Seeing spots

The structure of the dark spot of *Gorteria diffusa*, the beetle daisy

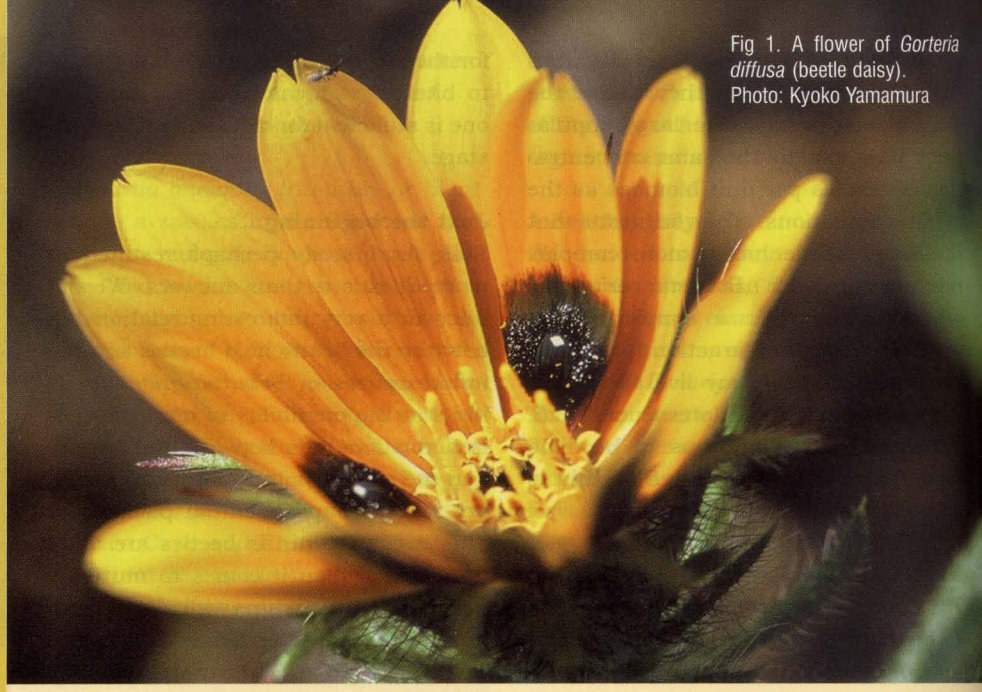
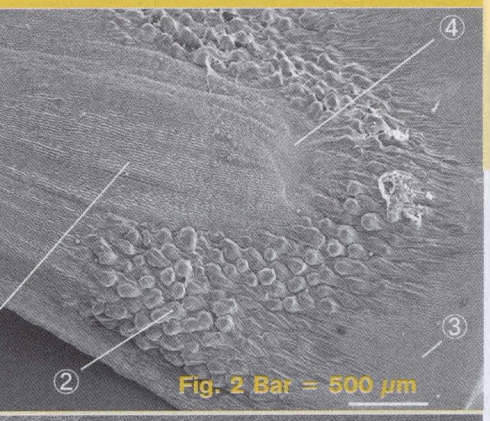


Fig 1. A flower of *Gorteria diffusa* (beetle daisy). Photo: Kyoko Yamamura

The common name of *Gorteria diffusa*, the beetle daisy, is not entirely appropriate, as the patterned dots on *Gorteria diffusa* ray florets are cunningly sculpted to reflect ultraviolet light, mimicking the glossy bodies of the bee fly, *Megapalpus ntidus*, that feeds on nectar and pollen. Artfully scattered around the central disk of the flower head, the glistening spots attract these gregarious little insects to the flower heads where they are dusted with pollen, some of which is successfully transferred to other flowers on subsequent visits.

From South African wild flowers: Jewels of the veld, by John Manning and Colon Paterson-Jones (Struik).

by **Kyoko Yamamura**, Shizuoka - kenritsu Hamamatsu- minami High School, Japan



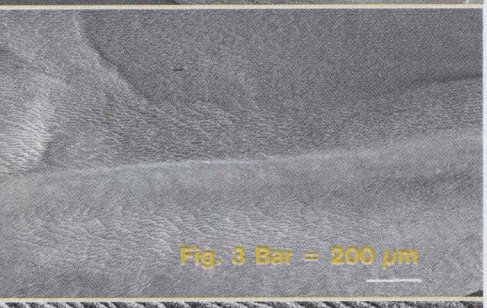


Fig. 2. A scanning electron micrograph of the upper side of the dark spot on a ray floret of *Gorteria diffusa*. Arrow 1: the swelling part, arrow 2: the large papillae, arrow 3: the outside of the spot, and arrow 4: the white dot (the white point in the centre of the dark spot clearly seen in the photo of the flower above).

Fig. 3 shows the under side of the 'swelling part' (arrow 1 of fig 2) of the dark spot.

Fig. 4 A closer look at the cells on the under side of the spot reveals that they look like pillows.

When I first saw a photograph of *Gorteria diffusa*, one of the annual Namaqualand daisies of South Africa, I was very surprised. I had never seen such a cubic decoration on a petal, except in the Orchidaceae. I observed the flowers closely when I visited Namaqualand in August 2004, and managed to get some seeds of this species from Silverhill Seeds of Cape Town. I planted them here in Japan last spring, where they grew well and produced a lot of flowers two months after sowing.

I was intrigued as to how the dark spots were formed. Prof. Johnson and Prof. Midgley published a paper (see further reading list) about these spots and described the structure and function, especially concerning the interaction between *G. diffusa* and its pollinators. They showed some scanning electron micrographs in this paper, which were very interesting, but my question was still 'how are the special dark spots formed?'

I teach biology in a high school and I can use the scanning electron microscope (SEM) in the education centre of our prefecture, so I took several scanning electron micrographs to try to find the answer to my question.

The scanning electron micrograph, fig. 2, shows the whole of the dark spot on a ray floret of *Gorteria diffusa*. I'll call arrow 1 the swelling part, arrow 2: the large papillae, arrow 3: the outside of the spot, and arrow 4: the white dot. The white dot is the highly reflective, white point in the centre of the dark spot that is clearly seen in the photo of the beetle daisy above. The large papillae can easily be seen as smaller white dots sparkling within the dark spot.

I had supposed that the dark spot was a kind of knot, but when I pulled out the ray floret and looked at the under side of it, I noticed I was wrong. The underside of the spot only curves toward the upper side like a dome (fig. 3). It doesn't thicken with specially many or large cells. Since the cells of the under side look like the pillows (fig. 4), it seems easy to bend the surface.

But how is the swelling part of the upper side supported? The centre of the cells of this part is rising like a mountain (figs 5 and 6) and several cells fall sideways. From the ridge-line of the fallen cells, wax sheets (the cuticle of the cell) are stretched to the ridge-line of upright cells.

Next, I could confirm that the large papillae (arrow 2 in fig. 2, and figs 7 and 8) are multicellular and formed by the enlargement of the epidermal cells. These are the sparkles of white

What does that mean?

cuticle A continuous layer of cutin (a waxy layer) secreted by the epidermis.

electron Indivisible unit of negative electricity and one of the fundamental constituents of matter, normally rotating about the positive nucleus of every atom.

floret Small flower, especially the flower of daisies; **disc florets:** the central florets of a daisy, having 5 small equal petals each; **ray florets:** the outer florets of a daisy, having a single very large strap-shaped petal-like lobe each.

micrometre (μm) A unit of length equal to a thousandth of a millimetre (10^{-6} m).

papilla (plural papillae) A projection from a cell, usually of the epidermis, and often swollen and covered with wax.

proximal The region of an organ that is nearest to the point of attachment.

scanning electron microscope (SEM) An instrument that uses electromagnetic lenses to focus a parallel beam of electrons and produce an image by differential electron scattering.

on the dark spot. When I looked at the living transverse sections under a light microscope, I observed some dark purple parts. Perhaps they are large vacuoles containing anthocyan (a group of glycoside pigments that occur in the cell sap of flowers). It seems that the cuticle (waxy layer) of the papillae is thicker than that of the 'swelling part' and the gap between the cuticle and the cell wall of the former is wider than the latter (fig.9). So I suppose that the secretion of the cells of the papillae is more active here than the other parts of the observed area.

Relatively small and densely corrugated cells make up the white dot. These thick cuticular lines may be the reason for the high reflection of this part (fig. 10).

Finally, we look at the outside of the spot as comparison (arrow 3 in fig. 2). The upper side of the orange-coloured part of the daisy's ray floret is relatively simple and regular (fig. 11) and is similar to the 'swelling part' and the 'white dot' in their mountain-like, ridged shape. The under side (fig. 12) is also simple and regular. It is interesting to note that the corrugations of the cuticle on the upper side run across the corolla, while those on the under side run parallel to the main veins of the corolla.

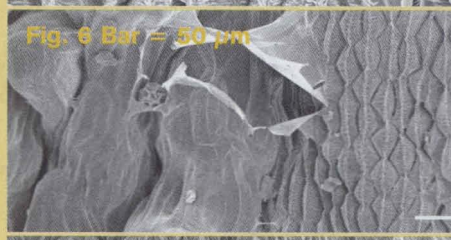
Fig.5: **The 'swelling part'** of the upper side of the dark spot (arrow 1 of fig. 2). The centres of the cells are ridged, and several cells fall sideways.

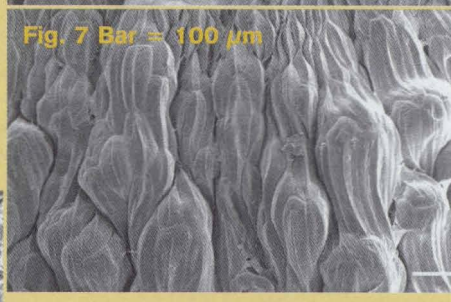
Fig.6: From the ridge-line of the fallen cells, wax sheets are stretched to the ridge-line of upright cells.

Fig.7: **The white sparkles.** In the photo of the daisy on the opposite page, within the dark spot, white speckles can clearly be seen sparkling around the larger white spot. These are the large papillae and cells that can be seen in arrow 2 of fig. 2.

Fig. 8 shows a cross section of these large papillae.

Fig. 9 shows a cross section of the papilla and, on the right side of it, the cells of the 'swelling part' (arrow 1 in fig. 2).





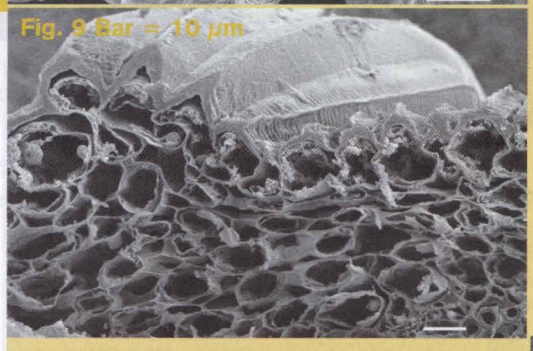
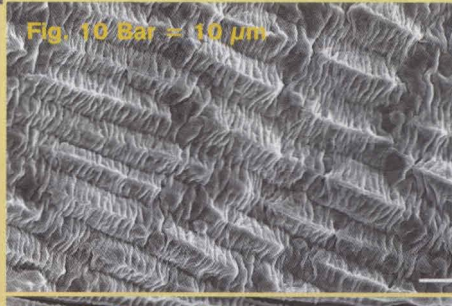
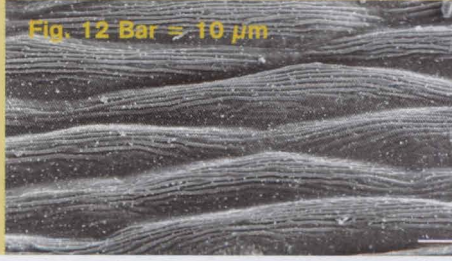


Fig.10: **The white dot** (arrow 4 in fig. 2) shows the relatively small and densely corrugated cells that make up the white dot you can see in the photo of the daisy on the opposite page. The thick cuticular lines may be the reason for the high reflection of this part.

Fig. 11: **Outside the dark spot** (arrow 3 in fig. 2). The upper side of the orange part of the daisy's ray floret is relatively simple and regular and the cells are similar to those of the 'swelling part' and the 'white dot' in their ridged shape.

Fig. 12: The under side is also simple and regular. Note that the corrugations of the cuticle of the upper side (fig. 11) run across the corolla, while those on the underside run parallel to the main veins.





About the author

Kyoko Yamamura is a high school teacher. She is a member of the Botanical Society of South Africa and has visited the Cape and Namaqualand specifically to see its flora five times. She grows several South African plant species from seed in Japan.

Further reading

Johnson, S. D. & Midgley, J. J. 1997. Fly pollination of *Gorteria diffusa* (Asteraceae), and a possible mimetic function for dark spots on the capitulum. *American Journal of Botany* 84(4), 429-436.

Cowling, R & Pierce, S. Photography by C. Paterson-Jones. 1999. *Namaqualand: A succulent desert*. Fernwood Press, Cape Town, p. 132.

Acknowledgements

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