

Systematics and Ecology of the genus: *Tectocephus* Berlese 1896 (Acarina).

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The genus *Tectocephus* was established by Berlese in 1896 based on *Tectocephus velatus* (Mich.) Berlese 1896. Originally Michael (1880) classed this species with the *Tegeocranus* genus with the proviso that it was "not a proper *Tegeocranus*".

Later the following species and varieties were included in the genus *Tectocephus*: *T. velatus* var. *sarekensis* Träg. 1910 (= *T. sarekensis* Träg. 1910 according to Balogh (1943)); *T. minor* Berl. 1903; *T. minor* var. *expansus* Berl. 1915; *T. personatus* Berl. 1910; *T. alatus* Berl. 1913.

In 1913 Berlese classed *T. personatus* with the genus *Tegeocranellus*. Jacot (1937) classes *Tectocephus minor* var. *expansus* as a variety of *Tectocephus velatus*. At the same time he divides it into "an impressed and unimpressed form" according to the presence or absence of depressions on the dorsal side of the hysterosoma.

The primary systematic points of distinction between the species and varieties are the following: total length and total width. Width and length of cuspis. Size and shape of the pteromorpha. The more or less pronounced swelling of the tip of the pseudostigmal organs. The size of the dots of the epiostracum. The absence or presence of dorsal depressions of the hysterosoma.

As Michael's descriptions of *Tectocephus velatus* (1880, 1883) and the descriptions published by other authors (Berlese 1896, Trägårdh 1910, Haarløv 1942, Sengbusch

1951 a. o.) are not adequate I have studied the morphology of the species on the basis of four slides with specimens from Michael's own collection (British Museum, Natural History). According to information from G. Owen Evans, PH.D., these specimens must have formed the basis for Michael's description of the species. The slides show two complete animals (fig. 1, 2) and several dissected organs (fig. 3, 4). Based on examinations of these specimens Michael's original description may be supplemented as follows:

The length and width of the two complete animals is 0.31—0.17 mm and 0.32—0.19 mm. The lamellae and cuspes are visible on these two specimens only. The lamellae are broad in both animals. In one (fig. 1) the cuspis is as broad as that of var. *sarekensis*. In the other specimen (fig. 2) the cuspis is considerably more narrow. Fig. 1 shows that the shape of the two cuspes on one and the same animal need not necessarily be identical. The tips of the pseudostigmal organs are more or less oval (fig. 1, 3, 4). The size of the dots of the epiostracum varies both in the individual animal and from animal to animal (fig. 1, 2, 3, 4). Only the dorsal depressions at the back are visible (the animals are mounted in Canada balsam). It must furthermore be added that four pairs of hairs can be seen on the upper side of the the animal besides the two interlamellar hairs and the six hairs along the rim of the back (fig. 1).

I have not studied the type specimens of the other species and varieties of the *Tectocephus* genus. After a study of the original descriptions I am however of opinion that they may be characterized as shown in

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- Fig. 1. *Tectocephus velatus* (no. 600 from Michael's collection). Upperside of total animal. a: cuspis. b: lamellae. c: pseudostigmal organs. d, e, f: projecting points of pteromorphae.
- Fig. 2. *Tectocephus velatus* (no. 598 from Michael's collection). Propodosoma with lamellae and cuspes.
- Fig. 3. *Tectocephus velatus* (no. 604 from Michael's collection). Pseudostigmal organ.
- Fig. 4. *Tectocephus velatus* (no. 596 from Michael's collection). Pseudostigmal organ.

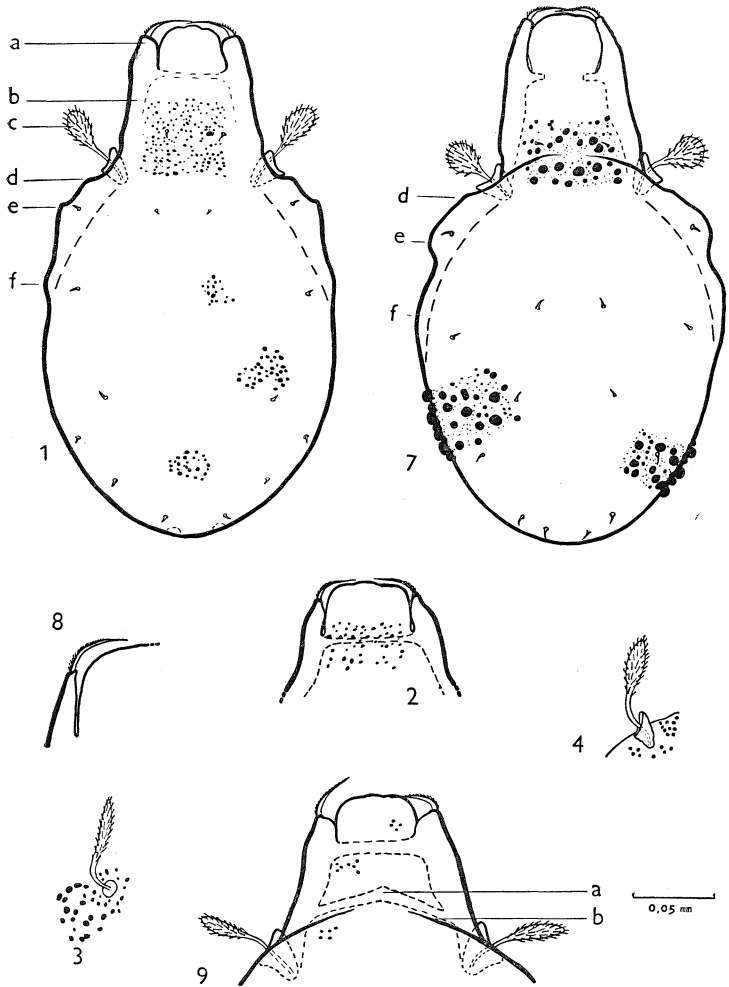


Fig. 7. *Tectocephus alatus* (South side of hillock, Dyrehaven, Denmark). Upper side of total animal.

Fig. 8. *Tectocephus velatus* (Mælifell, Iceland). Left cuspis.

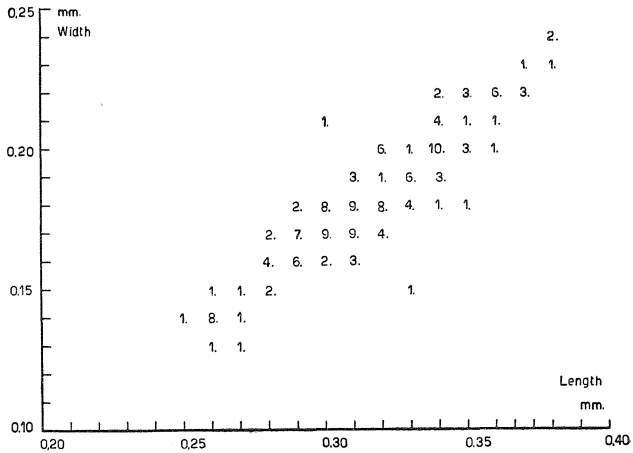
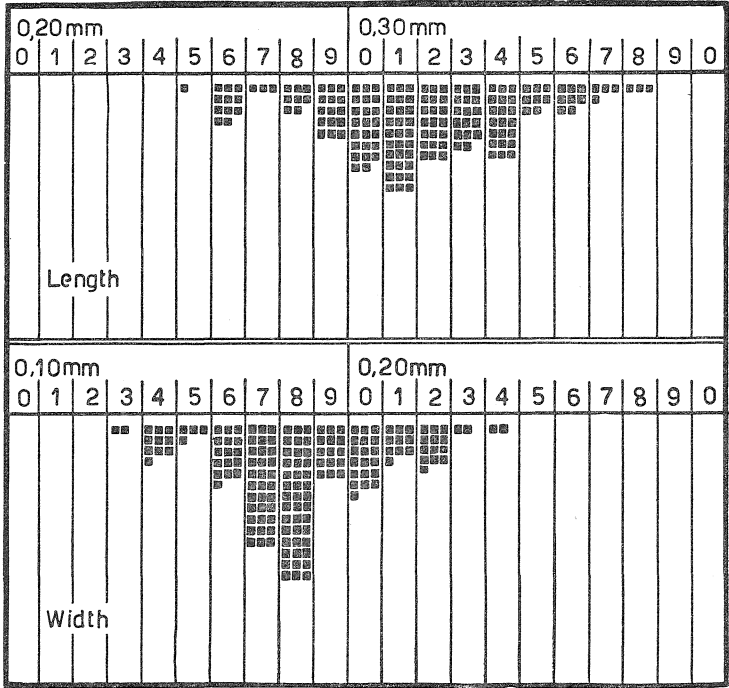
Fig. 9. *Tectocephus velatus* (Mørkefjord, NE Greenland). Propodosoma. a: cuticular thickening under epiostracum. b: extension of epiostracum from pteromorphae towards median line of animal.

table 1. With regard to *Tectocephus minor* I have previously shown (1942) that it is doubtful whether the cuspis has a dent at the tip (Sellnick 1929). This character has therefore not been included in the table.

Table 1.

Characteristics \ <i>Tectocephus</i> :	<i>velatus</i> var. <i>sarekensis</i>	<i>minor</i>	<i>minor</i> var. <i>expansus</i>	<i>alatus</i>
Length—width (mm)	0.35—0.18	0.29—?	0.26—0.15	0.34—0.20
Cuspis	Sides parallel; very broad.	Sides converging towards the tip; narrow.	With parallel sides; rather broad.	Sides converging towards the tip (Inner line concave); narrow.
Pseudostigmal organ	Like fig. 3	Like fig. 1	Like fig. 4	Like fig. 7
Dots of Epiostracum	Like fig. 2	Like fig. 1	Like fig. 2	Like fig. 7
Dorsal depressions	(+)	(+)	(+)	÷

Even though it should thus be possible to define the various species and varieties, some difficulty in keeping them separate has been experienced in practice (Trägårdh 1910, Jacot 1937). When examining a material collected in North East Greenland (1942) I came to a similar conclusion. In 1942 when I began the determination of a new collection of among other things 1852 adult animals of the *Tectocephus* genus it was once more confirmed that great variations might occur in the systematic characters. Yet in 729 of the 1852 animals a certain combination of the characters did not vary from one animal to another. This deviation from the general rule induced me to think that it would be justified to re-engage in a study of the problem of the individual species of the genus *Tectocephus*.



For this purpose I have examined 182 animals of the genus *Tectocephus* selected at random from available material from the following countries: Afghanistan (3), Canada (8), Denmark (66), France (28), Iceland (5), Italy (9), North East Greenland (12), Spain (10), and Sweden (41). With such a large basic material it should be possible to decide whether there is a free combination of the characters of the species in the individual animals or whether certain combinations of characters accompany each other?

Fig. 5 and 6 show the result of measurements of the total length and width of 170 of the 182 animals examined. The squares in fig. 5 show the number of animals in each size group. On the whole the distribution is as expected from a uniform material. The measurements, length and width, of all described species and varieties of *Tectocephus* fall within the framework of fig. 5.

Fig. 6 demonstrates the same figures as fig. 5 but drawn up in a coordinate system: the measurements for width placed along the ordinate and those for length along the abscissa. For each intersection a figure states the number of animals showing the coordinations in length and width. In this way one can immediately see the most frequent coordinations. Fig. 6 furthermore shows that there is a linear variation in the measurements of width and length, as the different points, with a few exceptions, are distributed within two parallel lines. Although the points have a tendency to crowd in certain places, they form an entity from 0.25—0.14 mm to 0.38—0.24 mm. A natural division of the material on size groups is therefore impossible.

Fig. 5 (above). *Tectocephus velatus* and *Tectocephus alatus*. Length and width of 170 specimens. Each square means one specimen.

Fig. 6 (below). *Tectocephus velatus* and *Tectocephus alatus*. Length and width of 170 specimens.

Table 2 has been drawn up to show the distribution of all the characters of the genus on the 170 animals.

All used characters are given both along the abscissa and the ordinate. The combination with other characters of the same animal is given for each character. Each combination of the two characters is marked at their respective intersections and these points were finally counted to obtain the number of realized combinations of the respective intersections. The purpose of drawing up the characters of the species in this manner is to determine whether there is a possibility of a combination between two of these characters in one animal. Secondly I wanted to see how many of the 170 animals showed these different combinations. For the purpose of record the measurements of length and width have been included.

If the combinations are drawn up in detail it will be found that animals with cuspis, dots of epiostracum and pseudostigmal organ as on the specimen given in fig. 7 and besides with a lack of dorsal depressions, always have these characters combined as on fig. 7. It applies to the other characters that they are combined more or less frequently.

So in contrast to the result of the examinations of length and width it is now found that the 170 animals can be divided into two well-defined groups: 140 whose systematic characters vary considerably and 30 animals with a different and uniform combination of characters. The two groups must consequently represent two species within the *Tectocephus* genus.

When we compare the previous description of *Tectocephus velatus* (p. 425) and the diagrams of the characters of the other *Tectocephus* species and varieties (table 1), no doubt is left that the 140 animals contain the characters typical of all these forms (except *Tectocephus alatus*), i. e. some of the specimens have combinations typical for one of the "species" mentioned, some have

combinations mixed from several "species". No systematic distinction can therefore be drawn among the 140 animals mentioned above, they must all belong to the same group. Likewise the "species and varieties" shown in table 1 (except *Tectocephus alatus*) fall into the same category. All of them must correspond to one species which should be designated as *Tectocephus velatus* according to the rule of priority.

Based partly on the four mentioned specimens from Michael's collection partly on the 140 animals examined, the following description of *Tectocephus velatus* may therefore be given:

The width of the cuspis varies between the narrow (fig. 8) and the wide (fig. 1) form. The sides of the cuspis pointing inwards are convex or straight, never concave. The length of the cuspis varies. Fig. 9 shows the shortest I have found in the material. Similar cuspis were seen in animals from France and Spain too. The translamellae are more or less visible under the epiostracum (well developed in fig. 9, less developed in fig. 2, and only suggested in fig. 1). The transition between the propodosoma and the hysterosoma may be smooth (fig. 1), or, as shown in fig. 9, have a cuticular thickening under the epiostracum (a in fig. 9) or an extension of the epiostracum (b in fig. 9) from both pteromorphae towards the median line of the animal. In all cases the pteromorphae have looked as shown in fig. 1, i. e. having three curves (in the front of d and between d-e and e-f). Their reciprocal size shows some variations. These variations were in no case larger than that the basic form was distinct. The pseudostigmal organ most frequently has an appearance as shown in fig. 1 and 4. It is often long and narrow as in fig. 3; but very rarely as broad as in fig. 7. The individual dots of the epiostracum varies between the diameter measurements shown in fig. 1 and 3. The points stand slightly out from the epiostracum. It may often be difficult to discover the dorsal depressions even by use of side-light (Grandjean 1949). However by closer examination they seem always to be present. The circumference of the hysterosoma is egg-shaped but with a tendency of the lines to become parallel behind the pteromorphae.

As a result of this new description of *Tectocephus velatus* one obtains a species whose systematic characters

vary, but in which it is possible by an examination of a sufficiently large material to describe the framework of these variations.

This tendency to variation makes it possible to draw up a number of varieties within the same species (ex.: var. *sarekensis*). To erect these varieties from purely morphological motives does not appear to be of great value. This would not be justified unless it could be proved that certain habits, geographical range etc. could be linked with certain morphological characters.

From the material available at present it has not been possible to prove the existence of ecological, biological or geographical variations correlated with the morphological variations. Previous statements that broad lamellae are characteristic of animals from damp habitats (Haarløv 1942) no longer hold good.

The second group of the 30 animals from table 2 have been referred to the species *Tectocephus alatus* Berl. 1913. Berlese's description of the species is written in his usual short style. It may therefore be justified to make some supplementing comments to this description based on the material collected (fig. 7):

It applies to all characters of the species that practically no variations occur — a fact which was already apparent (as opposed to *Tectocephus velatus*) at the original sorting out of the 1852 animals from Denmark. Length and width vary between 0.30—0.33 mm and 0.16—0.18 mm. The specimen described by Berlese was 0.34 mm long and 0.20 mm broad. The cuspes are narrow and the inner sides slightly concave. The translamellae are incomplete. The pseudostigmal organs are hardly spatula-shaped at the tip. At the transition between the propodosoma and the hysterosoma the epiostracum from the pteromorphae stretches towards the median line of the animal. The pteromorphae do not deviate from *Tectocephus velatus* in their basic form. The curve corresponding to e-f (fig. 1) is more pronounced than in *Tectocephus velatus*. The epiostracum has dots like: "granis pergrossis" which stand above the epiostracum what is especially visible along the sides of the animal. The individual dots resemble drops of secre-

tion. A large number of smaller dots varying in size are spread between the very large dots. The same number of hairs as on *Tectocephus velatus* is found on the upper side of the animals but they are placed a little differently. Dorsal depressions do not appear to be present. The circumference of the hysterosoma is egg-shaped. The sides are nowhere parallel. In my material I have only got *Tectocephus alatus* from Denmark.

Also the larvae and nymphae of *Tectocephus velatus* and *alatus* can be distinguished from each other in their external morphology.

As a result of these systematic studies one can establish that only two species of the *Tectocephus* genus are known, i. e. *Tectocephus velatus* (Mich.) Berl. 1896, whose systematic characters vary, and *Tectocephus alatus* Berl. 1913, whose characters are constant.

A comparison between the ecology of the two above mentioned species discloses that the ecology of the two is not identical.

Tectocephus velatus appears to be eurytope (Thamdrup 1932, Dalenius 1949). Michael (1880) expresses this as follows: "I have met with it wherever I have searched". However available literature does not give any information as to whether the species prefers certain types of habitats to others.

About the ecology of *Tectocephus alatus* the literature gives no information except that it has been found at a height of 2500 m in Italy (Berlese 1913).

During the collection of material in Denmark I have got a certain impression of how the two species are distributed which is shown on table 3 diagrammatically.

Table 3 shows the relative numbers of the two species characterized by dominance and constancy figures introduced into the zoecology by Palmgren (1930) and Krogerus (1932).

Each of the squares of table 3 show the constancy

Table 3.

Species \ Biochorion	<i>Tectocephus velatus</i>		<i>Tectocephus alatus</i>	
	c	d	c	d
South side of hillock	86 0/0	20 0/0	93 0/0	8 0/0
North side of hillock	100 0/0	8 0/0	78 0/0	7 0/0
Flat commons between hillocks	100 0/0	4 0/0	<20 0/0	<2 0/0
Forest soil	72 0/0	<2 0/0	÷	÷
Lake bank	<20 0/0	<2 0/0	÷	÷

figures of the species (c) and the dominance figures for the biochorion of the species (d).

According to table 3 *Tectocephus velatus* appears to be able to live on all five biochorions but to prefer the North sides of the hillocks and the flat commons.

From table 3 it can be seen that *Tectocephus alatus* is only found on three of the five biochorions and that it clearly prefers the hillock-biochorions to the flat ground. It is further seen that it is especially found on the southern side of the hillock. Judging from this material the species must therefore be characterized as stenotope.

The ecological characteristic of the southern side is the free exposure to the sun. The soil thereby becomes more dry and warm than in any of the other biochorions. The distribution of *Tectocephus alatus* may possibly be connected with this factor.

Summary.

1) New description of *Tectocephus velatus* (Mich.) Berl. 1896. See fig. 1—9 (excl. fig. 7). The characters vary considerably.

2) New description of *Tectocephus alatus* Berl. 1913. See fig. 7. The characters of the species seem to be constant.

3) All hitherto described species and varieties of the genus *Tectocepheus* (except *T. alatus*) belong to *Tectocepheus velatus*.

4) Ecologically *Tectocepheus velatus* is eurytope, *Tectocepheus alatus* stenotope.

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