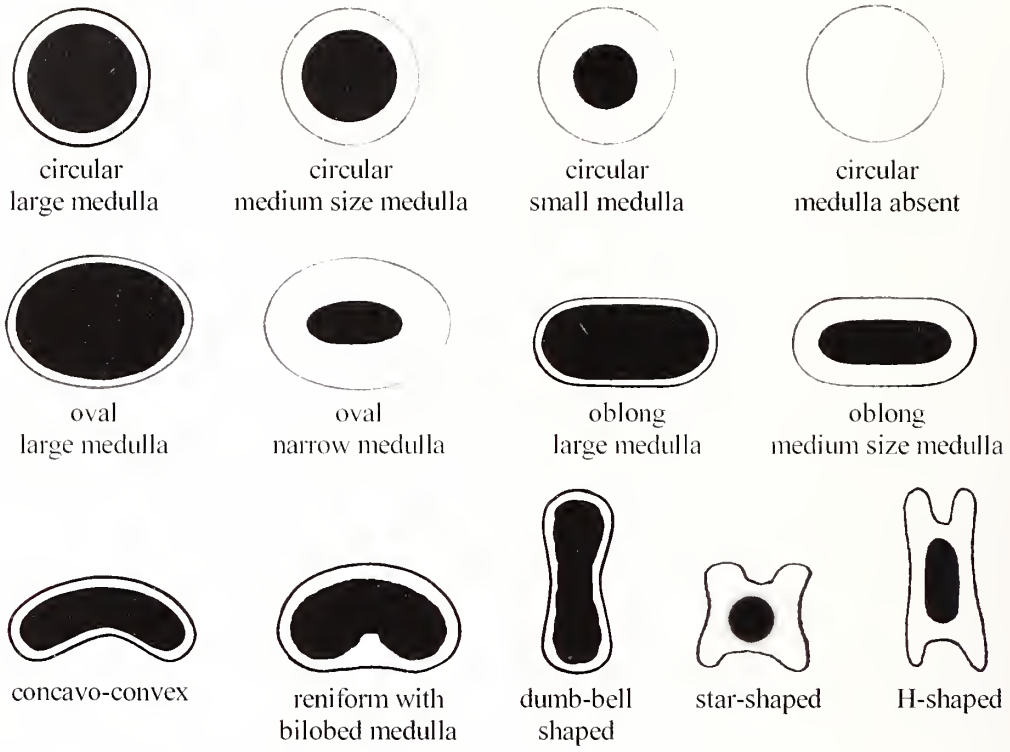

Fig. 3. Shapes cross sections of widest part of shield hairs.

Interrupted: The usually simple medulla is interrupted by one or several short sections of cortex material and appears more continuous than the fragmental medulla.

Uniserial ladder: A uniserial ladder medulla is composed of one column of alternating rows of medullar material and air spaces. The "rungs" of the ladder are either regular with parallel elongate, spiral-like, "L" or crescent shaped rungs or irregular with rungs forming letters like "N", "V" or "M". Uniserial ladders are common in underhairs, along the entire overhairs of many small mammals like of shrews and most elephant-shrews and the basal part of golden mole overhairs (DAY 1966).

2.7. Cross sectional shape at widest part of hair

The outer cortex and the central medulla characterize the internal structure of a hair, studied best on cross sections. Unless containing pigment granules, the cortex is of little diagnostic value due to the invisibility of the cortical cells under the light microscope (BRUNNER & COMAN 1974). The cross sectional and medullar shapes, however, are important hair characteristics and were categorized as shown in Figure 3, following WILLIAMS (1938) and BRUNNER & COMAN (1974). According to the medulla width, the shapes can be further divided into large, medium size or small medulla or the medulla can be absent.

Circular shapes are characteristic for cross sections of underhairs, thin basal sections of overhairs and the entire overhair of elephant-shrew hairs and hedgehogs.

Oval and **oblong** shapes characterize cross sections of hairs of hedgehogs, some elephant-shrews and the beginning of the shield region (before the groove) of hairs of some golden moles.

Concavo-convex shapes are typical for cross sections of the shield region of golden mole hairs.

Reniform with bilobed medulla is the shape of cross section found in the wider distal part of overhairs of some elephant-shrews. The concave side is the grooved side.

Dumb-bell shaped cross sections occur in the shield region of shield hairs of shrews and golden moles. The emarginations are the result of shallow longitudinal grooves on both sides of the hair.

Star- and **'H'-shaped** cross sections are typical for the shield region of shrew hairs and may have deep emarginations and prominent extensions of the apices of one or both grooved sides.

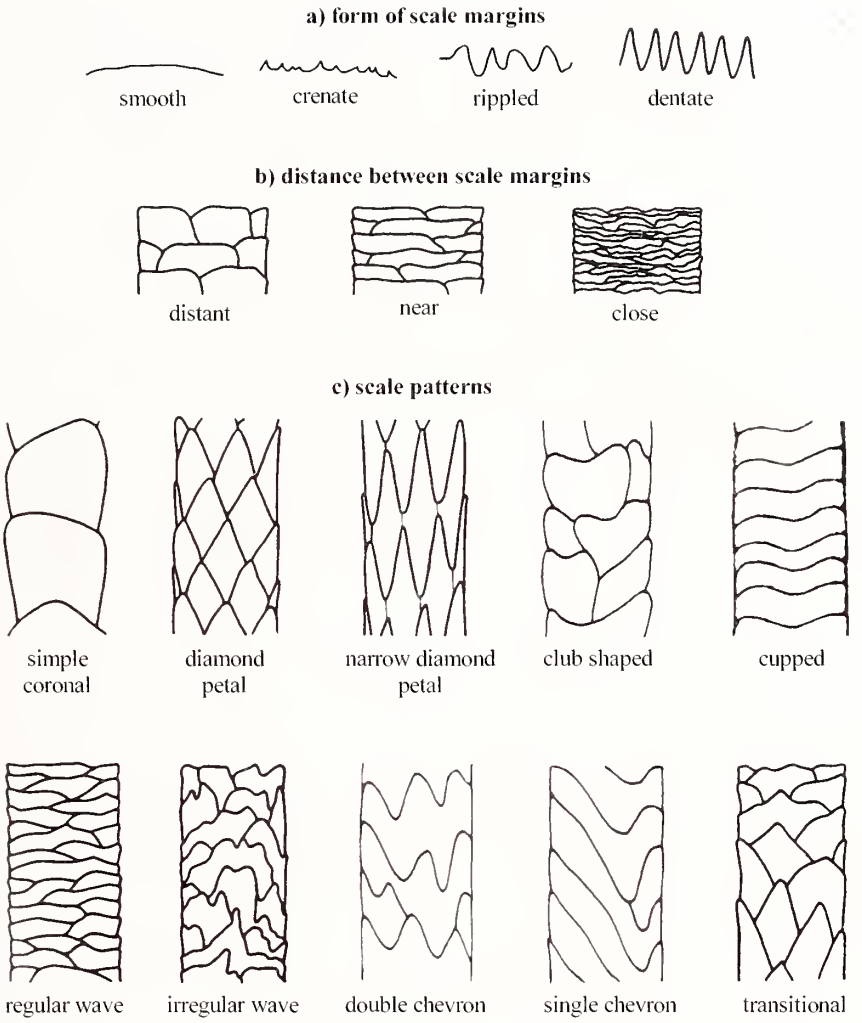

Fig. 4. Cuticular scale patterns.

2.8. Shapes and arrangement of cuticular scales

The cuticle is composed of keratinised overlapping scales, whose patterns, shape, size and types of margins are of diagnostic importance. The classification of scale margins according to BRUNNER & COMAN (1974) refers to the free distal margin of an individual scale according to Figures 4a, b.

Smooth margins form a straight line without indentations.

Crenate margins have shallow but pointed indentations.

Rippled margins are characterized by deeper but rounded indentations.

Dentate margins have tooth-like projections and are typical for petal scales.

The distance between scale margins is characterized by the ratio between width and length of a scale:

Distant scale margins are those with a width of no more than three times of the length.

Near scale margins have a ratio between three and eight.

Close scale margins have a width of more than eight times of the length.

2.9. Cuticular scale patterns

Scale patterns were classified according to Figure 4c following WILLIAMS (1938), BRUNNER & COMAN (1974), PERRIN & CAMPBELL (1980) and KEOGH (1985). The patterns of Lipotyphla, Chrysochloridea and Macroscelidea can be divided into:

Petal scale patterns are formed by a series of overlapping scales with the free distal scale margin slightly raised above the following scale. **Coronal** scale patterns are the common type of the slender base of hairs. They are made of a single or two scales that completely encircle the entire shaft of a hair. The scale margins are smooth and distant. **Diamond petals** are the common scale patterns of the basal part of shrew and elephant-shrew and golden mole hairs, following the coronal hair base. The scale margins are dentate and distant. **Club-shaped** scales are made of a single or two scales reaching across the entire width of a hair and commonly found at the basal part of golden mole hairs. The scale margins are smooth and distant. **Cupped** scale patterns characterize the grooved wider part of overhairs of shrews. This type is made of single scales reaching across the entire diameter. The scale margins are smooth and usually near.

Transitional scale patterns occur at the transition zone between the thinner basal (often diamond petal) and the wider distal part of hairs.

Waved scale patterns commonly occur along the distal wider part of hairs. **Regular waves** usually have smooth and near scale margins. **Irregular waves** have rippled or crenate margins with deeper emarginations, the distance between the scale margins can be near or close. **Chevron** scale patterns have more or less regular, parallel scale margins with one (single) or two (double) 'V'-like crests and are composed of two or more scales. This type can be found in the thinner basal part of some elephant-shrew and golden mole hairs.

3. RESULTS AND DISCUSSION

This Hair Atlas provides a key for the identification of 41 species of southern African Lipotyphla, Chrysochloridea and Macroscelidea based on their hair characteristics. Hair characteristics allowing definite species-level identification was found for the hedgehog *Atelerix frontalis*, some Macroscelid species (*Petrodromus tetradactylus*, *Macroscelides proboscideus*, *Elephantulus brachyrhynchus*) and some golden moles species (*Chrysopalax* spp., *Amblysomus* spp., *Chrysochloris asiatica*, *Calcochloris obtusirostris*, *Cryptochloris wintoni*). The unmistakable identification of all Macroscelidea and all golden moles was possible, when geographic distribution data were used in addition to hair characteristics. However, some shrew species were not identified unequivocally, even when combining hair characteristics with geographic distribution.

Other authors also reported of the unavailability of specific hair characteristics for some species (PERRIN & CAMPBELL 1980; KEOGH 1985). Therefore, it has been suggested that a more reliable identification can be obtained by combining geographic distribution of a species with hair characteristics (BRUNNER & COMAN 1974; PERRIN & CAMPBELL 1980).

Most species examined in the present study showed common generic characteristics, e. g. the hair length of the shrew genera *Myosorex* (7 mm to 9 mm), of *Suncus* (3 mm to 6 mm) and of *Sylvisorex* (about 7 mm). Almost all species of *Crocidura* have hairs with coronal scale patterns at their distal tip whereas this characteristic is less consistent in the other examined shrew genera. Additionally, shield hairs of the genus *Myosorex* usually have five constrictions and the hair length was more homogenous than in other shrew genera. Some genera of golden moles also showed distinct genus specific features, e.g., much longer hairs in the case of *Chrysopalax*. Within the elephant-shrews, the medulla type was not specific for the genus *Elephantulus*. Whole mounts of overhairs of *E. myurus* and *E. brachyrhynchus* revealed medulla lattice, whereas all other species of this genus had a medulla with uniserial ladder.

Hair characteristics of the four studied families are always very typical and allow a definite identification of the family. Such family specific characteristics for instance were the hair profile and the shape of hair cross sections for golden moles and shrews as well as the cupped cuticular scale patterns of the distal part of overhairs of all shrew species. This is in accordance with specific features of moles and shrews found by WILLIAMS (1938) and shrews described by DANNELID (1986). The results of the present study are also in conformity with the study of the hair morphology of the shield region of curly overhairs of various shrew genera (DUCOMMUN et al. 1994). Shallow V- or U-shaped notches were also found along the shield region of *Crocidura* and *Suncus* in the present study (e.g., Pl. 8N, 9N, 10K, 11N, 12N and Pl. 25N & O, 26L), whereas the *Myosorex* shield is deeply grooved (Pl. 20F, 21G, 22N). Additionally, both studies show similar scale patterns on the shield region of *C. luna* and *Sylvisorex megalura*.

Hair characteristics of some of the species included in the present study have already been described by PERRIN & CAMPBELL (1980). Apart from using different terms to classify hair profiles and scale patterns, the study of these authors was mainly based on cuticular scale patterns. Despite the differences in methodology, both studies show similar results; e.g., for *Atelerix frontalis*, *Crocidura cyanea* and *C. flavescens*. Regarding

the study of PERRIN & CAMPBELL (1980), the petal scale pattern in the fine region and the flattened mosaic at the midpoint of the shield region of *Macroscelides proboscideus* hair correspond with the transitional scale pattern between the narrow diamond petal and regular wave patterns (distal part of Pl. 6 M) and the regular scale pattern (Pl. 6 N) of the present study. PERRIN & CAMPBELL (1980) solely used cuticular scale patterns of the shield region to differentiate between golden moles. However, in the present study additional characteristics like cross sections and geographical distribution were used to discriminate more reliably between these species.

The hair characteristics used in the present study are based on the longitudinal view of the medulla, cross sectional shape of hair and medulla, medulla and cortex pigmentation, cuticular scale pattern, angle of distal hair tip, constrictions of hairs as well as hair profiles, colouration, length, minimum and maximum diameter. The consideration and use of certain hair characteristics is controversial and largely depends on the author. In the present study a combination of various hair characteristics along the entire hair was studied in order to overcome the shortcomings of the one or the other feature.

Regarding characteristics related to the medulla structure, KEOGH (1983) argues that the medulla varies considerably along the length of the hair and between individuals of the same species, and therefore this feature was not included in her study. On the other hand, WILLIAMS (1938), DAY (1966) and BRUNNER & COMAN (1974) stress the importance of a number of medulla characteristics. Some authors (BRUNNER & COMAN 1974; KEOGH 1983) even include the "infiltrated" medulla in which the air or gas of the air spaces has been substituted with mounting medium. In the present study, a simplified classification system of the longitudinal view of the medulla according to BRUNNER & COMAN (1974) has proven to be of diagnostic value, particularly in combination with other hair characteristics.

The cross sectional shape of a hair and the medulla are widely used in hair analyses (WILLIAMS, 1938; DREYER 1966; BRUNNER & COMAN 1974; KEOGH 1983). As described by BRUNNER & COMAN (1974) and found in the present study, cross sectional shapes in particular are prominent features characterizing hair of shrews and golden moles. Furthermore, with the help of cross sections the longitudinal grooves along the shield region of shield hairs of shrews and golden moles can be easily studied. Grooves were also considered of diagnostic importance for the identification of Cricetidae and Muridae by PERRIN & CAMPBELL (1980) and KEOGH (1985). However, the preparation of cross sections is delicate and requires a skilled operator (BRUNNER & COMAN 1974), particularly when dealing with short hairs as those of shrews.

Cuticular scale patterns are another diagnostic feature used in the present and many other studies (e.g., DREYER 1966; BRUNNER & COMAN 1974; PERRIN & CAMPBELL 1980; KEOGH 1983; KEOGH 1985). According to DAY (1966), cuticular scale patterns of the basal region of hairs are characteristic and thus useful for hair identification. In the present study, however, scale patterns were rarely found to be species-specific but were in most cases characteristic for genera or the entire family. Even electron microscopic scans did not reveal more detail of the cuticular scales than did light microscopy, as the comparison shows (Pl. 42). Therefore, the much faster, cheaper and simpler light microscopy was used for the examination of scale patterns.

Even though the use of hair length is a controversial characteristic, length together with minimum and maximum hair diameter were used in the present study and specifically for some of the golden mole species and shrew genera. Hair length was also used by MATHIAK (1938), MAYER (1952) and KEOGH (1983 & 1985), but since this feature might be subject to large individual variations, DREYER (1966) and other authors only considered the minimum and maximum hair diameter.

For similar reasons, pigmentation of hairs has not been used widely as a characteristic; however, there are a number of authors employing this feature (e.g., DREYER 1966; KEOGH 1983). According to BRUNNER & COMAN (1974), hair pigmentation is not of primary diagnostic importance, but can be used to confirm an identification made on the basis of other features. In the present study, colouration of entire hairs as well as of the cortex and medulla in cross sections were considered, despite the fact that colour might vary according to the age of the animal and the season of the year (PERRIN & CAMPBELL 1980). In order to minimize colour variations of different body parts, hairs from the back, flanks and belly of the animal were described. Additionally, colour charts can be used to minimize subjective interpretation of the hair colour (MAYER 1952).

Identification keys based on hair characteristics have a number of limitations (e.g., DAY 1966; BRUNNER & COMAN 1974; PERRIN & CAMPBELL 1980). The most criticised shortfalls are the variations of hair characteristics with age, sex, diet, body part, geographic origin, season of the year, etc.

BRUNNER & COMAN (1974) studied the different stages of hair development and showed that the hair, once protruded above the skin, is fully differentiated and no longer subject to further morphological changes. KEOGH (1975) found that season, sex and diet had no effect on cuticular scale patterns of rodents. According to the same author, variations of scale patterns solely depended on the age of an individual and after six months of age, the scale pattern remained constant. According to BRUNNER & COMAN (1974), the development of the pelage of *Rattus norvegicus* is completed after three months of age. A comprehensive study of the Bovidae *Tragelaphus strepsiceros*, *Aepyceros melampus*, *Sylvicapra grimmia* and *Gorgon taurinus* did not reveal any differences in cuticular scale patterns, pigmentation and hair profiles between adult males and females (DREYER 1966). However, this author found higher variations of the cuticular scale patterns in subadult Kudus. Different to this, DAY (1966) noticed that subadults of small mammals showed similar cuticular scale patterns to adult animals, but these patterns were expressed in a simplified form. In order to minimize the influence of age on certain hair characteristics, only adult animals were used in the present study for hair sampling and the subsequent hair analyses.

Morphological differences between hair types and samples taken from different body parts can be considerable and are particularly pronounced in whiskers, ornamental hairs, hairs of legs, tail, etc. (DE BOOM & DRYER 1953; DAY 1966; BRUNNER & COMAN 1974). Hairs of the body trunk, however, show more uniform characteristics and therefore are more suitable for hair studies. As done in the present study, the difficulty arising from variations in hairs of different body parts can be overcome by including hairs of several parts of the trunk. In the present study hair samples of different body parts commonly vary in colour. A hair characteristic typical for hair of a certain part of the trunk could be found only in a single instance, the concavo-convex cross sections of ventral hairs of *Chrysochloris asiatica* (Pl. 35 D).

Individual morphological variations of hair structure render an unequivocal identification of a certain species more difficult (BRUNNER & COMAN 1974). Therefore, PERRIN & CAMPBELL (1980) suggest the sampling of hairs derived from different individuals of the same species. Additionally, hair development and the resulting hair characteristics can vary with the geographic origin of a hair sample, particularly with the prevailing climate and habitat (e.g., DREYER 1966; PERRIN & CAMPBELL 1980) so that samples of various origins are recommended (PERRIN & CAMPBELL 1980).

The process of digestion usually causes little alteration of the hair structure of a consumed mammal (BRUNNER & WALLIS 1986) and thus, photographic reference systems and identification keys can be based on hair samples; e. g., taken from museum skins (BRUNNER & COMAN 1974). DAY (1966) suggests the additional analysis of teeth and skeletal remains contained in predator scats would confirm the identification of the prey species based on hair examinations.

Finally, the revision of the genus *Amblysomus* (BRONNER 1995) is supported by the findings of the present study: *A. hottentotus* and *A. iris* differ from *Neamblysomus gunningi* and *N. julianae* in terms of hair diameter and shape of cross section. The same author also separated *Carpitalpa arendsi* from the genus *Chlorotalpa*. Even though having some similar hair characteristics such as maximum diameter and shape of cross section, *C. arendsi* has double chevron scale patterns and thus differs from *Chlorotalpa duthieae* and *C. sclateri*, as shown by the present study. The comparison of hair samples of *Crocidura bicolor* with *C. fuscomurina* showed identical hair characteristics and therefore supports the assemblage of the two species as *C. fuscomurina* (HUTTERER 1993). The revision of the formerly separated species *Crocidura olivieri occidentalis* and *C. olivieri martiensseni* (HUTTERER 1993), is not supported by the findings of the present studies, since the examined hairs differ quite considerably in hair length, diameter and scale patterns.

4. HAIR ATLAS OF SOUTHERN AFRICAN ELEPHANT-SHREWS, SHREWS, HEDGEHOGS AND GOLDEN MOLES

4.1. Order Macroscelidea

Family Macroscelididae (elephant-shrews, sengis)

Elephant-shrews have long overhairs that are wider at their distal part (Fig. 1a). Underhairs are long, soft, sometimes constricted and more abundant than overhairs. Hairs occasionally have an intumescence at the distal part. Cross sections of hairs are almost always circular, the medulla has a uniserial ladder and some species have wide lattice at the distal part of hair. Scale patterns of distal hair part are regular or irregular waves, the distal tip often is of coronal type. Unless indicated, the described hair characteristics refer to both types of hairs.

Elephantulus brachyrhynchus (A. Smith, 1836) Short-snouted elephant-shrew (Pl. 1)

Origin of hair sample: MHN: junction Sabi-Lundi south bank, Mozambique (*Nasilio brachyrhynchus*); NKW 4: Mwambia Pan, KNP, South Africa.

Hair colour: Dorsal hairs dark red at base and dark brown at the distal part; hairs of the flanks dark at base and dark red at the distal end; ventral hairs dark grey basally and brownish-yellow at distal part.

Hair types, shape and length: Overhairs long and thick, underhairs relatively thin and constricted. Hairs sometimes with intumescences (F, G) at distal part. Length of overhairs about 15.5 ± 1.1 mm (n = 9); maximum hair diameter 58 µm, minimum diameter about 19 µm.

Description of whole mounts: Overhairs basally with uniserial ladder (B, C), wide medulla lattice at distal part (D-F) and distally ending with simple medulla (H). Generally, the distal parts have transparent and slightly thickened areas (D, F). Underhairs with uniserial ladder with crescent-shaped rungs distally (A).

Form of scale margins: Basally smooth (J, K), dentate (L-N), smooth (O), crenate (P) and smooth (Q-S) at distal hair tip.

Distance between scale margins: Scale margins near at base (basal part of J), distant (distal part of J-N), near (O) and close (P-S) at distal hair tip.

Cuticular scale patterns: Basally simple coronal scale patterns (J, K), narrow diamond petal (L, M), diamond petal/transitional (N), regular waves (O), irregular waves (P) and regular waves (Q-S) at distal hair tip.

Description of cross sections: Circular cross sections with large medulla (Ia) or medium size medulla (Ib); medulla always dark; cortex of some cross sections orange or gold, resulting in an intense brilliant sheen of the cortex in transmitted light of microscope (Ib); cortex and medulla of other cross sections dark (Ic).

Elephantulus edwardi (A. Smith, 1839) Cape rock elephant-shrew (Pl. 2)

Origin of hair sample: TM 687: Hannover, Central Prov., South Africa.

Hair colour: Dorsal hairs dark grey basally and light brown at distal part; hairs of flanks and belly basally grey and light brown at distal part.

Hair types, shape and length: Overhairs relatively long and thick and less abundant than underhairs; underhairs thin and sometimes constricted. Length of overhairs about 14.3 ± 0.8 mm (n = 4); maximum hair diameter 30 µm, minimum diameter about 15 µm.

Description of whole mounts: Medulla with uniserial ladder (A-E) along entire hair, distally rungs crescent-like (C) and L-shaped (D).

Form of scale margins: Smooth at base (G, H), dentate (I, basal part of J) and smooth (distal part of J-N) at distal hair tip.

Distance between scale margins: At base near (basal part of G), distant scale margins (distal part of G, H-J) and near (K-N) at distal hair tip.

Cuticular scale patterns: Basally simple coronal scale patterns (G, H), narrow diamond petal (I, J), transitional (distal part of J), regular waves (K-M) and coronal (N) at distal hair tip.

Description of cross sections: Circular shapes of cross sections with medium size to large medulla (Fa); medulla and cortex of some cross sections light brown, some cross sections with lighter medulla and darker cortex (Fa) or vice versa, or medulla and cortex of other cross sections black (Fb).

Elephantulus intufi (A. Smith, 1836) Bushveld elephant-shrew (Pl. 3)

Origin of hair sample: TM 15239: Nguia, Botswana Reserve, Botswana.

Hair colour: Dorsal hairs dark grey at basal part and dark red distally; hairs of flanks and belly dark grey at basal part and light red distally.

Hair types, shape and length: Overhairs relatively long and wider along distal part; underhairs thinner and sometimes constricted. Hairs sometimes with intumescence (D) at distal part. Length of overhairs about 14.7 ± 0.5 mm (n = 6); maximum hair diameter 53 µm, minimum diameter about 21 µm.

Description of whole mounts: Overhairs basally with uniserial ladder /simple medulla (B, C) and simple at distal part (D-F). Medulla of underhairs with uniserial ladder with spiral-like rungs (A).

Form of scale margins: Smooth at base (H, I) dentate (J, basal part of K) smooth/crenate (distal part of K, L, M) and smooth (N, O) at distal hair tip.

Distance between scale margins: Scale margins near at base (H), distant (distal part of H, I-K) and near (L-O) at distal hair tip.

Cuticular scale patterns: Basally simple coronal scale patterns (H and I), narrow diamond petal (J), diamond petal/transitional (K), regular waves (L, M) and coronal (N, O) at distal hair tip.

Description of cross sections: Circular shapes of cross sections with medium size medulla or large medulla (Gc); medulla and cortex of some cross sections light brownish-grey (Gb, c), medulla and cortex of other cross sections dark (Ga).

Elephantulus myurus Thomas & Schwann, 1906 Rock elephant-shrew (Pl. 4)

Origin of hair sample: NKW 18: Pafuri, KNP, South Africa; NHM: junction Sabi-Lundi, south bank, Mozambique; TM 39049: Moshanens, Botswana.

Hair colour: Dorsal hairs grey at basal part and dark red distally; hairs of flanks grey at basal part and distally dark red with a brown hue; ventral hairs grey at basal part and light yellow distally.

Hair types, shape and length: Overhairs relatively long, underhairs thinner and constricted. Hairs sometimes with intumescences along distal part (F). Length of overhairs about 12.0 mm ± 0.8 (n = 9); maximum hair diameter 46 µm, minimum diameter about 15 µm.

Description of whole mounts: Overhairs basally with uniserial ladder (C, D), wide medulla lattice (E) and simple medulla (F, G) at distal part and occasionally with protuberances at distal part (F). Underhairs of uniserial ladder along the entire hair (A, B), sometimes constricted (A).

Form of scale margins: Smooth (H, I) at base, dentate (J) and smooth (K-N) at distal hair tip.

Distance between scale margins: Scale margins near at base (H), distant (distal part of H, I, J), near (K) and close (L-N) at distal part of hairs.

Cuticular scale patterns: Basally simple coronal scale patterns (H, I), narrow diamond petal (J), regular waves (K-M) and coronal (N) at distal hair tip.

Description of cross sections: Circular shapes of cross sections with large medulla (Oa); medulla and cortex of some cross sections light brown (Oa), medulla and cortex of other cross sections dark (Ob).

Elephantulus rupestris (A. Smith, 1830) Smith's or Western rock elephant-shrew (Pl. 5)

Origin of hair sample: TM 10218: Tsabis, West of Rochboth, Botswana.

Hair colour: Dorsal hairs grey at basal part and dark red distally; hairs of flanks grey at basal part and light red distally; ventral hairs dark grey at basal part and light yellow distally.

Hair types, shape and length: Overhairs relatively long and distal part wider; underhairs thinner and quite long. Length of overhairs about 18.2 ± 0.8 mm (n = 6); maximum hair diameter 34 µm, minimum diameter about 18 µm.

Description of whole mounts: Medulla of underhairs (A) and overhairs (B-H) with uniserial ladder along the entire hair; rungs distally crescent-shaped (F, G, H) and occasionally with transparent parts (D, F); distal tip without medulla (H).

Form of scale margins: Smooth at base (J-L), dentate (M-O), smooth (P, Q), crenate (R) and smooth (S) at distal hair tip.

Distance between scale margins: Scale margins near (J) at base, distant (K-P) and near (Q-S) at distal hair tip.

Cuticular scale patterns: Basally simple coronal scale patterns (J-L), narrow diamond petal (M-O), transitional (P), regular waves (Q, R) and coronal (S) at distal hair tip.

Description of cross sections: Circular shapes of cross sections with medium size (Ia) to large medulla (Ib); medulla and cortex of some cross sections light brown, resulting in a weak golden sheen of the cortex in transmitted light of microscope (Ib), some cross sections with more or less transparent cortex and dark medulla (Ia) or dark cortex and medulla.

Macroscelides proboscideus (Shaw, 1800) Round-eared or short-eared elephant-shrew (Pl. 6)

Origin of hair sample: TM 28146: Faron Kongras, Springbok Game Reserve, Transvaal, South Africa.

Hair colour: Dorsal and lateral hairs dark grey at basal part and dark red distally; ventral hairs dark grey at basal part and light yellow distally.

Hair types, shape and length: Hairs relatively long and thin, distal part of overhairs wider, underhairs thinner. Hairs sometimes with intumescence (F) at distal part. Length of overhairs about 18.1 ± 0.9 mm (n = 4); maximum hair diameter 26 µm, minimum diameter about 9 µm.

Description of whole mounts: Medulla of all hairs with uniserial ladder (A-F) along the entire hair; distally rungs 'L'-shaped (D, E), occasionally with transparent parts (C), with protuberances (F) and with intransparent distal hair tip (G).

Form of scale margins: Smooth (I, J) at base, dentate (K, L, basal part of M) and smooth (distal part of M-Q) at distal hair tip.

Distance between scale margins: Scale margins near at base (I), distant (distal part of I-M), near (N, O) and close (P, Q) at distal hair tip.

Cuticular scale patterns: Basally simple coronal scale patterns (I, J), narrow diamond petal (K-L), transitional (M), regular waves (N-P) and coronal (Q) at distal hair tip.

Description of cross sections: Circular shapes of cross sections with medium size medulla or large medulla (Ha); medulla and cortex of some cross sections transparent (Hb) or with more or less transparent cortex and dark medulla, resulting in a weak sheen of the cortex in transmitted light of microscope (Ha); some cross sections with dark cortex and medulla.

Petrodromus tetradactylus Peters, 1846 Four-toed elephant-shrew (Pl. 7)

Origin of hair sample: NKW10: Tussen, Magabene, Makembane KNP, South Africa; NHM: north bank Sabi, Mozambique.

Hair colour: Dorsal hairs grey at basal part and dark red distally; hairs of flanks grey at basal part and red with a yellow hue distally; ventral hairs vary from dark to light red.

Hair types, shape and length: Overhairs relatively long and thick, distal part wider; underhairs thinner and occasionally with constrictions. Hairs sometimes with intumescence (B, F) at distal part. Length of overhairs about 17.5 ± 0.5 mm (n = 9); maximum hair diameter 59 µm, minimum diameter about 21 µm.

Description of whole mounts: Medulla at base of overhairs with uniserial ladder with oblique, "V"-shaped rungs (E, G); further distally, rungs resembling "letters" (H) and with simple medulla towards distal hair tip (I, J). Medulla of underhairs with uniserial ladder (A-C), at distal part with crescent-shaped rungs (C).

Form of scale margins: Smooth at base (L), dentate (M-O), smooth/crenate (P), rippled (Q) and smooth (R, S) at distal hair tip.

Distance between scale margins: Scale margins near (L) at base, distant (distal part of L-O) and close (P-S) at distal hair tip.

Cuticular scale patterns: At base simple coronal scale patterns (L), narrow diamond petal (M, N); diamond petal/transitional (O), regular waves (P), irregular waves (Q) and regular waves (R, S) at distal hair tip.

Description of cross sections: Circular shapes of cross sections with large medulla (Ka) or medium size medulla (Kb); medulla and cortex of some cross sections light brown, resulting in an intense brilliant sheen of the cortex in transmitted light of microscope (Ka, b); other cross sections dark medulla and dark cortex (Kc).

4.2. Order Soricomorpha

Family Soricidae (shrews)

The pelage of shrews is soft and plush-like, the hairs (Fig. 1b) are relatively short. Curled overhairs (shield hairs) usually have one or two constrictions and a flattened, expanded distal part of the hair with a pronounced longitudinal groove on one or both surfaces. Heavy overhairs are straight, longer, lack constrictions and are rare in number. Underhairs have a thin distal end and several constrictions, at which the hair changes its direction (Pl. 13 H), resulting in a zigzag-like shape. Cross sections of hairs are typically rectangular or quadrangular with emarginations of several sides resulting in a dumb-bell shaped, "H"-like or star-like outline (Fig. 3); the medulla has uniserial ladder. Scale patterns of grooved part of shield region are always cupped, the hair tip has with coronal or regular waves. Unless indicated, the described hair characteristics refer to overhairs with shield region (shield hair).

Crocidura cyanea (Duvernoy, 1838) Reddish-grey musk shrew (Pl. 8)

Origin of hair sample: NKW 2: Malelane, KNP, South Africa.

Hair colour: Dorsal and lateral hairs light grey at basal part and greyish-brown distally; ventral hairs light grey.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and two constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 6.2 ± 0.5 mm (n = 7); maximum diameter of shield region 29 µm, minimum diameter about 7 µm.

Description of whole mounts: At base simple medulla (A), further distally uniserial ladder (B-F) with regular and straight rungs (D, E) or less regular, 'mushroom' -shaped rungs (F) ending in a transparent distal hair tip (G).

Form of scale margins: Smooth (I, J) at base, dentate (K, L), smooth (M, N), crenate (O, P) and smooth (Q) at distal hair tip.

Distance between scale margins: Scale margins at base close, further distally distant (I-M), near (N) and close (O-Q) at distal hairs tip.

Cuticular scale patterns: At base simple coronal (I, J), further distally narrow diamond petal (K), diamond petal (L), regular waves (M), cupped (N), irregular waves (O, P) and coronal (Q) at distal hair tip.

Description of cross sections: Rectangular shaped outline of cross section with slightly invaginated sides (Ha), "H"-shaped outline with more or less pronounced extensions (Hb), both with large medulla, other outlines of cross sections circular with medium size medulla (Hc); medulla black or grey, cortex brown, light or dark grey.

Crocidura flavescens (Geoffroy, 1827) Greater red musk shrew (Pl. 9)

Origin of hair sample: TM 9000: Krysna Distr. Deepwalls, Cape Province, South Africa.

Hair colour: Hairs light grey at basal part and dark brown to greyish-brown distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and two or three constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 5.5 ± 0.2 mm (n = 5); maximum diameter of shield region 35 µm, minimum diameter about 6 µm.

Description of whole mounts: At base simple medulla (A, B); further distally uniserial ladder (C-E), sometimes irregular forming 'letters' (D, E) and ending in a thin transparent distal tip (F).

Form of scale margins: At base smooth (H, I), dentate (J-L), smooth (M, N) and rippled (O, P) at distal hair tip.

Distance between scale margins: Scale margins near (H) at base, distant (I-L), near (M, N) and close (O, P) at distal hair tip.

Cuticular scale patterns: At base simple coronal (H, I), further distally narrow diamond petal (J, K), diamond petal (L), transitional (M), cupped (N) and irregular waves (O, P) at distal hair tip.

Description of cross sections: Cross sections predominantly rectangular shaped with slight emarginations of all sides resulting in short extensions of one or both short sides (Ga), dumb-bell shaped (Gb), trapezoidal (Gc, d) or circular outlines (Ge, Qa); all cross sections with medium size to large medulla; medulla black or grey, cortex brown, light or dark grey, sometimes with a brilliant sheen in transmitted light of microscope (G).

Crocidura fuscomurina (Heuglin, 1865) Tiny musk shrew (Pl. 10)

Origin of hair sample: NKW 1: Skukuza, KNP, South Africa; TM 45738: Vryburg Distr., Mopolo Nat. Res., North West Province, South Africa; TM 37158 (*C. bicolor*): Pietermaritzburg Distr., Natal, South Africa.

Hair colour: Hairs dark grey at basal part and light brown to dark brown distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and one or two constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 2.7 ± 0.1 mm (n = 5); maximum diameter of shield region 26 µm, minimum diameter about 6 µm.

Description of whole mounts: At base simple medulla (A); further distally uniserial ladder (B-D), at distal part with slightly oblique rungs (C, D), ending in a thin transparent distal hair tip (E).

Form of scale margins: Smooth at base (G, H), further distally smooth/crenate (I-K), rippled (L) and smooth (M) at distal hair tip.

Distance between scale margins: Scale margins near (basal part of G), distant (distal part of G, H) at base, near (I, J) and close (K-M) at distal hair tip.

Cuticular scale patterns: At base simple coronal (G, H), at distal part regular waves (I, J), cupped (K), irregular waves (L) and coronal (M) at distal hair tip.

Description of cross sections: Cross sections predominantly quadrangular or rectangular shaped with slight emarginations of the short sides resulting in prominent extensions of these sides (Fa) or circular (Fb) shapes in outline; all cross sections with small or medium size medulla; medulla black or grey, cortex brown, light or dark grey.

Crocidura hirta Peters, 1852 Lesser red musk shrew (Pl. 11)

Origin of hair sample: NKW 13: Pafuri, KNP, South Africa; MHN: Maringa, Sabi north bank, Mozambique.

Hair colour: Hairs dark grey at basal part and light brown to brownish-grey distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and three constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 5.5 ± 0.2 mm (n = 7); maximum diameter of shield region 33 µm, minimum diameter about 6 µm.

Description of whole mounts: At base simple medulla (A), further distally uniserial ladder (B-G), rungs sometimes irregular and "V"-shaped (E) or "mushroom"-like (D, F), ending in a thin transparent distal hair tip (G).

Form of scale margins: Smooth at base (I), further distally dentate (J, K), smooth (L), rippled (M, N), crenate (O) and smooth (P) at distal hair tip.

Distance between scale margins: Scale margins at base close; distant (I-L), near (M, N) and close (O, P) at distal hair tip.

Cuticular scale patterns: At base simple coronal (I), further distally narrow diamond petal (J, K); transitional (L), cupped (M), irregular waves (N, O) and coronal (P) at distal hair tip.

Description of cross sections: Cross sections dumb-bell shaped in outline with emarginations of the long sides with prominent extensions (Ha) or round short sides (Hb) and circular in outline (Hc); cross sections with medium size to large medulla, sometimes emarginated, reflecting the shape of the cross section; medulla black or grey, cortex brown, light or dark grey, sometimes with a brilliant sheen in transmitted light of microscope (Ha).

Crocidura luna Dollman, 1910 Greater grey-brown musk shrew (Pl. 12)

Origin of hair sample: TM 7728: Mt. Selinda, Melsetter Distr., Zimbabwe.

Hair colour: Dorsal and ventral hairs dark grey at basal part and light brown distally, lateral hairs dark grey at basal part and dark brown distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and three constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 6.7 ± 0.5 mm (n = 5); maximum diameter of shield region 31 µm, minimum diameter about 11 µm.

Description of whole mounts: Hairs lack medulla at base (A), further distally fragmental simple medulla (B) and uniserial ladder (C-F), sometimes with irregular and "N" or "V"-shaped rungs (E), ending in a thin transparent distal hair tip (G).

Form of scale margins: Smooth at base (I, J), dentate (K-M), smooth (N), rippled (O) and smooth (P) at distal hair tip.

Distance between scale margins: Scale margins near (I) at base, distant (J-M), near (N) and close (O, P) at distal hair tip.

Cuticular scale patterns: At base simple coronal (I-K), further distally narrow diamond petal (L), diamond petal/transitional (M), cupped (N), regular waves (O) and coronal (P) at distal hair tip.

Description of cross sections: Cross sections predominantly rectangular shaped in outline with emarginations of all sides with prominent extensions (Ha, Hb, Qa), dumb-bell shaped (Qb), quadrangular shaped with concave sides resulting in a star-like shape (Hc) or trapezoidal (Qc), others circular in outline (Hd); cortex and medulla clearly separated; all cross sections with medium size or large medulla, sometimes emarginated (Hb), reflecting the shape of the cross section; medulla black or grey, cortex brown, light or dark grey, sometimes with a brilliant sheen in transmitted light of microscope (Ha, b, Qa-c).

Crocidura maquassiensis Roberts, 1946 Maquassie musk shrew (Pl. 13)

Origin of hair sample: TM 40460: Kosi Lake, Dept. of Health Camp, Natal, South Africa.

Hair colour: Hairs dark grey at basal part and light brown distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and two constrictions; underhairs thinner and undulating at constrictions (H). Length of overhairs about 4.3 ± 0.3 mm (n = 5); maximum diameter of shield region 31 µm, minimum diameter about 9 µm.

Description of whole mounts: Hair margins at base strongly serrated with simple medulla (A, B), further dis-

tally uniserial ladder (C-E), with regular (D) or slightly oval rungs (E), ending in a thin transparent distal hair tip (F).

Form of scale margins: Smooth at base (I, J), dentate (K-M), smooth (N), crenate (O) and smooth (P) at distal hair tip.

Distance between scale margins: Scale margins near (basal part of I) at base, distant (distal part of I-M), near (N) and close (O, P) at distal hair tip.

Cuticular scale patterns: At base simple coronal (I, J), further distally narrow diamond petal (K, L), diamond petal/transitional (M), cupped (N), irregular waves (O) and coronal (P) at distal hair tip.

Description of cross sections: Cross sections predominantly rectangular shaped in outline with emarginations of the long sides and prominent extensions of short sides (Ga) or dumb-bell shaped with rounded short sides (Gb); other cross sections with emarginations of all sides resulting in "star"-like shapes (Gc); all cross sections with medium size or large medulla, sometimes emarginated, reflecting the shape of the cross section; medulla black or grey, cortex brown, light or dark grey.

Crocidura mariquensis (A. Smith, 1844) Swamp musk shrew (Pl. 14)

Origin of hair sample: NKW 16: Punda, KNP, South Africa.

Hair colour: Dorsal and lateral hairs dark grey, ventral hairs brownish-dark grey at basal part and dark brown distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and three constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 6.0 ± 0.6 mm (n = 7); maximum diameter of shield region 31 µm, minimum diameter about 7 µm.

Description of whole mounts: Hairs at base with simple medulla (A) and uniserial ladder (B-E), further distally with individual rungs touching one another (D, E), ending in a thin transparent distal hair tip (F).

Form of scale margins: Smooth at base (H, I), dentate (J, K), smooth (L), rippled (M), crenate (N) and smooth (O) at distal hair tip.

Distance between scale margins: Scale margins near (basal part of H) at base, distant (distal part of H-L), near (M) and close (N, O) at distal hair tip.

Cuticular scale patterns: At base simple coronal (H, I), further distally narrow diamond petal (J, K), transitional (basal part of L), cupped (distal part of L), irregular waves (M, N) and coronal (O) at distal hair tip.

Description of cross sections: Cross sections predominantly trapezoidal (Ga), others square in outline with emarginations of all sides resulting in "star"-like shapes (Gb) or circular in outline (Gc); all cross sections with medium size or large medulla, sometimes emarginated, reflecting the shape of the cross section; medulla black or grey, cortex brown, light or dark grey.

Crocidura olivieri martiensseni (Lesson, 1827) Olivier's shrew (Pl. 15)

Origin of hair sample: TM 1026: Mamba, Tanzania (*Sorex martiensseni*).

Hair colour: Hairs dark grey at basal part and dark brown distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and three constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 9.5 ± 0.6 mm (n = 3); maximum diameter of shield region 67 µm, minimum diameter about 12 µm.

Description of whole mounts: Hairs at base with simple medulla (A, B), uniserial ladder (C-F) with rungs very close to one another (C) and further distally with irregular rungs forming 'letters' (D), ending in a thin transparent distal hair tip (F).

Form of scale margins: Smooth at base (I, basal part of J), dentate (distal part of J-L), smooth/crenate (M-P) at distal hair tip.

Distance between scale margins: Scale margins near (basal part of I) at base, distant (distal part of I-L), near (M) and close (N-P) at distal hair tip.

Cuticular scale patterns: At base simple coronal (I, basal part of J), narrow diamond petal (distal part of J-K), diamond petal/transitional (L), irregular waves (M), cupped (N), regular waves (O) and coronal (P) at distal hair tip.

Description of cross sections: Cross sections square in outline and emarginations of short sides (Ha), oval (Hb), trapezoidal with (Ga) or without emarginations of the sides (Gb) or circular in outline (Qa); cross sections with small, medium size or large medulla, sometimes emarginated, reflecting the shape of the cross section;

medulla black or grey, cortex brown, light or dark grey, sometimes with a brilliant sheen in transmitted light of microscope (Q).

Crocidura olivieri occidentalis (Lesson, 1827) Olivier's shrew (Pl. 16)

Origin of hair sample: TM 11413: Inyanga, Zimbabwe.

Hair colour: Hairs grey at basal part and brownish-grey distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and one or two constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 5.3 ± 0.1 mm (n = 5); maximum diameter of shield region 38 µm, minimum diameter about 7 µm.

Description of whole mounts: Hairs lack medulla at base (basal part of A), further distally simple medulla (distal part of A), uniserial ladder (B-D), sometimes with irregular rungs forming "letters" (C), distally with oblique rungs (D), ending in a thin transparent distal hair tip (E).

Form of scale margins: Smooth at base (G, H), dentate (I), smooth (J), crenate (K) and smooth (L) at distal hair tip.

Distance between scale margins: Scale margins near (basal part of G) at base, distant (distal part of G-I), near (J) and close (K, L) at distal hair tip.

Cuticular scale patterns: At base simple coronal (G, H), narrow diamond petal (I), diamond petal/transitional, cupped (J), irregular waves (K) and coronal (L) at distal hair tip.

Description of cross sections: Cross section rectangular (Fa) or trapezoidal (Fb) in outline, with emarginations of long sides and small extensions or circular outlines (Fc) of cross sections; all cross sections with small size, sometimes emarginated, reflecting the shape of the cross section; medulla black, brown or grey, cortex brown, light or dark grey.

Crocidura silacea Thomas, 1895 Peters' or lesser grey-brown musk shrew (Pl. 17)

Origin of hair sample: KNP 13482: Skukuza Camp, KNP, South Africa.

Hair colour: Dorsal hairs brownish-grey and dorsal hairs light grey with a brown hue.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and one or two constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 4.3 ± 0.4 mm (n = 7); maximum diameter of shield region 34 µm, minimum diameter about 8 µm.

Description of whole mounts: Hairs lack medulla at base (basal part of A), further distally simple medulla (distal part of A), uniserial ladder (B-F) with regular rungs, ending in a thin transparent distal hair tip (F).

Form of scale margins: Smooth at base (H), dentate (I-K), smooth (L, M), crenate (N) and smooth (O) at distal hair tip.

Distance between scale margins: Scale margins near (basal part of H) at base, distant (distal part of H-K), near (L, M) and close (N, O) at distal hair tip.

Cuticular scale patterns: At base simple coronal (H), narrow diamond petal (I, J), diamond petal/transitional (K), cupped (L, M), irregular waves (N) and coronal (O) at distal hair tip.

Description of cross sections: Cross sections square (Ga) or trapezoidal (Pa) in outline with emarginations of sides, small extensions and medium size medulla, other cross sections circular in outline with large medulla (Gb); medulla black or grey, cortex brown, light or dark grey.

Crocidura turba Dollman, 1910 Tumultuous shrew (Pl. 18)

Origin of hair sample: TM 13797: N. R. Abercorn, L. Chiela, Zambia.

Hair colour: Hairs dark grey at basal part and brownish-grey distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and two or three constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 6.2 ± 0.5 mm (n = 4); maximum diameter of shield region 36 µm, minimum diameter about 6 µm.

Description of whole mounts: Hairs at base with simple medulla (A, B), further distally uniserial ladder (C-E), at distal part with irregular rungs forming "letters" (D) or "mushroom"-like (E) rungs, ending in a thin transparent distal hair tip (F).

Form of scale margins: Smooth at base (H-J), dentate (K, L), smooth (M), crenate (N, O) and smooth (P) at distal hair tip.

Distance between scale margins: Scale margins near (basal part of H) at base, distant (distal part of H-L), near (M) and close (N-P) at distal hair tip.

Cuticular scale patterns: At base simple coronal (H-J), narrow diamond petal (K), diamond petal/transitional (L), cupped (M), irregular waves (N, O) and coronal (P) at distal hair tip.

Description of cross sections: Cross sections predominantly square (Ga), rectangular, dumb-bell shaped (Gb) or trapezoidal (Gc) in outline with emarginations of long sides and occasionally with small extensions, some with oval outline (Gd); cross sections with small or medium size medulla, sometimes emarginated, reflecting the shape of the cross section; medulla black or grey, cortex brown, light or dark grey, sometimes with a brilliant sheen in transmitted light of microscope.

Myosorex cafer (Sundevall, 1846) Dark-footed forest shrew (Pl. 19)

Origin of hair sample: TM 823: Port St. Johns, Pondoland, Cape Province, South Africa.

Hair colour: Hairs dark grey at basal part and light brown to dark brown distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and three constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 8.3 ± 0.2 mm (n = 5); maximum diameter of shield region 40 µm, minimum diameter about 12 µm.

Description of whole mounts: Hairs lack medulla at base (basal part of A), further distally fragmental medulla (distal part of A) and uniserial ladder (B-F), at distal part sometimes with irregular rungs (D), ending in a thin transparent distal hair tip (F).

Form of scale margins: Smooth at base (H, I), dentate (J, K, basal part of L), smooth (distal part of L, basal part of M), crenate/rippled (distal part of M, basal part of N) and coronal (distal part of N) at distal hair tip.

Distance between scale margins: At base scale margins near (basal part of H), distant (distal part of H-L), near (M) and close (N) at distal hair tip.

Cuticular scale patterns: At base simple coronal (H, I), narrow diamond petal (J, K), diamond petal/transitional (basal part of L), cupped (distal part of L, basal part of M) and irregular waves (distal part of M, N) at distal hair tip.

Description of cross sections: Cross sections predominantly square in outline with emarginations of two sides, some with extensions forming the letter "H" (Ga, Oa), some cross sections circular (Gb, Ob) in outline, all cross sections with medium size or large medulla reflecting the shape of the cross section; medulla black, dark or light grey, cortex black, brown or grey, sometimes with a brilliant sheen in transmitted light of microscope (Ga).

Myosorex longicaudatus Meester & Dippenaar, 1978 Long-tailed forest shrew (Pl. 20)

Origin of hair sample: TM 32182: Langeberge, Boosmanskos Wilderness Area, Cape Province, South Africa.

Hair colour: Hairs dark grey at basal part and brownish grey to light brown distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and five constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 8.9 ± 0.4 mm (n = 6); maximum diameter of shield region 31 µm, minimum diameter about 5 µm.

Description of whole mounts: Hairs lack medulla at base (basal part of A), further distally simple medulla (distal part of A) and uniserial ladder (B-D), at distal part with regular rungs (C, D), ending in a thin transparent distal hair tip (E).

Form of scale margins: Smooth at base (G), dentate (H, I), smooth (J, K), and rippled (L, M) at distal hair tip.

Distance between scale margins: Scale margins near (basal part of G) at base, distant (distal part of G-J), near (K) and close (L, M) at distal hair tip.

Cuticular scale patterns: At base simple coronal (G), narrow diamond petal (H, I), diamond petal/transitional (J), cupped (K) and irregular waves (L, M) at distal hair tip.

Description of cross sections: Cross sections predominantly square (Fa), occasionally trapezoidal (Fb) in outline with slight emarginations of short sides, some with extensions forming the letter "H", some cross sections circular in outline, medulla of all cross sections small or medium size; medulla black or grey, cortex brown or

grey, sometimes with a brilliant sheen in transmitted light of microscope.

Myosorex sclateri Thomas & Schwann, 1905 Sclater's forest shrew (Pl. 21)

Origin of hair sample: TM 32418: Umlalazi Natl. Res. Mtunzini, Natal, South Africa.

Hair colour: Hairs dark grey at basal part and brownish grey to light brown distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and five constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 7.3 ± 0.3 mm (n = 5); maximum diameter of shield region 42 µm, minimum diameter about 9 µm.

Description of whole mounts: Hairs lack medulla at base (basal part of A), further distally simple medulla (distal part of A), uniserial ladder with regular rungs (B-E), ending in a thin transparent distal hair tip (F).

Form of scale margins: Smooth at base (H, I), dentate (J, K), smooth (L), crenate (M) and smooth (N) at distal hair tip.

Distance between scale margins: Scale margins near (basal part of H) at base, distant (distal part of H-K), near (L) and close (M, N) at distal hair tip.

Cuticular scale patterns: At base simple coronal (H, I), narrow diamond petal (J), diamond petal/transitional (K), cupped (L), irregular waves (M) and coronal (N) at distal hair tip.

Description of cross sections: Cross sections predominantly square (Ga), rectangular (Gb) and trapezoidal (Gc) in outline with slight emarginations of short sides, some with extensions forming the letter "H", some cross sections circular (Gd, Oa) in outline, medulla of all cross sections small or medium size; medulla black or grey, cortex black, brown or grey.

Myosorex tenuis Thomas & Schwann, 1905 Zuurbon forest or thin mouse shrew (Pl. 22)

Origin of hair sample: TM 43410: Wolkberg Wilderness Area, Transvaal, South Africa.

Hair colour: Hairs dark grey at basal part and brownish grey to light brown distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and five constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 8.2 ± 0.4 mm (n = 4); maximum diameter of shield region 33 µm, minimum diameter about 9 µm.

Description of whole mounts: Hairs lack medulla at base (basal part of A), further distally simple medulla (distal part of A), uniserial ladder with regular rungs (B, C), ending in a thin transparent distal hair tip (D).

Form of scale margins: Smooth at base (F, G), dentate (H, basal part of I), smooth (distal part of I, J), rippled (K, L) and smooth (M) at distal hair tip.

Distance between scale margins: Scale margins near (basal part of F) at base, distant (distal part of F, G-I), near (J) and close (K-M) at distal hair tip.

Cuticular scale patterns: At base simple coronal (F), narrow diamond petal (G, H), diamond petal/transitional (I), cupped (J), irregular waves (K, L) and coronal (M) at distal hair tip.

Description of cross sections: Cross sections predominantly rectangular (Na), some quadrangular (Ea) in outline with slight emarginations of two or all four sides, some cross sections circular in outline (Eb); medulla medium size or large, sometimes divided (Na) reflecting the shape of the cross section; medulla black or grey, cortex brown or grey, sometimes with a brilliant sheen in transmitted light of microscope (Eb).

Myosorex varius (Smuts, 1832) Forest shrew (Pl. 23)

Origin of hair sample: TM 29409: Cathedral Peak Forest Reserve, Natal, South Africa.

Hair colour: Hairs dark grey at basal part and light brown at distal hair tip.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and six constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 7.3 ± 0.9 mm (n = 6); maximum diameter of shield region 38 µm, minimum diameter about 6 µm.

Description of whole mounts: Hairs lack medulla at base (basal part of A), further distally simple medulla (distal part of A), uniserial ladder with regular rungs (B-D), ending in a thin distal hair tip (E).

Form of scale margins: Smooth at base (G, H, basal part of I), dentate (distal part of I, J, basal part of K),

smooth (distal part of K, L), crenate (M) and smooth (N) at distal hair tip.

Distance between scale margins: Scale margins near (basal part of G) at base, distant (distal part of G-K), near (L) and close (M, N) at distal hair tip.

Cuticular scale patterns: At base simple coronal (G-I), narrow diamond petal (J), diamond petal/transitional (K), cupped (L), irregular waves (M) and coronal (N) at distal hair tip.

Description of cross sections: Cross sections predominantly rectangular (Fa), some quadrangular (Fb) in outline with slight emarginations of short sides and extensions forming the letter "H", some cross sections circular in outline (Fc); all cross sections with small to medium size medulla; medulla black or grey, cortex brown or grey, sometimes with a brilliant sheen in transmitted light of microscope (Fa, b).

Suncus infinitesimus (Heller, 1912) Least dwarf shrew (Pl. 24)

Origin of hair sample: TM 3494: Waterkloof, Pretoria, TV, South Africa.

Hair colour: Hairs dark grey to brownish-grey.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and two constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 2.7 ± 0.2 mm (n = 7); maximum diameter of shield region 29 µm, minimum diameter about 4 µm.

Description of whole mounts: Hairs lack medulla at base (A); further distally simple medulla (B), uniserial ladder with regular rungs (C, D), ending in a thin transparent distal hair tip (E).

Form of scale margins: Smooth at base (G, basal part of H), dentate (distal part of H, I), smooth (J) and crenate (K-M) at distal hair tip.

Distance between scale margins: Scale margins near (basal part of G) at base, distant (distal part of G-I), near (J, basal part of K) and close (distal part of K-M) at distal hair tip.

Cuticular scale patterns: At base simple coronal (G), narrow diamond petal (H, I), diamond petal/transitional (basal part of J), cupped (distal part of J) and irregular waves (K-M) at distal hair tip.

Description of cross sections: Cross sections predominantly rectangular (Fa), some quadrangular (Fb) in outline with slight emarginations of short sides and with extensions, some cross sections circular in outline (Fc); all cross sections with small to medium size medulla, sometimes divided (Fa) and reflecting the shape of the cross section; medulla black or grey, cortex brown or grey.

Suncus lixus (Thomas, 1898) Greater dwarf shrew (Pl. 25)

Origin of hair sample: TM 41827: Pietermaritzburg Natal, South Africa.

Hair colour: Hairs light grey to dark grey.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and two or three constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 3.7 ± 0.3 mm (n = 7); maximum diameter of shield region 24 µm, minimum diameter about 7 µm.

Description of whole mounts: Hairs lack medulla at base (basal part of A), further distally simple medulla (distal part of A, B), uniserial ladder (C-F), at distal part with regular (D), oval-shaped (E) or "mushroom"-shaped rungs (F), ending in a thin transparent distal hair tip (G).

Form of scale margins: Smooth at base (I, J) and dentate (K, L) and smooth (M-P) at distal part.

Distance between scale margins: Scale margins near (basal part of I) at base, distant (distal part of I-M), near (N, O) and close (P) at distal end.

Cuticular scale patterns: At base simple coronal (I, J), narrow diamond petal (K), diamond petal (L), transitional (M), cupped (N, O) and coronal (P) at distal end.

Description of cross sections: Cross sections predominantly rectangular (Ha), some trapezoidal (Hb) in outline with slight emarginations of long sides and convex short sides; some cross sections circular in outline (Hc); all cross sections with medium size medulla, reflecting the shape of the cross section; medulla black, cortex lighter brown or grey.

Suncus varilla (Thomas, 1895) Lesser dwarf shrew (Pl. 26)

Origin of hair sample: TM 7842: Odendals Rest, OFS, SA, South Africa.

Hair colour: Hairs dark grey at basal part and light brown distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and three constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 5.5 ± 0.8 mm (n = 7); maximum diameter of shield region 27 µm, minimum diameter about 7 µm.

Description of whole mounts: Hairs lack medulla at base (basal part of A), further distally simple medulla (distal part of A, B), uniserial ladder with regular rungs (C-E), ending in a thin transparent distal hair tip (E).

Form of scale margins: Smooth at base (G, H), dentate (I, J, basal part of K), smooth (distal part of K, L) and crenate (M, N) at distal hair tip.

Distance between scale margins: Scale margins near (basal part of G) at base, distant (distal part of G-K), near (L) and close (M, N) at distal hair tip.

Cuticular scale patterns: At base simple coronal (G, H), narrow diamond petal (I, J), diamond petal/transitional (K), cupped (L) and irregular waves (M, N) at distal hair tip.

Description of cross sections: Cross sections predominantly rectangular (Fa) in outline with slight emarginations of long sides; some cross sections circular (Fb) or oval/oblong (Fc) in outline; all cross sections with small to medium size medulla, reflecting the shape of the cross section; medulla black, cortex lighter brown or grey.

Sylvisorex megalura (Jentink, 1888) Climbing shrew (Pl. 27)

Origin of hair sample: TM 34610: Mount Selinda. Chirinda Forest, Zimbabwe.

Hair colour: Dorsal and lateral hairs dark brown at basal part and dark brown to brownish-grey distally; ventral hairs light grey at basal part and dark brown to brownish-grey distally.

Hair types, shape and length: Heavy overhairs straight and without constrictions; curled overhairs (shield hairs) with thickened and grooved distal part and three constrictions; underhairs thinner and undulating at constrictions. Length of overhairs about 7.3 ± 0.4 mm (n = 7); maximum diameter of shield region 32 µm, minimum diameter about 6 µm.

Description of whole mounts: Hairs lack medulla at base (basal part of A), further distally simple medulla (distal part of A, B), uniserial ladder (C, D), distally sometimes with oblique rungs (D), ending in a thin transparent distal hair tip (E).

Form of scale margins: Smooth at base (G, H), dentate (I, basal part of J), smooth (distal part of J, K), crenate (L) and smooth (M) at distal hair tip.

Distance between scale margins: Scale margins near (basal part of G) at base, distant (distal part of G-J), near (K) and close (L, M) at distal hair tip.

Cuticular scale patterns: At base simple coronal (G, H), narrow diamond petal (I); diamond petal/transitional (J), cupped (K), irregular waves (L) and coronal (M) at distal hair tip.

Description of cross sections: Cross sections predominantly rectangular in outline with emarginations of long sides (Fa), some additionally with one plane short side and extensions on the opposite convex side (Na); some cross sections quadrangular (Fb) and circular (Fc, Nb) in outline; all cross sections with small to large medulla, sometimes divided (Fd) and reflecting the shape of the cross section; medulla black or grey, cortex black, brown or grey, sometimes with a brilliant sheen in transmitted light of microscope (Na, b).

4.3. Order Erinaceomorpha

Family Erinaceidae (hedgehogs)

The pelage of hedgehogs consists of straight, stiff hairs variable in size. Overhairs are relatively long or shorter, very thick and bristle-like (Fig. 1c); underhairs are thinner. Cross sections of hairs are circular, the medulla is simple or of uniserial ladder type. Scale patterns with irregular waves. The described hair characteristics refer to thicker overhairs.

Atelerix frontalis (A. Smith, 1831) Southern African hedgehog (Pl. 28)

Origin of hair sample: TM 8019: Oshikango, Ovamboland, Namibia.

Hair colour: The colour of lateral hairs is dark brown alternating with light brown, hairs of head and some lateral hairs uniformly light brown.

Hair types, shape and length: Length and width of hairs variable from very long and thick to shorter and thinner hairs. Overhairs wider at distal part. Length of overhairs about 24.8 ± 5.9 mm (n = 5); maximum diameter of hair 160 µm, minimum diameter about 29 µm.

Description of whole mounts: Overhairs with black spot and fragmental medulla at base (A), further distally uniserial ladder (B, C) and simple medulla (D-F), distal hair tip transparent (G).

Form of scale margins: At base dentate (I) and crenate (J-N) distally.

Distance between scale margins: Scale margins distant at base (I), near (J-L) and close (M, N) at distal hair tip.

Cuticular scale patterns: At base petal scale patterns (I); irregular waves (J-N) at distal part of hair.

Description of cross sections: Predominantly circular shapes of cross sections with small medulla (Ha) or large medulla (Hc); medulla always dark brown or black, cortex of some cross sections light brown, resulting in an intense brilliant sheen in transmitted light of microscope (Hc), cortex of other sections dark brown or black (Hb)

4.4. Order Chrysochloridea

Family Chrysochloridae (golden moles)

The pelage of golden moles consists of very characteristic soft, silky hairs with a golden sheen. The relatively long overhairs are thicker, grooved and flattened at the distal third and much thinner at their basal part (Fig. 1d). Subtypes of overhairs are shorter and thinner at their distal third. Cross sections of wider part of hairs typically have oval, oblong or concavo-convex outline (Fig. 3); the medulla has wide medulla lattice. Scale patterns of grooved part of shield region always with regular or irregular waves. The described hair characteristics refer to longer and thicker type of overhairs.

Amblysomus hottentotus (A. Smith, 1829) Hottentot golden mole (Pl. 29)

Origin of hair sample: TM 40789: Grasskop Town, Transvaal, South Africa.

Hair colour: Dorsal hairs grey at basal part and distally vary from dark brown to gold; lateral hairs are golden-brown at their distal part; ventral hairs light grey at base and light gold distally.

Hair types, shape and length: Hairs long and very thick at distal third; distal hair tip forming an angle of about 11°. Subtypes distally thinner. Hair length about 13.0 ± 1.3 mm (n = 5); maximum diameter of shield region 153 µm, minimum diameter about 18 µm.

Description of whole mounts: At base fragmental medulla (basal part of A), uniserial ladder (distal part of A), at thicker distal third wide medulla lattice (B-E), occasionally with cells reaching from one margin to the other (D).

Form of scale margins: At base smooth (G, H), dentate (I), smooth (J), rippled (K) and crenate (L) at distal hair tip.

Distance between scale margins: Scale margins near (G, H) at base, distant (I, J); near (K) and close (L) at distal hair tip.

Cuticular scale patterns: At base simple coronal (G, H), club-shaped/transitional (I, J), regular waves (K) and irregular waves (L) at distal hair tip.

Description of cross sections: Cross section of shield region predominantly oblong with medium size or large medulla (Fa), some cross sections with one invaginated convex side (Fb); cross sections of thin basal part of hairs circular in outline with medium size medulla (Fc); medulla always dark brown or black and cortex light brown, resulting in a brilliant sheen in transmitted light of microscope (F).

Amblysomus iris Thomas & Schwann, 1905 Zulu golden mole (Pl. 30)

Origin of hair sample: TM 26304: Diepwalle Forest Res., Krysna, Cape Province, South Africa.

Hair colour: Hairs grey at basal part and greyish-brown distally.

Hair types, shape and length: Hairs relatively short and very thick at distal third; distal hair tip forming an angle of about 4°. Subtypes distally thinner. Hair length about 7.9 ± 0.5 mm (n = 4); maximum diameter of shield region 143 µm, minimum diameter about 14 µm.

Description of whole mounts: At base fragmental medulla (distal part of A), further distally uniserial ladder, at thicker distal third wide medulla lattice (B, C), ending in a transparent thin tip (D).

Form of scale margins: At base smooth scale margins (F), dentate (G, basal part of H), at wider distal third of hair smooth (distal part of H, I-M).

Distance between scale margins: Scale margins close (basal part of F) at base, distant (distal part of F, G-I); near (J) and close (K-M) at distal hair tip.

Cuticular scale patterns: At base simple coronal (F), narrow diamond petal (G, basal part of H), club-shaped/transitional (H, I); regular waves (I-L) and irregular waves (M) at distal hair tip.

Description of cross sections: Cross sections of shield region oblong or concavo-convex in outline with large medulla (Ea); cross section of thin basal portion of hair of circular outline with large medulla (Eb); medulla black and cortex brown or gold, resulting in an intense brilliant sheen in transmitted light of microscope (E).

Calcochloris obtusirostris (Peters, 1851) Yellow golden mole (Pl. 31)

Origin of hair sample: MHN: Tofo, Inhambane Prov., Mozambique; NKW 7: Machai Sandveld, KNP, South Africa.

Hair colour: Hairs yellow-gold at basal part and distally dark brown.

Hair types, shape and length: Hairs relatively short and thick at distal third; distal hair tip forming an angle of about 15°. Subtypes distally thinner. Hair length about 6.3 ± 0.3 mm (n = 5); maximum diameter of shield region 99 µm, minimum diameter about 19 µm.

Description of whole mounts: At base fragmental medulla (basal part of A), further distally uniserial ladder (distal part of A), at thicker distal third wide medulla lattice (B, C), ending in a blunt tip (C).

Form of scale margins: At base with smooth scale margins (E); dentate (F, G); at wider distal third of hair smooth (H) and rippled/crenate (I-K) at distal hair tip.

Distance between scale margins: Scale margins close at base, further distally distant (E-G); at wider distal part of hair near (H, I) and close (J, K) at distal hair tip.

Cuticular scale patterns: At base coronal (basal part of E), further distally narrow diamond petal (F), club-shaped/transitional (G, H) and irregular waves (I-K) at thicker distal third of hair.

Description of cross sections: Cross sections of shield region oblong in outline (Da), slightly dumb-bell shaped (Db) or concavo-convex shapes (Dc) with small medulla; cross section of thin basal part of hair circular in outline with small medulla (Dd); medulla often light brown or grey and cortex dark (Da).

Carpitalpa arendsi Lundholm, 1955 Arend's golden mole (Pl. 32)

Origin of hair sample: TM 12778: Vumba Mt., Umtali Distr., Zimbabwe (*Chlorotalpa arendsi*).

Hair colour: Dorsal and lateral hairs grey at basal part and dark brown further distally. Ventral hairs grey at basal part and distally light brown.

Hair types, shape and length: Hairs relatively long and thick at distal third; distal hair tip forming an angle of about 3°. One subtype with thinner distal part. Hair length about 13.0 ± 0.8 mm (n = 5); maximum diameter of shield region 101 µm, minimum diameter about 5 µm.

Description of whole mounts: At base simple medulla, sometimes fragmental (basal part of A), further distally uniserial ladder (distal part of A); at thicker distal third wide medulla lattice (B-D), ending in a thin tip (E).

Form of scale margins: At base with smooth scale margins (G); dentate (H, basal part of I); at wider distal third of hair smooth (distal part of I, J) and crenate (K-M) at distal hair tip.

Distance between scale margins: Scale margins close at base, further distally distant (G-I); at wider distal part of hair near (J) and close (K-M) at distal hair tip.

Cuticular scale patterns: At base simple coronal (G), further distally narrow diamond petal/composed double chevron (H), club-shaped/transitional (I), regular waves (J) and irregular waves (K-M) at distal hair tip.

Description of cross sections: Cross sections of shield region oblong or oval in outline with large medulla (Fa) or concavo-convex outline with large medulla (Fb); cross section of thin basal part of hair circular in outline with large medulla (Fc); medulla grey or black, cortex of some cross sections light brown resulting in a weak sheen in transmitted light of microscope (Fa), cortex of other sections black.

Chlorotalpa duthieae (Broom, 1907) Duthie's golden mole (Pl. 33)

Origin of hair sample: TM 19119: Krysna, Cape Province, South Africa.

Hair colour: Hairs grey at basal part and brown distally.

Hair types, shape and length: Hairs relatively long and thick at distal third; distal hair tip forming an angle of about 10°. Subtypes with thinner distal part. Hair length about 12.1 ± 1.1 mm (n = 5); maximum diameter of shield region 101 µm, minimum diameter about 7 µm.

Description of whole mounts: At base fragmental medulla (A), further distally uniserial ladder (B); at thicker distal third wide medulla lattice (C-E).

Form of scale margins: Scale margins at base smooth (G), further distally dentate (H); at wider distal third of

hair smooth (I), rippled (J) and crenate (K, L) at distal hair tip.

Distance between scale margins: Scale margins near (G) at base, further distally distant (H); at wider distal part of hair near (I, J) and close (K, L) at distal hair tip.

Cuticular scale patterns: At base coronal (G), further distally narrow diamond petal (H), regular waves (I) and irregular waves (J-L) at thicker distal third of hair.

Description of cross sections: Cross sections of shield region oblong with large medulla (Fa) or concavo-convex outline with large medulla (Fb); cross section of thin basal part of hair circular in outline with large medulla; medulla dark grey or black, cortex light brown or grey resulting in a weak sheen in transmitted light of microscope (F).

Chlorotalpa sclateri (Broom, 1907) Sclater's golden mole (Pl. 34)

Origin of hair sample: TM 39445: Mount View, Karoo N. P., Cape Province, South Africa.

Hair colour: Dorsal hairs grey at basal part and brownish-gold distally. Lateral and ventral hairs grey at basal part and light gold at distal part.

Hair types, shape and length: Hairs relatively short and thick at distal third; distal hair tip forming an angle of about 8°. Subtypes with thinner distal part. Hair length about 7.0 ± 0.8 mm (n = 5); maximum diameter of shield region 86 µm, minimum diameter about 10 µm.

Description of whole mounts: At base fragmental medulla (basal part of A), further distally uniserial ladder (distal part of A); at thicker distal third wide medulla lattice (B-D), ending in a thin transparent tip (D).

Form of scale margins: At base smooth (F-H) scale margins, at wider distal third of hair rippled (I) and crenate (J, K) at distal hair tip.

Distance between scale margins: Scale margins near at base (F, G), further distally near (H, I) and close (J, K) at distal hair tip.

Cuticular scale patterns: At base simple coronal (F, basal part of G); at thicker distal third of hair regular waves (H) and irregular waves (I-K).

Description of cross sections: Cross sections of shield region oblong with large medulla (Ea) or concavo-convex outline with large medulla (Eb); cross section of thin basal part of hair circular in outline with large medulla; medulla with brown, grey or black, cortex of some cross sections light brown resulting in an intense brilliant sheen in transmitted light of microscope (E).

Chrysochloris asiatica (Linnaeus, 1758) Cape golden mole (Pl. 35)

Origin of hair sample: TM 5808: Goudini, Worcester, Cape Province, South Africa.

Hair colour: Dorsal hairs grey at basal part and light grey distally; ventral hairs entirely brownish-gold.

Hair types, shape and length: Hairs relatively long and thick at distal third; distal hair tip forming an angle of about 4°. Subtypes shorter and with thinner distal part. Hair length about 11.2 ± 0.5 mm (n = 5); maximum diameter of shield region 92 µm, minimum diameter about 9 µm.

Description of whole mounts: At base uniserial ladder, sometimes fragmental (A); at thicker distal third wide medulla lattice (B, C), ending in a thin transparent tip (C).

Form of scale margins: Scale margins smooth (F-H) at base, at thicker distal third crenate (I-K).

Distance between scale margins: Scale margins near (F-H) at base and close (I-K) at distal hair tip.

Cuticular scale patterns: At base simple coronal (F); at thicker distal third of hair regular waves (G-I) and irregular waves (J, K) at distal hair tip.

Description of cross sections: Cross sections of shield region oblong (Ea) or oval (Eb) with large medulla; cross sections of ventral hairs concavo-convex in outline with medium size medulla (Da); cross section of thin basal part of hair circular in outline with medium size medulla (Db, Ec); medulla black, cortex light brown resulting in an intense brilliant sheen in transmitted light of microscope (D, E).

Chrysospalax trevelyani (Günther, 1875) Giant golden mole (Pl. 36)

Origin of hair sample: TM 746: Port St. Johns, Cape Prov., South Africa.

Hair Colour: Hairs light yellow at basal part and dark brow distally.

Hair types, shape and length: Hairs very long and very thick at distal third; distal hair tip forming an angle of about 9°. Subtypes with thinner distal part. Hair length about 20.6 ± 0.4 mm (n = 5); maximum diameter of shield region 190 µm, minimum diameter about 25 µm.

Description of whole mounts: At base fragmental medulla (A), further distally uniserial ladder (B); at thicker distal third wide medulla lattice (C-E).

Form of scale margins: At base with smooth (G) scale margins, dentate (H, I), smooth (J, K) and crenate (L, M) at distal hair tip.

Distance between scale margins: Scale margins close (G) at base, further distally distant (H-J), near (K) and close (L, M) at distal hair tip.

Cuticular scale patterns: Simple coronal (G) at base, narrow diamond petal (H), club-shaped/transitional (I, J), regular waves (K, L) and irregular waves (M) at distal hair tip.

Description of cross sections: Cross sections of shield region predominantly oblong with large medulla (F); cross section of thin basal part of hair circular in outline with medium size medulla; medulla black, cortex light brown resulting in an intense brilliant sheen in transmitted light of microscope (F).

Chrysospalax villosus (A. Smith, 1833) Rough-haired golden mole (Pl. 37)

Origin of hair sample: TM 22416: Pietermaritzburg Natal, South Africa.

Hair colour: Hairs grey at basal part and dark brow distally.

Hair types, shape and length: Hairs very long and thick at distal third; distal hair tip forming an angle of about 2°. Subtypes with thinner distal part. Hair length about 20.8 ± 1.0 mm (n = 5); maximum diameter of shield region 105 µm, minimum diameter about 11 µm.

Description of whole mounts: At base fragmental simple medulla (A), at distal third of hair wide medulla lattice (B, C); ending in a thin, transparent distal hair tip (D).

Form of scale margins: At base smooth (G) scale margins, dentate (H); at wider distal third of hair smooth (I), smooth/crenate (J), rippled (K) and crenate (L, M) at distal hair tip.

Distance between scale margins: Scale margins near at base (G), further distally distant (H, I), near (J) and close (K-M) at distal part of hair.

Cuticular scale patterns: At base simple coronal (G), narrow diamond petal (H), club-shaped/transitional (I), regular waves (J) and irregular waves (K-M) at distal hair tip.

Description of cross sections: Cross sections of shield region predominantly oblong (Fa) and oval (Ea, Fb) with large medulla; cross section of thin basal part of hair circular in outline with large medulla (Eb); medulla dark grey or black, cortex light brown, resulting in an intense brilliant sheen in transmitted light of microscope (E, F).

Cryptochloris wintoni (Broom, 1907) de Winton's golden mole (Pl. 38)

Origin of hair sample: TM 8235: Port Nolloth, Namaqualand, Cape Prov, South Africa.

Hair colour: Hairs dark grey at basal part and of gold colour distally.

Hair types, shape and length: Hairs relatively short and thick at distal third; distal hair tip forming an angle of about 12°. Subtypes with thinner distal part. Hair length about 6.9 ± 0.6 mm (n = 5); maximum diameter of shield region 113 µm, minimum diameter about 9 µm.

Description of whole mounts: At base fragmental uniserial ladder (A); at thicker distal third wide medulla lattice with large aerial spaces (B-D).

Form of scale margins: At base smooth (F) scale margins, further distally dentate (G); at wider distal third of hair smooth (H) and crenate (I-K) at distal hair tip.

Distance between scale margins: Scale margins close at base (F), further distally distant (G), near (H, I) and close (J, K) at distal hair tip.

Cuticular scale patterns: At base coronal (F), further distally narrow diamond petal (G); at thicker distal third of hair regular waves (H) and irregular waves (I-K) at distal hair tip.

Description of cross sections: Cross sections of shield region predominantly oblong with small medulla (Ea) and some cross sections with one invaginated convex side (Eb); cross section of thin basal part of hair circular in outline with medium size medulla (Ec); medulla light or dark grey, cortex light brown, resulting in an intense brilliant sheen in transmitted light of microscope (E).

Eremitalpa granti (Broom, 1907) Grant's golden mole (Pl. 39)

Origin of hair sample: TM 8237: North Nolloth Distr., Namaqualand, Cape Province, South Africa; TM 15154: Sossusvlei, Namib Desert, Namibia.

Hair colour: Dorsal hairs grey and dark brown at small portion of distal tip, lateral and ventral hairs grey at basal part and distally of light gold colour.

Hair types, shape and length: Hairs long and moderately thick at distal third; distal hair tip forming an angle of about 6°. Subtypes with thinner distal part. Hair length about 15.5 ± 0.6 mm (n = 5); maximum diameter of shield region 78 µm, minimum diameter about 9 µm.

Description of whole mounts: At base fragmental uniserial ladder (A), at thicker distal third wide medulla lattice (B-E) with larger clear spaces (D).

Form of scale margins: Scale margins smooth (G, H) at base, and crenate (I-K) at distal third of hair.

Distance between scale margins: At base scale margins near (G, H) and close (I-K) at distal third of hair.

Cuticular scale patterns: At base simple coronal (basal part of G), regular waves (distal part of G, H); at thicker distal third of hair irregular waves (H-K).

Description of cross sections: Cross sections of shield region predominantly oblong (Fa) or dumb-bell shaped with large medulla (Fb), occasionally concavo-convex in outline; cross section of thin basal part of hair circular in outline with medium size medulla (Fc); medulla light or dark grey, cortex light brown, resulting in a weak sheen in transmitted light of microscope (F).

Neamblysomus gunningi (Broom, 1908) Gunning's golden mole (Pl. 40)

Origin of Hair Sample: TM 40780: Magoebas Kloof, de Hoek Nat. Res. Transvaal, South Africa (*Amblysomus gunningi*).

Hair colour: Dorsal hairs light grey at basal part and distally brown, lateral and ventral hairs light grey at basal part and distally of gold colour.

Hair types, shape and length: Hairs moderately long and thick at distal third; distal hair tip forming an angle of about 6°. Subtypes with thinner distal part. Hair length about 8.1 ± 1.1 mm (n = 4); maximum diameter of shield region 102 µm, minimum diameter about 9 µm.

Description of whole mounts: At base uniserial ladder (A); at thicker distal third wide medulla lattice (B, C), sometimes with clear spaces (B), ending in a thin tip (C).

Form of scale margins: At base smooth (E-G) scale margins and crenate (H, I) at distal hair tip.

Distance between scale margins: At base scale margins near (E-G) and close (H, I) at distal hair tip.

Cuticular scale patterns: At base coronal (basal part of E), club-shaped/transitional (F); at thicker distal third of hair regular waves (H) and irregular waves (H, I) at distal hair tip.

Description of cross sections: Cross sections of shield region predominantly dumb-bell shaped with large medulla (Da); cross section of thin basal part of hair circular in outline with medium size (Db) or small medulla (Dc); medulla black, light or dark grey, cortex dark or light brown, resulting in a brilliant sheen in transmitted light of microscope (D).

Neamblysomus julianae Meester, 1972 Juliana's golden mole (Pl. 41)

Origin of hair sample: NKW 4: Manchulane, KNP, South Africa (=*Amblysomus julianae*).

Hair colour: Hairs grey at basal part and distally light to dark brown.

Hair types, shape and length: Hairs relatively long and thick at distal third; distal hair tip forming an angle of about 7°. Subtypes shorter and with thinner distal part. Hair length about 13.8 ± 0.7 mm (n = 5); maximum diameter of shield region 86 µm, minimum diameter about 14 µm.

Description of whole mounts: At base uniserial ladder (A); at thicker distal third wide medulla lattice (B-D) with some aerial spaces (C), ending in a thin tip (D).

Form of scale margins: At base scale margins smooth (F-J) and crenate/rippled (K-N) at distal hair tip.

Distance between scale margins: At base scale margins near (F, G), further distally distant (H-J), near (K, L) and close (M, N).

Cuticular scale patterns: At base simple coronal (F, G), further distally club-shaped/transitional (H), regular waves (I, J) and irregular waves (K-N) at distal hair tip.

Description of cross sections: Cross sections of shield region oblong (Ea) and dumb-bell shaped (Eb) with large medulla; cross section of thin basal part of hair circular in outline with medium size medulla (Ec); medulla black, light or dark grey, cortex light brown, resulting in an intense brilliant sheen in transmitted light of microscope (E).

5. KEY TO SOUTHERN AFRICAN ELEPHANT-SHREWS, SHREWS, HEDGEHOGS AND GOLDEN MOLES BASED ON HAIR CHARACTERISTICS

1 Pelage composed of distally enlarged overhairs and slightly curved underhairs with or without constrictions (Fig. 1a); hairs occasionally with intumescence (e.g., Pl. 1F & G, 4F, 6F, 7B & F); length of dorsal hairs varies between 11 mm and 18 mm; medulla with uniserial ladder, medulla of some species distally with wide lattice; scale patterns of distal part of hair with regular or irregular waves, hair tip often of coronal type; cross section almost always circular ..... **elephant-shrews**

2 Pelage composed of straight, long heavy overhairs without constrictions, a second type of distally enlarged, grooved and slightly curved overhairs (shield hairs) and undulating underhairs (Fig. 1b); the latter two types with one or several constrictions along the hair (Pl. 13 H); hairs very short varying between 3 mm and 10 mm; except from immediate base and tip, medulla always with uniserial ladder; scale patterns of grooved part of shield region always cupped, hair tip with coronal or regular waves; cross section of enlarged part of shield hair typically rectangular, or "H"-like with two or more emarginations (e.g., Pl. 9Gb) ..... **shrews**

3 Pelage composed of straight, stiff, distally enlarged overhairs lacking constrictions and dilatations (Fig. 1c) and thinner underhairs; length of hairs up to 25 mm; medulla simple or with uniserial ladder; scale patterns with irregular waves; cross section circular ..... **hedgehogs**

4 Pelage composed of long overhairs (shield hairs) with distal third expanded, flattened and club-like (Fig. 1d) and shorter sub-types with thinner distal part; length of dorsal hairs between 6 mm and 21 mm; medulla at thickened part of hair always with wide medulla lattice; scale patterns of grooved part of shield region always with regular or irregular waves; cross section of enlarged part of hair oblong, oval or concavo-convex ..... **golden moles**

Elephant-shrews (or sengis)

1a Maximum diameter of hairs between 40 µm and 70 µm **2**

1b Maximum diameter of hairs smaller than 40 µm .. **5**

2a Cross sections with golden sheen in transmitted light of microscope **3**

2b Cross sections not with golden sheen in transmitted light of microscope **4**

3a Hair length about 16 mm; wide medulla lattice at distal part of overhair; maximum diameter of hairs approx. 58 µm; circular cross sections with bright sheen. Distribution: N South Africa and NE Namibia; Angola; S Zaire; Zimbabwe, Mozambique to Kenya and Uganda ... ***Elephantulus brachyrhyuchus***

3b Hair length about 18 mm; medulla with uniserial ladder; maximum diameter of hairs approx. 59 µm; circular cross sections with bright sheen. Distribution: Mozambique; Tanzania (including Mafia and Zanzibar); SE Kenya; S Uganda; Zambia, Malawi; SE Zimbabwe; Zaire; Namibia; NE Angola; N Natal and E Transvaal, South Africa ..... ***Petrodromus tetradactylus***

4a Medulla with uniserial ladder; hair length about 15 mm; maximum diameter of hairs approx. 53 µm; cross sections circular in outline. Distribution: SW Angola; Namibia; Botswana; NW Transvaal and N Cape Prov., South Africa ..... ***Elephantulus intufi***

4b Hair length about 12 mm; medulla with wide medulla lattice; maximum diameter of hairs approx. 46 µm; cross sections circular in outline. Distribution: Zimbabwe, Namibia, E Botswana, E and N South Africa, Mozambique ..... ***Elephantulus myurus***

5a Hair length about 18 mm; medulla with uniserial ladder; maximum diameter of hairs about 34 µm; circular cross sections with bright sheen. Distribution: Namibia; Cape Prov., South Africa ..... ***Elephantulus rupestris***

5b Hair length about 14 mm; medulla with uniserial ladder; maximum diameter of hairs approx. 30 µm; circular cross sections without sheen. Distribution: SW and C Cape Prov., South Africa ..... ***Elephantulus edwardi***

5c Hair length about 18 mm; medulla with uniserial ladder; maximum diameter of hairs approx. 26 µm; circular cross sections with bright sheen. Distribution: W and NW Cape Prov., South Africa to SW Namibia ..... ***Macroscelides proboscideus***

Shrews

1a Length of overhairs longer than 7 mm **2**

1b Length of overhairs shorter than 7 mm **5**

2a Cross sections of widest part of shield hair in the form of an H in outline **3**

2b Cross sections of widest part of shield hair not in the form of an H in outline **4**

3a Hair length about 8.3 mm; maximum diameter of hairs about 40 µm. Distribution: South Africa, eastern escarpment and north to the Transvaal; extreme W Mozambique and E Zimbabwe . ***Myosorex cafer***

3b Hair length about 8.9 mm; maximum diameter of hairs about 31 µm. Distribution: SE Cape Province, South Africa ..... ***Myosorex longicaudatus***

3c Hair length about 7.3 mm; maximum diameter of hairs about 42 µm; distribution: Natal, South Africa; Swaziland; Mozambique; Zimbabwe .... ***Myosorex sclateri***

3d Hair length about 8.2 mm; maximum diameter of hairs about 33 µm. Distribution: Transvaal, South Africa; possibly W Mozambique .. ***Myosorex tenuis***

3e Hair length about 7.3 mm; maximum diameter of hairs about 38 µm. Distribution: South Africa, from NW Cape Province to E Transvaal; Lesotho and Orange Free State ..... ***Myosorex varius***

4a Hair length about 9.5 mm; maximum diameter of hairs about 67 µm; medulla typically with 'letters' (Pl. 15D). Distribution: Egypt; Senegal to Ethiopia and southwards to N South Africa .... ***Crocidura olivieri maltieusseui***

4b Hair length about 7.3 mm; maximum diameter of hairs about 32 µm; cross sections quadrangular or rectangular in outline with plane and convex short sides (Pl. 27 Na). Distribution: Upper Guinea to Ethiopia and south to Namibia, Angola, Mozambique and Zimbabwe ..... ***Sylvisorex megalura***

5a Hair length shorter than 4 mm **6**

5b Hair length between 4 mm and 7 mm **7**

6a Hair length about 2.7 mm; maximum diameter of hairs about 26 µm; cross sections rectangular in outline with a deep invagination of one side resulting in prominent extensions of the margin (Pl. 10Fa). Distribution: Sudan and Guinea, from Senegal to Ethiopia and south to South Africa .... ***Crocidura fuscomurina***

6b Hair length about 2.7 mm; maximum diameter of hairs about 29 µm. Distribution: South Africa to Kenya; Central African Republic; Cameroon .... ***Suncus infinitesimus***

6c Hair length about 3.7 mm; maximum diameter of hairs about 24 µm. Distribution: Kenya, Tanzania, Malawi, Zaire, Zambia, Angola, Botswana, Namibia, Zimbabwe and Transvaal, South Africa .... ***Suncus lixus***

7a Cross sections dumb-bell shaped in outline; rungs of uniserial ladder irregular and often like "letters" ... **8**

7b Cross sections quadrangular or rectangular in outline; rungs of uniserial ladder more regular **9**

8a Hair length about 5.5 mm; maximum diameter of hairs about 33 µm. Distribution: Angola, Zaire, Uganda, Kenya, Somalia, Tanzania, Malawi, Zimbabwe, Zambia, Mozambique, Botswana, Namibia, South Africa ..... ***Crocidura hirta***

8b Hair length about 4.3 mm; maximum diameter of hairs about 31 µm. Distribution: Transvaal, South Africa; Swaziland, Nyamaziwa Falls, Matopo Hills, Zimbabwe ..... ***Crocidura maquassiensis***

8c Hair length about 6.7 mm; maximum diameter of hairs about 31 µm. Distribution: Mozambique, Zambia, Zimbabwe, E Angola, Zaire, Malawi, Tanzania, Kenya, Uganda, Rwanda ..... ***Crocidura luna***

8d Hair length about 6.2 mm; maximum diameter of hairs about 36 µm. Distribution: Angola, Zambia, Zaire, Malawi, Tanzania, Kenya, Uganda, Cameroon ..... ***Crocidura turba***

8e Hair length about 5.5 mm; maximum diameter of hairs about 35 µm. Distribution: southern and eastern South Africa, southern Mozambique .... ***Crocidura flavescens***

9a Hair length about 6.2 mm; maximum diameter of hairs about 29 µm. Distribution: South Africa, Namibia, Angola, Botswana, Mozambique, records further north uncertain ..... ***Crocidura cyanea***

9b Hair length about 5.3 mm; maximum diameter of hairs about 38 µm; medulla typically with "letters" (Pl. 16C). Distribution: Egypt; Senegal to Ethiopia, and southwards to N South Africa .... ***Crocidura olivieri occidentalis***

9c Hair length about 6.0 mm; maximum diameter of hairs about 31 µm. Distribution: South Africa to Mozambique, W Zimbabwe and Zambia; NW Botswana and NE Namibia to SC Angola; perhaps SE Zaire ..... ***Crocidura mariquensis***

9d Hair length about 4.3 mm; maximum diameter of hairs about 34 µm. Distribution: most of South Africa, parts of Botswana, Mozambique and Zimbabwe; possibly wider distribution .... ***Crocidura silacea***

9e Hair length about 5.5 mm; maximum diameter of hairs about 27 µm. Distribution: Cape, South Africa to Zimbabwe, Mozambique, Zambia, Tanzania, E Zaire, Malawi; an isolated record from Nigeria ..... ***Suncus varilla***

Hedgehogs

1 Hair length about 25 mm; maximum diameter of hairs about 160 µm; overhairs with black spot at base (Pl. 28A). Distribution: Cape Province, South Africa to E Botswana and W Zimbabwe, Namibia to SW Angola, Zambia ..... ***Atelerix frontalis***

Golden moles

1a Hair length about 21 mm **2**

1b Hair length much less than 21 mm **3**

2a Hair length about 21 mm; maximum diameter of hairs about 190 µm; distal hair tip forming an angle of about 9°. Distribution: Cape Prov., South Africa ..... ***Chrysospalax trevelyani***

2b Hair length about 21 mm; maximum diameter of hairs about 105 µm; distal hair tip forming an angle of about 2°. Distribution: Transvaal and Natal, South Africa ..... ***Chrysospalax villosus***

3a Maximum diameter of hairs between 125 µm and 160 µm **4**

3b Maximum diameter of hairs smaller than 125 µm **5**

4a Distal hair tip forming an angle of about 11°; hair length about 13 mm; maximum diameter of hairs about 153 µm. Distribution: Natal, Transvaal to S Cape Prov., also NE Orange Free State, South Africa; Lesotho; Swaziland; S Mozambique ..... ***Amblysomus hottentotus***

4b Distal hair tip forming an angle of about 4°; hair length about 8 mm; maximum diameter of hairs about 143 µm. Distribution: S Cape Prov. to Transkei, Natal, including Zululand, and SE Transvaal, South Africa; S Mozambique ..... ***Amblysomus iris***

5a Distal hair tip forming an angle of about 15°; hair length about 6 mm; maximum diameter of hairs about 99 µm. Distribution: Zululand and E Transvaal, South Africa; S Zimbabwe; S Mozambique .... ***Calcochloris obtusirostris***

5b Distal hair tip forming an angle < 15° **6**

6a Medulla lattice with large aerial spaces; hair length about 7 mm; maximum diameter of hairs about 113 µm; distal hair tip forming an angle of about 12°. Distribution: Little Namaqualand; Cape Prov., South Africa ..... ***Cryptochloris wintoni***

6b Medulla lattice not with large aerial spaces **7**

7a Cross sections of extended part of ventral hairs predominantly showing concavo-convex outline (Pl. 35Da); hair length about 11 mm; maximum diameter of hairs about 92 µm; distal hair tip forming an angle of about 4°. Distribution: W Cape Prov. and Robben Isl., South Africa; perhaps Damaraland, Namibia ..... ***Chrysochloris asiatica***

7b Cross sections of extended part of ventral hairs predominantly showing other than concavo-convex outline **8**

8 The following species can be distinguished according to their distribution:

8a Hair length about 8 mm; maximum diameter of hairs about 102 µm; distal hair tip forming an angle of about 6°. Distribution: E Transvaal, South Africa ..... ***Neamblysomus gunningi***

8b Hair length about 14 mm; maximum diameter of hairs about 86 µm; distal hair tip forming an angle of about 7°. Distribution: Pretoria, Nylstroom/Nylsvley and Kruger Nat. Park (Transvaal), South Africa ..... ***Neamblysomus julianae***

8c Hair length about 13 mm; maximum diameter of hairs about 101 µm; distal hair tip forming an angle of about 3°. Distribution: E Zimbabwe and adjacent Mozambique ..... ***Carpitalpa arendsi***

8d Hair length about 12 mm; maximum diameter of hairs about 101 µm; distal hair tip forming an angle of about 10°. Distribution: S Cape Prov., South Africa ..... ***Chlorotalpa duthieae***

8e Hair length about 7 mm; maximum diameter of hairs about 86 µm; distal hair tip forming an angle of about 8°. Distribution: Cape Prov., E Orange Free State, S Transvaal, South Africa; Lesotho ..... ***Chlorotalpa sclateri***

8f Hair length about 16 mm; maximum diameter of hairs about 78 µm; distal hair tip forming an angle of about 6°. Distribution: Cape Prov., South Africa to Namib Desert, Namibia; Botswana ..... ***Eremitalpa granti***

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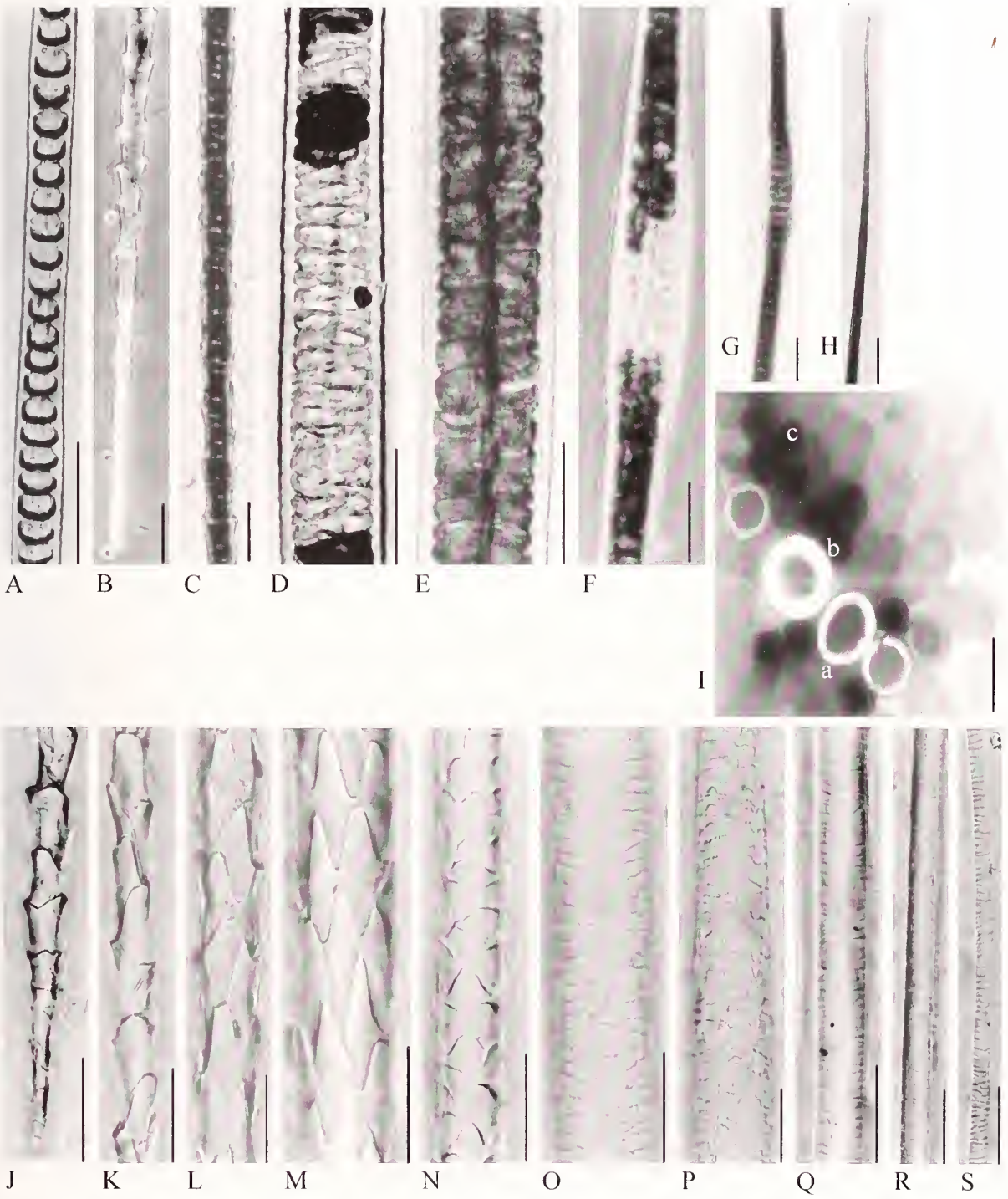

Plate 1. Whole mounts, cross sections and cuticular scale casts of *Elephantulus brachyrhynchus* (bars equivalent to 50 µm).

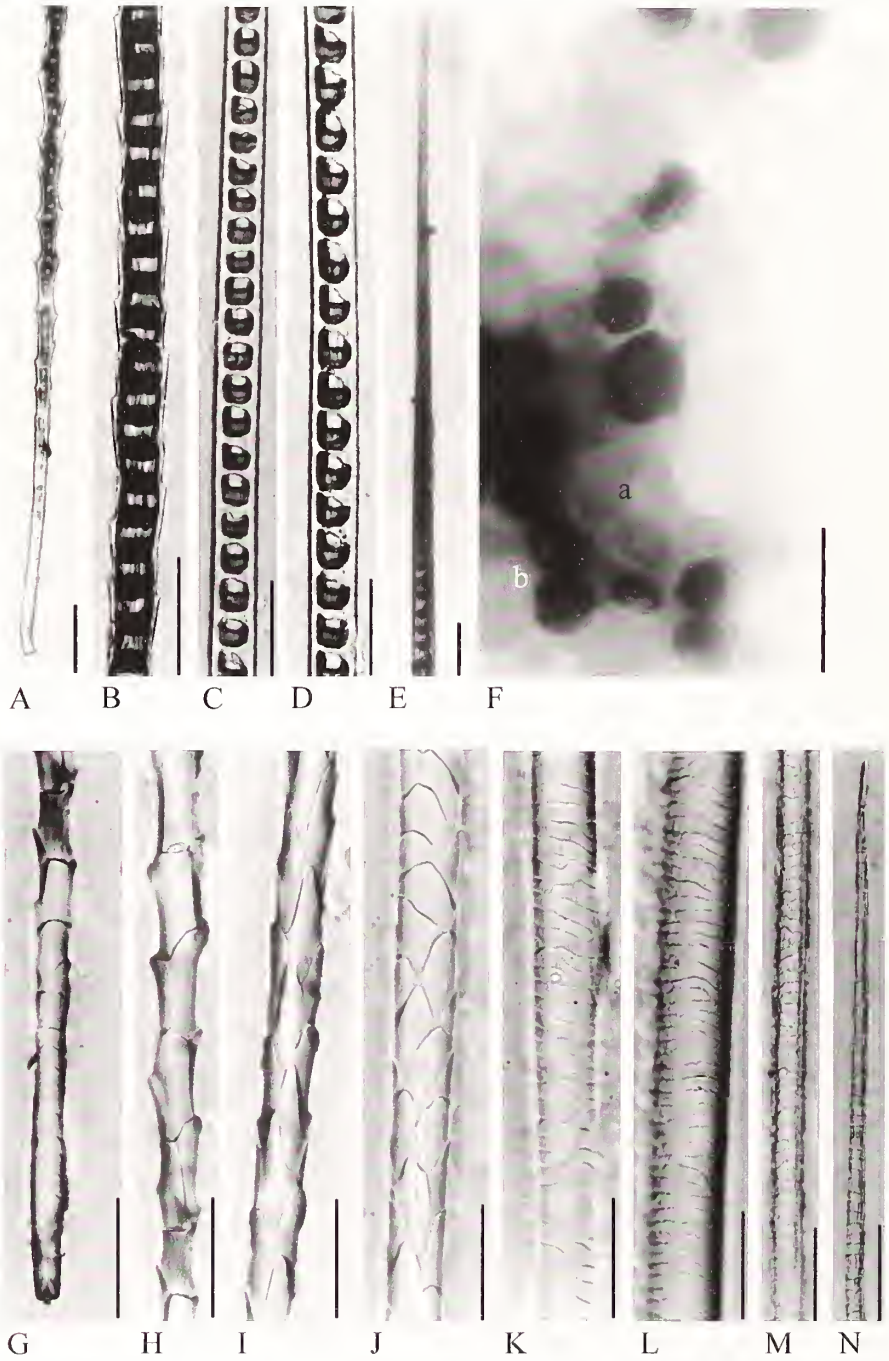

Plate 2. Whole mounts, cross sections and cuticular scale casts of *Elephantulus edwardi* (bars equivalent to 50 µm).

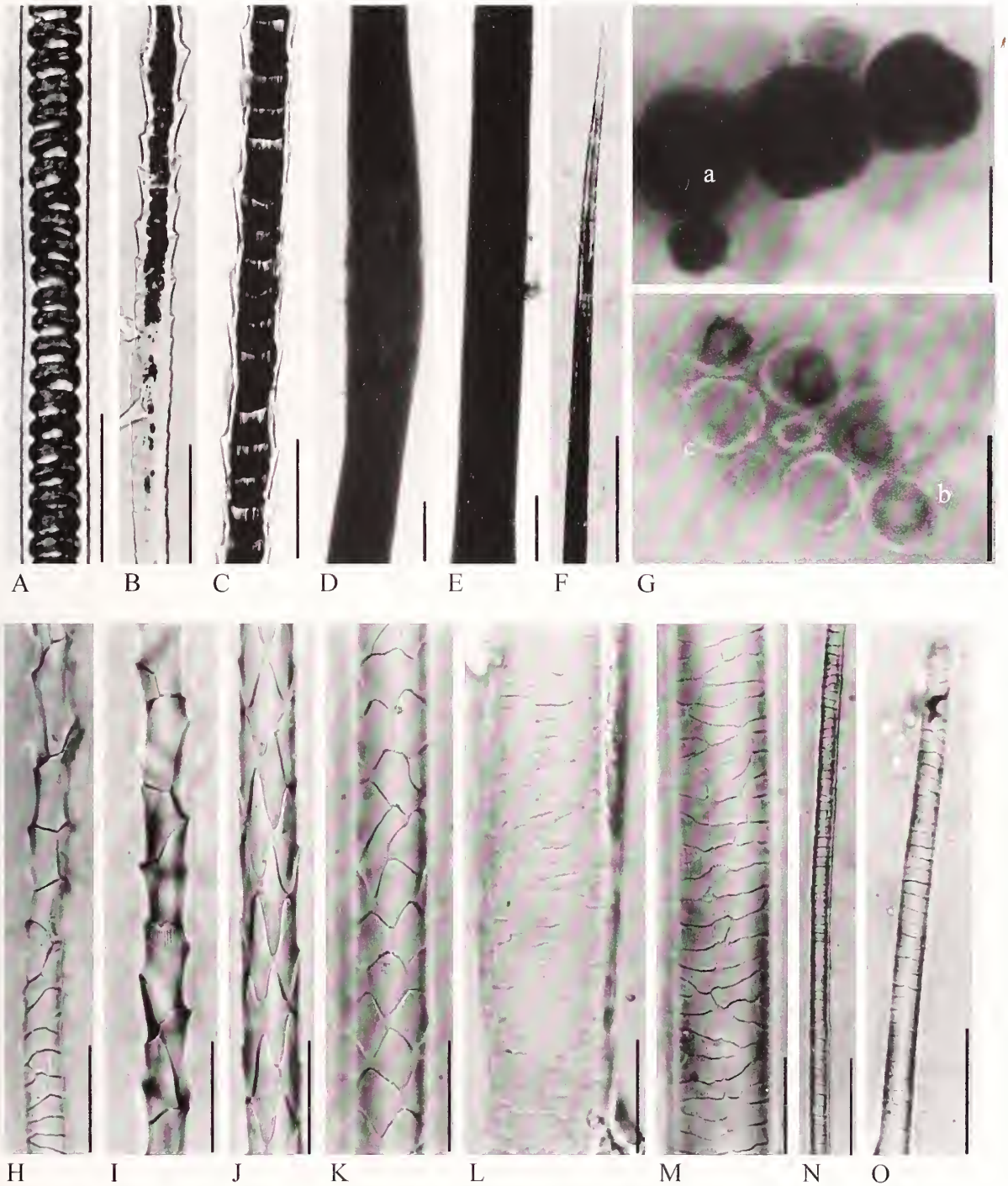

Plate 3. Whole mounts, cross sections and cuticular scale casts of *Elephantulus intufi* (bars equivalent to 50 µm).

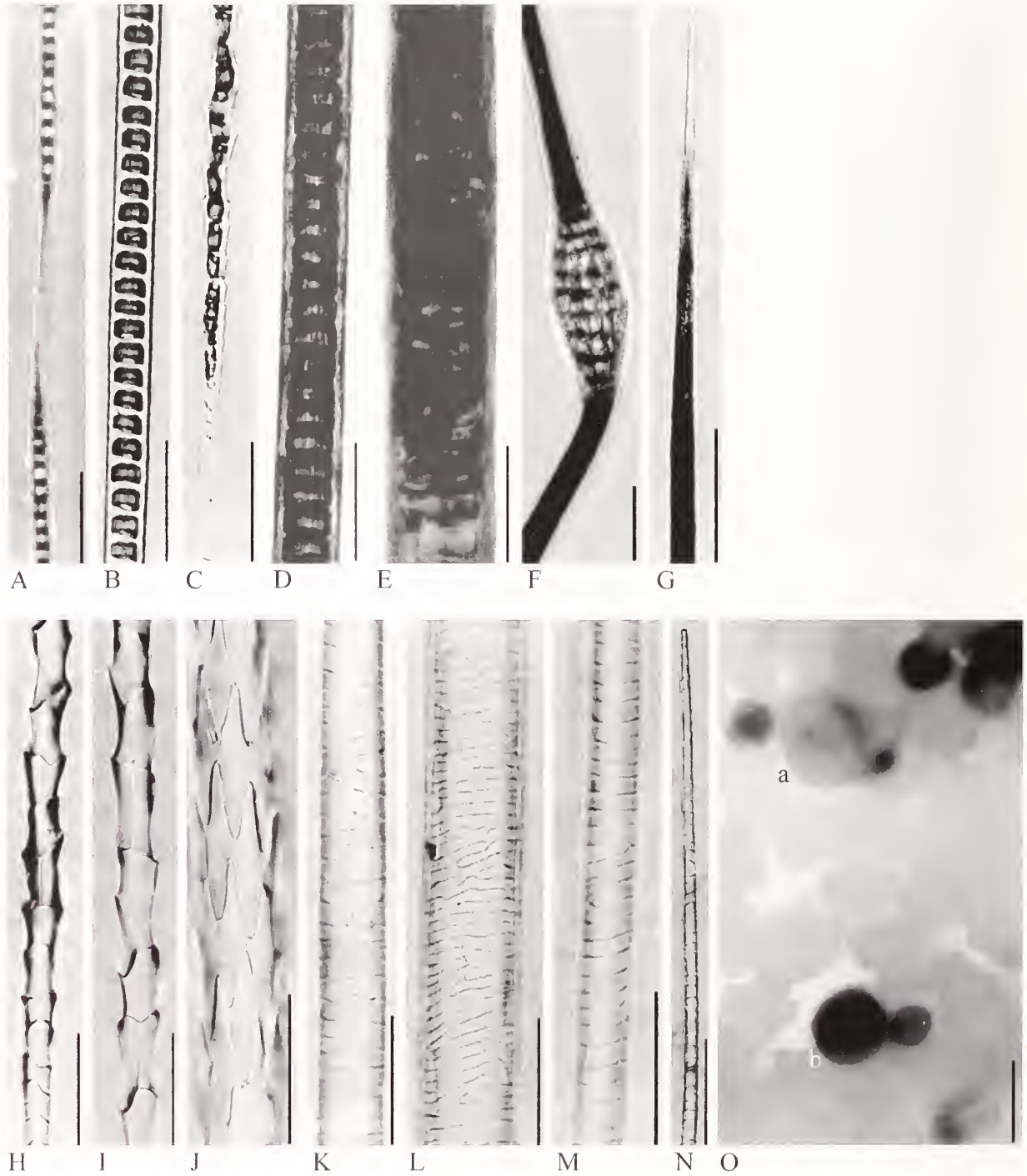

Plate 4. Whole mounts, cross sections and cuticular scale casts of *Elephantulus myurus* (bars equivalent to 50 µm).

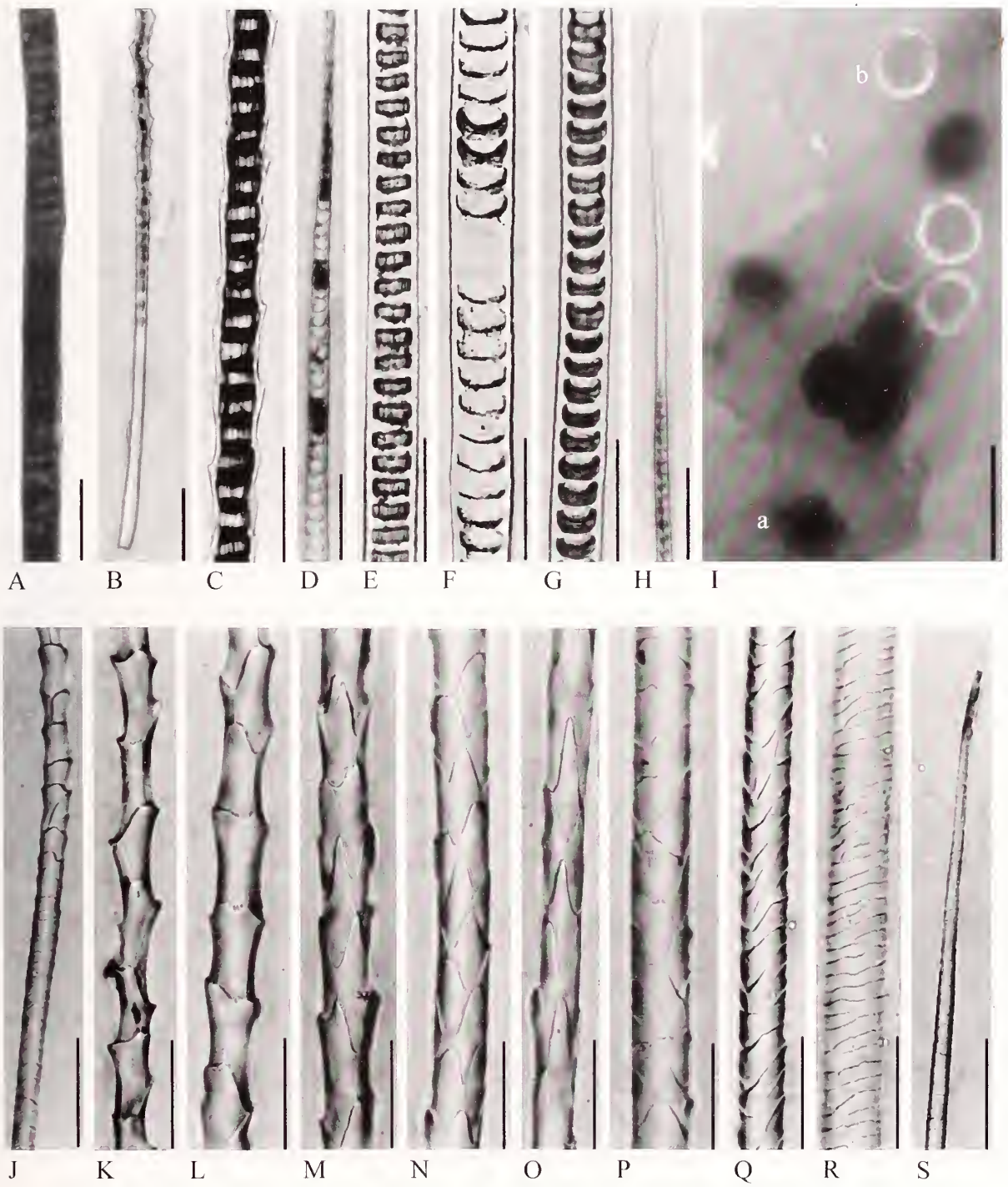

Plate 5. Whole mounts, cross sections and cuticular scale casts of *Elephantulus rupestris* (bars equivalent to 50 µm).

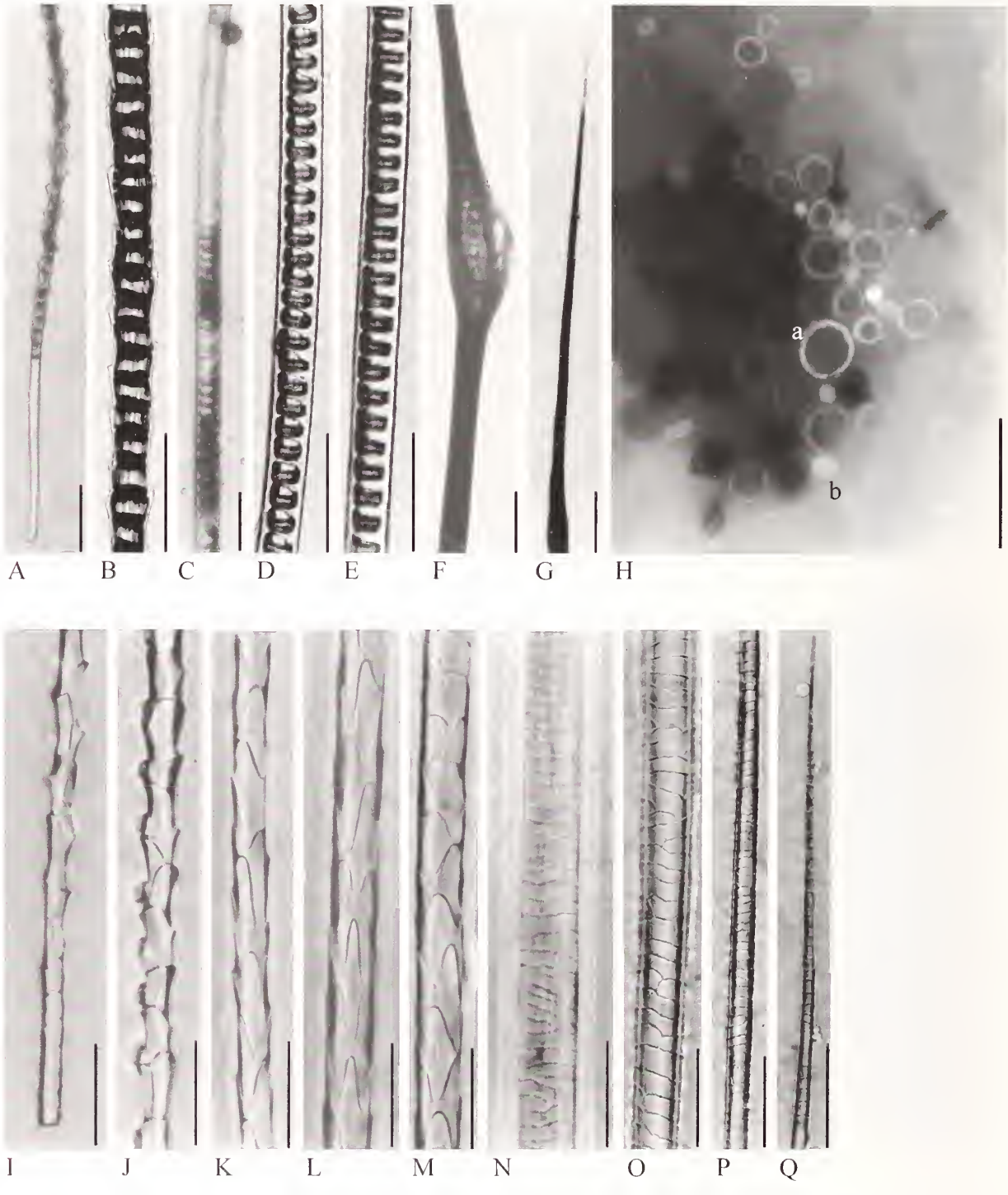

Plate 6. Whole mounts, cross sections and cuticular scale casts of *Macroscelides proboscideus* (bars equivalent to 50 µm).

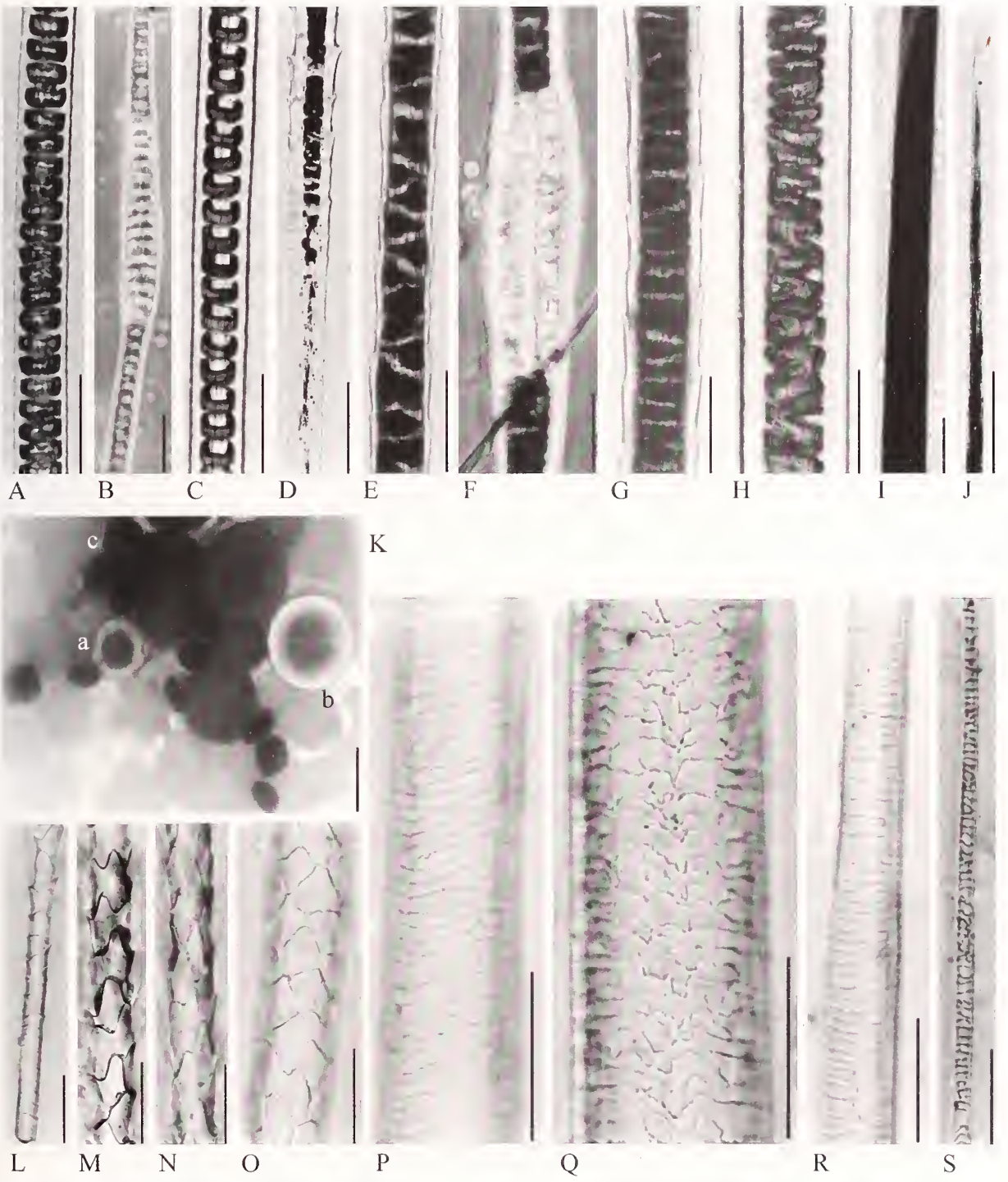

Plate 7. Whole mounts, cross sections and cuticular scale casts of *Petrodromus tetradactylus* (bars equivalent to 50 µm).

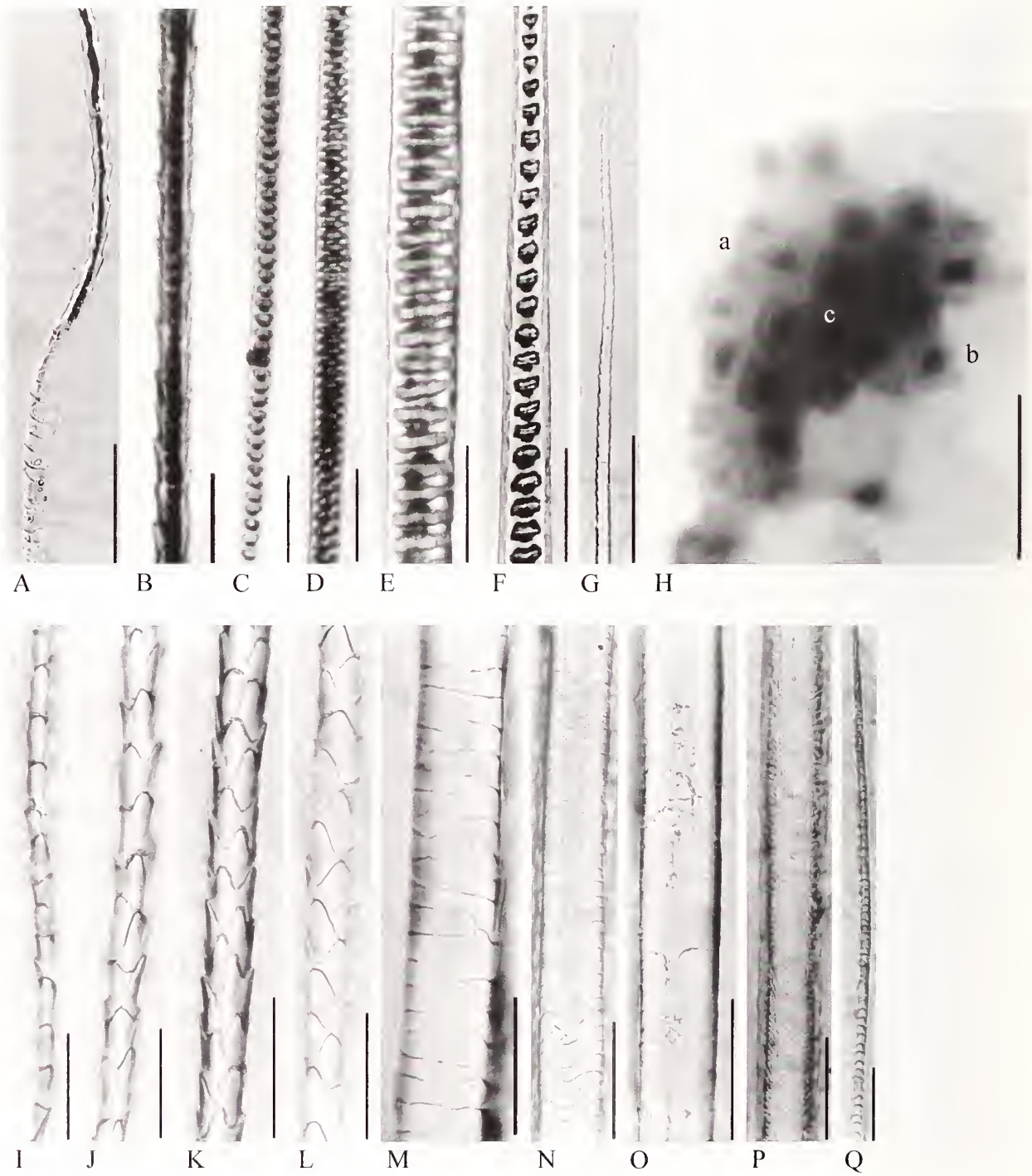

Plate 8. Whole mounts, cross sections and cuticular scale casts of *Crocidura cyanea* (bars equivalent to 50 µm).

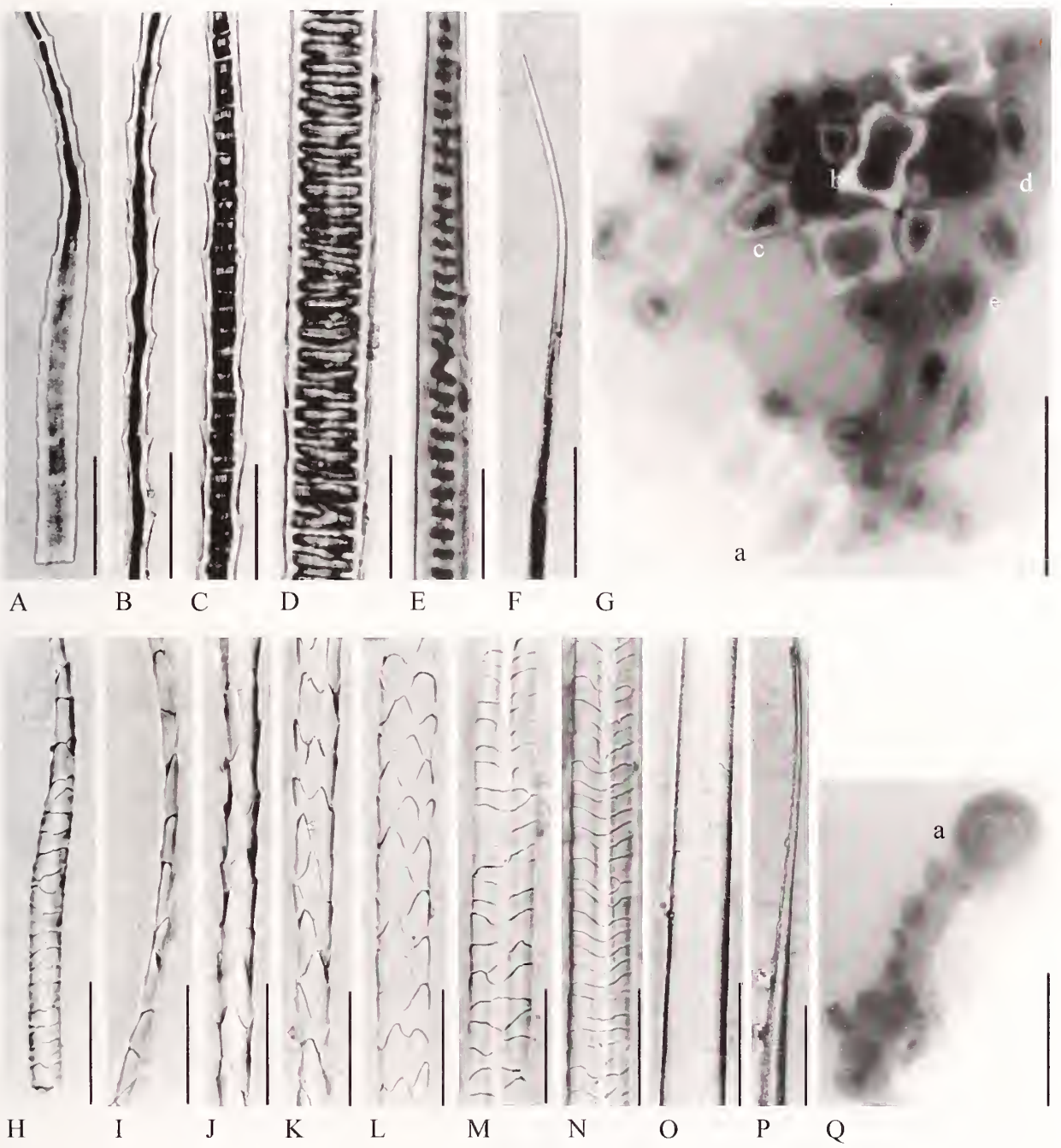

Plate 9. Whole mounts, cross sections and cuticular scale casts of *Crocidura flavescens* (bars equivalent to 50 µm).

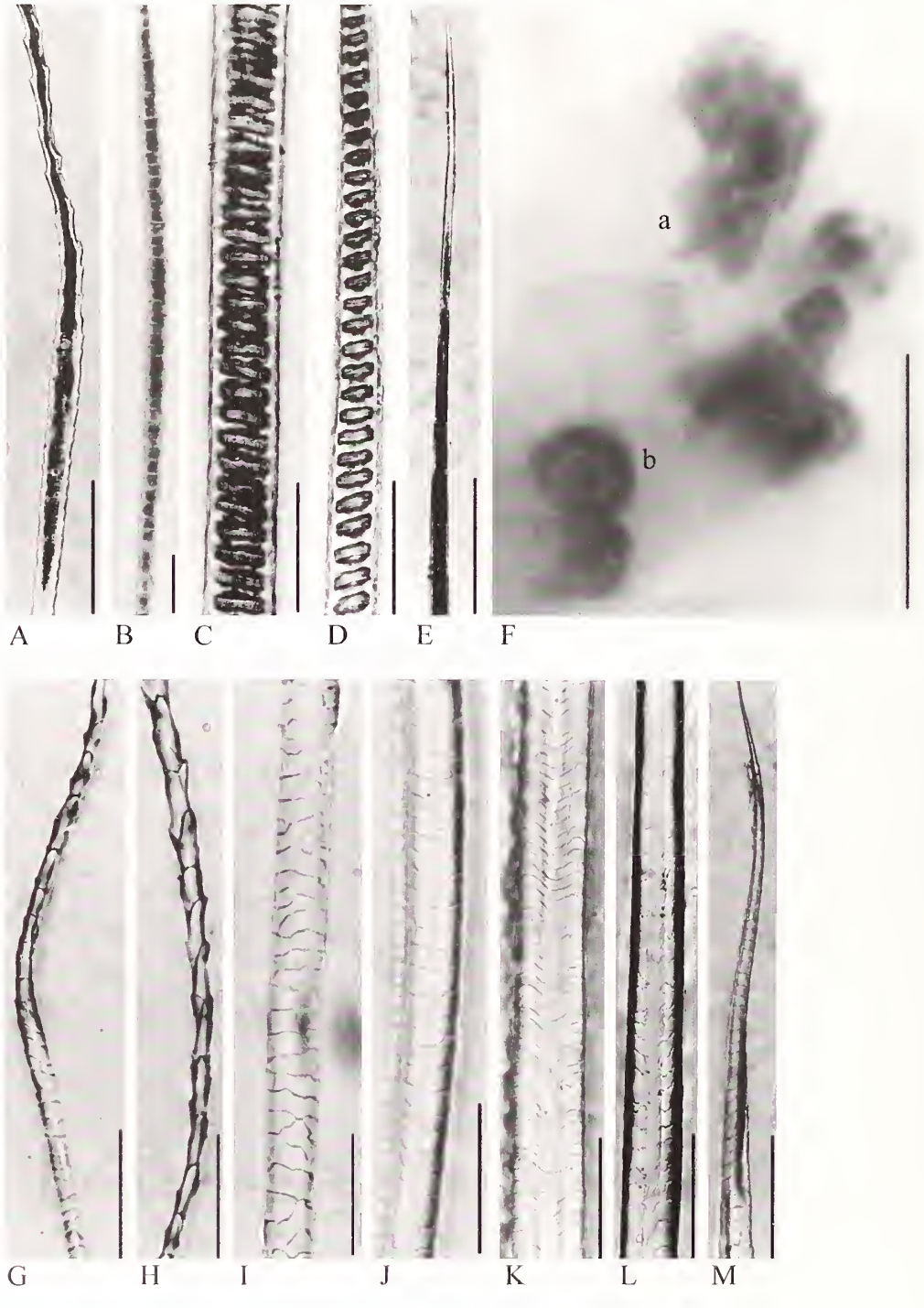

Plate 10. Whole mounts, cross sections and cuticular scale casts of *Crocidura fuscomurina* (bars equivalent to 50 µm).

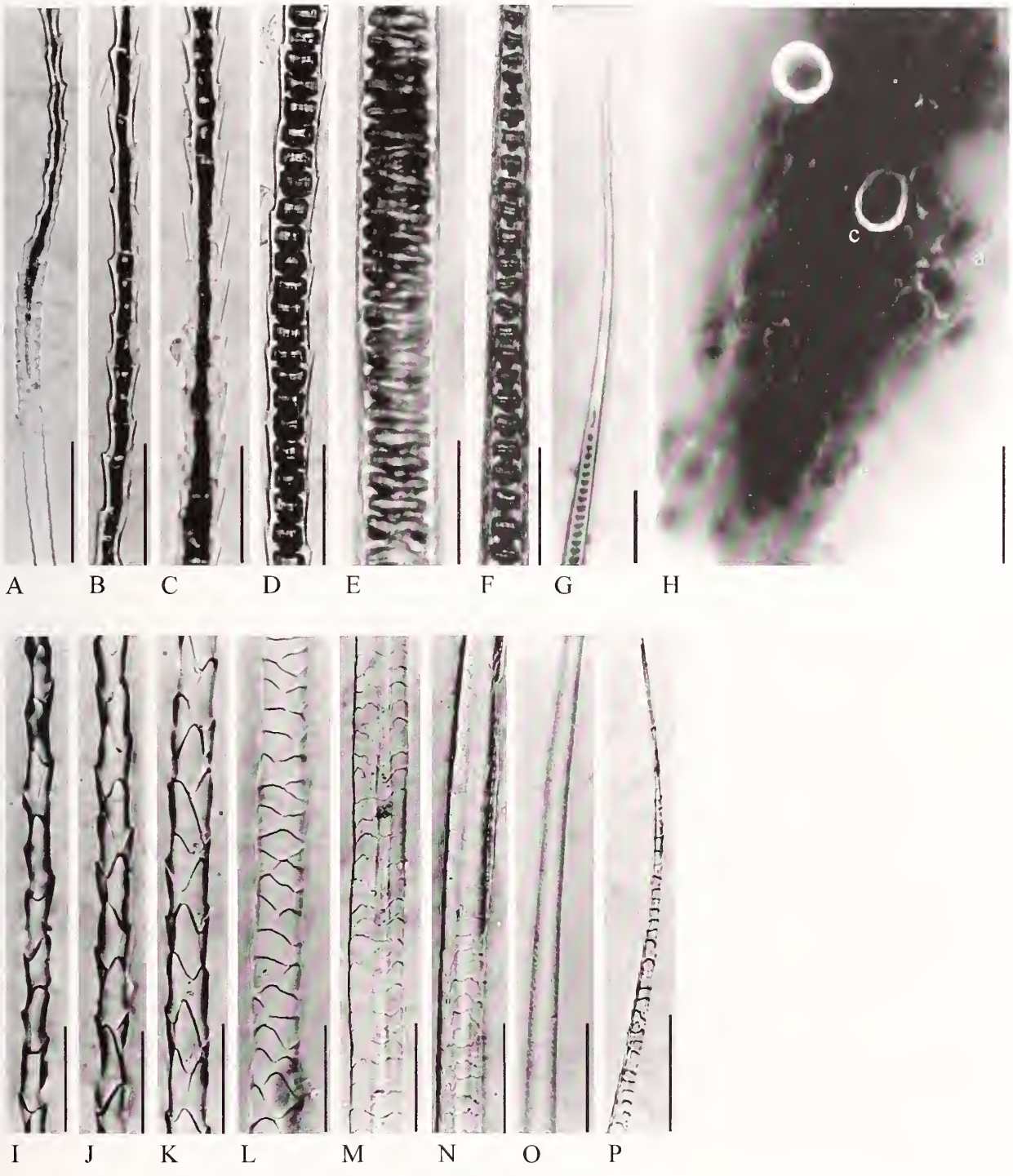

Plate 11. Whole mounts, cross sections and cuticular scale casts of *Crocidura hirta* (bars equivalent to 50 µm).

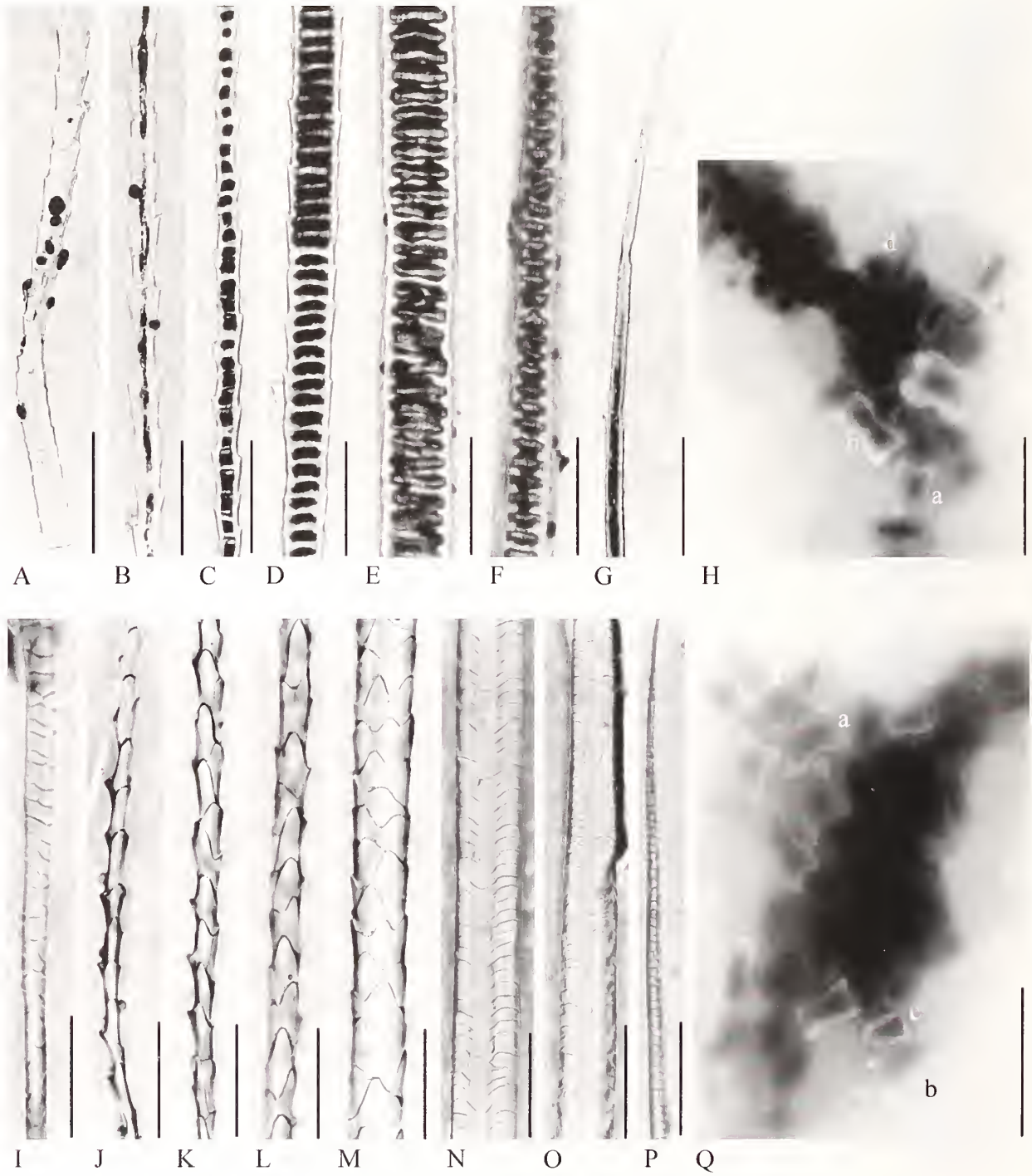

Plate 12. Whole mounts, cross sections and cuticular scale casts of *Crocidura luna* (bars equivalent to 50 µm).

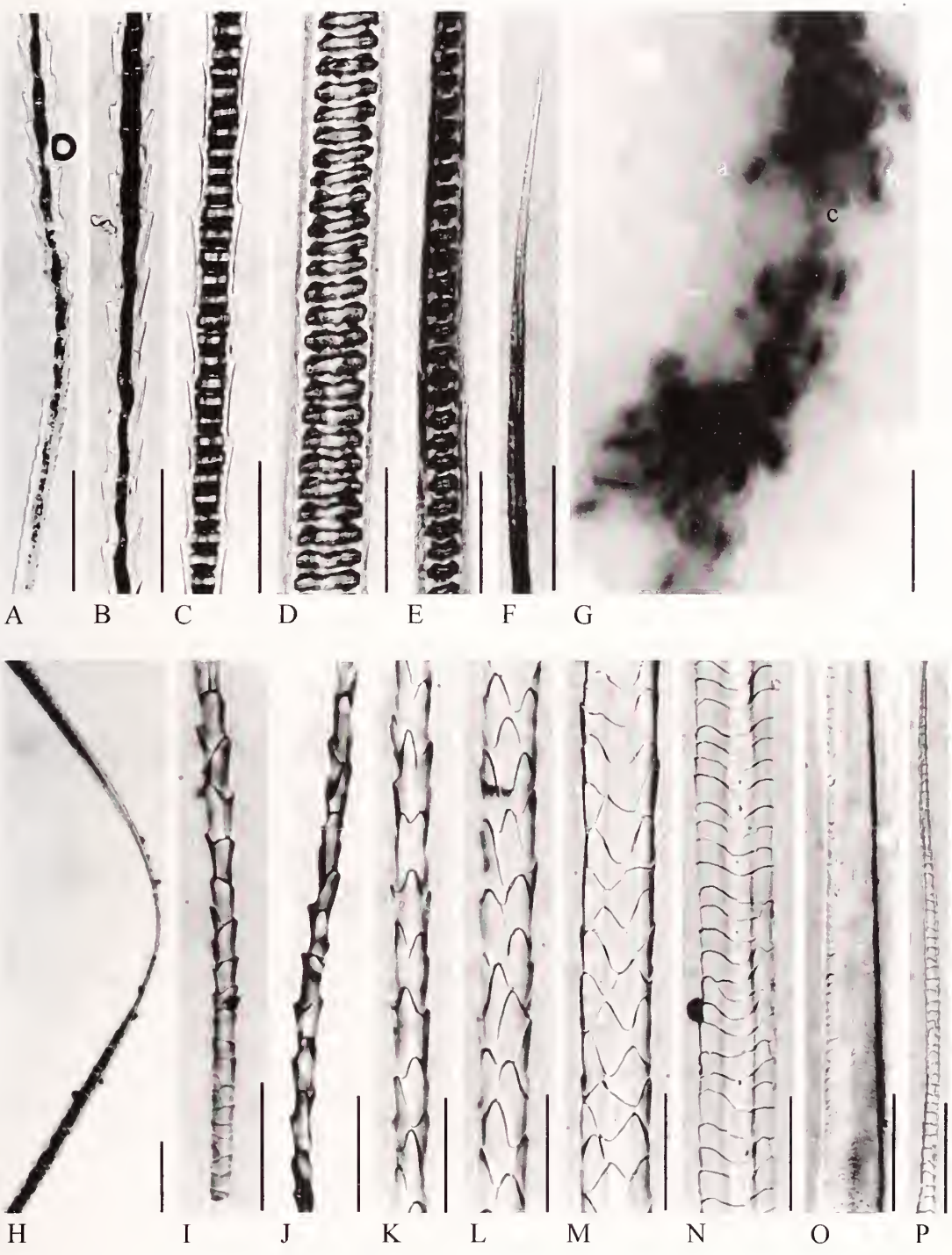

Plate 13. Whole mounts, cross sections and cuticular scale casts of *Crocidura maquassiensis* (bars equivalent to 50 µm).

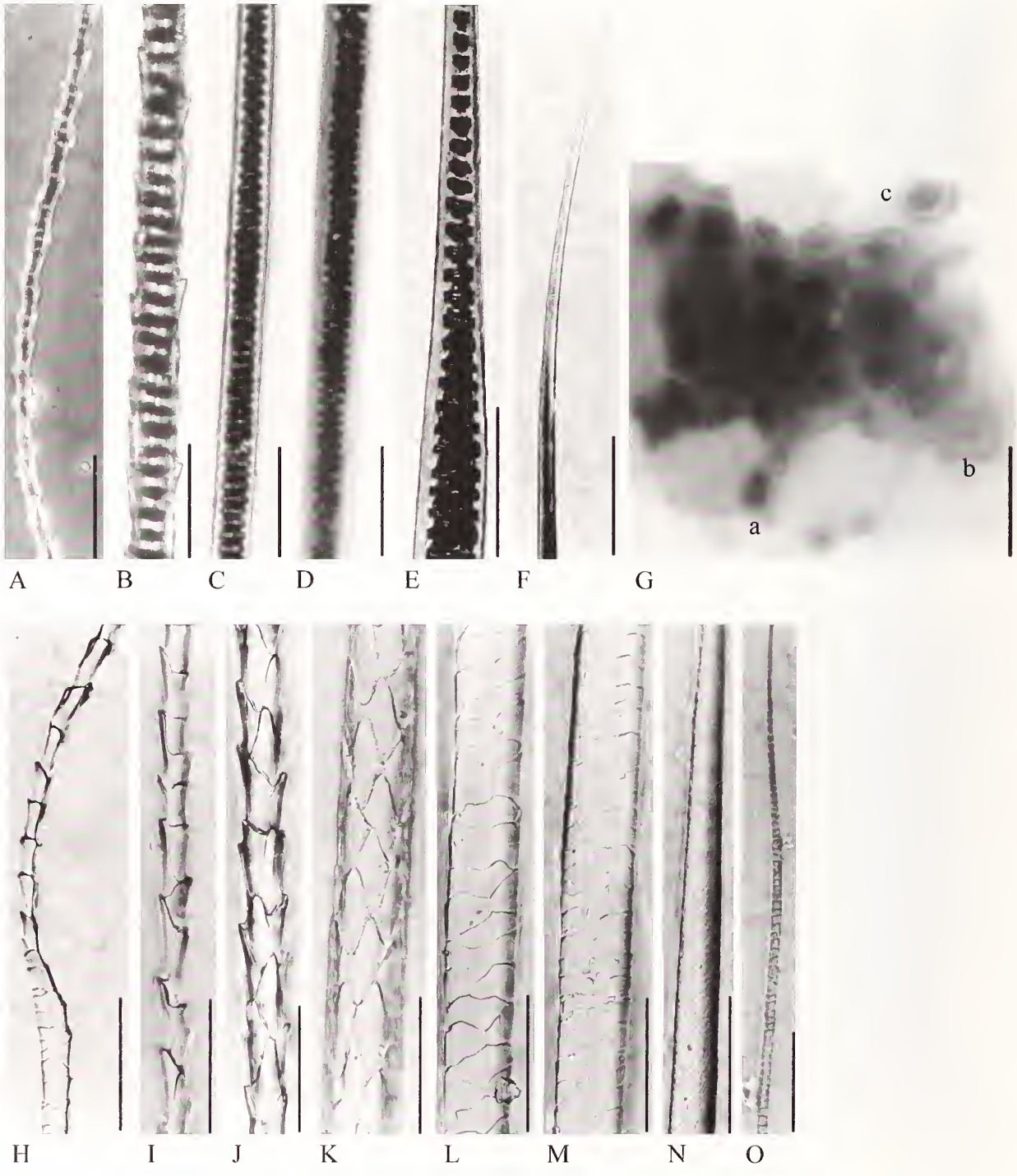

Plate 14. Whole mounts, cross sections and cuticular scale casts of *Crocidura mariquensis* (bars equivalent to 50 µm).

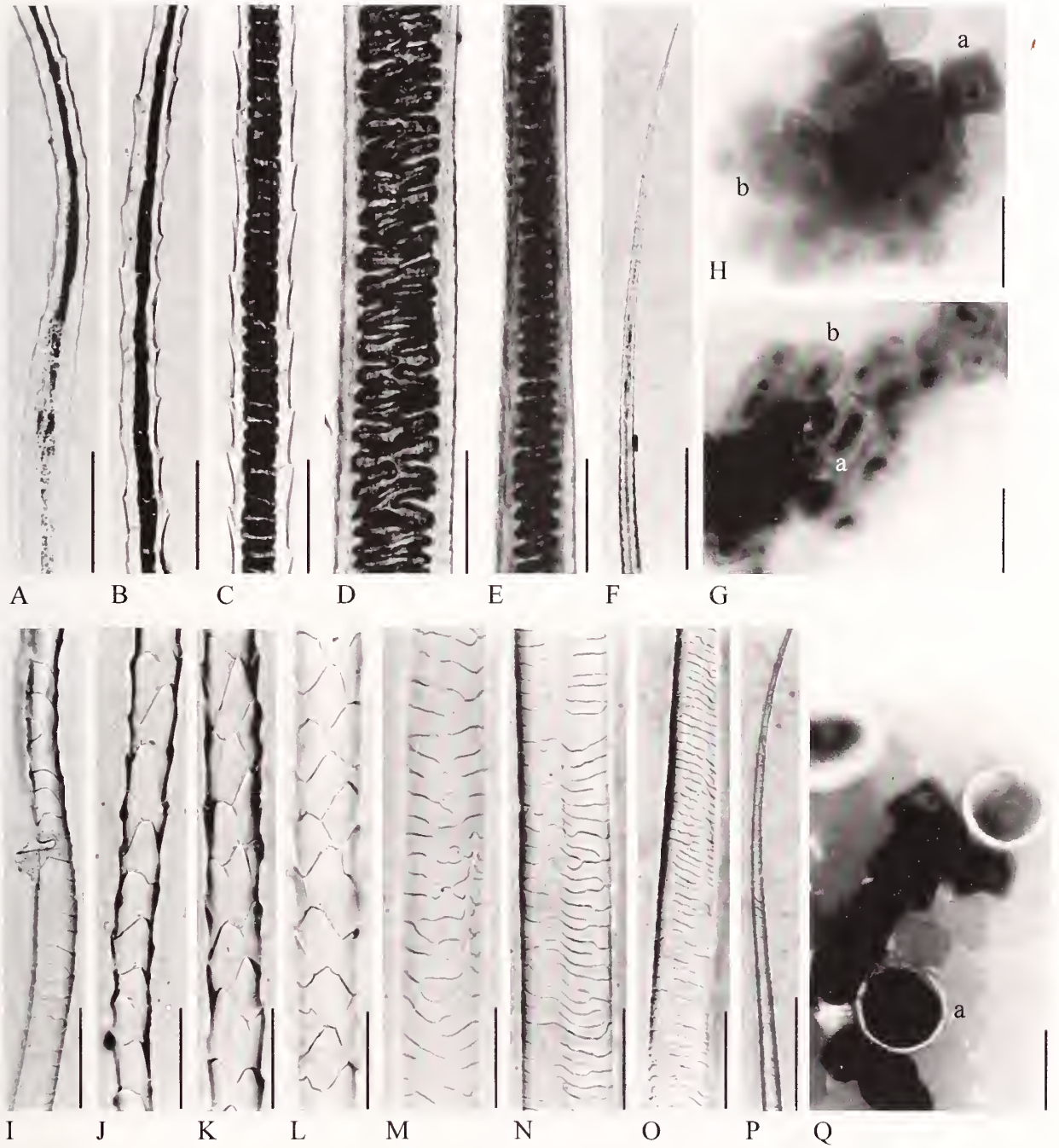

Plate 15. Whole mounts, cross sections and cuticular scale casts of *Crocidura olivieri martiensseni* (bars equivalent to 50 µm).

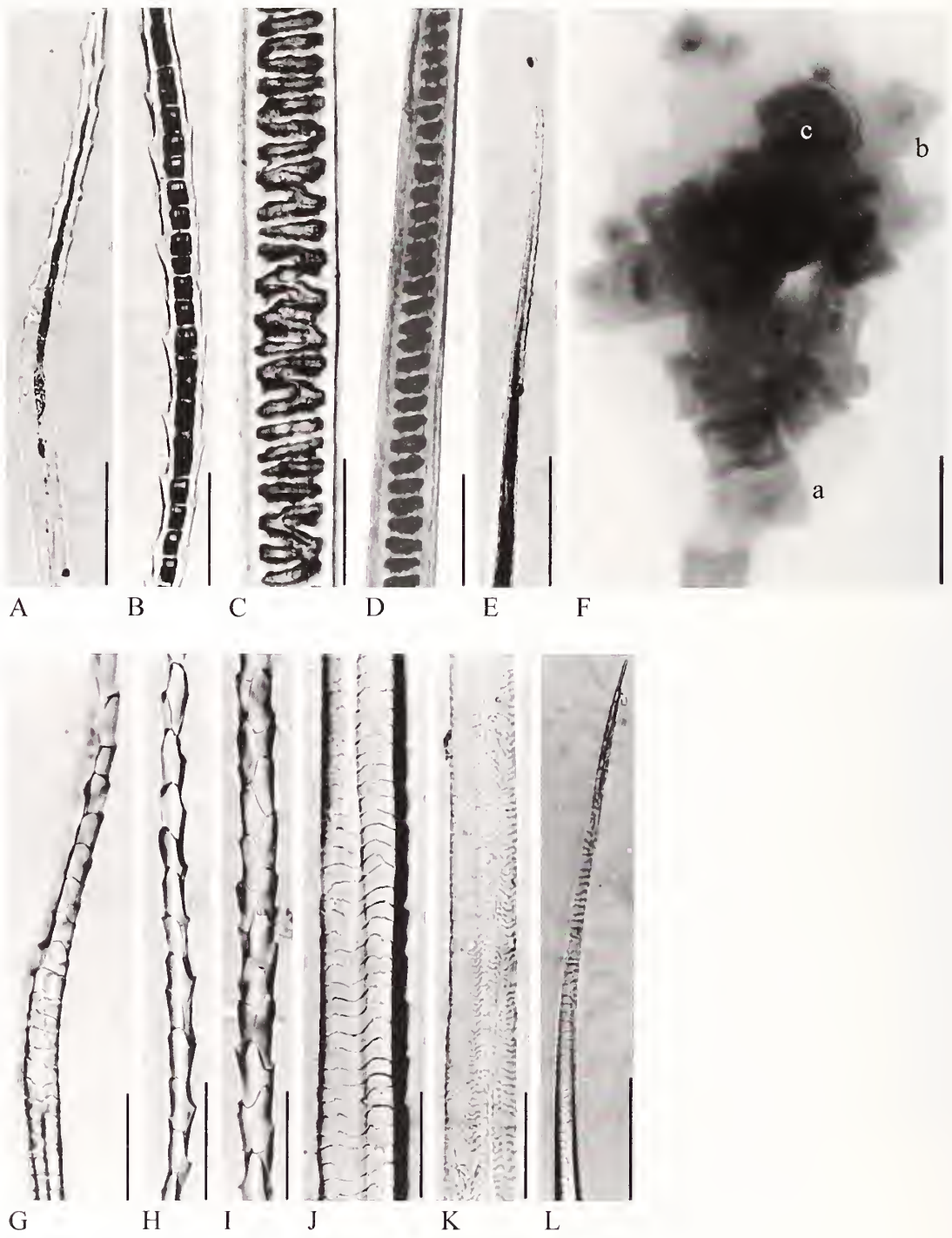

Plate 16. Whole mounts, cross sections and cuticular scale casts of *Crocidura olivieri occidentalis* (bars equivalent to 50 µm).

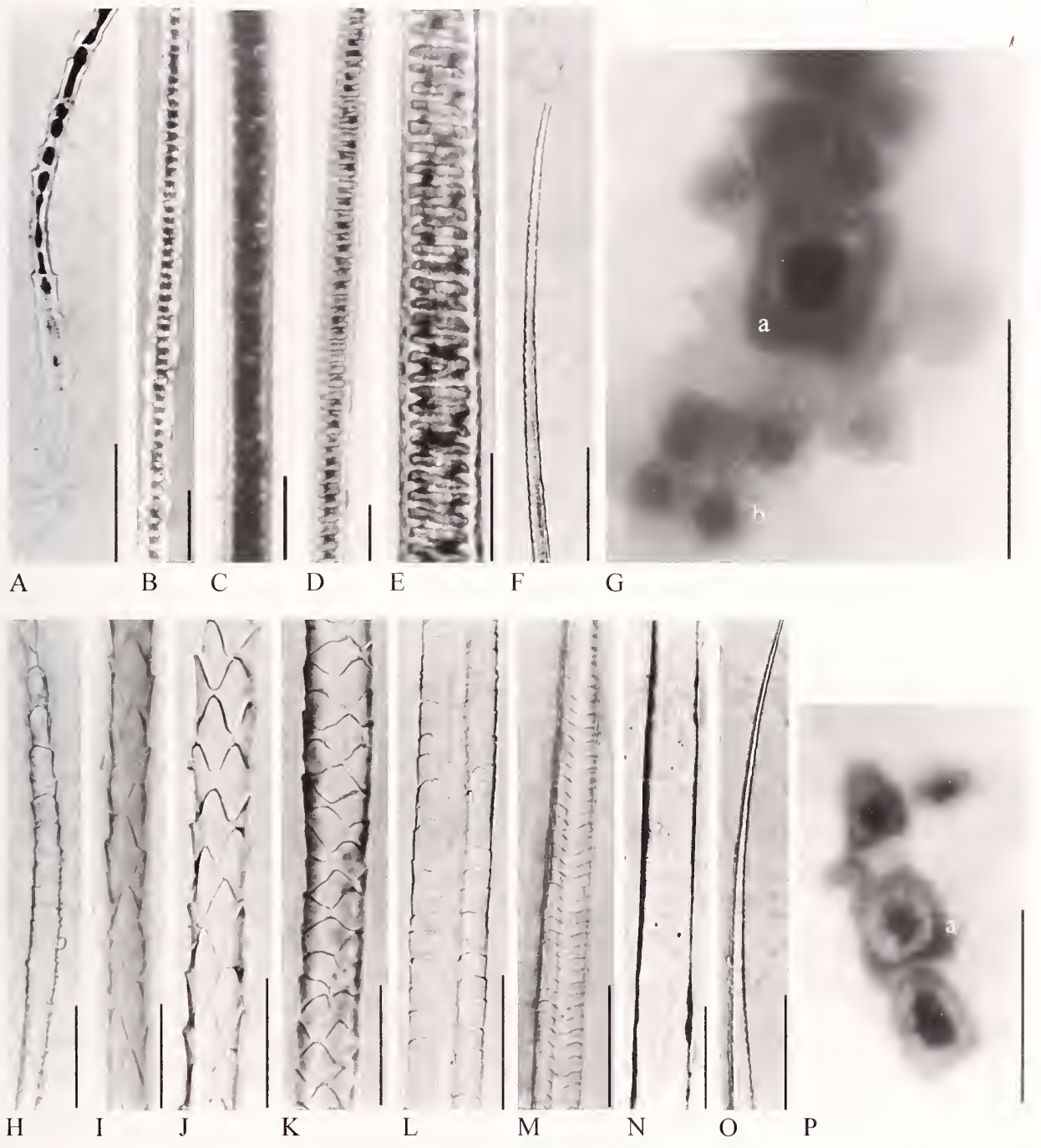

Plate 17. Whole mounts, cross sections and cuticular scale casts of *Crocidura silacea* (bars equivalent to 50 μm).

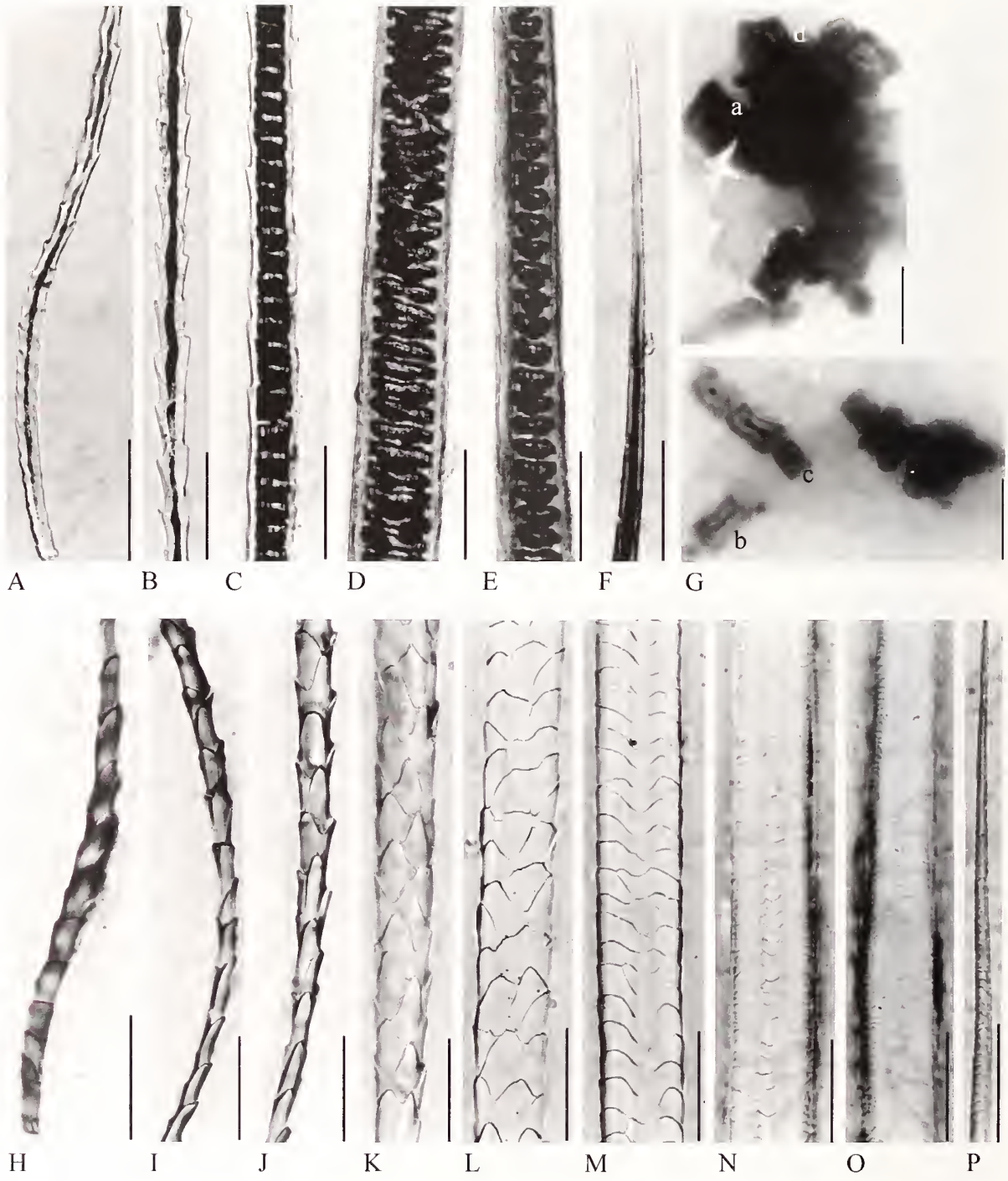

Plate 18. Whole mounts, cross sections and cuticular scale casts of *Crocidura turba* (bars equivalent to 50 µm).

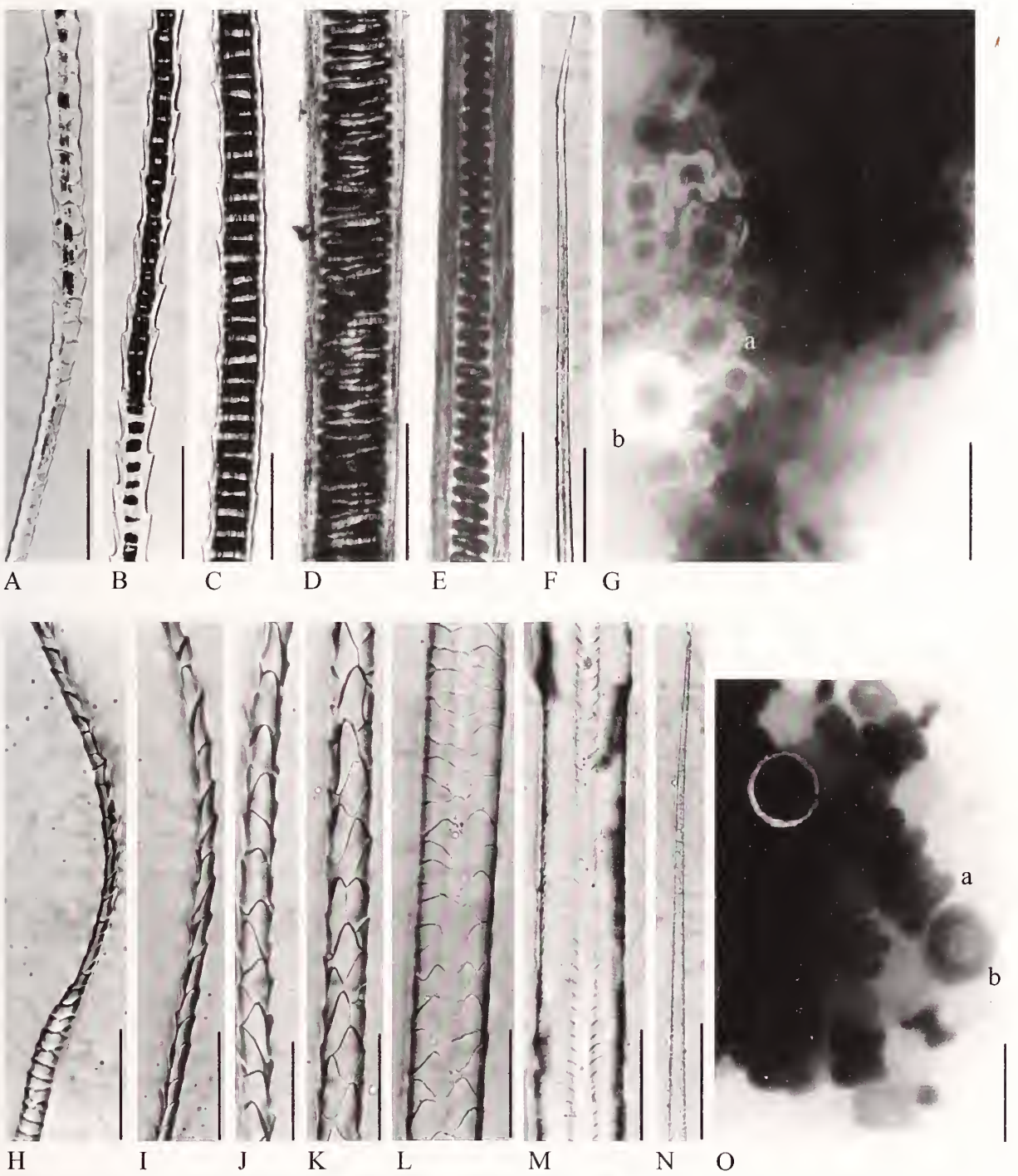

Plate 19. Whole mounts, cross sections and cuticular scale casts of *Myosorex cafer* (bars equivalent to 50 µm).

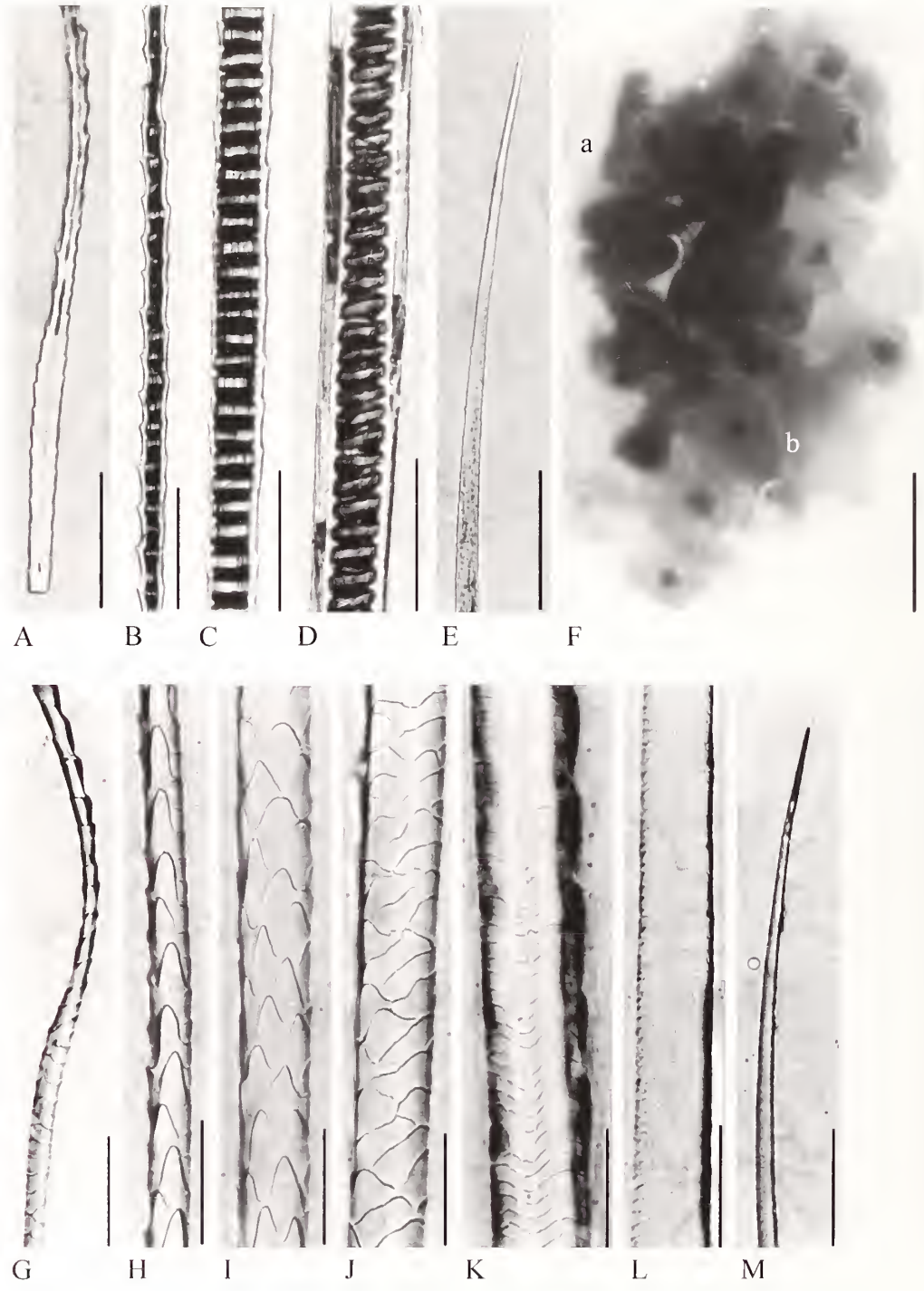

Plate 20. Whole mounts, cross sections and cuticular scale casts of *Myosorex longicaudatus* (bars equivalent to 50 µm).

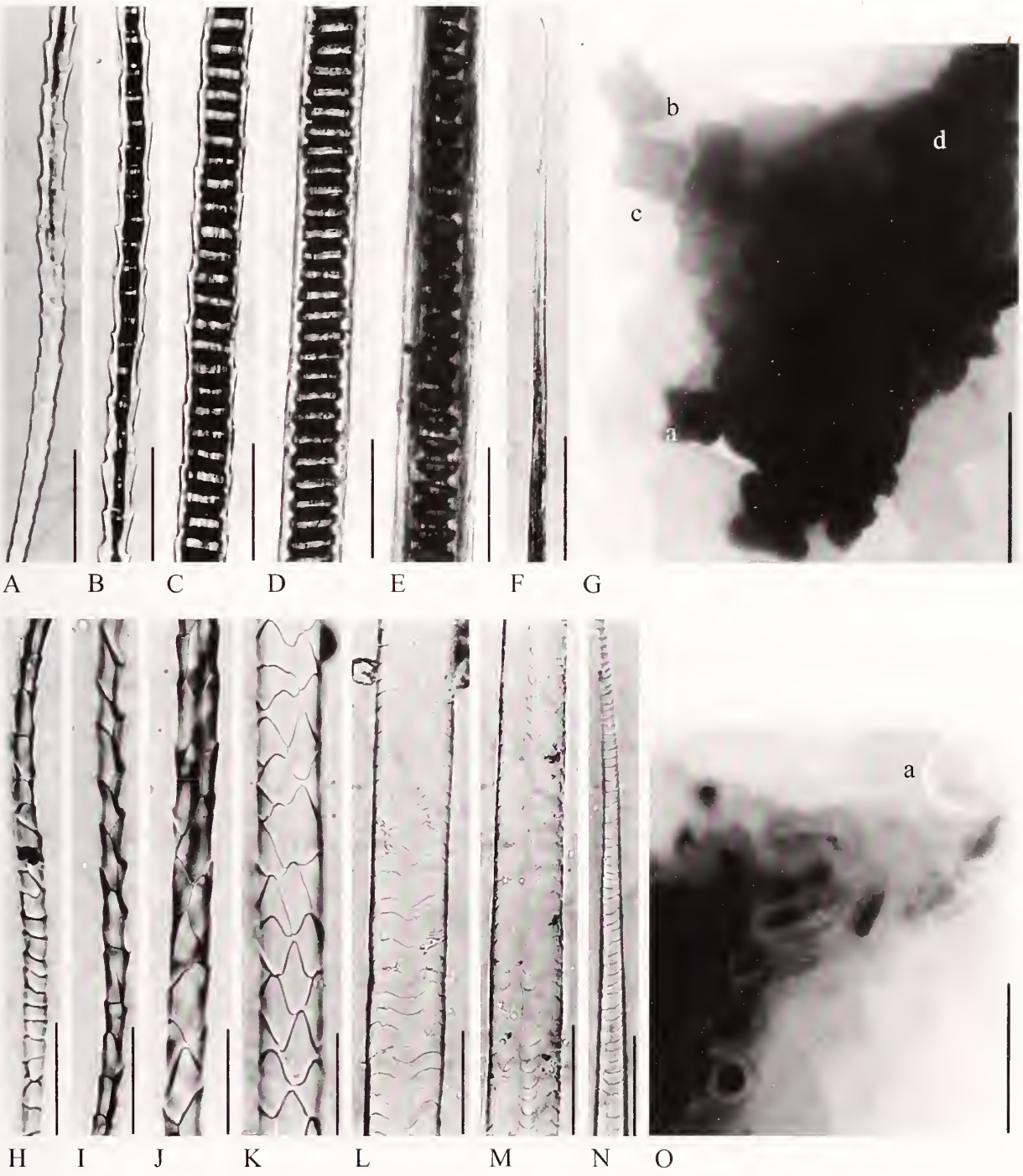

Plate 21. Whole mounts, cross sections and cuticular scale casts of *Myosorex sclateri* (bars equivalent to 50 μm).

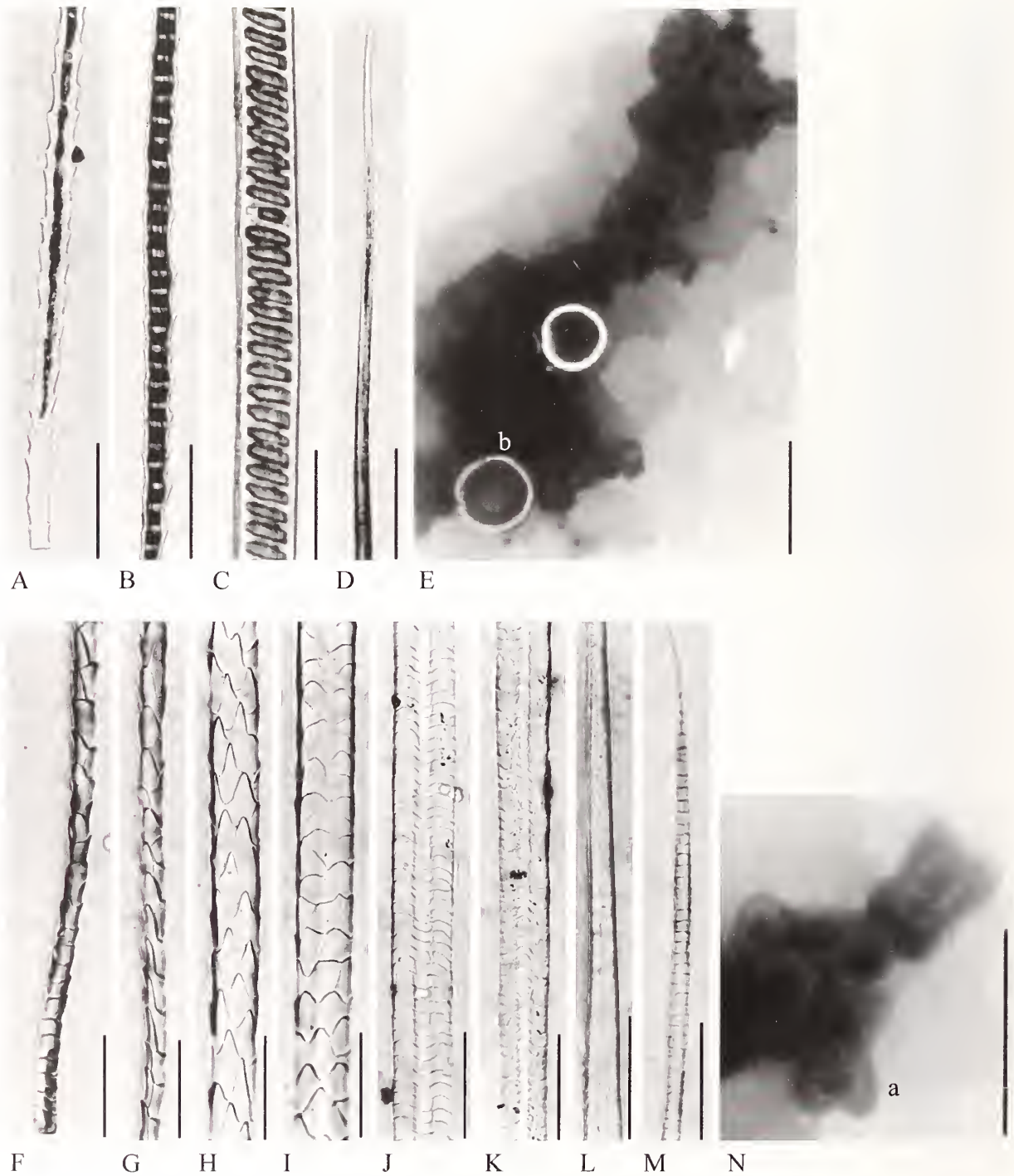

Plate 22. Whole mounts, cross sections and cuticular scale casts of *Myosorex temis* (bars equivalent to 50 µm).

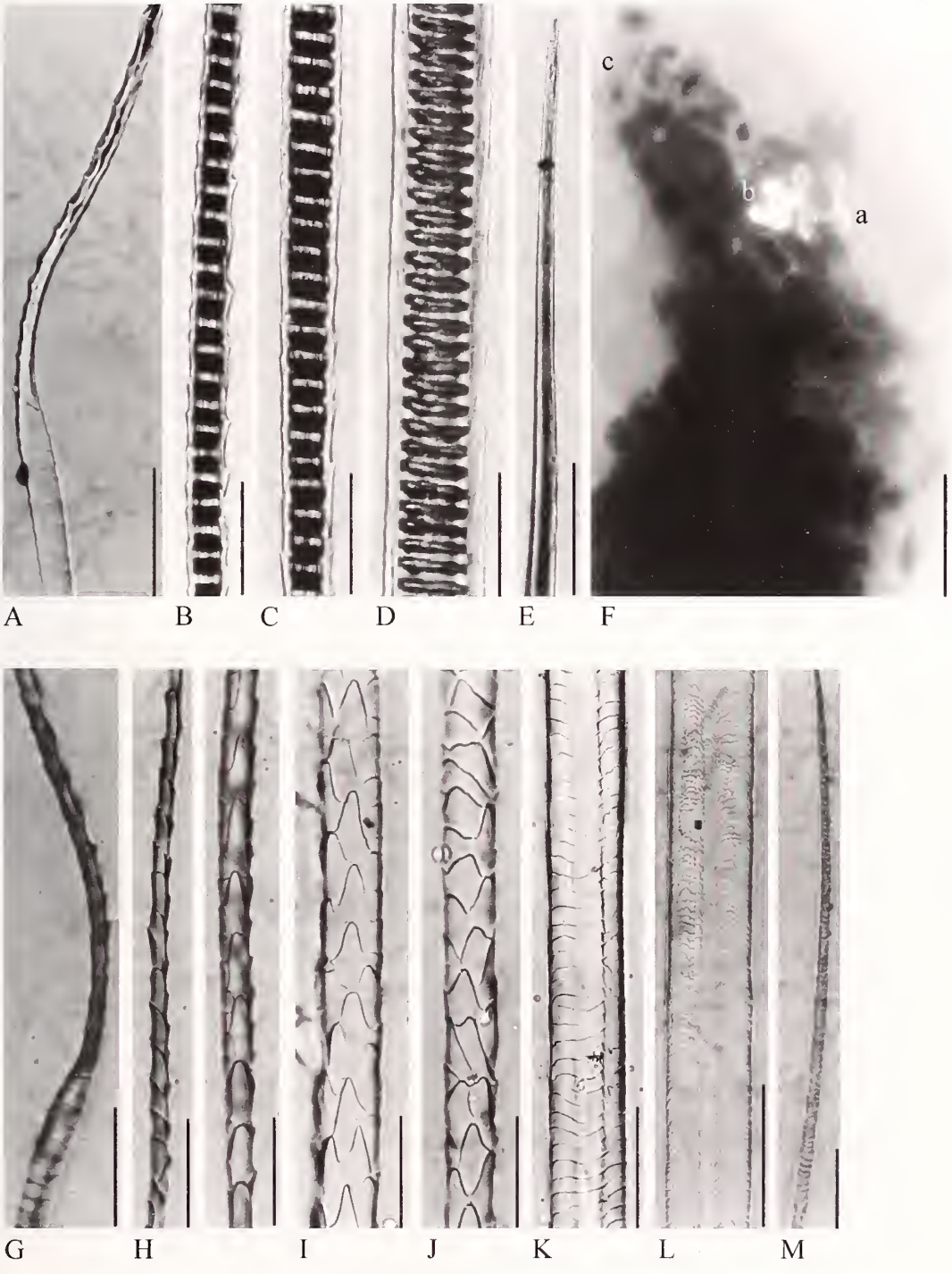

Plate 23. Whole mounts, cross sections and cuticular scale casts of *Myosorex varius* (bars equivalent to 50 μm).

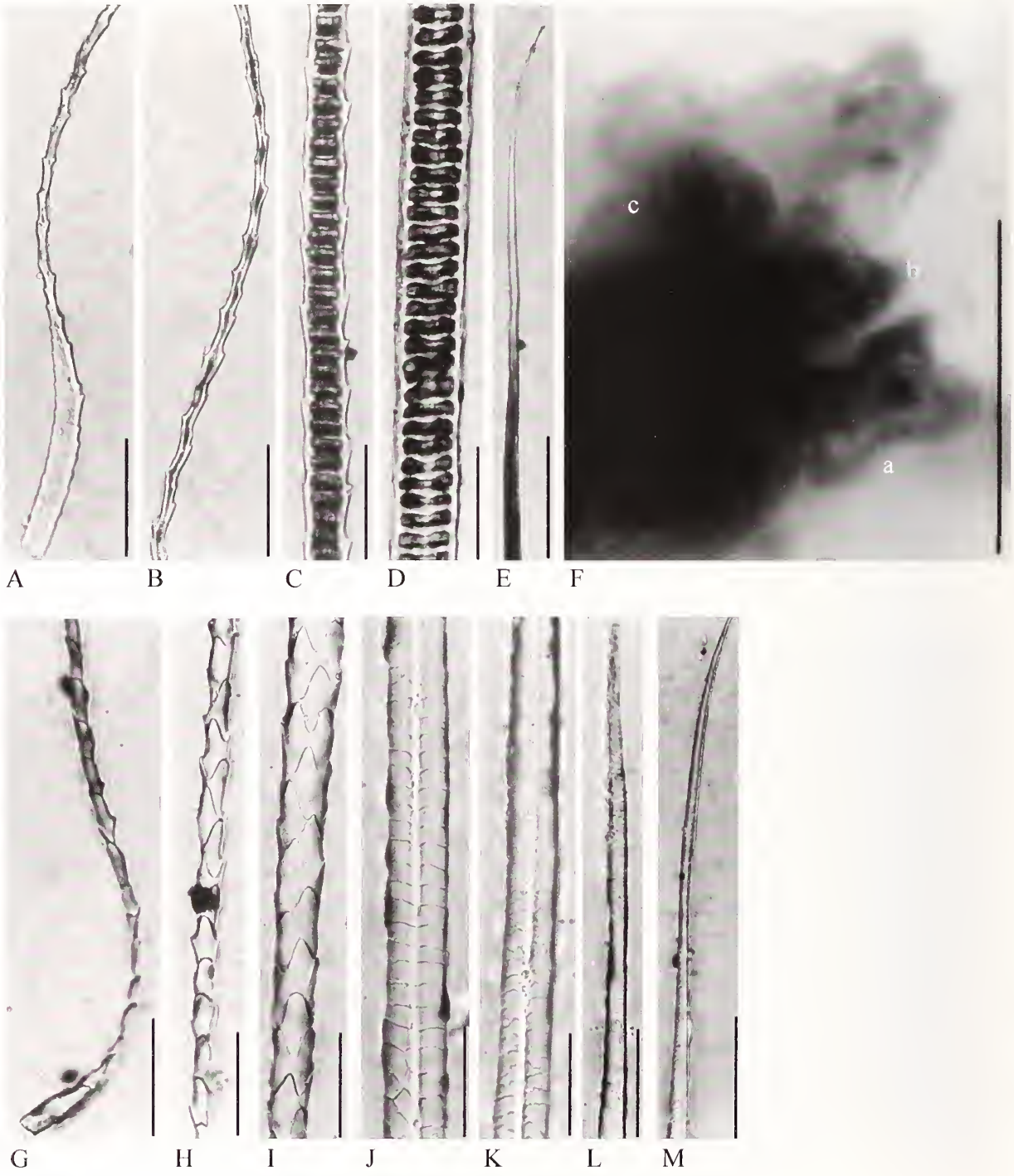

Plate 24. Whole mounts, cross sections and cuticular scale casts of *Suncus infinitesimus* (bars equivalent to 50 µm).

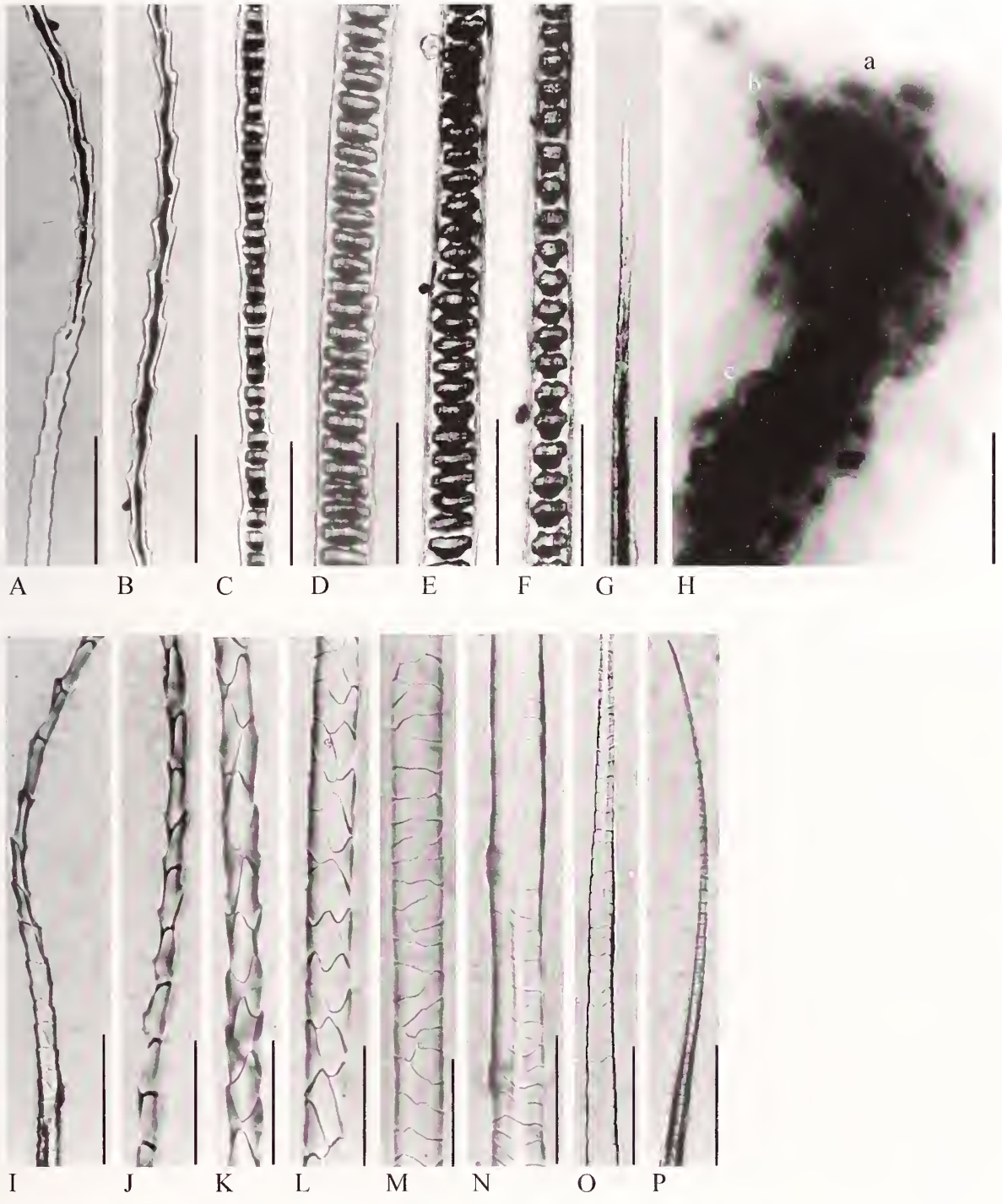

Plate 25. Whole mounts, cross sections and cuticular scale casts of *Suncus lixus* (bars equivalent to 50 µm).

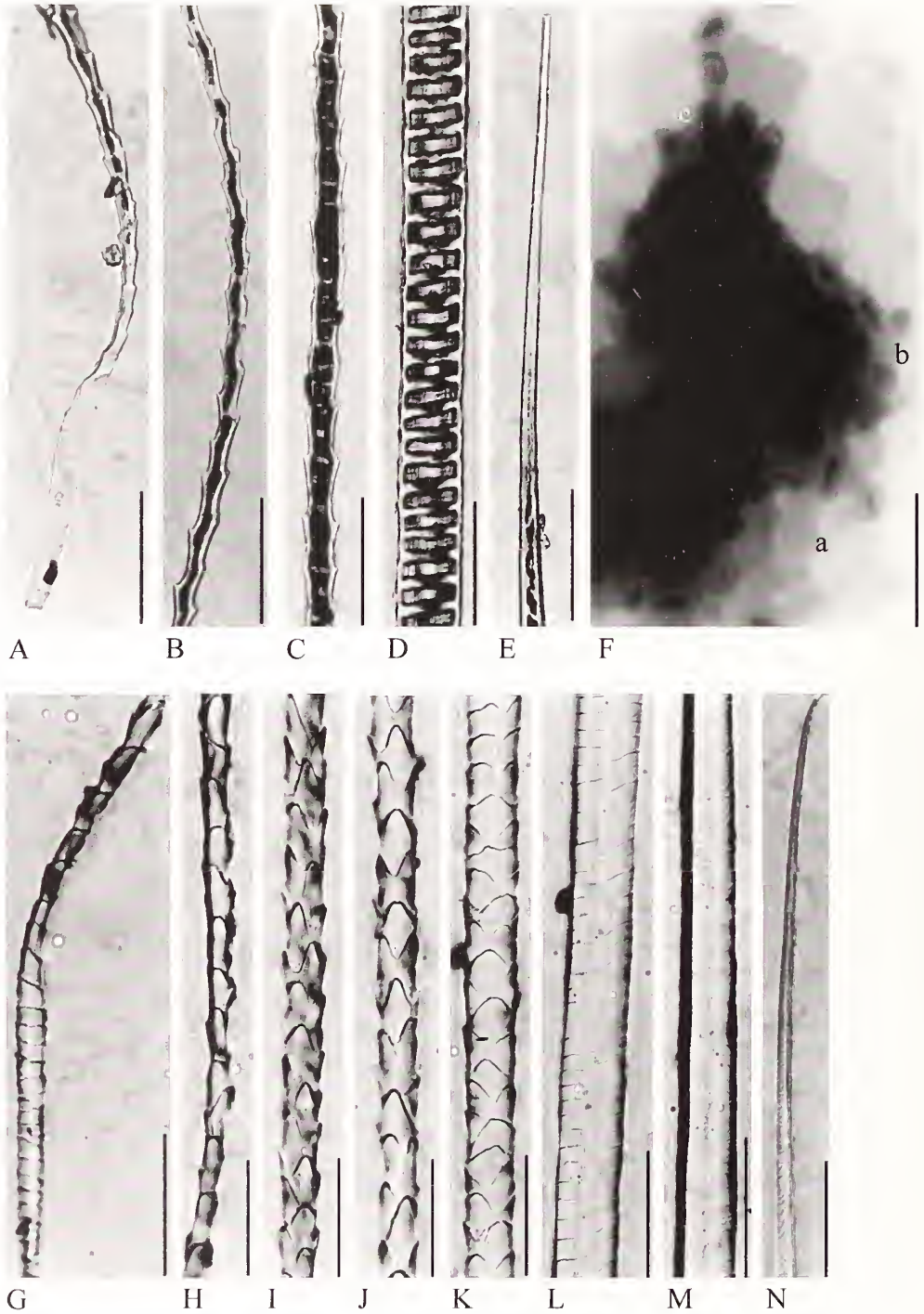

Plate 26. Whole mounts, cross sections and cuticular scale casts of *Suncus varilla* (bars equivalent to 50 µm).

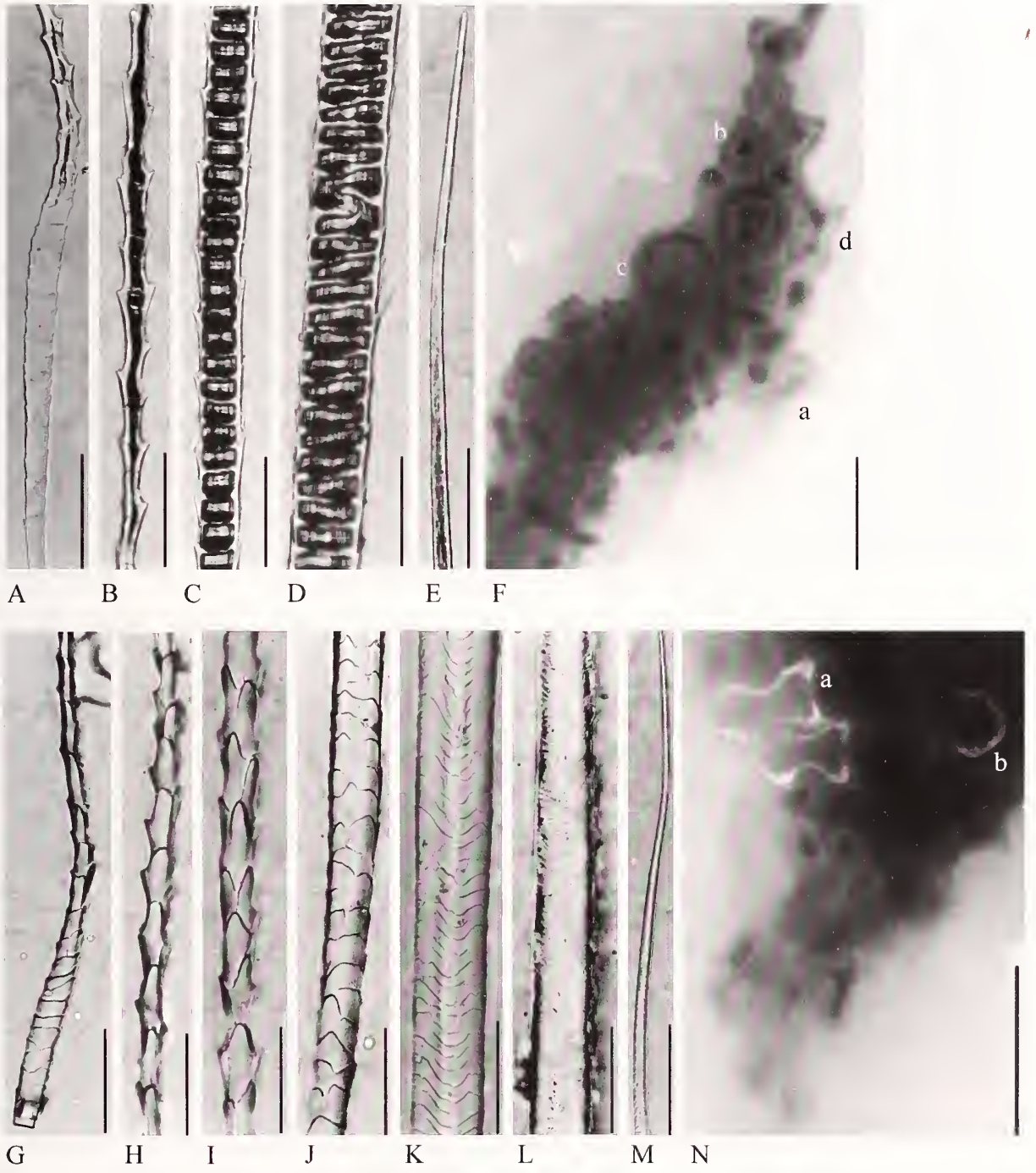

Plate 27. Whole mounts, cross sections and cuticular scale casts of *Sylvisorex megalura* (bars equivalent to 50 μm).

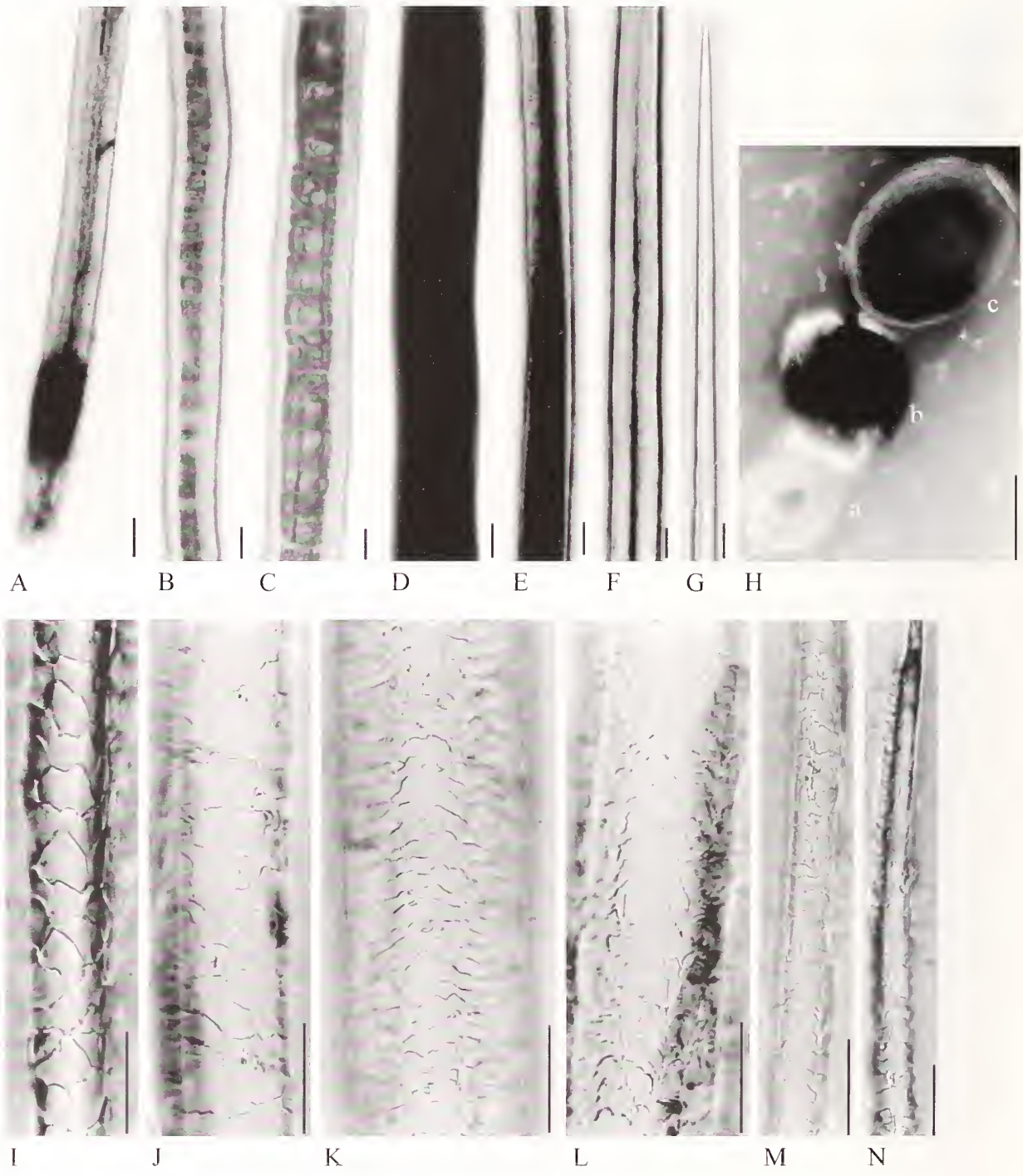

Plate 28. Whole mounts, cross sections and cuticular scale casts of *Atelerix frontalis* (bars equivalent to 50 µm).

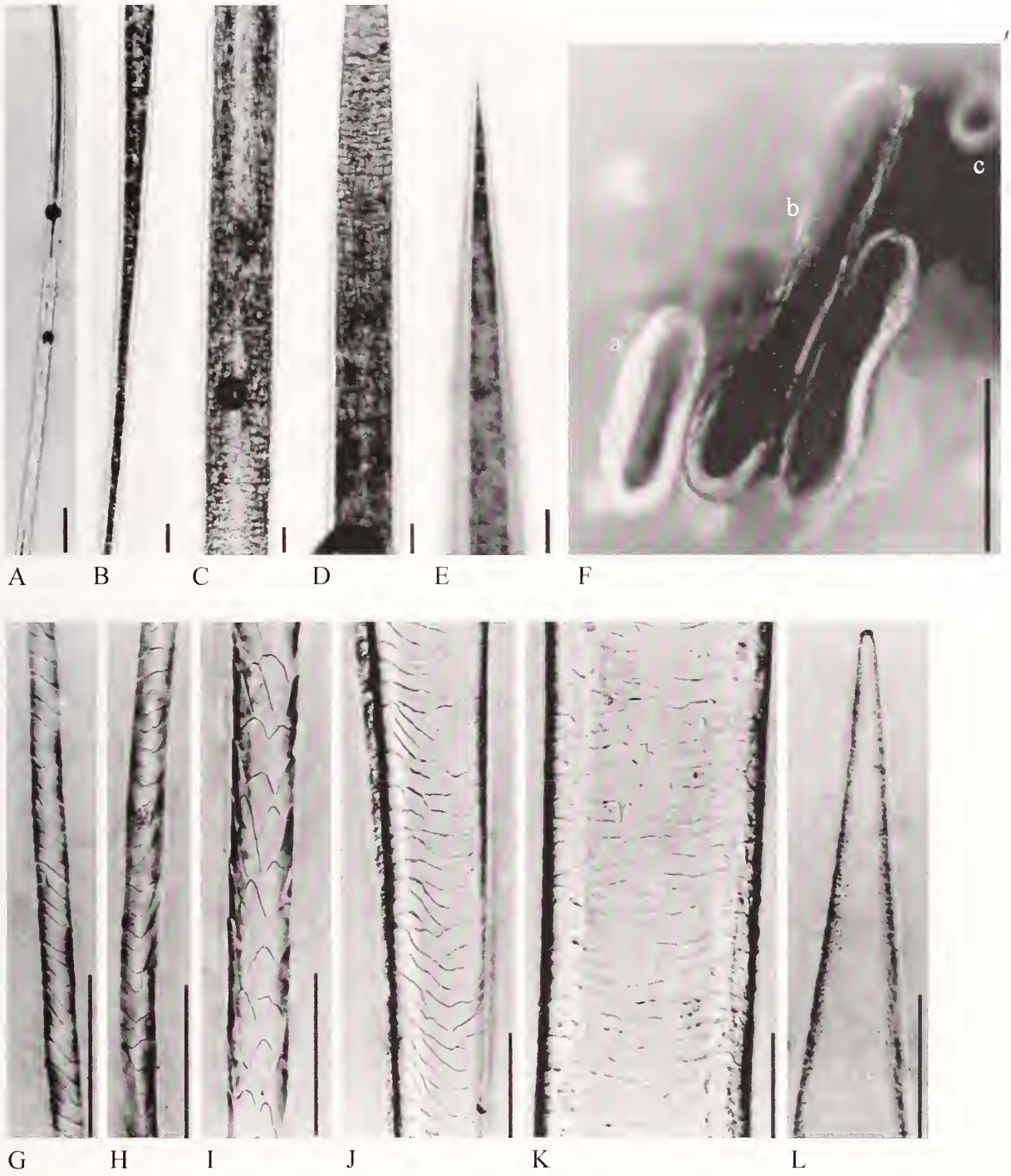

Plate 29. Whole mounts, cross sections and cuticular scale casts of *Amblysomus hottentotus* (bars equivalent to 50 µm).

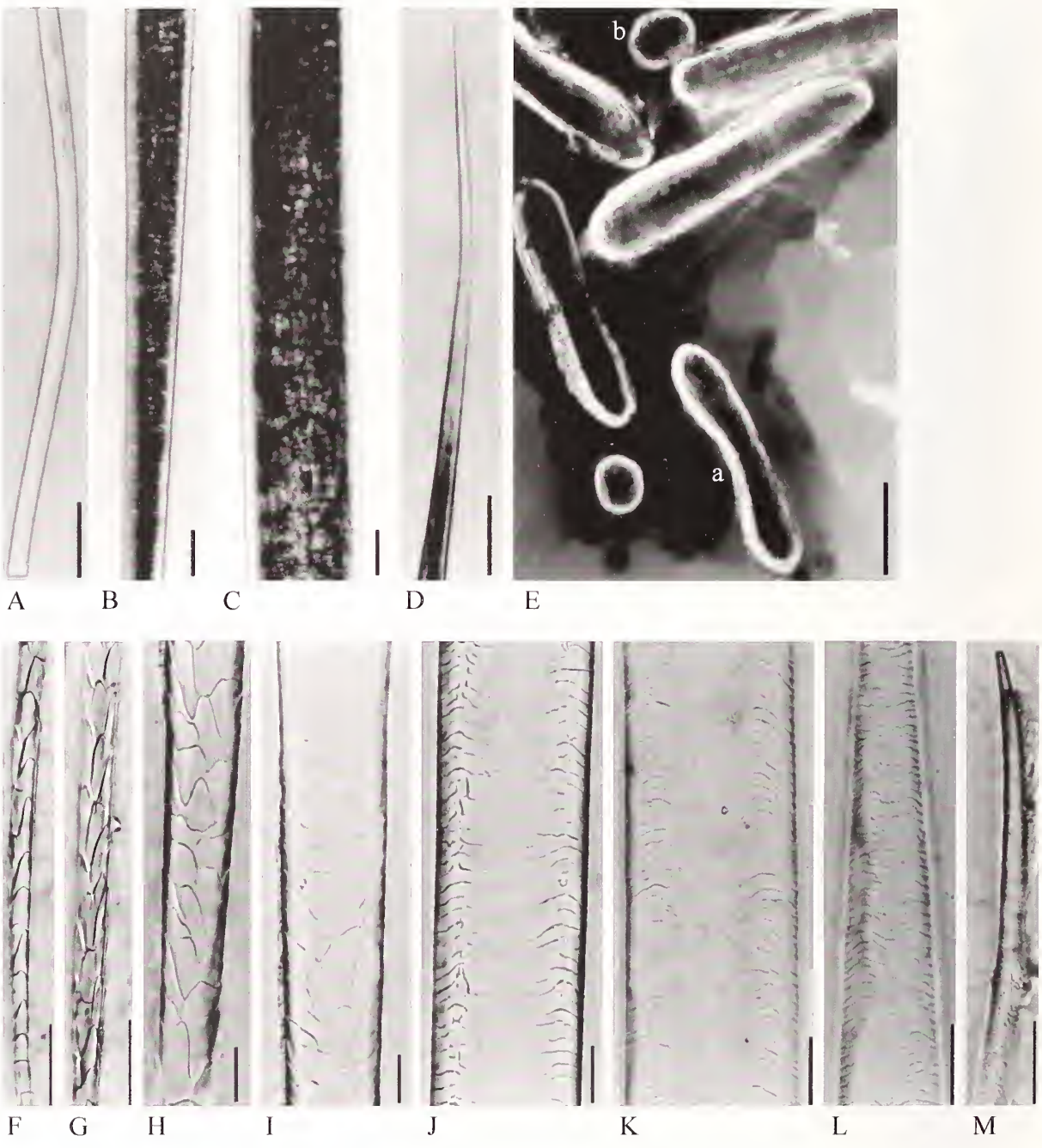

Plate 30. Whole mounts, cross sections and cuticular scale casts of *Amblysomus iris* (bars equivalent to 50 µm).

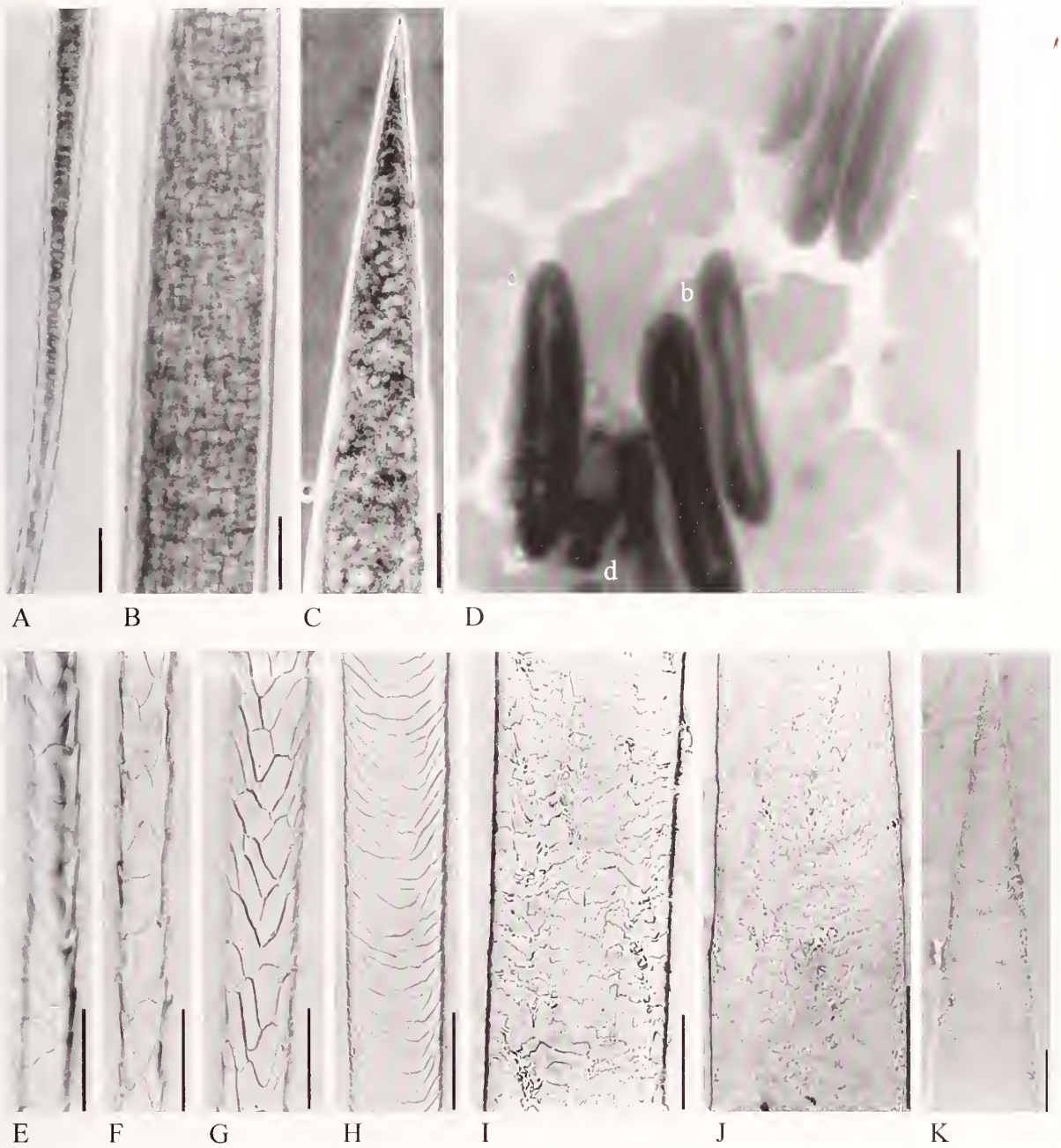

Plate 31. Whole mounts, cross sections and cuticular scale casts of *Calcochloris obtusirostris* (bars equivalent to 50 µm).

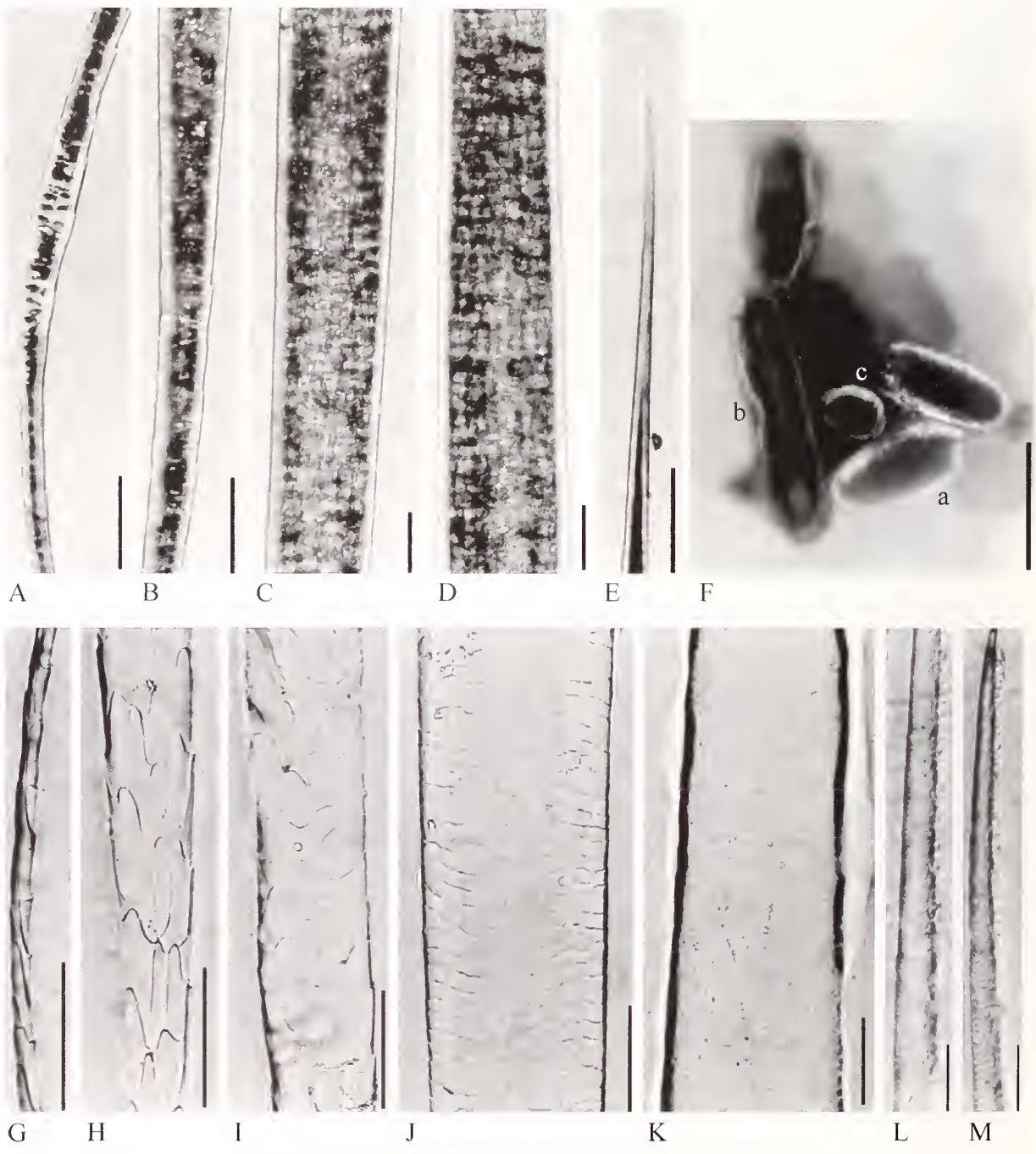

Plate 32. Whole mounts, cross sections and cuticular scale casts of *Carpitalpa arendsi* (bars equivalent to 50 µm).

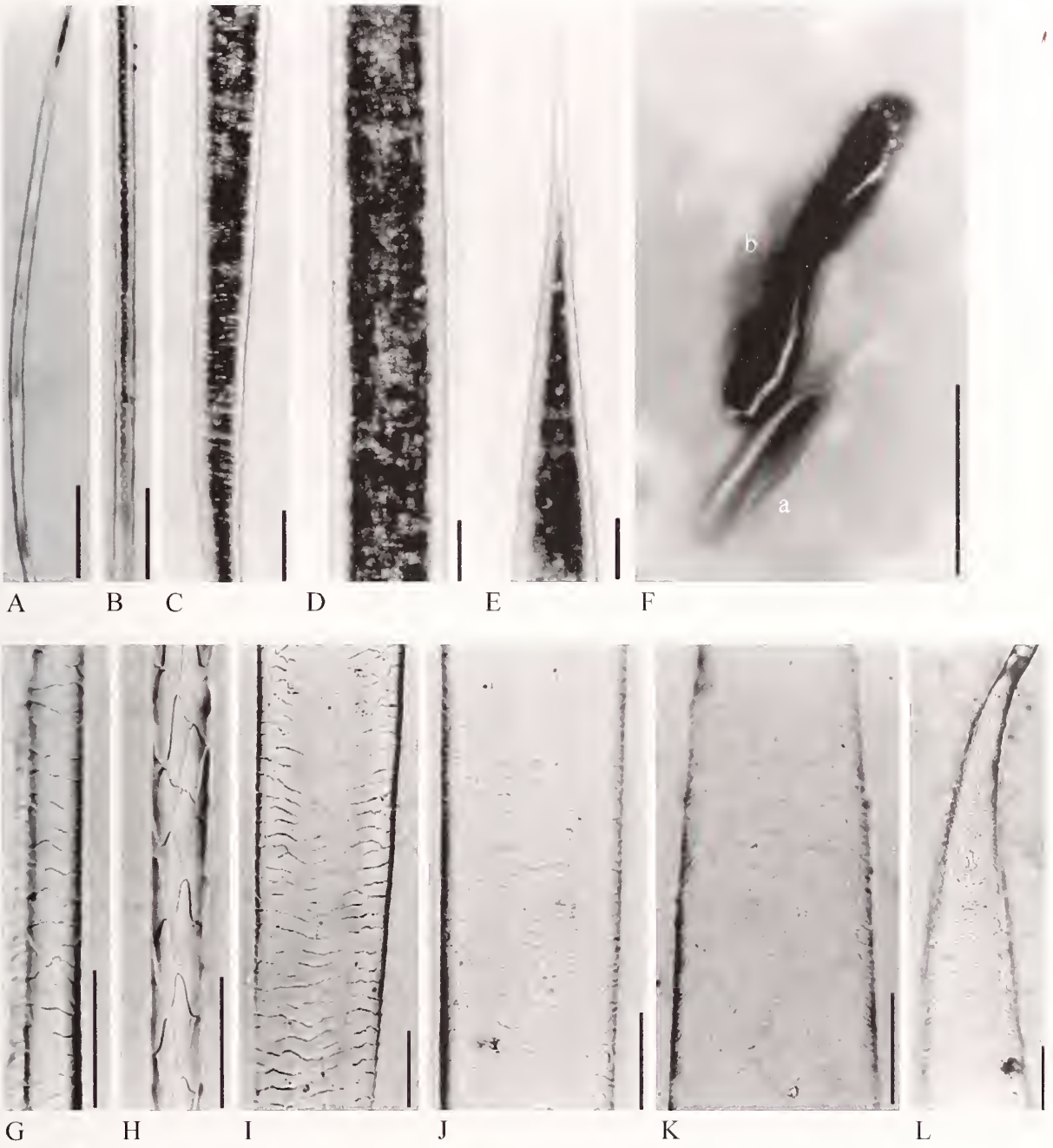

Plate 33. Whole mounts, cross sections and cuticular scale casts of *Chlorotalpa duthieae* (bars equivalent to 50 µm).

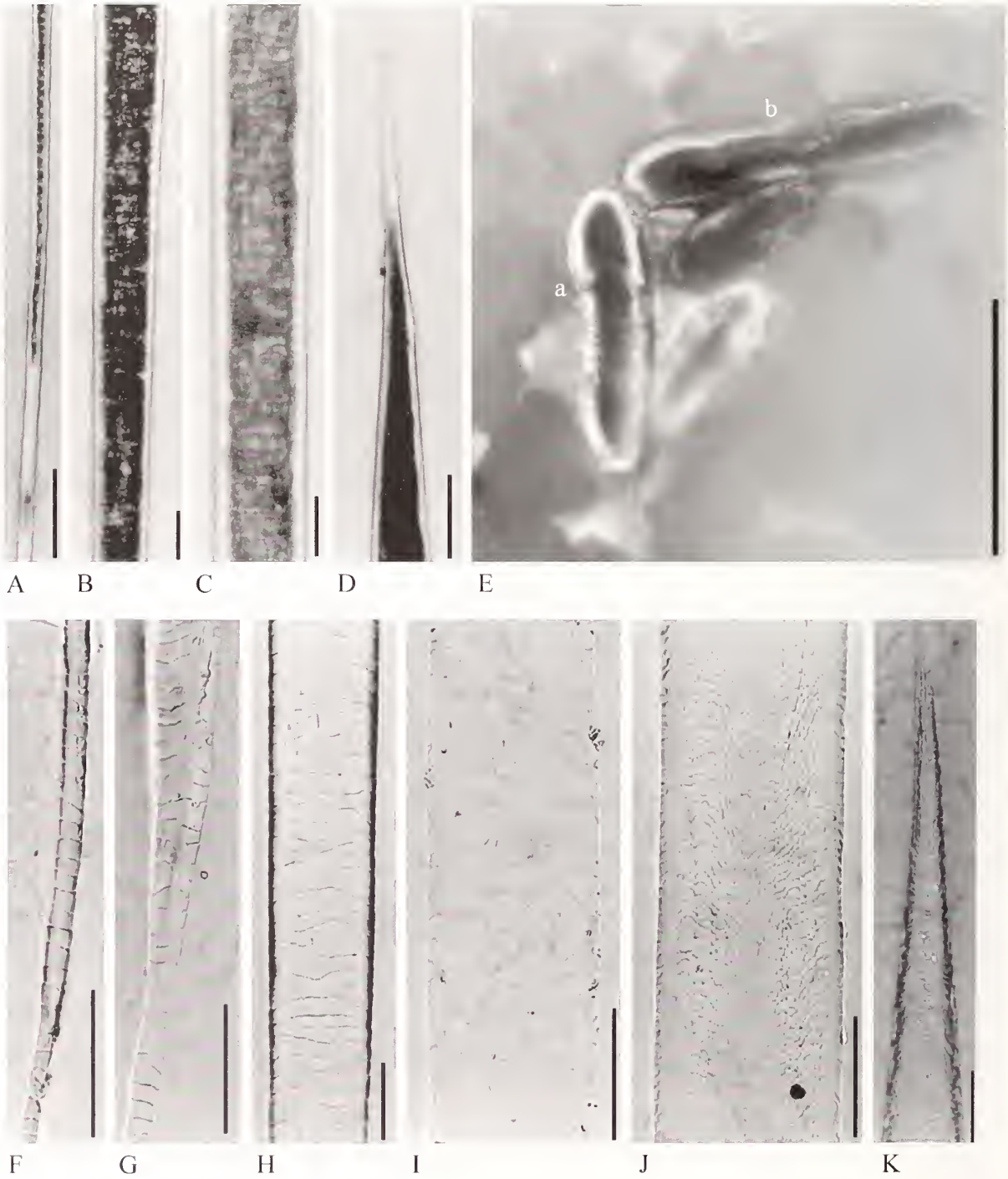

Plate 34. Whole mounts, cross sections and cuticular scale casts of *Chlorotalpa sclateri* (bars equivalent to 50 µm).

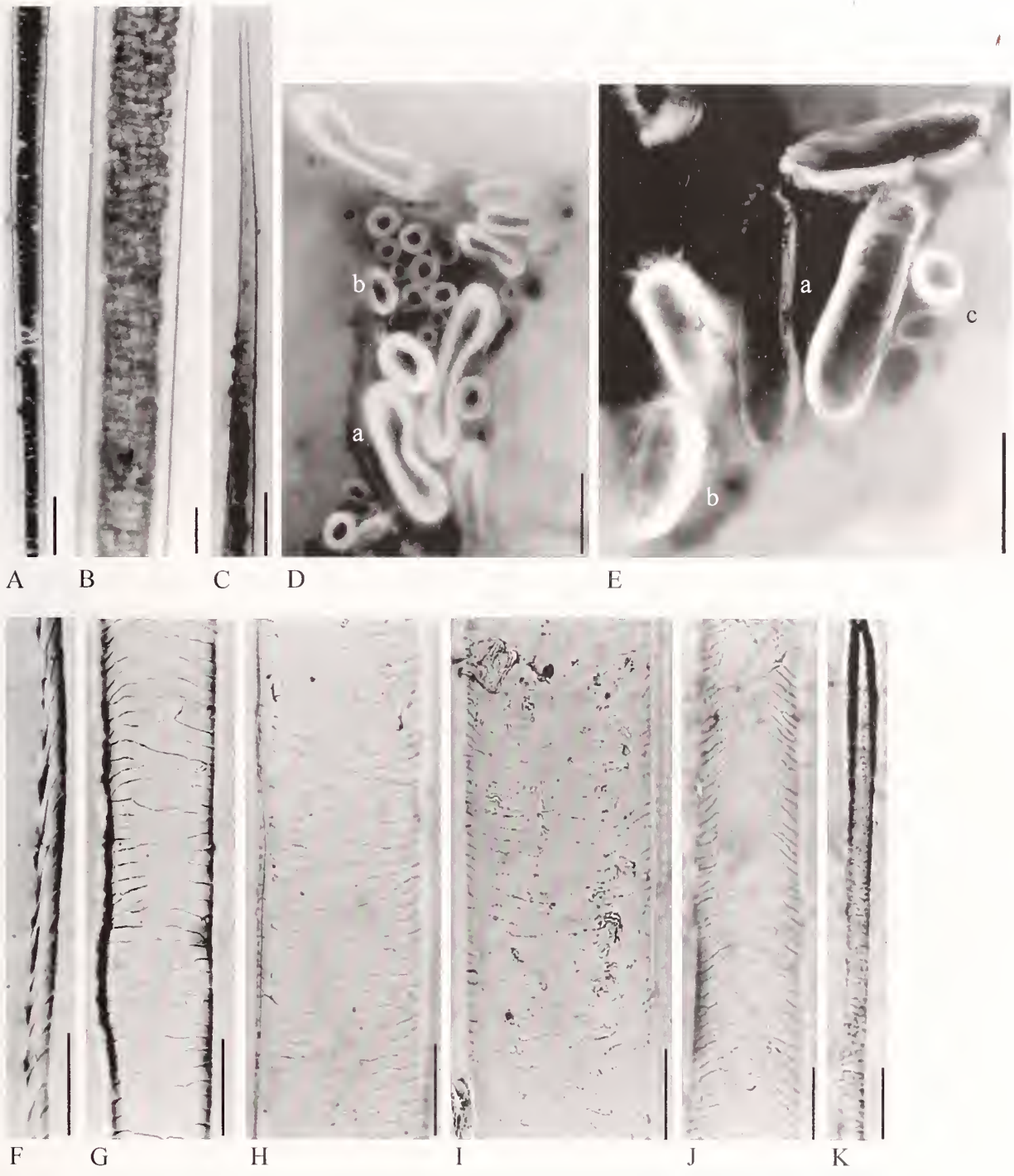

Plate 35. Whole mounts, cross sections and cuticular scale casts of *Chrysochloris asiatica* (bars equivalent to 50 µm).

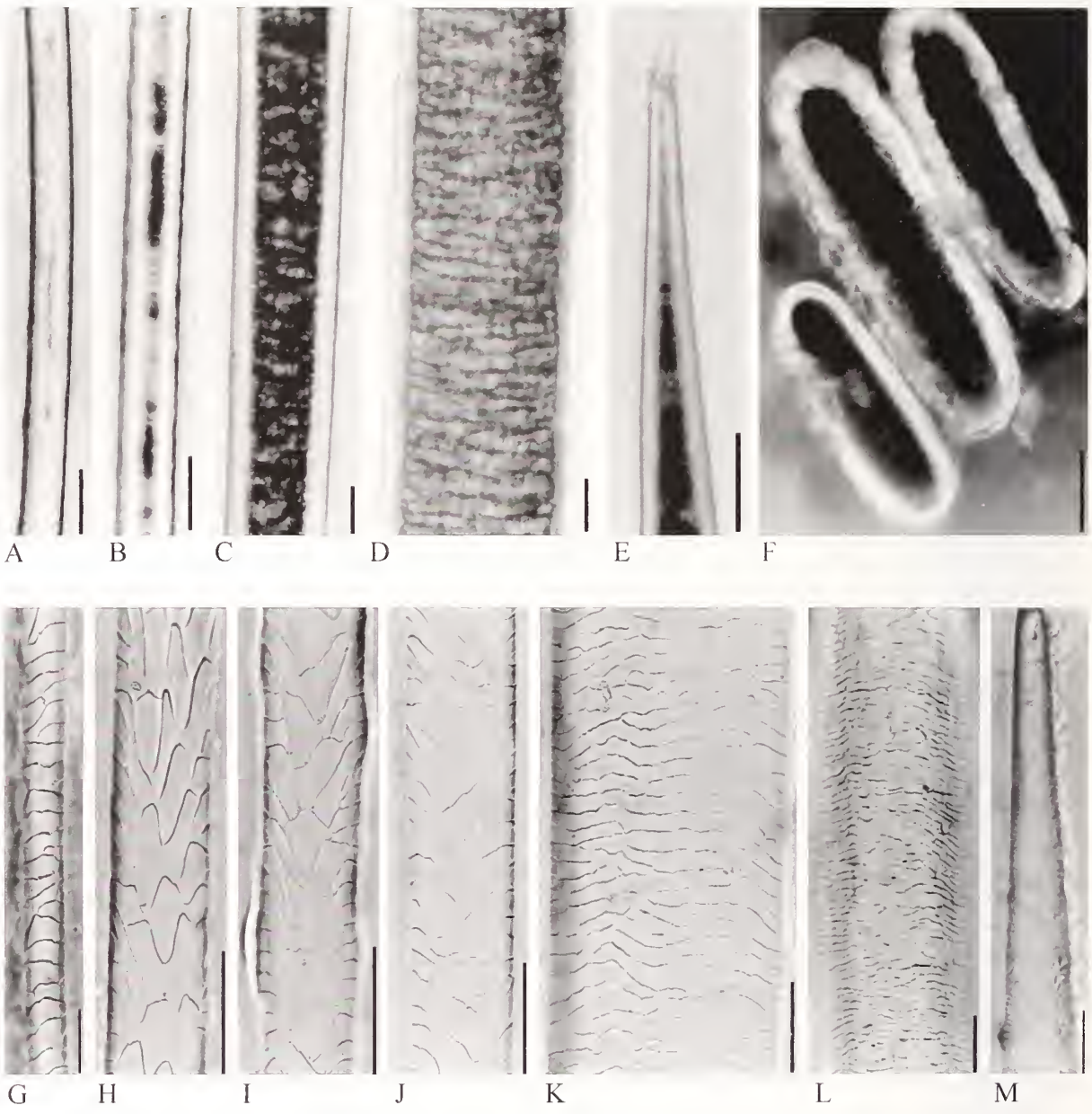

Plate 36. Whole mounts, cross sections and cuticular scale casts of *Chrysospalax trevelyani* (bars equivalent to 50 µm).

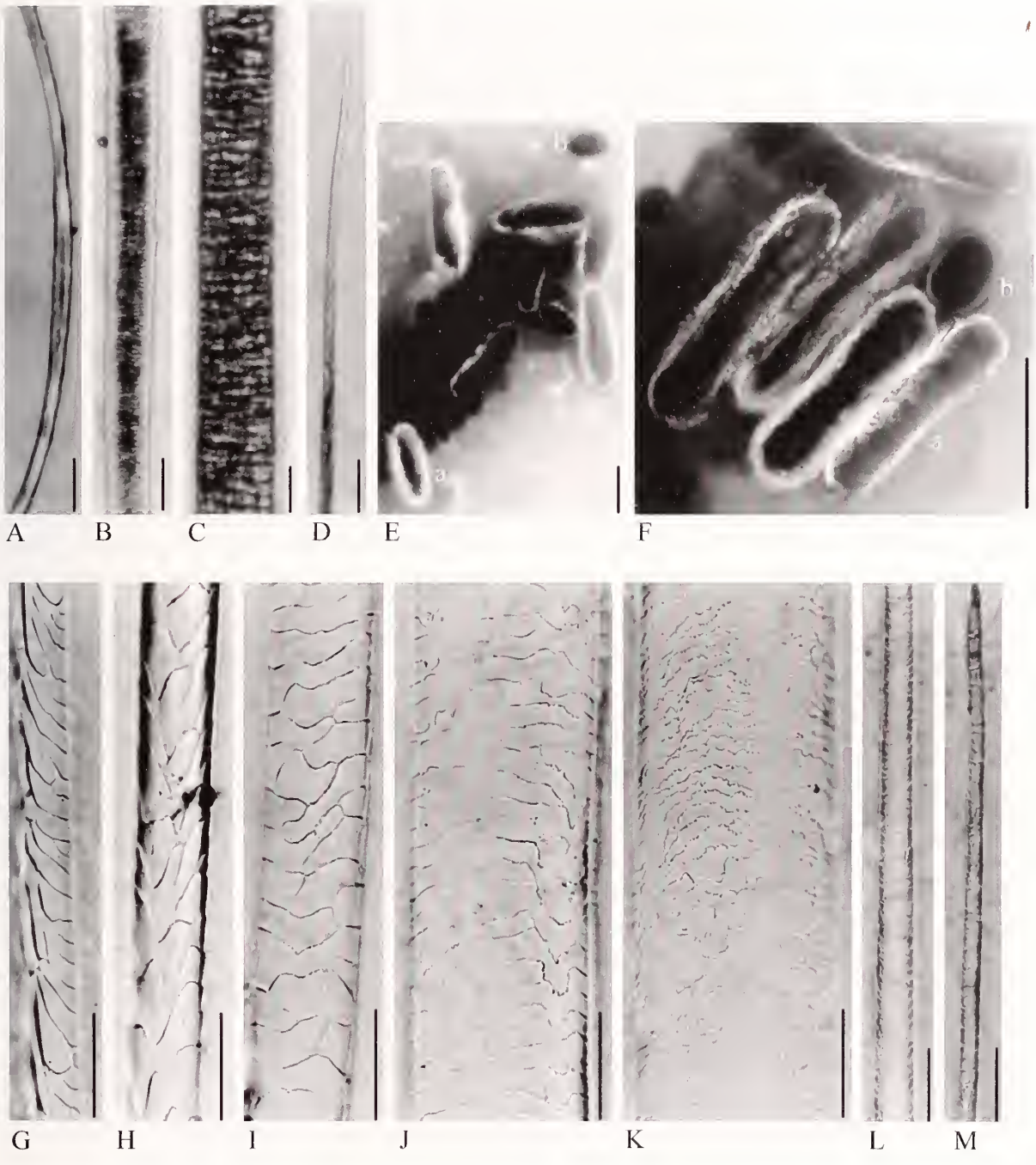

Plate 37. Whole mounts, cross sections and cuticular scale casts of *Chrysospalax villosus* (bars equivalent to 50 µm).

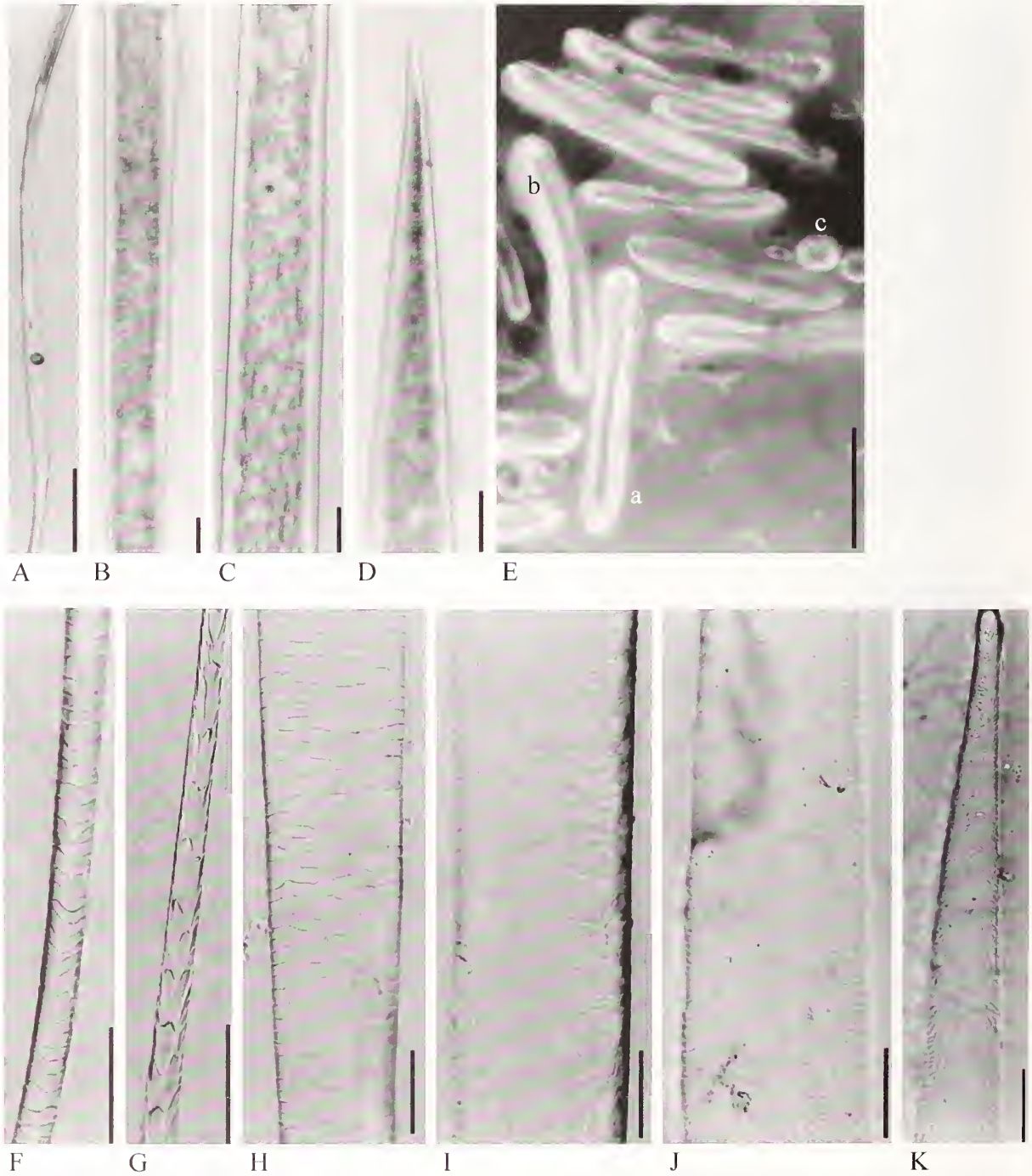

Plate 38. Whole mounts, cross sections and cuticular scale casts of *Cryptochloris wintoni* (bars equivalent to 50 µm).

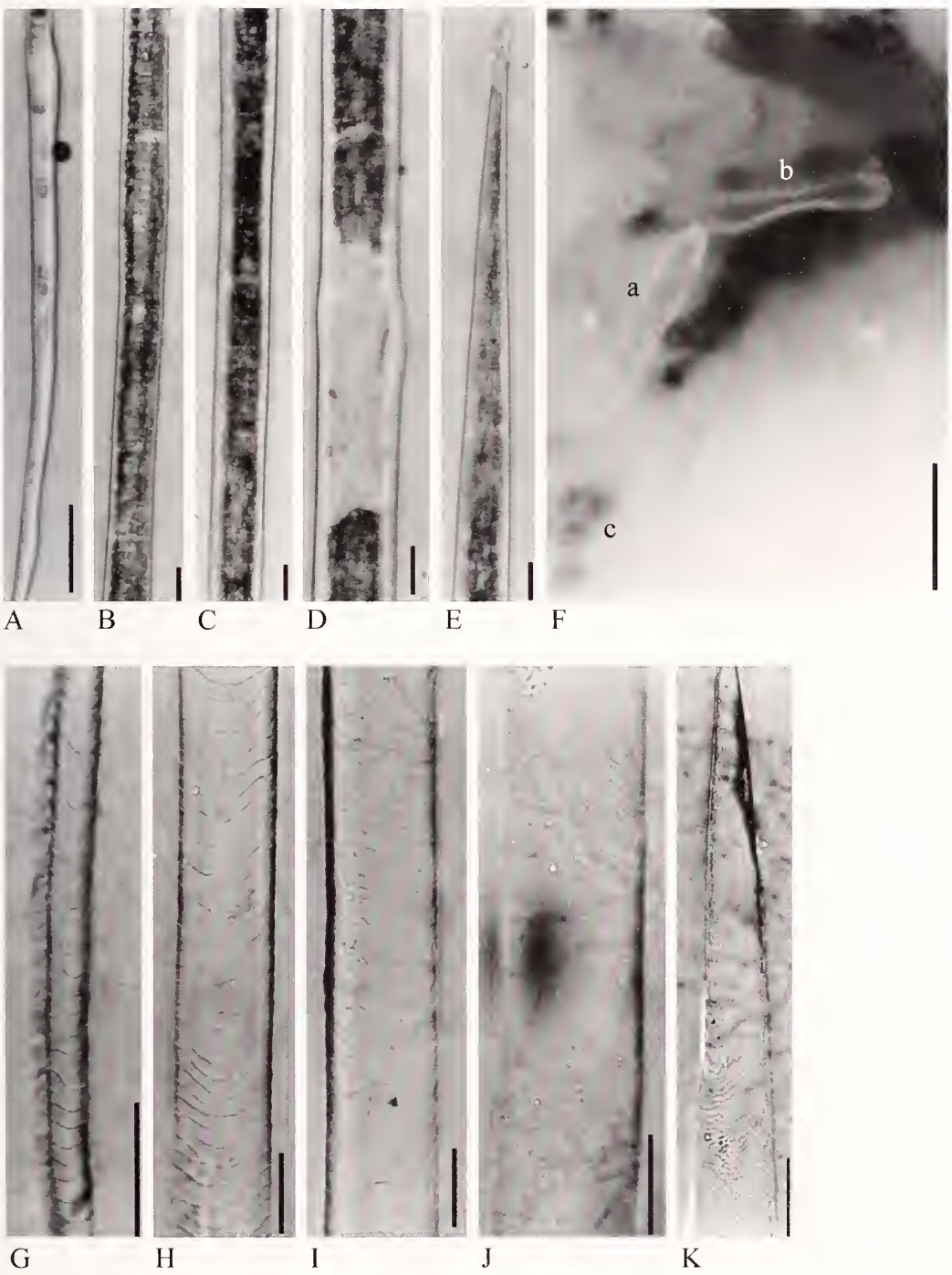

Plate 39. Whole mounts, cross sections and cuticular scale casts of *Eremitalpa granti* (bars equivalent to 50 μm).

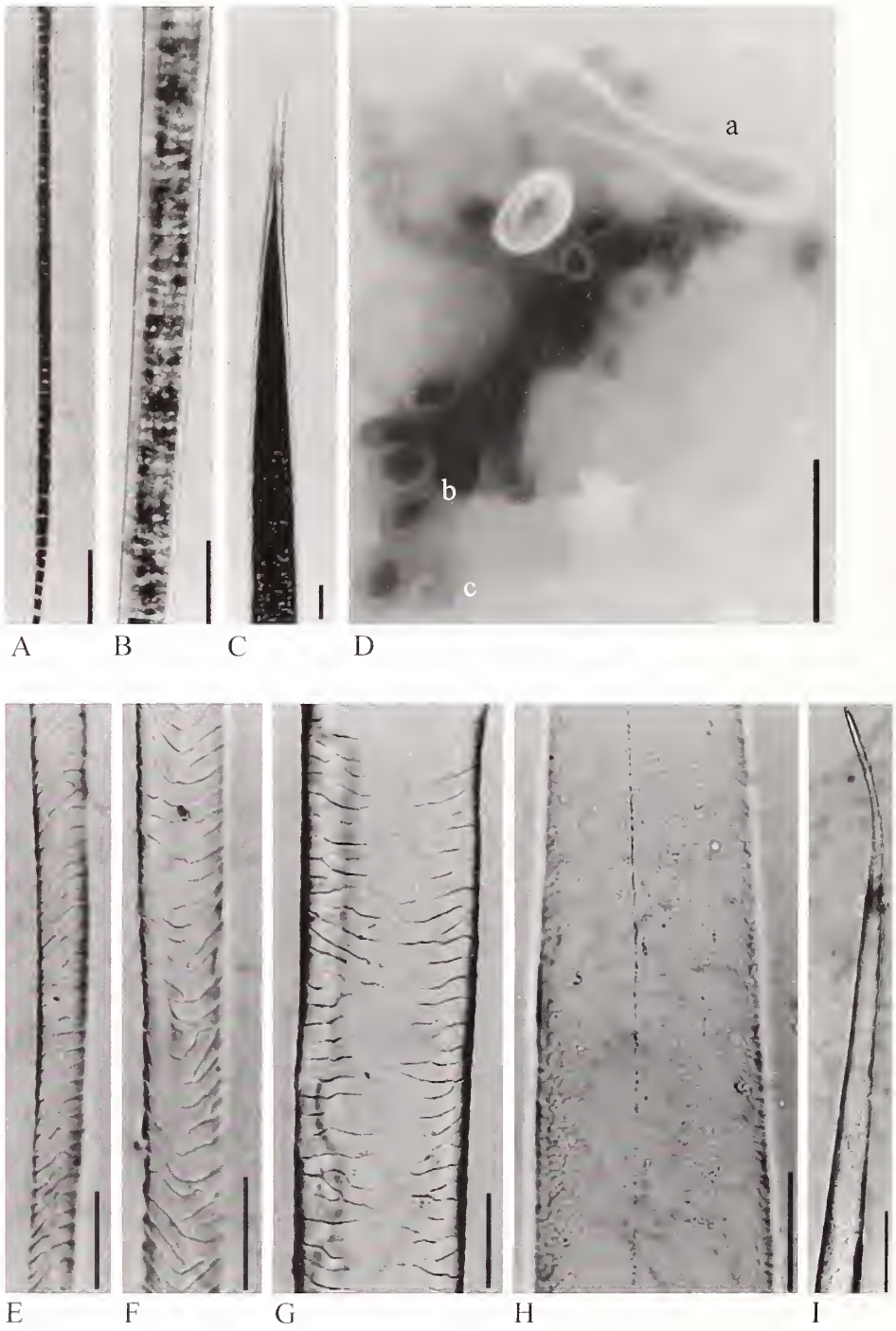

Plate 40. Whole mounts, cross sections and cuticular scale casts of *Neamblysomus gunningi* (bars equivalent to 50 µm).

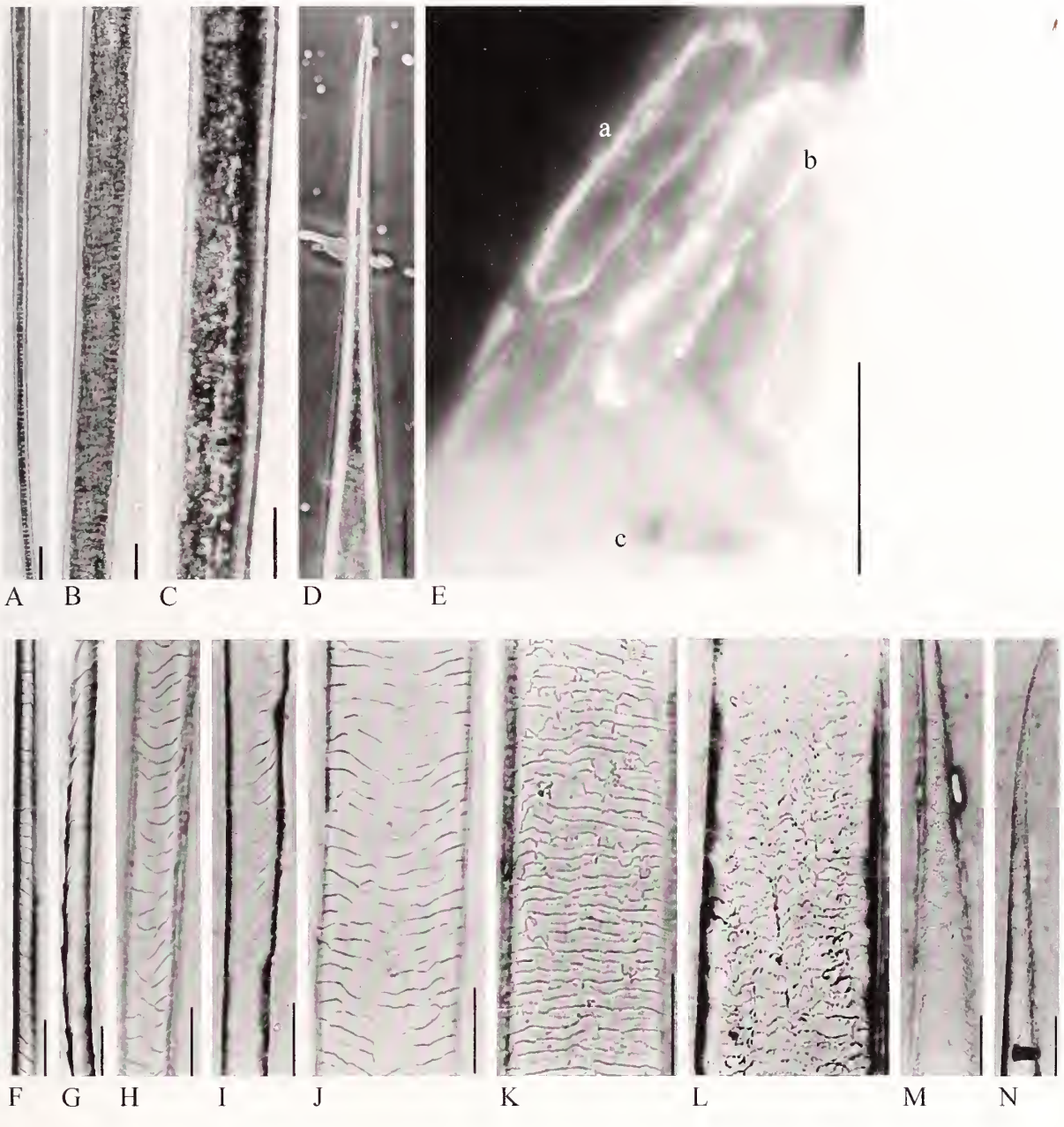

Plate 41. Whole mounts, cross sections and cuticular scale casts of *Neamblysomus julianae* (bars equivalent to 50 µm).

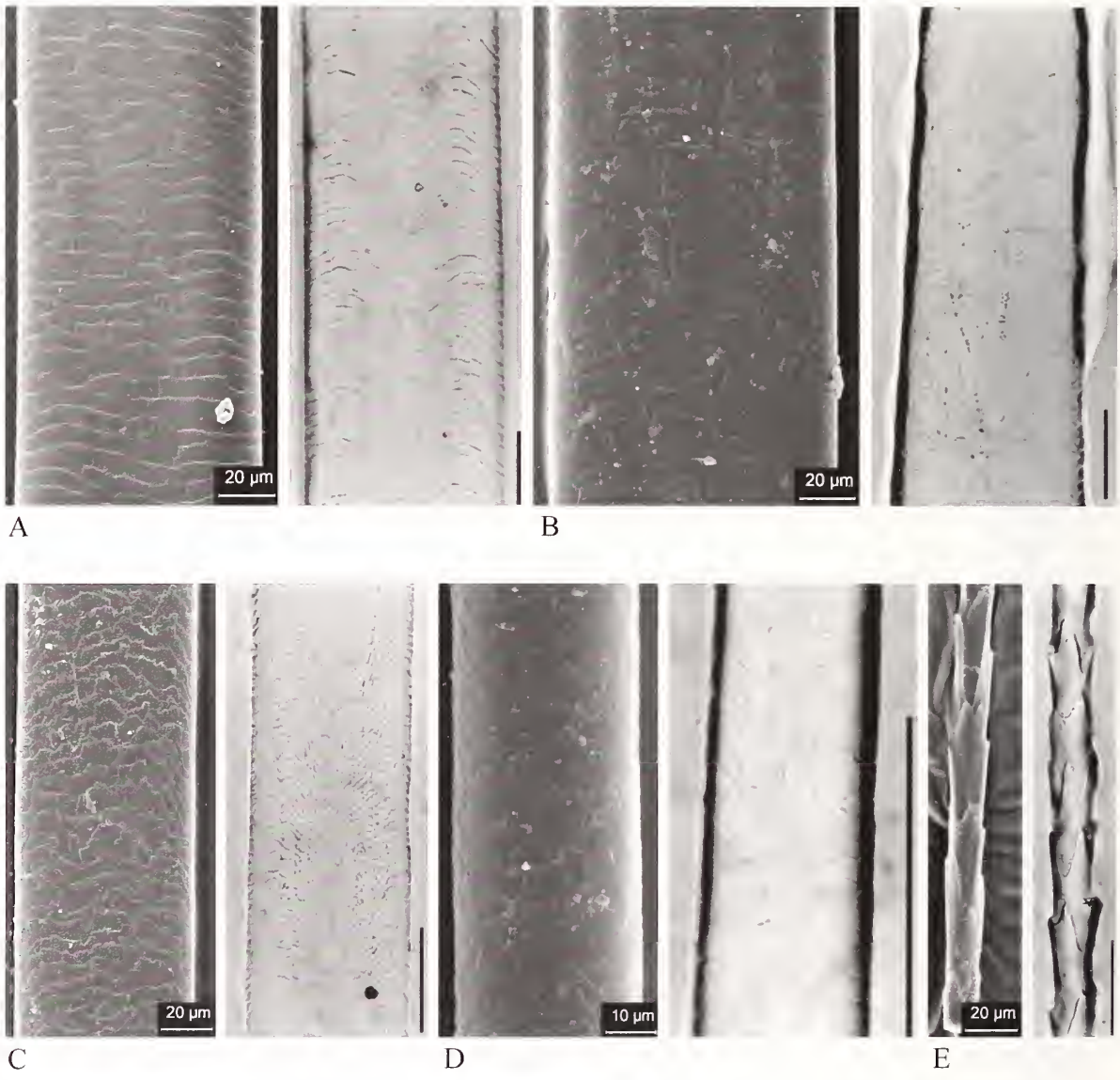

Plate 42. Comparison of cuticular scale structure using electron microscopic scans and light microscopy of scale casts of *Neamblysomus iris* (A), *Chlorotalpa arendsi* (B), *C. sclateri* (C), *Crocidura flavescens* (D) and *Elephantulus rupestris* (E) (bars of light microscopic scale casts equivalent to 50 µm).