Some remarks about the microstructure of the scale surface of Psammophioid snakes

April 2014
BRANDSTÄTTER (1995, Teil II) has studied the skin and the microstructure of the dorsal and lateral scales of several Psammophiinae. Species are characterized by the specific structure of the most superficial layer of the scales, within a species he could not detect intraspecific differences. Many of the studied scales contained a thin outermost layer of a waxy or lipid substance, that covered (but not entirely) the microstructure of the scales. BEYERLEIN (1933) and IRISH et. al. (1988) state that these are lipids, excreted through pores in the epidermis, and serving the protection against water loss.

This layer was mainly observed in specimens of the schokari-group and in *Dipsina multimaculata*. Especially in the latter this layer appears to 'fit' precisely in the underlying microstructure, 'like a key in a lock'. In gecko's, such a layer is also found (Maderson 1966), and this 'clear layer' seems to be generated during the process of sloughing. It is not yet studied if this is also the case in *Psammophis*, but it seems plausible.

In the following picture, taken from BRANDSTÄTTER (1995, Teil II, Abb. 127) we see the lipid layer of a *Dipsina multimaculata* that forms a mirrored replica of the micro-ornamentation of the scale.

It is interesting that Brandstätter found that this layer is most apparent in the species that live in dry habitats, which he considers as an indication that it serves as a protection against water loss.
Brandstätter only studied the dorsal scales as the ventral scales have a weakly developed microstructure.

The attentive reader will at this point in this text maybe remember the water loss hypothesis that was the main starting point of the dissertation of DE PURY in 2010, and of the subsequent summary of it in the Salamandra paper of DE PURY & BÖHME (2013). I objected in my 2014 paper (STEEHOUDER 2014) that this hypothesis was very poorly argued and was only based on the in no way substantiated hypothesis 'between the lines' of DUNSON, DUNSON & KEITH (1978).

De Pury has indeed read the thesis of Brandstätter, but for some reason didn't use the information to which I referred above. She could and should have used it, as it would have served as a far better argumentation for her main hypothesis. She could then for some strange reason have ignored the plausible hypothesis that in Psammophiids the layer was also generated during the sloughing process, and formulated a new one, stating that this layer is applied by rubbing. The mistake would still have been that the rubbing does not involve the dorsal scales. But, let me try to help her: if a clear layer of lipids on the dorsal and lateral scales serves the retention of water, then the absence of a useful microstructure to hold such a layer on the ventral scales could have induced the application of a protective layer through the activity of self-rubbing as seen in Psammophiids.

Would this hypothesis have been confirmed by the evidence in DE PURY (2010)? Would this better argument for her hypothesis have helped De Pury?

I think not. Firstly because in the study of DE PURY (2010) it could not be confirmed that there is through the act of self-rubbing an ample quantity of lipids applied from a kind that could have protected against water loss, nor has she studied whether the applied substance is in any way equal to the substance Brandstätter found. Secondly because there has not been demonstrated (not even investigated) whether in reality through the rubbing act a significant layer is applied on the ventral scales, and whether this presumed layer would last long enough to be considered a significant protection against water loss. Thirdly because it was never investigated what the difference in water loss is between snakes that have and that have not been rubbing, or: between snakes with and without such a hypothesized layer on the ventral scales. And last: the layer mentioned by Brandstätter was only found on the skin of Psammophiids of the schokari-group and Dipsina, the ones from arid habitats.

Let us go back to the micro-ornamentation. What is its function?

When Brandstätter wrote his dissertation (1995), there was no consensus about that - and there still isn't as far as I can see. In par. 5.3 of the second part of his thesis Brandstätter reviews what he has found in literature, and he did this very thoroughly. There are all kinds of hypotheses, like that it would help in shedding, or to move easier. Objection against the latter is, that the ventral side is mostly used in crawling and there the micro-ornamentation is almost absent. This is an example of a hypothesis that is not really well thought over. A very elegant explanation is found on p. 392-395 van BRANDSTÄTTER (2010). GANS & BAIC (1977) observed that the microstructures caused interference colors with unknown function. A comparison with the surface of the scales on butterfly wings can be made. The microstructure system of these scales amazingly resembles that on the scales of Psammophis. Structural colors are caused by the effects of light on the surface structures. The structure as is found in many snakes of the sibilans group, with a vermiculite structure between the rigs, causes light effects that make them shine strongly, while a simple grid
structure as seen in the *schokari* group (*namibensis, leightoni, trinasalis, jallae, notostictus, punctulatus, schokari, aegyptius, tanganicus, trivirgatus*) lacks this luster and makes the animal appear dull. I add to this that perhaps the presence of the described waxy layer on the surface of the scales of these snakes increases this effect of dullness. The function of all this remains unclear. Brandstätter hypothesizes a function in the regulation, filtering, of the reception of UV light of different wave length. Another function could be found in the intake of energy. Butterfly wings are considered as a sort of solar cells, that collect energy. The similarities of those wings and the surface structures of Psammophids could indicate a comparable function. The differences between the surface structure of species of the savanne and those of the deserts would then be explained. Brandstätter points at *Psammophis schokari* and both the other Egyptian species. *Schokari* inhabits there the dry areas of the outskirts of the Sahara and its skin microstructure is a simple grid with unstructured gap (dull colored in comparison with the shining sibilans). *P. aegyptius* that lives in oases of the Libyan Sahara, has the same basic structure, but with lightly vermiculate gap between the grid. *P. sibilans* has a structure that makes it shining. It is plausible that the conditions of humidity, temperature and light in the oases differ from those in the gravel deserts of the outskirts of the Sahara.

What follows, are pictures taken from Brandstätter 1995 of the micro-ornamentation of some mentioned *Psammophis*-species.
Abb. 48: Psammophis leightoni namibensis.

Abb. 49: Psammophis leightoni namibensis.
Abb. 47: Psammophis leightonii trinacalis.

Literature


