

Further contributions towards the comparative morphology and classification of the Mesostigmata.

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Introduction.

The building up of a natural system of the *Mesostigmata* has been greatly hampered by the fact that the classification has been based almost exclusively on the fauna of Europe. This region is, however, rather meagre in comparison with the tropics which, to judge from the few glimpses one has so far obtained of them, must be literally teeming with strange and interesting forms, which when once thoroughly known will surely profoundly alter our conceptions regarding the system of all the terrestrial acarina.

It is evident to every acaridologist that the present system is based on only a small fraction of the existing forms. One cannot expect such a system to be ideal any more than one could conceive a satisfactory classification of the mammals without knowledge of the fauna of Australia and South America.

Another feature which has also greatly impeded the progress of a satisfactory classification of the acarina is our backward state of knowledge of their anatomy. As a result of this the specialists have been forced to restrict themselves mostly to characters of the exoskeleton which may or again may not offer sufficient guidance in this matter. One must not put all the blame for this on the shoulders of the acaridologists. They are severely handicapped by the unfortunate fact that the acarina are, with the exception of forms of economic importance, hardly recognized as worthy of any attention at all by most museums of natural history. I very much doubt, whether there is a single museum, to which there is attached an acaridologist who is only an acaridologist. At the best there is a department with a specialist, who has also to attend to the aranéids, the scorpions and myriopods, sometimes also the crustaceans.

As a consequence most acaridologists are men who earn their living as teachers and can only devote their leisure hours to this

study and generally have not the aid of a modern laboratory equipment.

It is very important that this deplorable state of things soon be altered for the better, because the acarina are so exceedingly rich both in forms and numbers almost everywhere, that they must not be overlooked any longer. And there are many important problems which cannot be solved without a comprehensive knowledge of them, which means not only that the present chaotic state of the systematic literature is succeeded by monographic treatments of the different genera and families, but also that their biology, ecology and anatomy is thoroughly studied.

I speak from personal and painful knowledge, because I have during the last years devoted much time to the study of the fauna of the soil in the Swedish forests for the purpose of supplementing data relative to a deeper understanding of the processes which take place in the soil, the result of which is the breaking down of the litter, moss and lichens etc. into inorganic matter available for the growth of the trees. And everywhere my work on the acarina of the forest soil has been hampered or even frustrated by the obstacles mentioned above. This is one of my reasons for calling attention in this paper to the necessity of a new classification of the *Mesostigmata*.

1. The taxonomic evidence offered by the ventral shields of the female.

The supercohors *Mesostigmata* of the suborder *Parasitiformes* is by the now living acaridologists, f. i. Oudemans and Vitzthum divided into only two subdivisions, the *Gamasides* Leach 1810 and the *Uropodina* Kramer 1881. But even if we take into consideration only the European genera it is obvious that this classification does not take into account the diversity displayed by these forms, and for this reason it is in some respects quite artificial.

Thus it does not make any allowance for the remarkable shape of the ventral shields of the *Antennophoridae*, nor of the *Celaenopsidae*; in the subcohors *Sejina* we find thrown together such divergent families as the *Sejidae*, the *Ascaidae* and the *Fedrizziidae*, the genus *Trachytes* is placed amongst the *Uropodina*, whereas the closely related genus *Polyaspis* is referred to the *Ascaidae*.

Even if we take into consideration only the European forms it is quite obvious that the present classification does not do justice to their great diversity of shape.

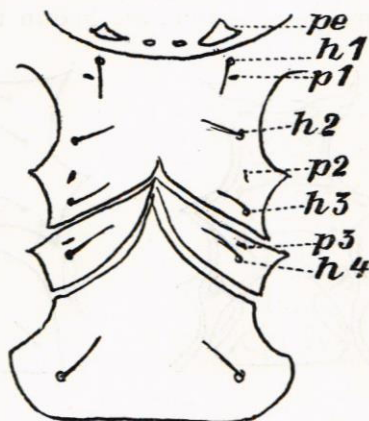
Although admittedly as many characters as possible ought to be taken into account when a classification is attempted, I am convinced that the shape of the ventral shields, especially of the

female, is one of the most important features, and for this reason I begin my arguments with this feature.

Both in the *Gamasides* and the *Uropodina* the female epigynal shield is more or less triangular, top forwards and with free lateral edges, attached only along its posterior margin where it is hinged to the ventral side along a transverse line and more or less movable like a trap-door. But although these shields are very alike in shape in the two groups they cannot be considered morphologically equivalent, as I have tried to prove already in my paper: »Contributions towards the comparative morphology of the Parasitidae» (1912). Because the epigynal shield of the *Uropodina* has no hairs (fig. 11), whereas in the *Gamasides* it generally has one pair of hairs (fig. 1.)

It may seem preposterous to attach so great importance to a pair of hairs, but nevertheless it is my firm conviction that it is impossible to understand the varying shape of the ventral shields of the *Mesostigmata* unless we pay close attention to the number of hairs and their position. If f. i. we compare the two genera *Pergamasus* and *Macrocheles* we notice,

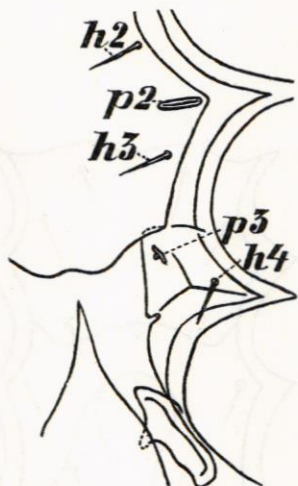
that in the former (fig. 1) the metasternal (or paragnyal) shields have one pair of hairs and that their lateral edge embraces the inner side of the coxae exactly in the same way as the endopodal shields do when they are distinct. In *Macrocheles*, on the other hand, (fig. 2) the metasternal shields, although rather small and insignificant have one pair of hairs and are not fused with the corresponding pair of endopodal shields. In both these genera the sternal shield has only three pairs of hairs, but in other genera as f. i. *Gamasellus* (fig. 3) where there are no metasternal shields and the corresponding endopodal shield is free, we find four pairs of hairs on the sternal shield, a fact which can only be explained by the assumption that the metasternal shield has coalesced with the sternal shield. In other genera, f. i. *Gamasiphis* (fig. 4) all the endopodal shields are fused both with the sternal and the metasternal shield. In *Eviphis*, on the other hand



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 Fig. 1. *Pergamasus lapponicus* Tgdh. ♀. Praependopodal shields (pe), sternal, metasternal and epigynal shields. h 1—h 4 sternal hairs p 1—p 3 sternal pores (lyriform organs).

and the gnathosoma, in a way corresponding to the endopodal shields of the other segments (fig. 1). For this reason I suggested for them the name »*praependopodal*» shields, while the old name *jugular* shields was reserved for the other shields.

Beside the four pairs of hairs the sternal shields are characterized by three pairs of generally large, slit-shaped pores¹, one pair close to the first sternal hair, the second one between the 2nd and 3rd sternal hair and the last one on the metasternal shield, provided these are well developed (fig. 1). If the pores were metamericly arranged there would be four pairs of them, and I believe it would be worth while to look more systematically for them. Thus I have found them in the genus *Eviphis* (fig. 5) where they are plainly visible although the metasternal shield is very small and fused with the corresponding endopodal shield. Probably there is one pore between each pair of hairs, which would be equal to 3 pairs. At least in the males where, the conditions being more simple, it is easier to see the pores, there are 3 pairs of pores, situated between the hairs (comp. Trägårdh 1936 fig. 9).



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Fig. 5. Part of ventral side of *Eviphis ostrivus* (K) ♀. Metasternal shield very small, fused with endopodal shield, but recognizable by the pore and the hair. h 2—h 4, hairs 2—4. p 2—p 3, pores 2—3.

Zercon, Epicrosejus and Polyaspis.

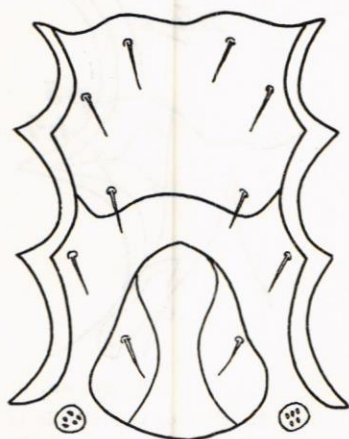
The confusion prevailing in the present classification of the *Mesostigmata* is, as pointed out earlier, due to the fact that greater importance has been attached to a general similarity in shape than to the similarity of such fundamental features as the shape and position of the ventral shields of the females, as it is revealed through an examination of the sternal hairs. There is, indeed, no better illustration of this confusion than the fact that the three genera *Zercon*, *Epicrosejus* and *Polyaspis* have been placed in the same family although there cannot be the slightest doubt about that they belong to three different families.

In *Zercon* (*Asca*) (fig. 6) the sternal shield is of the type found in *Macrocheles* (fig. 2) with 3 pairs of hairs. The metasternal shield

¹ These pores correspond probably for the »lyriform organs» of other arachnida, which have f. i. been recorded by Grandjean in the Oribatidae.

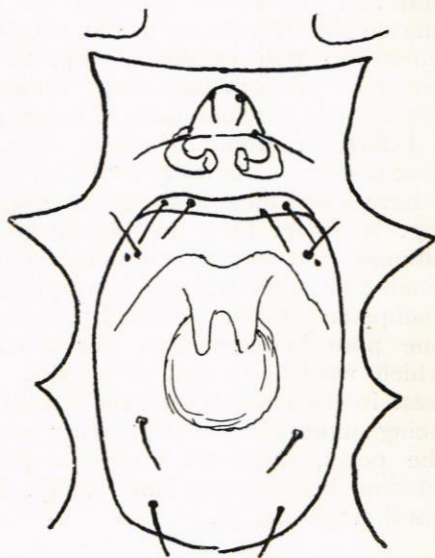
is very poorly developed but the 4th sternal hair is present in the same place as in *Macrocheles*. The epigynial shield is hinged to the anterior edge of the great ventri-anal shields and has one pair of hairs.

The genus *Epicrosejus* (fig. 7), on the other hand, of which I have examined one species from the museum of Honolulu, is most closely related to the genus *Sejus*. Its sternal shield has only two



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Fig. 6. Ventral side of *Zercon curiosus* Tgdh. The metasternal shield is rudimentary its place being indicated by hair 4.



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Fig. 7. *Epicrosejus* sp. ♀. Sternal and ventri-anal shields ♀.

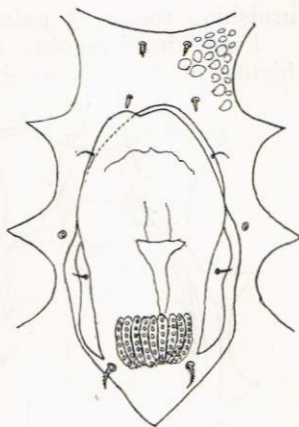
pairs of hairs, the anterior one of which is inserted on a median, triangular thickening of the cuticle, embracing the basis of the tritosternum; the 2nd pair is inserted on a pair of small shields which have a button-shaped projection directed towards the middle. Behind this shield there is a narrow, crescent-shaped shield having the remaining two pairs of hairs, the shield forming the anterior lip of the transverse genital aperture. This shield, which I interpret as the fused 3rd and 4th coxal plates, is a very singular feature which *Epicrosejus* shares only with the genus *Sejus* (fig. 9).

The geniti-ventral shield is of the shape typical in *Sejus* but is less simple, its antero-lateral angles being set off by two very narrow, oblique ridges, which do not, however, extend to the an-

terior margin of the shield but bend backwards in a V-shaped curve and unite. The shield has 3 pairs of hairs and near the antero-lateral angles one pair of pores. It is possible that these lines foreshadow the splitting up of the geniti-ventral shield into 3 shields which is a common feature in other tropical genera.

The genus *Epicrosejus* has no place in the *Ascaidae* but must be placed in the *Sejidae*, being fairly closely related in the genus *Sejus* K.

The genus *Polyaspis* Berlese (fig. 8) hitherto referred to the same family, the *Ascaidae*, has no affinity either to *Zercon* or to *Epicrosejus*. It has fundamentally the same characters as *Trachytes* (fig. 12), although in different proportions. Thus the tritosternum has exactly the same, very peculiar shape, the trunk being very short and broad. The sternal shield is deeply excavated to receive the very long and narrow epigynial shield which has neither hairs nor pores and is flanked in the posterior half by the very narrow metasternal shields which are placed extraordinarily far back but are easily recognized by their hair. Consequently this genus finds no place in the *Ascaidae* but is most closely related to *Trachytes* Mich.



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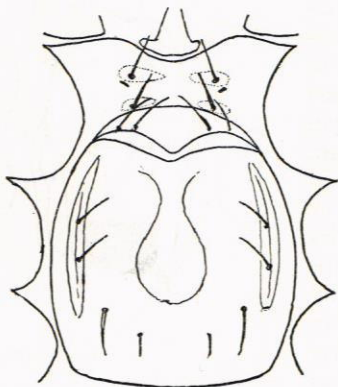
Fig. 8. *Polyaspis* sp. ♀. Sternal, metasternal and epigynial shield.

Sejus and Epicrius.

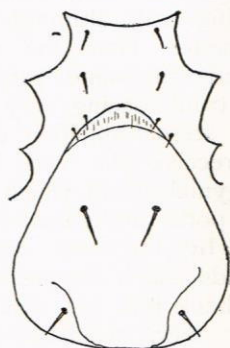
In *Sejus* (fig. 9) the sternal shield is of a very peculiar shape, being divided into two pairs of small, oval shields each bearing one pair of hairs. These two shields obviously correspond to the two first pairs of coxal shields, as I have previously suggested (1912, p. 19). The epigynial shield is very large, covering almost the entire space between coxae III and IV. It is not fused with the corresponding endopodal shields, from which it is separated by a narrow strip of soft cuticle. The anterior edge is concave and forms the posterior lip of the genital aperture, the anterior lip being formed by a very peculiar, transverse, crescent-shaped shield which bears two pairs of hairs. If the assumption be true that the hairs of the sternal shields through their position indicate the presence of the coxal plate of the leg-bearing IV—VI segments, then this insignificant shield must be interpreted as consisting of the fused 3rd and 4th coxal plates as in *Epicrosejus*.

The epigynial shield of *Sejus* must be interpreted as a coalesced genital and ventral shield or rather a ventral shield where there is not yet developed any genital shield, in spite of the fact that it is placed far forward between the coxae. This interpretation is supported by the fact that this shield has 3—4 pairs of hairs. This feature is, as a matter of fact, unique amongst the European *Gamasides*, but is easily explained by the assumption of a fused genital and ventral shield or part of ventral shield, the latter shield furnishing the 2—3 pairs of hairs.

From the foregoing it is evident that the shape of the ventral shields of *Sejus* is so singular that it represents a type quite dif-



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Fig. 9. *Sejus togatus* K. ♀. Sternal and geniti-ventral shield.

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Fig. 10. *Epicrius geometricus* ♀. Sternal and geniti-ventral shield.

ferent from both the *Gamasides* and the *Uropodina*. This genus is also in other respects, as pointed out by me long ago (op. c. p. 22—23) a very primitive genus. Its systematic position will be discussed further on.

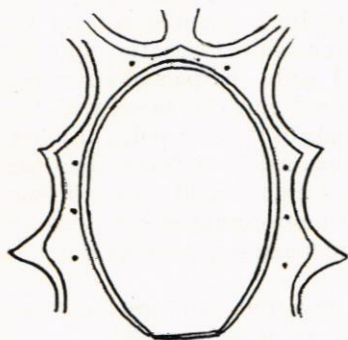
The genus *Epicrius* is by v. Vitzthum referred to the *Sejidae* of the subcohors *Sejina*. An examination of the female of *Epicrius geometricus* from Sweden has revealed the following features (fig. 10). The number and position of the sternal hairs is the same as in *Sejus*, only all the hairs and especially hairs III and IV being much smaller and the latter not being inserted on any crescent-shaped transverse shield, as in *Sejus* and *Epicrosejus*.

The geniti-ventral shield has a free margin only at the top, the other edges being so indistinct that even with the aid of oil immersion it is difficult to trace them. This proves that in *Epicrius* the genital aperture is a transverse fissure, as in *Sejus* and *Epicrosejus*. Most significant is the presence of two pairs of hairs.

on the geniti-ventral shield. We have thus 4 pairs of hairs in *Sejus*, 3 pairs in *Epicrosejus* and 2 in *Epicrius*, corresponding to the different portions of the ventral shield which have coalesced with the genital shield.

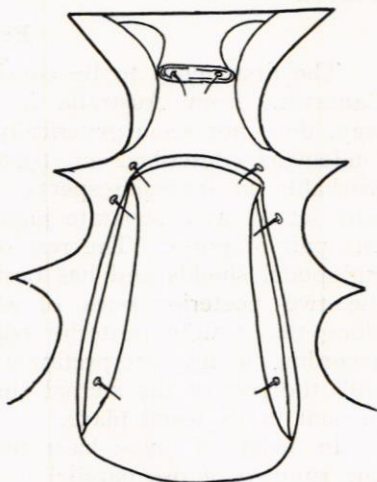
Trachytes.

The next genus which does not fit in the present classification is *Trachytes*. It is now placed amongst the *Uropodina*, but as already pointed out this group is characterized by the feature that



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Fig. 11. *Urobonella bicarinata* Tgdh. Sterniti-metasternal and epigynial shield.



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Fig. 12. *Trachytes aegrota* K. var. *inermis* Tgdh. ♀. Sternal-metasternal and epigynial shield.

there are no distinct metasternal shields, these being fused both with the sternal and the ventral shield, forming a narrow rim round the large, epigynial shield, as is indicated by the presence of the usual 4 pairs of hairs, which precludes the possibility of any metasternal shields being concealed beneath the epigynial shield (fig. 11). The epigynial shield itself has no hairs, while in the *Gamasides* it has generally one pair of hairs (figs. 1—5). This means that the epigynial shield of the *Uropodidae* is not homologous with that of the *Gamasides*, not being fused with any hair-bearing shield, as in the *Gamasides*.

In such an homogeneous group as the *Uropodidae*, characterized by the absence of any distinct metasternal shields, there is obviously no place for the genus *Trachytes* in which I already in 1910 demonstrated the presence of a pair of distinct, very elongate meta-

sternal shields (1910, fig. 10). On the other hand, the absence of hairs on the epigynial shield is a character shared with the *Uropodidae*.

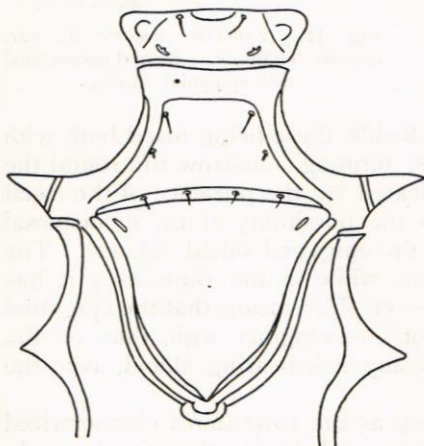
Another family the present systematic position of which is wrong is the *Celaenopsidae*, which is now placed in the subcohors *Gamasina*, but is altogether too aberrant to be placed in any of the now existing groups. Before I make an attempt to interpret the ventral shields of this group it will be necessary to examine some tropical genera.

Fedrizzia.

The first genus to be considered is *Fedrizzia*, described by G. Canestrini from Australia in 1884. This genus (which, by the way, does not seem generically different from the genus *Toxopeusia* Oudemans, described in 1928 from the Buru Islands) is very remarkable in several respects. The sternal shield has the anterior part set off as a separate jugular shield with one pair of hairs and one pair of pores. The rest of the sternal shield is fused with the endopodal shields and has beside one pair of pores 3 pairs of hairs, the two posterior ones of which are placed in a transverse line along the straight posterior edge of the sternal shield. This proves according to my interpretation that the metasternal shield is fused with the rest of the sternal shield. The posterior pair of pores is present in its usual place.

In front of these hairs there is a very fine but quite distinct line running across parallel to the posterior margin of the sterniti-metasternal shield. This line seems rather significant, because if we assume that this line indicates the place of a fusion between two shields, we recognize without difficulty in the very narrow, transverse shield the crescent-shaped shield of *Sejus* and *Epicrosejus*, which also has two pairs of hairs placed in a transverse row, exactly as in *Fedrizzia*.

The most remarkable feature is, however, a large shield shaped in outline almost like a cup with perfectly straight anterior edge, adjacent to the posterior margin of the sterniti-metasternal shield and distinctly



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Fig. 13. *Fedrizzia* sp. ♀. Jugular, sterniti-metasternal, median and lateral shields.

set off at the sides from the endopodal shields. It has no hairs but a pair of very conspicuous pores in the antero-lateral angles.

To an acaridologist, who is most familiar with the European forms, it is a very peculiar shield, indeed, like nothing more than the epigynial shield of the *Uropodina* turned round 180°. It is attached to the posterior edge of the sterniti-metasternal shield, the other edges being free.

It is evident that this shield, although it occupies the same position as the epigynial shield behind the sterniti-metasternal shield, is not homologous with it but is altogether a different structure already for the reason that it is situated in front of the genital aperture.

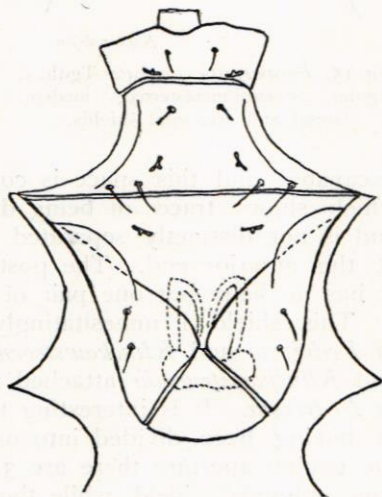
If we examine some other tropical acarina the median shield, as I am going to call it, loses, however, much of its strangeness. And this investigation will also enable us to understand the features even of the *Celaenopsidae* and the *Antennophoridae* which do not fit at all in the picture of the *Mesostigmata* as conceived hitherto.

Klinckowstroemia Tgdh.

The new genus *Klinckowstroemia* Tgdh from Surinam resembles *Fedrizzia* in the division of the sternal shield. The jugular shield is very large and has the usual hair and pore. The rest of the shield has 3 pairs of hairs and one pair of pores, exactly as in *Fedrizzia*, from which I conclude that it is a sterniti-metasternal shield. But instead of the single shield which one detects at first behind the sternal shield in *Fedrizzia* there are not less than four shields in *Klinckowstroemia*. The median one of these is evidently homologous with the median shield of *Fedrizzia* on account of its exactly similar position and the presence of the conspicuous, slit-shaped pores. The posterior shield is undoubtedly the epigynial shield.

But the lateral shields, the edges of which in the anterior half project a little and overlap the edges of the median shield and have 2 pairs of hairs, how are they to be interpreted?

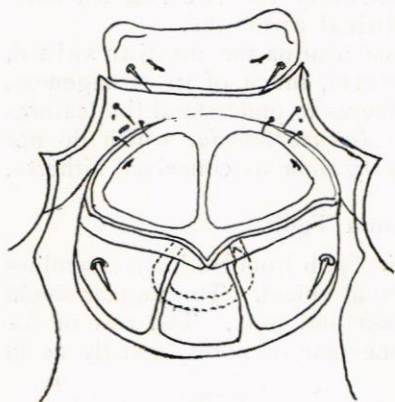
I may add that at first I failed to notice these three shields in



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Fig. 14. *Klinckowstroemia* nov. gen. ♀. Jugular, sterniti-metasternal, median, lateral and epigynial shields.

Fedrizzia and it was only after the examination of *Klinckowstroemia* had revealed their presence in that genus that I began looking for them in *Fedrizzia* and allied forms of which I have quite a few, as yet undescribed. The reexamination of several species left no doubt that they are present also in this genus, although highly modified. In some species the lateral shields are only visible as almost linear shields running along the lateral edges of the median shield, whereas the posterior, epigynial shield is to be found in various degrees of reduction behind the median shield.



Auctor delin.

Fig. 15. *Paramegistus confrater* Tgdh. ♀. Jugular, sterniti-metasternal, median, lateral and epigynial shields.

Paramegistus Tgdh.

In order to interpret these structures I have resorted to the reexamination of the myriopodophilous *Antennophoridae Paramegistus confrater* Tgdh (described by me from South Africa in 1907) after having it macerated and made transparent with lactic acid. We notice that there is a distinctly separate jugular shield with one pair of hairs and one pair of pores. The sternal shield is fused with the metasternal shield and with the corresponding endopodal shields and has 3 pairs of hairs beside not less than 2 pairs of pores. The posterior margin of the sterniti-metasternal shield is deeply

excavated and this space is covered by a big, semicircular shield which shows traces of being divided into a left and a right half and is not distinctly separated from the sterniti-metasternal shield at the anterior end. The posterior margin has a median mucro. It has no hairs but one pair of lateral pores.

This shield I unhesitatingly identify with the *median shield* of *Fedrizzia* and *Klinckowstroemia*, and it is both in *Paramegistus* and *Klinckowstroemia* attached along the anterior edge exactly as in *Fedrizzia*. It is interesting that the median shield shows traces of having been divided into one left and one right half. Behind the genital aperture there are 3 shields, the median one being the true epigynial shield, while the other two are homologous to the lateral shields of *Klinckowstroemia*.

Cercomegistus.

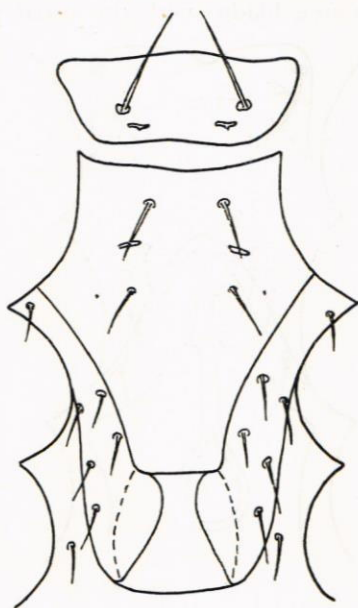
In the genus *Cercomegistus* Berlese (fig. 16) we find a blending of the features of the genera *Paramegistus* and *Klinckowstroemia*. The jugular shield is very large, distinctly separated from the rest of the sternal shield and has the usual pair of hairs and pores. The sternal shield is fused both with the metasternal shield and with the median shield. In the anterior half of this large shield we find the usual 3 pairs of hairs in their usual places, only the exterior hair in the posterior row is so exceedingly small that it might easily have been overlooked, but for the fact that there is a pair of hairs in this place in the other genera.

The median shield is completely fused with the sterniti-metasternal shield, only faint traces of the fusion being seen as a transverse line running across on a level with the angles between coxae II and III. If there are any pores, of which I am not sure, they are very difficult to detect, being so close to the lateral margin that they are concealed underneath the overlapping edges of the lateral shields.

The lateral shields and the posterior one, the epigynial shield, resemble very much those of *Klinckowstroemia* and are without the slightest doubt homologous with them.

Cercomegistus is by Berlese (1914, p. 145) placed in the *Megisthanidae* with which it has nothing to do, as will be patent through the following discourse.

I have now endeavoured to offer evidence that the large, median, posternal shield which is such a conspicuous feature in the genera *Fedrizzia*, *Klinckowstroemia*, *Paramegistus* and *Cercomegistus* has nothing to do with the epigynial shield, because it is always situated in front of the genital aperture. It is indeed strange that such a shield does not exist in the *Gamasides* nor in the *Uropodina*. Is it a new departure in the tropical genera mentioned above, or does it exist in the European genera although it is poorly developed



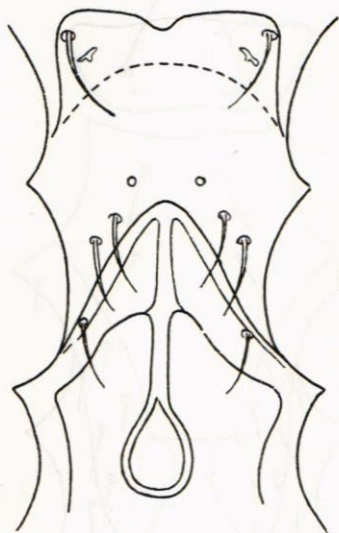
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Fig. 16. *Cercomegistus* sp. ♀. Jugular shield, sterniti-metasternal shield fused with median shield, lateral and epigynial shields.

and perhaps concealed by other shields? Before endeavouring to answer this question it is best to study the different ways in which the median shield may be modified on some other tropical genera, *Euzercon*, *Neo-Oudemansia* and *Syngynaspis*.

Euzercon.

Euzercon has the anterior edge of the sternal shield shaped as a free blade, with the usual pair of hairs and pores, but it is not distinctly separated from the rest of the shield.



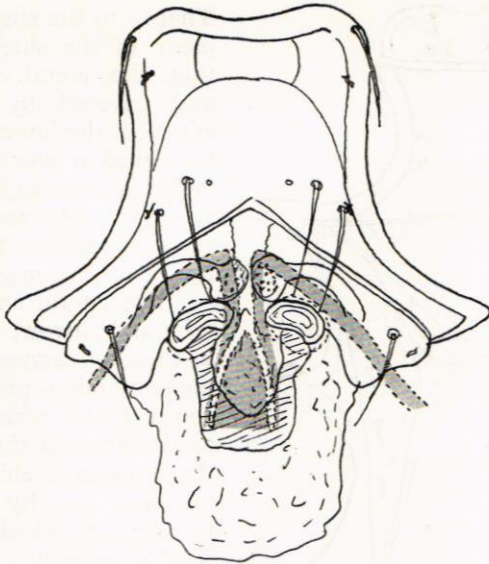
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Fig. 17. *Euzercon* sp. ♀. Sternal, metasternal, lateral and epigynial shield.

The remaining part of the sternal shield has the posterior margin deeply concave and along this margin are placed one pair of circular pores and two pairs of hairs; close to the lateral hair there is another pore of the typical shape (fig. 17). From this I conclude that the metasternal shields are not fused with the sternal shield; and, as a matter of fact, there is a pair of very well developed, triangular metasternal shields which are fused in the middle and have one pair of hairs and one pair of pores. This is a most unusual feature which we have not met in the tropical genera so far examined.

But the shape of the posterior shields very vividly recalls the features known from *Klinckowstroemia* a. o. viz. a pair of lateral shields and one median, the epigynial shield. The lateral shields widen, however, so much in the anterior half that they meet in the middle for some distance, where their edges are strongly chitinized. In this way they foreshadow the development of the lateral shields of the the genus *Celaenopsis* and allied genera. In *Euzercon* we find no median shield and must conclude that it is hidden beneath the lateral shields.

In order to investigate more closely the structures hidden by the lateral and the epigynial shields I dissected another species of *Euzercon* and removed the last mentioned parts (fig. 18). We notice that the paragynial shields are well developed, widening gradually backwards and wholly coalesced at the median ends. We further notice that their surface is thickened to a narrow ridge, curved almost like the upper lobe of a human ear, the median end of the ridge widening like a pestle.



Auctor delin.

Fig. 18. *Enzercon* sp. Sternal and metasternal shields and vaginal structures seen when the epigynal and lateral shields have been removed. Their outlines are, however, delineated.

The wall behind the paragnathal shields has a peculiar structure consisting of a pair of narrow, dark-coloured bars united at the base and widening to two swollen, kidney-shaped knobs. The lateral shields are excavated on the ventral side above these knobs in order to leave room for them when the epigynal shield is shut.

Neo-Oudemansia.

The new genus *Neo-Oudemansia* called so in honour of the venerable nestor amongst the European acaridologists dr. A. C. Oudemans Arnhem, Holland, was discovered in a collection of acari entrusted to me by Professor G. H. Carpenter Oxford, long after I had investigated its two closest relatives *Klinckowstroemia* and *Cercomegistus*. The new genus fits in beautifully between these genera (fig. 19).

During the preparation the shields were separated a little which was rather advantageous, enabling me to see their outlines better. We notice that the jugular shield is well developed, with its hairs and pores. The metasternal shield is fused with the sternal shield, as is evidenced by the hairs. The median shield is well developed and of the shape known from *Fedrizzia* and *Klinckowstroemia*.

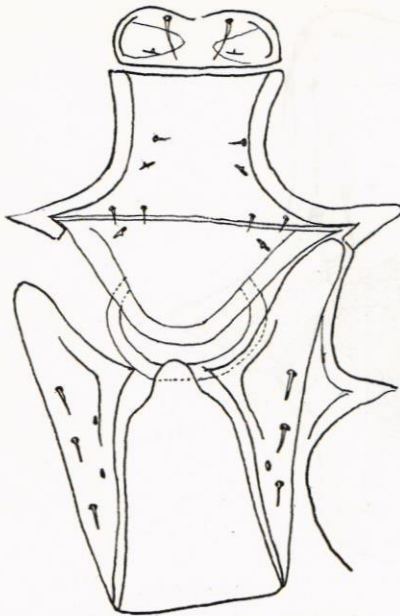


Fig. 19. Jugular, sterniti-metasternal, median, lateral and epigynial shield of *Neo-Oudemansia* ♀.

Thanks to the slight disarrangement of the shields we notice that the lateral edges are thin and covered by the adjacent edges of the lateral shields. To the median shield there is attached a peculiar, handle-shaped, strongly chitinized piece which vividly recalls the structure found in *Paramegistus* (fig. 15).

The lateral shields are very long and narrow, shaped almost as those of *Cercomegistus*. Their median edge projects into a sharp tooth which fits in the angle between the median and the epigynial shield. Fortune favoured me by enabling me to see in which way these shields opened. The specimen being quite dry its interior was filled by air which even the heating in lactic acid failed to expel entirely. The only way to remove the remaining air, which made the mite obscure,

was to press its belly with the blunt back of a dissecting knife. The air bubbles then escaped through the genital aperture and during the passage of the air through this opening both the lateral shields and the epigynial shield opened like trap-doors, the median shield remaining immovable thus acting in exactly the way one assumed them to do according to their shape and structure.

Beside the handle-shaped structure mentioned above the walls of the vagina have other, much more complicated structures. It is, however, impossible to describe or understand these until a detailed study of these parts has been made in many other genera.

Syngynaspis Tgdh.

In the next genus, *Syngynaspis*, the ventral shields are developed quite differently (fig. 20). There is one pair of jugular shields, each with one hair and one pore. The metasternal shields are, according to the evidence of the hairs, fused with the sternal shield; but the three pairs of hairs and the pore have a very peculiar position being all arranged along the slightly concave posterior margin of

the sterniti-metasternal shield. Behind this edge there is a narrow strip of weakly chitinized cuticle and on this we notice very plainly the characteristic, slit-shaped pore which is such a distinct feature of the median shield of *Fedrizzia*, *Klinckowstroemia* a. o. This narrow strip then is possibly the only visible remnant of the so highly developed median shield of these genera.

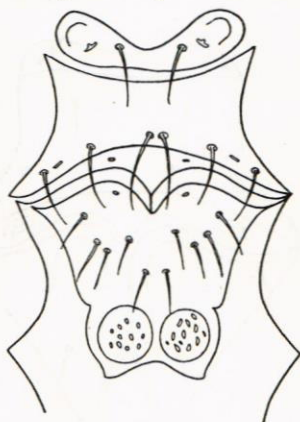
There is no median, epigynial shield, the space between coxae III being occupied by a single shield which, to judge from the median incision in the anterior margin, is composed by two lateral shields fused together. This shield, in outline cup-shaped, is continued backwards by a irregular band of dark chitin. The shield has not less than 8 pairs of strong bristles. Near the base of the cup there is a pair of almost circular, slightly convex discs with numerous pores, which are presumably homologous with the so-called *inguinal* shields found in some genera (comp. fig. 6).

Between the sternal shield and the anterior margin of the shield composed by the fused lateral shields there is a pair of narrow, strongly chitinized shields, bent backwards in the middle which on closer examination prove to be pickaxe-shaped structures the handles of which extend backwards underneath the lateral shields while their anterior free edges act as extra margins to the lateral shields. So far I have failed to discover any similar structures in the genera examined by me. In *Eviphis* (fig. 5) there is, however, a pair of somewhat similar sclerites placed far backwards between the epigynial shield and coxae IV and in *Eusercon* there are similar structures (fig. 18).

Very remarkable is the absence of a true, external epigynial shield. Because the presence of a median incision at the top of the posterior shield and the 8 pairs of hairs seems to indicate that it corresponds to the lateral shields of *Klinckowstroemia* and *Cercomegistus* which are derived from the ventral shield.

Celaenopsis.

Finally, in the genus *Celaenopsis* and allied genera we find a different type of ventral shields which it would be difficult to inter-



Auctor delin.

Fig. 20. *Syngynaspis* nov. gen. ♀. Jugular shield, sterniti-metasternal shield, and fused lateral shields. Epigynial shield not visible of the median shield only a narrow strip with the pores.

pret, unless we were acquainted with the shape of the genera described above.

The sternal shield has sometimes the anterior part divided from the rest and developed as jugular shields with one hair and one pore, sometimes not. This seems to prove that these division is of a secondary, adaptive nature and is not primitive. The metasternal shields are not fused with the sternal shield, which, as a consequence, has only two pairs of hairs beside the one pair of pores. The genital aperture is covered by two large shields which meet

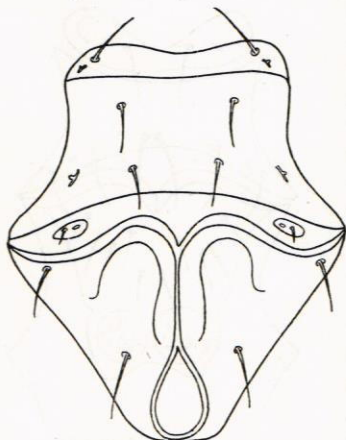


Fig. 21. *Calaenopsis* sp. ♀. Jugular, sternal, lateral and epigynal shields. The metasternal shields are very small.

in the middle where they are generally contiguous except at the posterior end where there is a median epigynal shield, very differently developed in the different species. These two shields undoubtedly correspond to the lateral shields of *Klinckowstroemia*, *Cercomegistus* a. o. In the species examined by me they have only two pairs of very distinct hairs.

The anterior margin of these shields is generally in the middle contiguous with the posterior margin of the sternal shield. Further laterally the margin is slightly concave and here we notice a pair of very small but distinct shields which bear one pair of hairs and one of pores. In these we recognize the metasternal hair and the pore of the median shield and this feature seems to me so significant that I interpret these small shields as remnants of a fused metasternal and median shield.

The objection may of course be raised that the pore may just as well be the metasternal pore, which is present in many genera as f. i. *Pergamasus*, *Eviphis* a. o. But, on the other hand, whenever the metasternal shield is free, viz. not fused with either the sternal or the endopodal shield and is of insignificant size as f. i. in *Macrocheles* then there is no pore. Hence the assumption may be advanced that when on this small shield there is both a hair and a pore the latter originates from the median shield.

Moreover, in *Syngynaspis* (fig. 20) we found a pair of pores between the posterior edge of the sterniti-metasternal shield and the fused lateral shields, which can hardly be anything else than the pores of the median shield, the metasternal shield in this genus being fused with the sternal shield.

At all events the genital shields of *Celaenopsis* and allied genera are build on a pattern so utterly different from that of the *Gamasides* and the *Uropodina* that the family must be referred to a distinct cohorts.

Megisthanus.

Further there remains to be considered the great tropical genus *Megisthanus* Thorell (fig. 22) which by *Berlese* was classed amongst the *Celaenopsidae* as a distinct subfamily, the *Megisthaninae*, but is placed amongst the *Antennophoridae* by *Vitzthum* (1931).

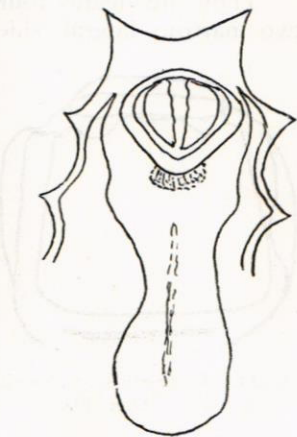
The ventral shields of this genus differ from all the genera hitherto investigated and do not show any closer affinity to any of them. The sternal shield is very short, although it seems to be fused with the metasternal shields to judge from the presence of four pairs of hairs on it. Behind this shield there is a large aperture closed by two semicircular shields fused in the middle and carrying 4 pairs of hairs and one pair of pores. These shields are surrounded by a horseshoe-shaped, strongly chitinized shield or thickening which is the anterior edge of the long ventri-anal shield.

These shields I unhesitatingly interpret as the lateral shields present in *Cercomegistus* and *Klinckowstroemia* because they have 4 pairs of hairs; although derived from the ventral shield the lateral shields are often distinctly separated from it, as we have seen in *Klinckowstroemia* (fig. 14), *Paramegistus* (fig. 15) and *Cercomegistus* (fig. 16). It is therefore not strange that they are detached in *Megisthanus*, but it is strange that they have entirely usurped the function of both the median and the epigynial shields.

Of the median shield and the epigynial shield there does not seem to be any traces. Altogether *Megisthanus* is too differently build to be included amongst the *Celaenopsidae*, still less amongst the *Antennophoridae*. The most logical thing to do would be to raise it to the dignity of a cohorts, but provisionally I treat it as a family.

Holothyryus.

Finally there is the genus *Holothyryus* left, generally considered as a distinct suborder *Holothyroidea* Reuter on account of the four



Auctor delin.
Fig. 22. *Megisthanus* sp. ♀.
Sternal and ventral shields.

prosomatic stigmata, and embracing the largest Mesostigmata yet known and restricted apparently to S. E. Asia. I have not been able to examine any material of this group and must base my opinion on Thon's paper (1906), which is unfortunate because Thon was a specialist on Hydrachinds and his paper on the *Holothyridae* seems to be his only paper on other acarina. Hence, although his paper is excellent in many respects, he does not give us all the details necessary to the interpretation of the ventral shields.

Thon delineates four shields (fig. 23), one large posterior one, two narrow lateral shields and one anterior narrow, transverse shield. It seems to me that these shields probably correspond to the epigynial shield, the lateral shields and the median shield known from the review I have given. The metasternal shields are presumably fused with the sternal shield, although it is impossible to be sure, no hairs or pores being delineated or mentioned.



Fig. 23. *Holothyridae* sp. ♀. Genital shields. (After Thon.)

If we disregard the other features of the *Holothyridae* we may say that in the light of the present investigation this group does not appear to be quite as isolated as was formerly believed, or

shall we rather say that it shares its isolated position with quite a few other tropical genera.

One observation made by Thon (l. c. p. 707) is very suggestive. He noticed that in one female an egg was half-way through the genital aperture and in so doing had opened all the four genital shields which were movable in a manner similar to that of trap-doors. In *Neo-Oudemansia* I was able to see the lateral and epigynial shields move in the same way, the median shield remaining immovable. The same applied doubtless to *Klinckowstroemia* and *Cercomegistus*. This is a method fundamentally different from the method used in the *Gamasides* and the *Uropodina* where there is only one trap-door the epigynium, which opens the other shields bordering on the genital aperture being immovable or almost immovable.

2. The median and lateral shields.

When contemplating the facts brought to light by the present investigation the most bewildering structure is without doubt the median shield which is such a conspicuous feature of *Fedrizzia*,

Neo-Oudemansia, *Klinckowstroemia* and the *Antennophoridae*. Does this shield exist in the other groups, although in such a state of modification that it has escaped detection; has it altogether disappeared or has it never existed?

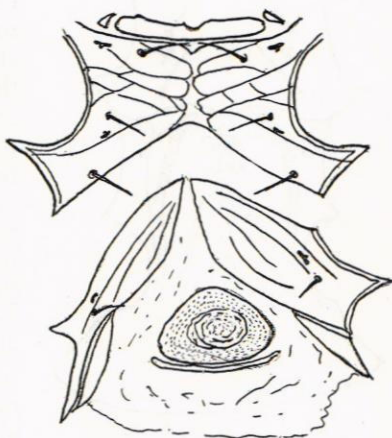
In my opinion the answer to these questions is quite simple. In those genera, where the anterior edge of the epigynial shield does not project as far as to the posterior margin of the sterni-metasternal shield or to the metasternal shield, there is in front of the genital aperture an area of very thin, structureless chitin which continues backwards into the dorsal wall of the vagina. This area corresponds in its position exactly to the median shield and it is only the absence of any distinguishing features which has prevented the acaridologists from taking any notice of it. We notice this thin shield in *Macrocheles* (fig. 2), in *Gamasellus* (fig. 3) and in *Zercon* (fig. 4). But in other genera, where the epigynial shield is so large that its edges are contiguous either with the metasternal shields, as in *Pergamasus* (fig. 30), or with the fused sterni-metasternal shield, as in *Urobovella* (fig. 11), we must expect the median shield to be concealed underneath the epigynial shield.

In order to reveal its existence it is necessary to make a special preparation by treating the mite with lactic acid, separating the ventral from the dorsal surface and finally, after having stained it, by removing the epigynial shield very carefully in order not to injure any parts covered by it.

Ologamasus.

For this purpose I choose the female of *Ologamasus pollicipatus* which seemed well suited, because its sternal shield has some presumably primitive features (fig. 24) which rendered it likely that the genus would also reveal other primitive features.

We notice that the sculpture of the sternal shield shows two very fine ridges exactly in the place where the coxal plates II and III are fused, and, furthermore, there is a median, longitudinal strip of soft cuticle in the place where the coxal plates meet. The metasternal shields are well developed and behind them the cuticle is very



Auctor delin.

Fig. 24. Sternal, metasternal and median shield of *Ologamasus pollicipatus* ♀. Epigynial shield removed.

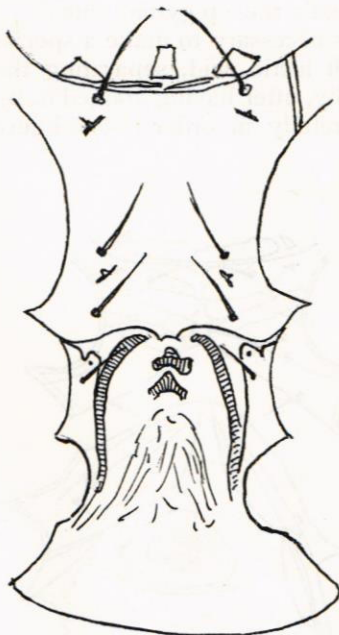
thin but has a distinct median shield. This shield can hardly be anything else than the median shield of *Fedrizzia* and *Klinckowstroemia*, and it is very gratifying to behold in *Ologamasus*, which in many other respects is a typical *Gamaside*, the great and conspicuous median shield of the genera mentioned above, albeit in a reduced state.

We notice also in *Ologamasus* that along the postero-lateral edges of the metasternal shields there is a small, more or less triangular shield acting as a rim to the posterior part of the metasternal shields. These shields I propose to call the *parasternal shields*. My first idea was that these shields which occur f. i. in *Pergamasus* (fig. 28) possibly were the highly modified remnants of the median shield, which in some *Antennophoridae* shows traces of being divided into two shields. But the fortunate finding of the median shield in *Ologamasus*, where the parasternal shields also are present, proved that this interpretation probably is wrong.

Veigaia.

Looking for other genera amongst the *Gamasides* beside *Ologamasus* which have traces left of the median shield it seemed to me that the genus *Veigaia* might fulfill my expectations in this respect. In a recent paper C. Willmann (1936) has pointed out that the anterior part of the epigynial shield is shaped as an exceedingly thin and transparent lamina, pointed anteriorly and with serrate edges, and often projecting as far forwards as to the middle of coxa II.

I have found the same lamina, which is indeed so exceedingly transparent that it is easy to understand that it has hitherto escaped the attention of even the most keen-eyed acaridologists. But even this important addition to our knowledge of the female ventral shields of *Veigaia* has left undiscovered some other details which are indeed so strange that it is evident that the genus occupies a very isolated position

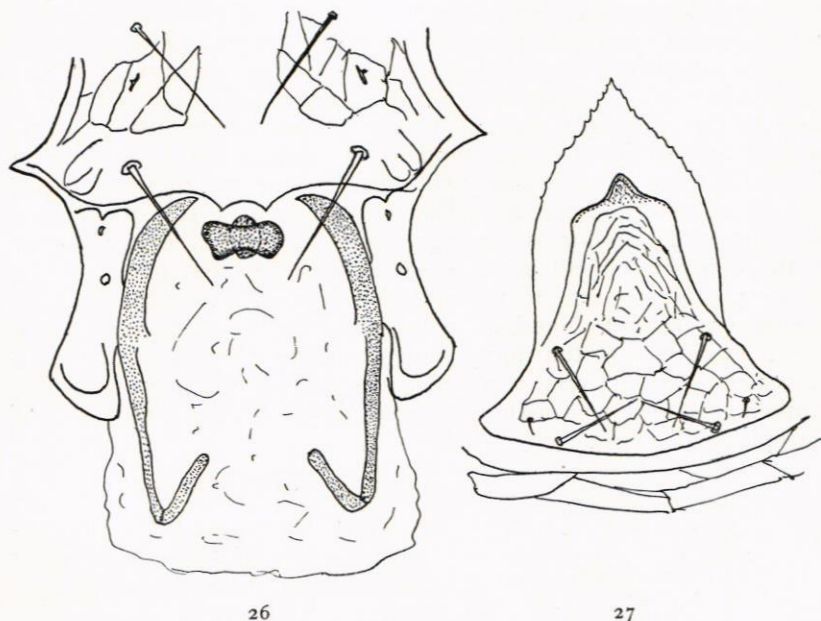


Auctor delin.

Fig. 25. *Veigaia* sp. ♀. Praeendopodal, sternal, metasternal and epigynial shields.

amongst the *Gamasides*, isolated enough to justify the establishing of a separate family.

If one looks at the ventral side of a *Veigaia*, even one made transparent in the usual way, it is not possible to discern plainly all the details of the shields forming the genital aperture. The picture one sees is delineated in fig. 25. Apparently in the anterior part of the epigynial shield one sees two dark-coloured sclerites,



Auctor delin.

Fig. 26. Posterior part of sternal shield, metasternal and median shield and dorsal side of vagina. — Fig. 27. Epigynial shield.

one behind the other, and the edge of the shield seems to be thickened, forming narrow, sickle-shaped pieces.

If, however, we separate the epigynial shield from the rest so carefully that no structures are distorted we notice that these structures are far more complicated than what appears on first view. The posterior of the two dark-coloured pieces proves to be the anterior top of the non-hyalin part of the epigynial shield, the hyalin rim of which is now very easy to see (fig. 27). But the anterior, button-shaped piece as well as the two sickle-shaped lateral pieces do not belong to the epigynial shield at all, but are thickenings of the dorsal wall of the vagina (fig. 26). Consequently

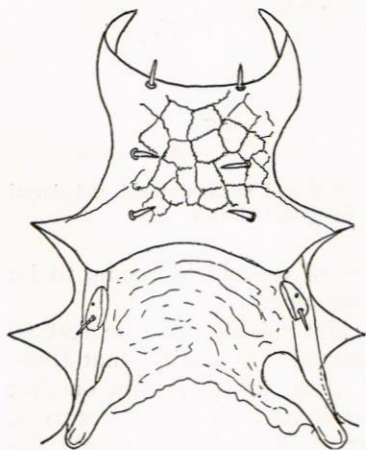
these sclerites are specialised structures of the median shield just as the rounded shield of *Ologamasus*!

In the genus *Gamasellus*, generally considered closely related to *Veigaia*, there are no such structures. Thus once more the minute examination of the female ventral shields has revealed unexpected features which must be taken into consideration, if a natural system is to be achieved.

In this instance only the lateral edges of the median shield are strongly chitinized, evidently for the purpose of forming the edges of the genital aperture. The function of the button-shaped structure which is supported on a short stalk is rather obscure, until the dorsal side of the epigynial shield is examined. It is placed so close to the posterior margin of the sternal shield, which is excavated in order to leave room for it, and at the same time so closely in front of the strongly chitinized top of the epigynial shield, that it seems to form a mechanism which acts as a lock when the epigynial trap-door is closed. Since, however, the hyalin part of the epigynial shield projects so far forwards that it covers the whole posterior part of the sternal shield, it is evident that the mechanism cannot function, unless the tooth of the epigynial shield projects on the upper, inner surface of the shield. As a matter of fact it was very easy to prove this by dissecting another specimen and making a preparation of the dorsal side of the epigynial shield.

Macrocheles.

The lateral edges of the epigynial shield of *Macrocheles* cover two oblique, bar-shaped sclerites (fig. 2, p 126). It is, however, not possible to see their relation to the epigynial shield unless the latter is removed. In fig. 28 such a preparation is delineated. We notice that the dorsal wall of the vagina of *Macrocheles* resembles that of *Veigaia* (fig. 26) in some respects. Thus the lateral edges are thickened in both, forming a kind of frame, between which the hyalin cuticle is stretched. To the posterior end of these thickened edges a pair of narrow, short bars are hinged; these widen anteriorly and evidently serve to



Auctor delin.

Fig. 28. *Macrocheles* sp. Sternal and metasternal shield and dorsal wall of vagina.

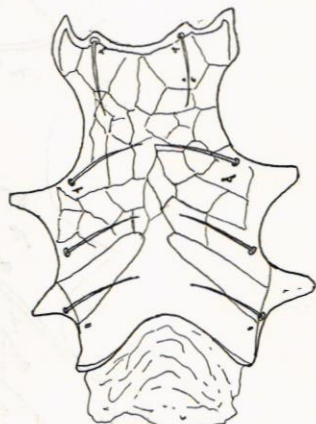
strengthen the attachment of the epigynial shield, at the same time forming a kind of articulation.

The metasternal shields are very small, oval but have both the hair and the pore.

This investigation shows how necessary it is to examine the parts concealed by the epigynial shield, if we wish to elucidate the relationship between the different genera. It is obvious that *Veigaia* and *Macrocheles* are closely related.

Pachylaelaps.

Finally I have investigated a genus where the metasternal shields are fused with the sternal shield (fig. 29). The surface structure reveals the fact that, just as in *Ologamasus* (fig. 24) some elevated lines seem to indicate the outlines of the sternal shield III, similar lines in *Pachylaelaps* seem to indicate the outlines of the metasternal shields. If this assumption is valid, the part of the sternal shield behind the metasternal shields which is devoid of any surface structure may be interpreted as the median shield. Further investigations are necessary to settle this question.



Auctor delin.

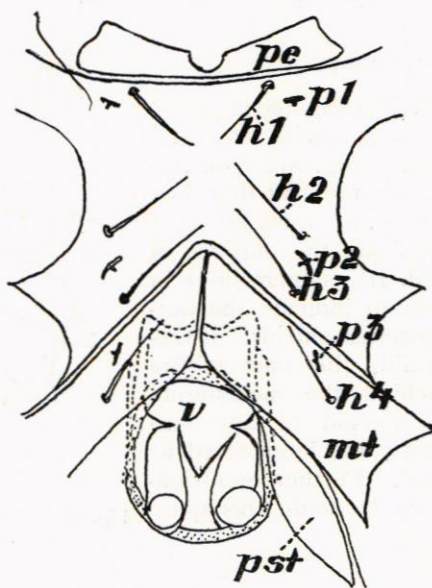
Fig. 29. *Pachylaelaps* sp. ♀. Sternal and metasternal shield.

Pergamasus.

In *Pergamasus* I have looked in vain for traces of the median shield. The *parasternalia*, on the other hand, are even better developed than in *Ologamasus*. But in *Pergamasus* the walls of the vagina have sometimes a very complicated structure, being provided with projections and pockets of different kinds. Thus in *P. brevicornis* (fig. 30) there is a pair of sharp, lateral teeth and in the posterior wall a bifurcate appendage, and in *P. crassipes* var. *longicornis* (fig. 31) there are two rather stout and blunt appendages.

It is conceivable that the median shield, which in *Ologamasus* is nothing else than a thickening of the dorsal wall of the vagina, has taken part in this armature of the vagina in *Pergamasus*. This assumption is strengthened by the fact that in *Ologamasus*, where the median shield has retained its presumably more primitive structure there is no armature in the walls of the vagina.

The *lateral shields*, on the other hand, which are so conspicuous in the same genera, seem to have left no traces, which after all is not so very remarkable, if my view that they are derived from the ventral shields is true. Because with the great development of the sternal and metasternal shields in the *Gamasides* there is really no space left for the lateral shield which presumably has its original position behind coxae IV.



Auctor delin.

Fig. 30. Ventral side of *Pergamasus brevicornis* Berl. ♀. Epigynial shield removed in order to show the armature of the vagina. Right metasternal shield only partly delineated. *pe*, praependopodal shield. *st* 1-4, sternal hairs. *p* 1-3, pores (lyriform organs); *mt*, metasternal shield; *pst*, parasternal shield; *v*, vagina.

In the *Uropodina* I have not been able to find any traces of the median shield, a fact which may be explained by the great size of the epigynial shield.

So far I have only considered the ventral shields of the females, and of these only the structures visible without any other preparation than making the animals transparent by lactic acid and afterwards separating the ventral side from the dorsal one and removing the epigynial shield, a procedure which I consider very important in order to show plainly all the structures.

But every specialist knows that underneath the epigynial shield there are quite a few structures, the mere outlines of which are

sometimes delineated and used as a mean for separating the different species. Nobody has, however, as yet seriously attempted the difficult task of dissecting these parts, still less of describing them in their relation to one another or of homologizing them.

In some species the walls of the vagina has a very characteristic armature, consisting of spines and processes of varying shape. Thus in *Pergamasus brevicornis* (fig. 30) this armature is so characteristic that the female is at once recognized. And the vaginal armature of *Pergamasus crassipes* var. *longicornis* (fig. 31) is not less easily recognized.

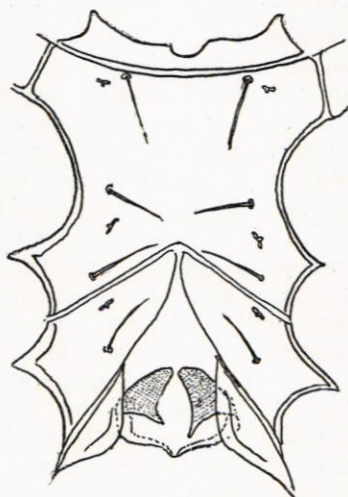
I am fully convinced that an investigation of the armature of the vagina would prove very fruitful and greatly help us to comprehend the bewildering diversity displayed by the *Mesostigmata*. These structures will, however, not been properly understood until we know more of the ways of copulating.

But not less important is that the fauna of the tropics be investigated thoroughly as regards the *Acarina*. We are bound to find a wealth of peculiar forms which will throw light on their comparative morphology and on their classification. That conclusion may safely be drawn from the examination presented here of only a few genera of which I happen to possess material.

Furthermore the characters of the ventral shield of the females must of course be correlated with other characters, as f. i. of the mouthparts, especially the hypostome the closer investigation of which has only begun, quite naturally since its investigation is bound to prove even more difficult than that of the genital armature.

3. Summary of the results.

The investigation of the ventral shields of the females of the *Mesostigmata* given here is admittedly of a rather fragmentary nature, because I have purposely chosen only a few genera the examination of which seems to throw light on the classification of the group. Still I venture to think that my purpose has been achieved at least to some extent, since it has brought out some salient



Auctor delin.

Fig. 31. Sternal and metasternal shields of *Pergamasus crassipes* var. *longicornis*, Epigynial shield removed.

points the interpretation of which may at least be used as a working hypothesis for future researches.

The results obtained may tentatively be formulated in the following way.

1. The so-called sternal shields are not real sterna, but coxal shields derived from the legs, the first article of which has coalesced with the body wall.

2. The coxal shields, four in number, are characterized by the presence of one pair of hairs each, which persist without exception and for this reason can be used as indicators of the presence of the shields even when they are fused with other shields or removed from their original position.

3. The coxal shields are further characterized by the presence of three pairs of pores (lyriform organs) of which the anterior one always is placed close to hair I, the posterior one close to hair IV and the median pore between hair II and III.

4. The coxal shields are generally fused with the corresponding endopodal plates, with the exception of the first endopodal plate which is generally free, since it does not take part in the formation of the armour surrounding the body, the first pair of legs being always directed forwards and more free than the other legs.

5. The so-called jugular shields are of two kinds: either detached portions of the sternal shield and homologous with coxal shields I or part of them, in which case they always bear hair I and pore I. Or they are mere thickenings of the cuticle, laterally often fused with the endopodal shield I. They have then neither hair nor pore. The former are here called *jugular*, the latter *praependopodal* shields.

6. The coxal shields I—III are generally coalesced, forming a single shield, except in some primitive genera, such as *Sejus* (fig. 9) and *Epicrosejus*, (fig. 8) where there are indications of separate coxal shields I and II, and in *Ologamasus* (fig. 24) where the surface-sculpture reveals the presence of a narrow, median strip of cuticle between the coxal shields and indicates the fusion line of the coxal shields II and III. Possibly the surface-sculpture in other genera will also reveal traces of these fusion lines. This seems at least to apply to *Pachylaelaps* (fig. 29).

7. The metasternal shields are subject to great variations both in shape, size and position, probably owing to their forming the antero-lateral rim of the genital aperture, which itself varies greatly in shape and position.

They may be fused with the rest of the sternal shield (*Gamasellus* (fig. 3), *Fedrizzia* (fig. 13) etc.), or they may be fused only with the corresponding endopodal plate but otherwise free and developed as paragnathal shields (*Pergamasus* (fig. 1) etc.), or they

may be free and almost obliterated (*Macrocheles* (fig. 2)), or they may be fused with the endopodal shield but small, not acting as paragynial shields (*Eviphis* (fig. 5)), or they may be free but greatly modified and placed far backwards along the lateral edge of the epigynial shield (*Trachytes* (fig. 12), *Polyaspis* (fig. 8)). But whatever their fate they are always recognized by the presence of hair IV on them.

8. Behind the metasternal shields or the sterniti-metasternal shield there is in some genera a large median shield, devoid of hairs but often provided with a pair of large pores (*Fedrizzia*, *Klinckowstroemia*, *Paramegistus* etc.). *This shield must not be confused with the epigynial shield, because it is always placed in front of the genital aperture and is attached to the posterior edge of the sterniti-metasternal shield.*

9. The median shield does not exist as a distinct thick, well defined surface structure in the two large groups *Gamasides* and *Uropodina*, being found only in the *Antennophoridae* and in the tropical genera enumerated above.

10. The median shield is most probably only a special development of the dorsal side of the vagina which in most genera is concealed by the epigynial shield, not taking part in the formation of the exterior body-wall. In many *Gamasides* (*Macrocheles*, *Zercon*) the shield is visible as a thin, transparent membrane between the sternal and epigynial shield.

11. It is not possible yet to judge whether an external median shield is a primitive feature or not. My personal opinion is, however, that the median shield is an highly adaptive feature found only in mites which live and presumably undergo their development on other arthropods which have a hard and polished surface.

12. These genera are all shieldshaped in order to adhere to the polished surface and the ambulacres are provided with powerful suckers. I suppose that the shape of the genital aperture, being opened not by a large, trap-door shaped shield as in many other acarina, but by slightly opening the lateral shield and the small epigynial shield, is indispensable when ovipositing under these circumstances.

13. Nevertheless it is a remarkable fact that, even in genera where the dorsal wall of the vagina is not visible from the outside but completely covered by the epigynial shield, there is sometimes a circular shield which vividly recalls the median shield (*Ologamasus* fig. 24). In *Veigaia* (figs. 25—27) the lateral edges of the shield are strongly chitinized and in many other genera there are structures which are specialised parts of the dorsal wall of the vagina.

14. The median shield is either quite distinct (*Fedrizzia*, *Klinckowstroemia*) or more or less fused with the sterniti-metasternal shield (*Cercomegistus*, *Paramegistus*).

15. In some of the *Gamasides* (*Pergamasus* etc.) there is a pair of distinct shields attached to the posterior edge of the metasternal shields; these I have called the *parasternal shields*. They have nothing to do with the median shield.

16. The reduction of the median shield in the *Gamasides* and the *Uropodina* is presumably due to the great development of the epigynial shield, which especially in the *Uropodina* occupies almost the entire intercoxal area.

17. In the more primitive forms (*Sejus*, *Epicrosejus*) there is no distinctly separated epigynial shield, only traces of a division of the anterior edge of the ventral shield into three lobes. When the epigynial shield is well developed as a distinct shield but not fused even with the endopodal shield IV, nor with any portion of the ventral shield, it has no hairs and never any pores at least of the type of the lyriform organs. When the epigynial shield has a pair of hairs or more this is due to its having coalesced with part of the ventral shield.

18. In many genera the epigynial shield is flanked by a pair of *lateral shields* which apparently have the same function as the paragynial shields, when these are present, as in *Pergamasus* a. o. genera, viz. that their median edges act as edges of the genital aperture and in some degree are movable.

19. The lateral shields are derived from the anterior part of the ventral shield through a further development of the division into three lobes indicated in the primitive genera. Their nature of being merely detached portions of the ventral shield is revealed by the presence of a varying number of hairs on them.

20. The lateral shields are best developed in the genera which have a well developed median shield (*Klinckowstroemia*, *Cercomegistus*), but at the same time there seems to exist a certain competition between the four shields surrounding the genital aperture. Thus in *Fedrizzia*, where the median shield has reached its greatest size, the lateral shields are reduced almost to linear structures. And in *Celaenopsis*, on the other hand, they are so large that they are contiguous in the middle, the epigynial shield becoming reduced in size accordingly. In *Syngynaspis* they are fused with one another so completely that there is no external epigynial shield, and in *Megisthanus* they are developed as the only genital shields visible from the outside.

4. The different types of genital apertures.

The main result of the present investigation is the discovery that there are at least five different types of genital apertures and surrounding shields in the females of the *Mesostigmata*.

Type I. *The primary transverse, slit-shaped aperture.*

This is accompanied by the absence of a distinct epigynial shield, this being either not differentiated from the geniti-ventral shield or fused with part of the ventral shield. This type which is the least specialized I consider the most primitive, because the forms belonging to this group have several other very primitive features. This group is the cohorts *Sejina*, embracing the two families *Sejidae* and *Epicriidae*.

Type II. *The V-shaped type of aperture with median shield.*

This is accompanied by the development of a great median shield, flanked by a pair of lateral shields, derived from the ventral shield, between the posterior ends of which the epigynial shield is situated. The genital aperture is opened in the way that the 3 shields forming its posterior edge open a little.

This group may seem to be as highly specialized as group III, which embraces what is left after the removal of quite a few genera and families from the groups *Gamasides* and *Uropodina*, which hitherto were considered sufficient for all the *Mesostigmata*. But, on the other hand, the presence of a vestigial median shield in some *Gamasides* is very puzzling and seems to suggest that this group may be derived from group II, which then must be the more primitive of the two.

This group embraces the cohorts *Fedrizziina* with the families *Fedrizziidae*, *Antennophoridae*, *Cercomegistidae*, *Celaenopsidae* and *Euzerconidae*.

Type III. *The trap-door-shaped type of genital aperture.*

The genital aperture is closed by a more or less triangular shield, point forwards.

This is either fused with part of the ventral shield (*Gamasides*) or not fused with any part of the ventral shield (*Uropodina*). This shield is hinged to the anterior edge of the ventral shield and opens like a trap-door. In many genera the anterior edge of the shield is exceedingly thin and adheres to the posterior edge of the sternal shield, so that in this way a kind of transverse fissure may be said to exist, which, however, is of a kind different from that of group I, because in the latter instance there is always a distinct epigynial shield.

Type IV. *The secondary transverse, slit-shaped aperture.*

This type is actually rather similar to type I, but is far more complicated (fig. 20) through the presence of the pickaxe-shaped sclerites, through the presence of the pores interpreted as belonging to a greatly reduced median shield and by the supposed fusion of the lateral shields. In spite of its superficial resemblance to type I it is undoubtedly related to type II from which it is derived through the complete fusion of the lateral shields, which is foreshadowed by their increasing in size in the *Celaenopsidae*. To this group only *Syngnaspis* belongs.

Type V. *The V-shaped type without median shield.*

The genital aperture is v-shaped and closed by a pair of shields, which are hinged to the posterior edge of the sterniti-metasternal shield. Only genus *Megisthanus*.

5. **Key to the Mesostigmata according to the shape of the female ventral shields.**

If we try to summarize the results of this investigation we may say that the present classification has altogether failed to take into consideration the different forms which do not conform with the characters of the *Gamasides* and the *Uropodina*. Both these groups are each in its way highly specialized groups. Neither *Sejus*, nor *Celaenopsis*, nor the *Antennophoridae*, nor *Fedrizzia*, *Klinckowstroemia*, *Cercomegistus*, or *Eusercon* belong to either *Gamasides* or *Uropodina*.

The genus *Sejus* (and allied genera) is, as pointed out by me already 25 years ago, the most primitive *Mesostigmata* as yet found, on account of the genital shield not being separated from the ventral shield. It would be tempting to compare them with the marsupials amongst the mammals. As a matter of fact isolated species of this group are found both in palearctic and nearctic regions but it attains its highest development in Australia where it has specialized in several directions just as the marsupials. For instance in the collection of acarina brought home by Mjöberg there is a species superficially exceedingly similar to a *Parasitus*, but it has the typical ventral shields of *Sejus*.

The first character to be considered when attempting a classification is the presence of a distinct epigynial shield. Still there is the difficulty that this feature may either be primitive or secondary. A systematic group comprising forms without distinct genital shield would, as a matter of fact, be very artificial. Because it would contain both *Sejus*, where this feature is without

doubt primary, and *Syngnaspis* where presumably the genital shield is concealed beneath the lateral shields which have coalesced except for a small incision in the anterior edge, and *Megisthanus* where the lateral shields have been detached from the rest of the ventral shield and imitate a pair of epigynial shields.

- I. Genital aperture a transverse fissure in front of a presumably primarily undivided geniti-ventral shield, which has 2 or more pairs of hairs. Traces of segmentation of sternal shield.

I Cohors Sejina.

- A. Sternal shield III and IV fused, forming a narrow transverse shield, separated from the remaining sternal shield
Fam. Sejidae.

- AA. All sternal shields coalesced *Fam. Epicriidae.*

- II. No epigynial shield, its function having been taken over by the lateral shields.

- B. Lateral shields fused in the middle except for a small median incision at the anterior margin. Median shield rudimentary *Fam. Syngnaspidae.*

- BB. Lateral shields not fused, separated from the rest of the ventral shield. No median shield . . *Fam. Megistanidae.*

- III. Distinct epigynial shield, without hairs. Median and lateral shields generally present.

- C. Metasternal shield fused with sternal shield. Median shield well developed **Cohors Fredrizziina.**

- E. Median shield separated from sterniti-metasternal shield. Lateral shields rudimentary.

Fam. Fredrizziidae.

- EE. Median shield partly fused with sterniti-metasternal shield *Fam. Antennophoridae.*

- EEE. Median shield completely fused with sterniti-metasternal shield *Fam. Cercomegistidae.*

- CC. Metasternal shields free. Median shield rudimentary.
Cohors Celaenopsina.

- F. Metasternal shields well developed.
Fam. Euserconidae

- FF. Metasternal shields greatly reduced.
Fam. Celaenopsidae

- IV. Distinct genital shield. No strongly chitinized, well-defined median shield nor any lateral shields.

- G. Epigynial shield with one pair of hairs (exceptionally more) **Cohors Gamasides.**

- GG. Epigynial shield without hairs.
H. No distinct metasternal shields **Cohors Uropodina.**

- HH. Distinct metasternal shields . **Cohors Trachytina.**

- i. Epigynial shield distinctly separated from ventral shield; no hairs *Fam. Trachytidae.*
- ii. Epigynial shield not separated from ventral shield; 1 pair of hairs. . . *Fam. Polyaspidae.*

For obvious reasons it has not been possible in this key to take into account more than some genera and families viz. precisely those which according to the new interpretation set forth here find no place in the *Gamasides* or the *Uropodina*. It has not been my intention here to build up a new classification, but only to point out the most apparent errors in the old classification. If the views expressed here are accepted by other acaridologists many genera will have to be reexamined in order to reveal the features emphasized here, which must be investigated in order to ascertain the systematic position of these genera.

The following explanatory remarks must be added to the classification given above.

Cohors Sejina. To this cohort, characterized by the presumably primary non-division of the ventral shield into an epigynial shield and by the presence of a simple, transverse genital fissure, only the genera *Sejus*, *Epicrosejus*, *Zuluacarus* Tgdh and *Epicrius* can be referred, until further investigations have been carried out. The former three genera belong to the same family *Sejidae*, from which, however, the genera *Epicrius* must be removed. *Epicrius* is, however, fairly closely related to *Sejus*, and for this reason the fam. *Epicriidae* has been referred to *Sejina*.

It is my firm conviction that as soon as the tropics have been more thoroughly investigated there will be found a wealth of new forms belonging to this, the most primitive group of the *Mesostigmata*. I may call attention in this connection to the fact that Mjöberg's collection from Australia contains a genus masquerading as a *Gamaside* but through the investigation of the ventral shields of the female revealed as closely related to *Sejus*.

Cohors Fredrizziina. Those forms which are characterized by the presence of the peculiar median shield it seems advisable to refer to a special cohort. The genus *Cercomegistus* has been provisionally made a family, because the median shield has coalesced with the sternal shield, a feature which is, however, foreshadowed by some *Antennophoridae*, where there is a partial fusion between these shields. *Klinckowstroemia* is a sufficiently close relative to *Fredrizzia* to be referred to that family.

Cohors Celaenopsina. Although the *Celaenopsidae* through the presence of a pair of lateral shields undoubtedly are related to the cohort *Fredrizziina*, yet the absence or almost reduced state of the median shield seems important enough to justify the establish-

ing of a distinct cohors for the *Celaenopsidae*. Although *Euzercon* is distinguished by the presence of well developed metasternal shields, yet the shape of the lateral shields is so similar to that of the *Celaenopsidae* that I treat the family *Euzerconidae* as belonging to the cohors *Celaenopsina*. The genus *Megisthanus* is altogether so aberrant to be included amongst the *Antennophoridae*. It certainly must be made the type of at least a special family, the *Megisthanidae*, and may eventually prove to represent a distinct cohors.

Cohors Gamasides. From the group must be removed the groups mentioned above and further the genus *Polyaspis* (and allied genera), which has only a quite superficial resemblance to *Asca* (*Zercon*) and *Epicrius*, and on closer examination reveals itself as most closely related to the genus *Trachytes*, hitherto placed amongst the *Uropodina*.

Cohors Uropodina. If this cohors is defined as having no distinct metasternal shields, these being fused both with the sternal shield and the ventral shield, the whole structure forming a rim round the large epigynial shield, then, as pointed out before, the genus *Trachytes*, and possibly other genera must be removed from it.

Cohors Trachytina. As pointed out before this genus shares with the *Uropodina* the feature that the epigynial shield has no hairs. But there is, on the other hand, a profound difference, in as much as *Trachytes* has very peculiar metasternal shields, flanking the sides of the epigynial shield. This is a quite unique feature, so far only shared with *Polyaspis*. Both genera also agree in the peculiar shape of the tritosternum which is exceedingly short but very broad. There is, on the other hand, the important difference between the two genera that in *Trachytes* the epigynial shield is distinctly separated from the ventral shield and has no hairs, whereas in *Polyaspis* the division between these shields is rather vague and the epigynial shield has a pair of thick hairs in the posterior angles, which probably are derived from the ventral shield.

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