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### XXVIII.—*On Dr. Bertkau's Classification of the Order Araneæ, or Spiders.* By Prof. T. THORELL.

It is a well-known fact that a natural classification of the Spiders—which form the best studied, the most numerous, and perhaps the most interesting Order of the Class Arachnida—is a problem; the solution of which offers very great difficulties, and that a generally adopted system of classification of these animals is therefore still a desideratum. Most of the older arachnologists, such as Lister, Clerck, De Geer, and, at first, even Latreille\*, based the distribution of the Spiders into higher groups, not on differences in their *organization*, but on certain peculiarities in their *habits*, especially on their mode of locomotion and the form of their webs. Against this principle of classification the objection may be reasonably made that it is rather unscientific, not being founded on characteristics taken from the animals themselves; it has nevertheless been maintained by some more recent authors as the basis of their classifications. It may at first sight appear difficult to understand the reason of thus adhering to a principle which in other departments of zoology is generally and justly abandoned, if ever made use of; but I think it may easily be explained by the fact that the differences in the form of the web and the mode of locomotion which the Spiders exhibit correspond, *upon the whole*, with a peculiar “habitus” and with modifications

\* In Cuvier, ‘Le Règne Animal, distribué d’après son Organisation,’ iii. (1817).

in the animals' structure, which, it is true, may sometimes be difficult sharply to define, but which, in general, make it easy to decide to which of the divisions, based on these differences, a spider belongs, even when nothing is known of its habits.

Concurrently with some classifications in which Spiders were grouped in two or more great divisions, according to differences in their inner (Dufour) or outer (Walckenaer, Blackwall, &c.) *structure*, several attempts were also made, at a rather early period, to combine the two principles in question, the *structural* and the *biological*, the principal stress being laid on the *organization*, especially on the modifications of the *external* parts, the characters taken from the animals' habits and webs being considered less important or auxiliary. Thus the old well-known biological groups were, in general, maintained, often even with the old denominations given to them by Latreille—Orbitelæ, Inæquitelæ, &c. An important step in this direction was made by Sundevall, who, in his "*Svenska Spindlarnes Beskrifning*"\* (Description of the Swedish Spiders), gave a rather detailed exposition of the characteristics, taken from the external parts, which he considered to distinguish each of the seven "*tribus*" (Orbitelæ, &c.) into which, with Latreille, he divided the Spiders†; the form of the web &c., he mentioned first at the end of the diagnoses of the different "*tribus*." In his '*Conspectus Arachnidum*' (1833) Sundevall retained, it is true, the same great groups, but he called them "*families*," and changed their names into *Epeirides*, *Theridides*, *Drassides*, &c.; and thus escaped the accusation of having regarded the form of the webs and the mode of locomotion, implied in the Latreillian names, as the distinguishing characters of the groups adopted. He was followed by Westring, who, in his admirable work '*Araneæ Suecicæ*,' characterized his "*families*" *Epeiridæ*, *Therididæ*, &c. still more sharply and more in detail than Sundevall had done. As, however, Sundevall and Westring were but insufficiently acquainted with extra-European spiders (Westring took into consideration only those found in Sweden), the characters of the groups adopted by these authors do not always hold good for the exotic forms, and are in many respects in need of enlargement and other modifications; but the method of characterization followed by them, and especially by Westring, is no doubt still the right one, *i. e.* to give a *detailed* exposition of (*at least*) the external parts in each group,

\* K. Vetenskaps-Akademiens Handlingar för år 1829, pp. 199-203 (1830).

† The Territelæ of Latreille he called, however, "*Theraphosæ* (Walck.)."

noticing the *exceptions* from every character thus given, so far as they are known; adding to this exposition such remarks on the habits &c. of the animals as may be of use in their determination or are of more general interest.

In a work treating of the synonyms of a certain number of European Spiders\*, in which some definition of the genera adopted was necessary, and where it also seemed desirable to have their systematic connection indicated, I have myself adopted, in the main, the classification of the aforesaid authors; but as it had become necessary, from the progress of arachnology in general, and especially from the great number of new genera and species discovered in later years, to resolve the seven great "families" or "tribus" into a number of smaller groups (already at that time in part called "families"), I readopted for those greater groups, each divided into a certain number of families, the old Latreillian denominations, only with a few slight modifications (Orbitelariæ, Retitelariæ, Tubitelariæ, &c.), and raised them to the dignity of *Suborders*† —a term instead of which I shall here use that of *Tribus*. I further endeavoured to characterize the different suborders or tribus as far as was necessary for the classification of the *European* genera; as to the *exotic* families and genera, I also tried to determine to which of the tribus adopted by me they probably belonged, without, however, concealing from myself that "a by no means inconsiderable number of forms could not without great uncertainty, even if at all, be included under the hitherto received families and higher groups"‡, and that probably one or more new tribus would in the course of time be proposed§, for instance by dismemberment of the

\* Thorell, "On European Spiders," I. (in *Nova Acta Reg. Soc. Sci. Upsal.* ser. 3, vol. vii. fasc. i. et ii., 1869 and 1870); [II.] 'Remarks on Synonyms of European Spiders' (1870-1873).

† Some years later (see Thorell, "Description of the Araneæ collected in Colorado in 1875 by A. S. Packard, jun., M.D.," in *Bulletin of the U.S. Geological and Geographical Survey*, vol. iii. no. 2, p. 477, 1877) I changed this word into the less significant term "Sections," it having been justly remarked (by Gerstäcker) that the differences between the groups in question were not of sufficient weight to warrant for them the name Suborder. The term "Tribus" used by Latreille has, however, the priority, and is also preferable, in so far as it implies that the groups are *natural*, or formed of closely allied families and genera.

‡ Rem. on Syn. p. 596.

§ In 'Die Arachniden Australiens,' p. 231, L. Koch has formed the Tribus (Suborder) *Ruditelariæ* for the genera *Celenia* or *Thlaosoma* and *Cryptothela*; I think, however, that these genera may be included under the Orbitelariæ (see Rem. on Syn. p. 599). More recently Dahl has formed the Tribus (Suborder) *Playtelariæ* for *Pholcus*, characterized by having only two air-sacs and no tubular trachææ (see F. Dahl, "Analytische Bearbeitung der Spinnen Norddeutschlands, mit einer anatomisch-

great and polymorphous tribus Tubitelariæ. But in spite of these and other shortcomings, the classification of the Spiders given in my work 'On European Spiders' has, with or without some slight modifications, been adopted by most living arachnologists.

Very different from this classification, in which the primary groups of the Spiders are distinguished chiefly by means of characters taken from the *totality* of their *external* parts, and little notice is taken of their internal or anatomical structure, is a system of classification lately proposed by Dr. Philipp Bertkau\* of Bonn; for not only are the principal groups in this system based on features which are more isolated and by most other authors considered to be of comparatively less importance, but he also gives much attention to the internal parts, and especially to the differences in the structure of the *breathing-organs*, thus approximating to the classification adopted by Dufour. But while Dufour† and, at last, following him, Latreille‡ divided the Spiders into "*Quadripulmonaires*" and "*Bipulmonaires*" (*Tetrapneumones*, Latr., and *Dipneumones*, Latr.), on the ground of the different number, four or two, of their *air-sacs* or so-called lungs (lung-sacs, lung-books, lamellar tracheæ), they are by Bertkau divided into the two suborders *Tetrasticta* and *Tristicta*, the former with *four*, the latter with *three breathing-holes* (spiracles, stigmata). The *Tristicta* are further divided into two groups, *Cribellata* and *Meromammillata*, of which the former are provided with the spinning-organs known under the names of *cribellum* (or *inframammillary organ*) and *calamistrum*, the latter being devoid of these organs; the *Meromammillata* Bertkau divides into *Perissonycha*, with *three*, and *Artionycha* with *two* tarsal claws. All these different groups are divided into a certain number of "*families*," in the characterization of which the structure of the organs of respiration and generation plays in general an important part. To the *biological*

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biologischen Einleitung," in Schriften des naturwissenschaftlichen Vereins für Schleswig-Holstein, vol. i. 1883).—On the systematic position of *Pholcus* (and *Ctenium*), see further on.

\* See especially his "Versuch einer natürlichen Anordnung der Spinnen," in Archiv für Naturgeschichte, xlv. i. pp. 351 *et seq.* (1878), and his treatise "Ueber das Cribellum und Calamistrum. Ein Beitrag zur Histologie, Biologie und Systematik der Spinnen," *ibid.* xlviii. i. pp. 316 *et seq.* (1882).

† "Observations sur quelques Arachnides quadripulmonaires," in Annales générales des Sciences Physiques, vol. v. p. 26 (1820). It is known that Dufour, believing that *Dysdera* had four air-sacs, erroneously referred that genus to his "*Araignées quadripulmonaires*."

‡ In his 'Familles Naturelles du Règne Animal, &c.,' 1825.

characteristics a systematic value is, on the contrary, but rarely attributed.

If I undertake here to offer some critical remarks on Dr. Bertkau's now-mentioned views, I do so with great hesitation, and because I have in vain waited for some person more competent than myself, or at least more versed in the anatomy of the Spiders, to undertake a review of Dr. Bertkau's works on the classification of this group of animals. These works (of which the most important, '*Versuch einer natürlichen Anordnung der Spinnen*'\*, was published nearly eight years ago) are indeed worthy of the greatest attention, not only of every arachnologist, but of zoologists in general; for besides being of great interest from a classificatory point of view, they are rich in new and important observations on the life-history and the anatomy of the animals on which they treat. Dr. Bertkau is, as is generally known, a most sagacious and learned entomologist; he has, more especially in the field of arachnology, enriched his science not only with good works of a systematic, descriptive, and zoogeographical character, but also with many anatomical and biological discoveries of great importance; it is, for instance, to Dr. Bertkau that we are indebted for our knowledge of the principal parts of the male organs of copulation in Spiders, and of the functions of these parts, of which we had formerly only imperfect and erroneous notions.

Before entering on the examination of Dr. Bertkau's spider-system I ought perhaps to try to give an answer to the criticisms which he has directed against the method now-a-days most generally adopted of classifying the animals in question, and especially against the classification adopted in my work '*On European Spiders*.' That this classification should, in many points, be modified and improved, and that some of Dr. Bertkau's criticisms are fully justified, I am, however, the first to acknowledge.

The considerable progress which arachnology has made during the last quarter of a century must of course have exercised a modifying influence on the attempts at a natural classification of the animals before us; but it cannot well be said that this progress has made the solution of the problem more easy than it formerly was. The difficulties which here present themselves depend, as Bertkau (*A*, p. 352) justly remarks, chiefly on the body of the spiders being (compared with that of insects and crustaceans, for instance) but little differentiated, or

\* In the following pages, when citing this '*Versuch*' and the treatise '*Ueber das Cribellum und Calamistrum*' (see above, p. 304, footnote), I shall, for the sake of brevity, call the former work *A* and the latter *B*.

formed of but a small number of parts (segments, extremities, &c.), which parts, again, show only slight variations in the different spiders; from this it follows that the entire group is, upon the whole, of a highly uniform aspect, exhibiting but few important structural points on which to rely for a natural classification.

Other difficulties arise from the fact that most of the characters generally found to be constant, and therefore of importance in the classification of these animals, *may* yet vary most materially in one and the same group. The *tarsal claws*, for instance, the number of which (three or two) gives such good and reliable characters for many tribus and families, may, however, within the same family, be sometimes two, sometimes three; in a few genera (*Palpimanus*, *Dasumia*) some of the legs have, in the same animal, three, and the other legs only two tarsal claws. The distribution and the number of the *eyes*, which also often give sure characters both for tribus and families, may nevertheless be very different within the same family or even the same genus (*Nesticus*, *Hadites*). It might have been expected that, just as the presence and peculiar structure of the *spinning-apparatus* is perhaps the most salient and most characteristic feature throughout the whole Order of Spiders, so the number and the shape of the *spinnners* ought to offer reliable characteristics for the different higher and lower groups within the Order; but even this is far from being the case, as I shall have occasion to remark further on.

Add to this that the two sexes of one and the same species often differ from one another in the most important points, and that the young specimens are often very unlike the adults, and it must be admitted that it is not an easy task to draw up a natural classification of this order of animals.

If (passing by, for the moment, the more special criticisms in Dr. Bertkau's works, viz. those which relate to the families and genera, and which we shall take into consideration as suitable opportunities occur) we fix our attention on his objections to dividing the Spiders into the seven tribus Orbiculariæ, Retitulariæ, Tubitulariæ, Territulariæ, Laterigradæ, Citigradæ, and Saltigradæ, these objections may perhaps be summarized as follows:—

1. A higher group, suborder or tribus, is natural only on the condition that all the families and genera included in it are more closely related to each other than to any genus or family of another suborder or tribus (*B*, p. 345). But in the system of classification in question there are genera which, though belonging to one and the same family, differ more



from each other than from genera belonging to another family, nay, even another tribus (*A*, p. 353); and the aforesaid condition is only fulfilled, among the seven tribus, by the Territelariæ, and approximately also by the Laterigradæ and the Citigradæ. The Orbitelariæ contain, as an alien element, the Uloborinæ; the Retitelariæ the genus *Pachygnatha*; the Saltigradæ the family Eresoidæ; the Tubitelariæ are composed of the highly heterogeneous families Agalenoidæ, Filistatoidæ, Dysderoidæ, and Drassoidæ (*B*, pp. 335 and 336), and form a receptacle into which all those forms have been thrown that could not find a place in the other tribus (*B*, p. 345).

2. Of a natural system of classification it may be required that the groups regarded as coordinate ("gleichwerthig") should really have the same systematic value; but this is not the case with the aforesaid tribus: the Territelariæ, for instance, correspond in value to all the other tribus taken together (*B*, pp. 86 and 87).

3. The characters employed to distinguish the different tribus are partly (for instance, Orbitelariæ and Retitelariæ) of a very subordinate nature, and even then liable to exceptions, partly not indicated at all or not given with sufficient sharpness (*B*, p. 334). The insufficiency of the hitherto received classification shows itself in the vacillating opinions as to the family in which various genera ought to be placed (*A*, p. 353).

4. The denominations Orbitelariæ, Retitelariæ, &c. are not systematic categories, but only names that indicate a biological peculiarity (*B*, p. 336).

Briefly, then, the tribus adopted by me are (1st) neither natural, (2nd) nor of the same value, (3rd) nor distinguished by sufficiently important or distinctly expressed characters; and, 4th, their names are inappropriate.

In so far as these criticisms are directed against the classification adopted in my work 'On European Spiders,' it should first of all be borne in mind that it was not my intention in that work to give a complete characterization of the different tribus, but only to adduce, concerning those groups, as much as appeared to be, at that period, necessary and sufficient for the referring of a given family or genus to the tribus to which it was believed to belong; it should further be observed that in that work the principal stress was laid on the *European* forms, the disentanglement of the synonyms of which was its chief object. It was supposed that the characters which had been given of the groups in question by other authors, and especially by Westring, were known to the

readers of the work, and consequently that they would not find it difficult to refer an unknown spider (at least a European one) to its respective tribus. Only the most prominent and interesting forms of *exotic* spiders then known were mentioned, and an attempt was made to assign to the exclusively exotic families a place in the different tribus, so far as my restricted knowledge of the matter permitted me to do. And when I believed I had determined, in a way sufficient for my purpose, the limits of the six higher tribus, I could, when coming to the lowest, the Tubitelariæ, which also is the most polymorphous and therefore most difficult to characterize in few words, restrict myself to a *negative* characteristic, viz. that of saying that all the spiders then known "which could not be classed under another tribus" belonged to the Tubitelariæ\*. In order to distinguish the Orbitelariæ from the Retitelariæ, only one character of the many given, for instance, by Westring, was, it is true, adduced by me—that, namely, which is taken from the height of the clypeus compared with that of the area formed by the four central eyes, a character which has its exceptions (duly indicated) quite as well as all the other marks adduced by Westring, including even that given by Bertkau as distinguishing his Epeiridæ from his Therididæ, viz. the presence in the mandibles of the former group of a so-called basal spot ("Basalfleck"). That there should exist an isolated characteristic always and without exceptions sufficient for the limitation of all the different tribus, I do not believe, and never have believed.

1. That *some* of the tribus, as they have been understood in my above-named work, contain elements that ought to be removed from them, I hasten to admit; and it is in the first place Dr. Bertkau's merit to have assigned to those alien elements a better place in the system. Thus I unhesitatingly admit that the Eresoidæ do not belong to the Saltigradæ, and that they probably have their true place in the vicinity of Bertkau's Amaurobiadæ, and therefore in the tribus Tubitelariæ (the Palpimanoidæ should probably also be classed under this tribus). I also agree with Dr. Bertkau that *Pachygnatha* ought to be detached from the Retitelariæ and united with the Tetragnathoidæ†, within the tribus Orbitelariæ. Both the Retitelariæ and the Saltigradæ may, I think, after this elimination, be considered entirely natural groups, at least as regards European forms. That not only the Territelariæ, but also the Laterigradæ and the Citigradæ

\* 'On European Spiders,' p. 109.

† On this family see further on.

are good systematic units, even Dr. Bertkau himself would seem to admit. There remain then to be discussed the Tubitelariæ and the Orbitelariæ. As to the former of these tribus, Dr. Bertkau enunciates nearly the same opinion about its nucleus, the family Drassoidæ, as I had expressed about the tribus Tubitelariæ in general, viz. that in their habitus and in their way of life the members of this family show a certain polymorphism and manifold points of contact ("Anklänge") with other families (*A*, p. 375; conf. Thor., On Europ. Spid. pp. 41 and 109). Just as the family Drassoidæ is a natural group notwithstanding its being looser and more polymorphous than most, if not all, other spider families, so the tribus to which the Drassoidæ belong, and which is, as it were, an enlargement or amplification of that family, is, I think, a natural group, although it be less compact and more polymorphous than the other tribus. As to the Agalenoidæ, they are so nearly related with the Drassoidæ, and show such gradual transitions to this latter family, that arachnologists have, in general, had recourse to the character (in this case quite artificial) afforded by the different number of the tarsal claws, in order to be able to distinguish these two families; so that genera (*Agræca*, for instance) which in all other respects closely agree with the Agalenoidæ have, on the strength of that character, been removed from this family and placed among the Drassoidæ. That the Dysderoidæ (of which we shall speak more in detail further on) differ from the other Tubitelariæ in a few important points and show some affinity with the Territelariæ is true; but they are, at all events, much more closely related to the typical Tubitelariæ than to any other spiders. If the Tubitelariæ should be resolved into two or more tribus, then the Dysderoidæ might, of course, be made to form a particular tribus, as might perhaps also be the case with the Filistatoidæ; I for my part prefer, however, for the present not to increase the number of the tribus generally admitted, and think it is better to add the two above-named (and other) more or less aberrant families to those tribus within which they have their nearest allies. It is indeed quite easy to dismember and divide the different groups, tribus, families, and genera almost *ad infinitum*; but it is more difficult and, I think, more meritorious to try to unite them into higher units, and thus to form of all these apparently "disiecta membra" an organic whole—a *system*.

2. With regard to the objection made by Dr. Bertkau under this head (2), it would indeed *appear* as if the claim to a natural classification, which he sets forth, were quite reasonable; but in reality it is not so. It is not the zoologist or

botanist who creates the natural groups of animals or plants, for these groups already exist in nature, sometimes sharply distinguished from each other, sometimes more or less closely united by means of transition-forms. The naturalist must take them as they are, learn to know them and to characterize them—that is all. Now it is not often the case, in nature, that two or more (in our classifications, coordinated) groups really are of precisely the same systematic value; and on this circumstance depend the often so greatly varying opinions as to whether a given group shall be considered coordinate with or subordinate to another. The case is the same with most zoological higher groups, as, for instance, with the zoogeographical “Regions” into which the surface of our globe is divided: one region is of greater value, in a zoogeographical respect, than the rest, and is therefore by some authors divided into *two* regions; another region is of less value than the others, and is therefore sometimes considered a mere *Subregion*, or part of another Region; and as we cannot change the distribution of land, water, &c. on the earth, there is no help for this. We need not go far to find similar examples in zoology. The class Arachnida is, I believe, in general (if we do not include the Pantopoda or Pycnogonoidæ in this class) divided into the following orders:—Araneæ, Pedipalpi, Scorpiones, Opiliones, Chelonethi (Pseudoscorpiones), Solifugæ, Acari, Acanthotheca, and Cormopoda (Tardigradæ). Now these groups ought, it would seem, to be of the same systematic value; but this is far from being the case; some of them may, in fact, with almost equal reason be regarded as subordinate to or as coordinate with another. Thus we see that the Pedipalpi and the Scorpiones are by some arachnologists united into a single order, of which they form two *suborders*; Pedipalpi, Scorpiones, Opiliones, Chelonethi, and Solifugæ are often *all* considered to form together a single order, that of the Arthrogastra. The Acari are sometimes considered to be a *subclass* (as I, for my part, think that the Cormopoda should be considered) of the same value as all the foregoing orders taken together—and so on. And it is quite impossible to change this state of things by assigning to the groups in question new limits, so as to form them into really coordinate groups, for they are all so well defined in nature, so “natural,” that nobody can think of altering their compass. In fact, “The works of Nature refuse to be crammed up into the pigeon-holes systematists would like to get them all into.”

I therefore think it of little use to enter upon a minute examination, from this point of view, of the tribes into which

Spiders are in general divided. I think these tribus are *approximately* of the same systematic value, and this, if true, is quite sufficient. An exception may, however, be made for the Territelariæ, which really differ from the other tribus by characters of much greater importance than those which distinguish the other tribus from each other; they form a group that may, with almost equal reason, be regarded as coordinate with *all* the other tribus taken together, as with each of them. However, since Holmberg\* and Bertkau (A, p. 361) have shown that *Catadysas pumilus*, Hentz, which Hentz† classed with the Territelariæ, although this spider has only *two* air-sacs, cannot belong to that tribus (it belongs probably, as Holmberg thinks, to *Zora* or to an allied genus), and that Hentz's description and figures of the mandibles and maxillæ of *Catadysas* must be erroneous, the most important reason for regarding the Territelariæ as a group of only about equal value with the other tribus, and as united with the other spiders by transition-forms, no longer exists. They now show themselves to be very sharply distinguished from all other spiders, and I do not hesitate to admit that they may be considered a group of higher rank than the others, which in their turn may be united into a group of the same dignity. For these higher groups or *suborders*, the old Latreillian names Tetrapneumones and Dipneumones may be readopted. The suborder Dipneumones, then, would consist of the six tribus Orbitelariæ, Retitelariæ, Tubitelariæ, Laterigradæ, Citigradæ, and Saltigradæ; the suborder Tetrapneumones, on the contrary, consists as yet only of *one* such group, the Territelariæ, from which, however, the Liphistioidæ might perhaps be separated and made the type of a separate tribus‡. When Bertkau says that "the family Theraphosoidæ alone shows nearly all those diversities that have been observed within the Tristicta" (A, p. 361), this is, no doubt, an exaggeration; I cannot find that within the whole suborder Tetrapneumones there exist such widely dissimilar forms as, for instance, *Gasteracantha* and *Attus*, or *Ulesanis* and *Pholcus*. But that the Theraphosidæ, Auss., ought to be divided into several *families*, there is no doubt whatever §.

\* "Observations à propos du sous-ordre des Araignées Territélaires (Territelariæ), spécialement du genre Nord-américain *Catadysas*, Hentz, et de la nouvelle famille Mecicobothrioidæ," in Boletín de la Academia Nacional de Ciencias en Córdoba (República Argentina), iv. p. 153 (1882).

† "Descriptions and figures of the Araneides of the United States," in Boston Journal of Natural History, vi. p. 287, pl. x. fig. 16 (1850).

‡ Compare Thorell, "Studi sui Ragni Malesi e Papuani. IV. Ragni dell' Indo-Malesia," in Annali del Museo Civico di Storia Naturale di Genova, xxiii. (ser. 2, iii.), 1886 (in the press).

§ See Thorell, *ibid.*

3. It by no means rarely happens that in groups that are highly specialized and very rich in species no sharp limits can be drawn between the different lower groups into which they must be divided. This must especially be the case with the order of the Spiders, on account of the peculiarities in the bodily structure of these animals, peculiarities of which we have spoken above (p. 306), and which make their classification so difficult. Even amongst the most natural coordinate groups we find examples of some one of them being united with another by "transition-forms" the systematic position of which must, by sad necessity, be more or less uncertain; and the consequence of this is, that when we have, for some practical purpose (as in my work 'On Eur. Spid.'), to define such groups by means of a single or a few characters, these become either artificial or of subordinate weight, or even assume a negative form. Such groups (and to them belong the tribus of the Dipneumones) should therefore, as has already been insisted upon, rightly be determined by means of a more *detailed* exposition of the structure of their different parts, with indications of the *exceptions* from all the characters given. And it will then be the preponderating *importance* and *number* of the characters by which a given form, for instance a genus, agrees more with the one than with the other of the groups in question, that decides to which of them it ought to be referred. In such cases the choice sometimes depends on individual appreciation, and the systematic place of the genus may thus appear to be "vacillating;" but this cannot well be avoided, nor would it seem to be of much consequence. Though, for instance, the Laterigradæ are a natural group, it is scarcely possible to draw a sharp limit between them and the Tubitelariæ, or rather between the Heteropodoidæ (Sparassidæ, Bertk.) and the Drassoidæ. Through the Thomisoidæ, the Laterigradæ also approach the Epeiroidæ of the tribus Orbitelariæ. The Lycosoidæ are not only nearly allied to the Drassoidæ (*Zora*, for instance), but they pass (through, for instance, *Sphedanus*, Thor.) gradually and almost imperceptibly into the Agalenoidæ, and might therefore *seem* to be more closely allied to this last-named family than to the Oxyopoidæ, which belong to the same tribus as the Lycosoidæ (Citigradæ), nay, are even regarded by Bertkau as a mere *subfamily* of the Lycosoidæ. Epeiroidæ and Theridioidæ are held to be different families even by Bertkau, notwithstanding that he considers (*A*, p. 401) "the different form of the *web* to be the essential and most important character by which these two families may be distinguished from one another." I think therefore that it would scarcely be just to reject the old and

most generally received classification on the ground of the imperfections of which I have now spoken.

4. As to the *denominations* of the different tribus, they are quite as appropriate as many others in constant use in zoology. Mammalia, Reptilia, Amphibia, Carnivora, Oscines, &c. are generally received names, notwithstanding that they express *biological* characters, and although there are "Amphibia" which live only in water, "Oscines" that do not sing, &c. The great majority of the Orbitelariæ are really "round-web" spiders; almost all Retitelariæ make more or less irregular nets; most, if not all, Citigradæ are fast runners; almost all Saltigradæ jump, &c. No reasonable objection can therefore be raised against the names Orbitelariæ &c., unless it were necessary to discard *all* such names of zoological groups as are taken from biological characters, or that do not suit *all*, but only the greater part, of the forms that belong to the group in question. But I do not think that any one will urge against such names any wholesale doom of condemnation.

I have now gone through and examined the criticisms which Bertkau has formulated against the principal traits of the classification of Spiders at present most in vogue, and have endeavoured to confute them, in so far as they appeared to me unfounded. I have tried to show that the deficiencies which, without any doubt, are to be found in this classification, have in a great part their source in the difficulties inherent in the subject itself, and depending on the peculiar organization of the Spiders, difficulties which it will therefore probably not be possible to conquer completely. In part these deficiencies may be overcome by dividing the order of Spiders into two suborders, *Tetrapneumones* and *Dipneumones*, and these latter into the six tribus *Orbitelariæ*, *Retitelariæ*, &c. (or into a greater number of tribus if this should be considered more convenient), as also by characterizing these groups by means of more detailed diagnoses, instead of by isolated characters, as is the case, for instance, in the modern and often useful, but not equally scientific, "analytical tables"\*. In the details of the system, as in the limitation of the families, and in assigning the right place to several among them whose affinities were contested or wrongly interpreted, many corrections have already been made by Dr. Bertkau, and many others may still remain to be carried out. By con-

\* In his "Analytische Uebersicht der europäischen Spinnenfamilien" ('Mittheilungen des naturwissenschaftlichen Vereins für Steiermark,' Jahrgang 1877), Ausserer has, with fine tact, omitted to try to characterize the different tribus (suborders).

tinuing, in this way, to build on the old ground, it would seem that arachnologists might gradually draw nearer and nearer to the point aimed at—a fully natural classification. This point is aimed at by all the different zoological departments, and by Zoology as a whole; nay, such a classification may be said to be the final end of this science, inasmuch as the “system” is, as it were, a compendium of all that is known about the natural objects in question; and a fully natural system presupposes complete knowledge of their natural history in its whole compass.

Bertkau's opinion is, on the contrary, that the present arrangement of the Order of Spiders must be abandoned, as being fundamentally erroneous, and new principles laid down for the classification of these animals. He says that, in contradistinction to former arachnologists, he has in his new system of classification taken into consideration all the modifications in the structure of Spiders that are known to him, laying more stress on the differences in the organs of respiration than has been in general the case, and making use of characters taken from the form of the web only in case of need (*A*, p. 354). The principal difference, in this respect, between the classification proposed by Bertkau and that of other more recent arachnologists would, in fact, seem to consist in his having, in characterizing both suborders and families, attributed greater importance to differences in the inner anatomical structure than is generally the case, taking into consideration, in the first place, the different structural features of the organs of respiration, and, in the second place, the organs of generation. In his characterization of the *families*, the different shape of the tubular tracheæ (which are sometimes ramified either in the form of a tree or in the form of a bundle, and sometimes quite simple and unramified) plays an important part. Now as the Arachnida may be divided into two great groups, according as they breathe with (tubular) tracheæ\* alone, or with air-sacs either alone or in combination with (tubular) tracheæ, it might have been expected that

\* If, as is most generally believed, the lamellæ of the air-sacs are nothing but modified ordinary or tubular tracheæ, then the Arachnida which breathe with these latter organs must be older than, as they no doubt are inferior to, those which breathe with air-sacs; some authors, however, regard these last-named Arachnids as the more original forms, and as being directly descended from the fossil Eurypterids, the gills of these Crustaceans having been directly transformed into the air-sacs of the Arachnida (the Scorpions). How this supposed change came to pass it is not easy to understand; in the meantime we possess no less than *four* different hypotheses for explaining it—one proposed by MacLeod, two by Ray Lankester, and one by Kingsley!



Bertkau, when he drew the characteristics for dividing the Spiders into two suborders from differences in their breathing-organs, would, in conformity with Dufour, have divided them into such as breathe only with air-sacs, and have *two* pairs of these organs, and those in which the posterior pair of air-sacs is replaced by tracheæ, and which therefore have only *one* pair of air-sacs. But instead of that he has, as I have already stated, chosen as the chief basis for his classification the number of the openings through which these different organs of respiration communicate with the exterior, and thus divided the Spiders into the two suborders, *Tetrasticta* with *four*, and *Tristicta* with *three* breathing-holes or *spiracles*. Accordingly he has separated the *Dysderoidæ* from the rest of the Spiders that have only one pair of air-sacs, or the *Dipneumones*, and united them with the *Tetrapneumones* or *Territelariæ* in his suborder *Tetrasticta*. But this new arrangement does not appear to be at all a natural one; the different number and position of the spiracles have not nearly the great systematic importance that Bertkau attributes to these characters. How untenable, in fact, is the basis for his two suborders, is demonstrated by the fact that Bertkau refers to his *Tristicta* two genera belonging to two widely different families, viz. *Pholcus*, Walck. (*A*, p. 398) and *Ctenium*, Menge\*, in which, according to Bertkau's own discoveries, the unpaired spiracle and its tracheæ are completely *wanting*! Consistently he ought to have formed for the reception of these spiders a separate suborder, *Disticta*; but he would then have been obliged to separate *Ctenium* from the rest of his *Therididæ*, and to place this genus in the vicinity of *Pholcus*†, which, of course, could not be done in a "natural" classification. As to the *unpaired* spiracle, it no doubt corresponds to the two posterior spiracles in the *Dysderoidæ*, or, in other words, *the two posterior spiracles of the Dysderoidæ are in the Tristicta moved more or less backward, and are more or less intimately united with each other*. This is proved not only by the fact that the unpaired spiracle is often, especially when situated further forward, evidently formed of *two* coalesced spiracles, but also by the tracheæ which debouch through this spiracle being, as in the *Dysderoidæ*‡, one or two on each side, though in the

\* See [Förster and] Bertkau, "Beiträge zur Kenntniss der Spinnenfauna der Rheinprovinz," in Verhandl. des naturhist. Vereins der preussischen Rheinlande und Westfalens, Jahrg. xl. (4 Folge, x.), p. 349 (1883).

† Bertkau remarks (*A*, p. 398) that the tarsi of *Pholcus opilionoides* are subdivided into a rather large number of small joints; the same had been shown to be the case in *Ph. pullulus*, Hentz. See Thorell, "Descript. of the Araneæ collected in Colorado, &c.," *loc. cit.* p. 488.

‡ Compare Menge, 'Preussische Spinnen,' pp. 298 and 300.

Tristicta they often unite into a single short stem before entering the common spiracle. The identity of the posterior spiracles in the Dysderoidæ and the unpaired spiracle in the Tristicta also explains why the *unpaired spiracle is always wanting in the Dysderoidæ* (as well as in the Territelariæ). The position of this spiracle when present is, as is known, very variable; in general it is drawn backwards to the vicinity of the spinners, but sometimes it has its place much more forward, nay, even in the vicinity of the rima genitalis, just as is the case with the posterior spiracles in the Dysderoidæ. That the unpaired spiracle in the group Anyphæninæ, *Sim.* (which Bertkau, on the strength of its arborescent tracheæ, separates from the Drassoidæ, making of it a separate family), is situated sometimes very far from the spinners, sometimes in their vicinity, shows clearly enough the little importance of the position of this spiracle.

Bertkau himself does not always consider the position of the unpaired spiracle and its tracheæ to be of much systematic importance; he even refers to the same *genus* (*Argyroneta*) two species, in one of which, the *A. aquatica* (Clerck), the two stems of the tracheæ have their opening immediately behind the rima genitalis and penetrate through the petiolum into the cephalothorax, there dividing into a bundle of fine tubuli; whereas in the other (fossil) species, *A. antiqua*, v. Heyd., the spiracle is, according to Bertkau, situated in the posterior third of the abdomen, while the tracheæ do not enter the cephalothorax, but divide into a bundle of tubuli before reaching the petiolum\*.

Even the *paired* spiracles of the Tristicta, by which the air-sacs debouch, and which are in most cases situated near the base of the abdomen, may sometimes be thrust far backwards; in *Tetrablemma medioculatum*, Cambr.†, for instance, they are situated far behind the middle of the abdomen, and are, moreover, placed very near to one another.

That the different form of the *tubular tracheæ* does not always offer a reliable characteristic for distinguishing closely allied families, is seen by the fact that Bertkau has been obliged, on the ground of such differences, to separate the genera *Thanatus* and *Tibellus* (*Metastenus*, Bertk.) from the other Thomisoidæ, and to refer them to the Heteropodoidæ

\* See Bertkau, "Einige Spinnen und eine Myriopode aus der Braunkohle von Rott," in Verhandl. des naturhist. Vereins der preussischen Rheinlande und Westfalens, Jahrg. xxxv. (4 Folge, v.), pp. 357 and 358 (1878).

† "On some new Genera and Species of Araneidæ," in Proceedings of the Zoological Society of London, 1873, p. 114, pl. xii. fig. 1.

(Sparassidæ), which are well distinguished from the Thomisoidæ by the form of the parts of the mouth (especially the tooth-armature of the mandibles), the low clypeus, &c.\* Would it not have been better to have written, in the diagnosis of the "Thomisidæ," "Die 4 Tracheenschläuche verästelt (selten einfach)," instead of "Die 4 Tracheenschläuche verästelt," quite as well as Bertkau, in his diagnosis of the "Lycosidæ," says, "Augen in 3 (selten in 4) Reihen gestellt"? Or are the structural characters to be considered invariable only because they are taken from internal organs? It would, on the contrary, seem that within the province of the Arthropoda in general, the characteristics given by the inner structure are by no means more important or more constant than those taken from the external parts. This has been remarked already by Sundevall†, who has strengthened his opinion with examples taken from the insects. And that also within the class Arachnida, both anatomical and embryological characters may be very different in closely related forms is seen, for instance, from the fact that within a group so compact and so little differentiated as the Scorpions, the first abdominal ganglion is, according to Ray Lankester‡, in the family Buthoidæ (An-

\* Compare Simon, "Révision de la famille des Sparassidæ," in *Actes de la Société Linnéenne de Bordeaux*, 1880.

† "Svenska Spindlarnes Beskrifning," *loc. cit.* p. 192.

‡ In a treatise with the title "On the Muscular and Endoskeletal Systems of *Limulus* and *Scorpio*; with some Notes on the Anatomy and Generic Characters of Scorpions," by E. Ray Lankester, assisted by W. B. S. Benham and Miss E. J. Beck: Part V. Notes on Certain Points in the Anatomy and Generic Characters of Scorpions, by E. Ray Lankester" ('Transactions of the Zoological Society of London,' xi. part 10, 1885), this author has proposed a new classification of the Scorpions, which cannot fail to cause some surprise among arachnologists. "No writer on Scorpions," says he, "has given consistently a clear statement or (what is more to be desired) good figures of the really important structural features of the genera, subgenera, and species proposed or recognized by him; and it is with the object of pointing out *what* are the important points in which Scorpions may vary that the present remarks are published." Among the *fifteen* points enumerated as important by Prof. Lankester, no less than *eleven* would, however, seem to have been duly appreciated by his predecessors; the remaining four are:—(a) the above-named different disposition of the abdominal ganglia and of the great nerves of these; (b) the different sculpturing or ornamentation of the lamellæ of the air-sacs; (c) the shape of the spiracula, which are *oval* in "*Euscorpius*," *slit-like* in "*Buthus* (*Heterometrus*, Ehr.)," and *circular* in "*Brotheas*" (of the shape of the spiracula in the "*Androctonini*" nothing is said); and (d) the "chitination of the genital operculum, whether in two quite separate plates, as in *Brotheas*, or in one imperfectly divided plate." Chiefly on the strength of the points (a) and (b) Prof. Lankester divides the order of the Scorpions (which according to him form a single family) into two *subfamilies*—I. Scorpionini (= Scorpionini + Tegenariini, Peters) and II. Androctonini (= Androctonini + Centruroidini, Peters). To his

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droctonoidæ) situated in the *fourth* abdominal segment, whereas in other scorpions it is, on the contrary, placed in the *third* of these segments—a peculiarity which in the Buthoidæ necessitates a different origin, from that in other scorpions, of the nerve-stems which go to the two first pairs of air-sacs; and while the embryos of *Pandinus africanus* are developed in separate cæca of the ovarian tubes, and are provided with a long apophysis, proceeding from the mandibles, the embryos of *Buthus (occitanus)* and of *Euscorpium* are devoid of this apophysis, and perform their whole development in the interior of the ovary itself\*. The case is no doubt the same, within the order of Spiders, with the characters derived from the form of the tracheæ and other internal organs, as with those taken from the external parts, or which have been found in their habits and instincts; in the same way as there are Orbitelariæ that do *not* construct a web, or only an irregular one, Lycosoidæ with only two tarsal claws (for instance *Thasyraea*), Pholcoidæ with only six eyes (*Spermophora*), Theraphosoidæ (Theraphosina, Auss.) with six spinnerets (*Hexathele*) or with only six eyes (*Masteria*), nay even Theridioidæ with only two spiracles (*Ctenium*), so there *may* be Thomisoidæ with simple, unramified tracheæ, Drassoidæ and Theridioidæ with a more highly developed system of tracheæ, &c.†

Scorpionini only *two* genera belong:—1. *Scorpio* (with the subgenera *Euscorpium*, *Buthus*, and *Brotheas*, and perhaps also *Hemiscorpion* and *Opisthophthalmus*), and 2. *Telegonus*. The Androctonini form a *single* genus, *Androctonus* (with the subgenera *Prionurus* and *Centrurus*). It is therefore quite natural that Prof. Lankester regards Peters's classification of the Scorpions as a failure, and the genera adopted by him as “in most cases unnecessary, often not even justifiable as subgenera.” On *my* attempt to develop this classification he says, “Thorell has added a number of genera to the already superfluous list, and has modified Peters's classification in what appears to me to be a retrograde spirit”; and, further, “Dr. Thorell has carried the formation of genera and subgenera too far.” To this I will only reply, that I have *never* proposed or adopted a *subgenus*, and that I do not understand why Prof. Lankester has done *me* the honour of mentioning my name; for as he is of course well acquainted with the works of all more recent authors in the field he treats of, he cannot be ignorant that other arachnologists, and especially *Simon* and *Karsch*, have increased the number of genera adopted by Peters and myself by a great many new ones, and that these authors therefore, more than I, are guilty of having modified the classification of the Scorpions in what Prof. Lankester considers a “retrograde” spirit. By going a little further in the opposite direction, or that now commenced by Prof. Lankester, one will, it is true, sooner and more easily arrive at a solution *ne ultra* of the problem how to divide the Scorpions into natural families and genera.

\* See, for instance, Metschnikoff, “Embryologie des Scorpions,” in *Zeitschrift für wissenschaftliche Zoologie*, xxi. 1870.

† I may be allowed here to mention a reason against laying, in the

The importance in the modifications in the *organs of generation* also appear to me to have been somewhat overestimated by Bertkau. That in the Dysderoidæ the testes and the ovaries are united so as to form a ring\*, just as in the Tetrapneumones, is a fact that shows, in combination with certain other features in the organization of the Dysderoidæ, that these spiders are more allied to the Tetrapneumones than are the other Dipneumones or Tristicta; and this is also generally admitted. But to draw from these resemblances the conclusion that they are more nearly related to the Tetrapneumones than to the Tristicta is, I think, erroneous, as the Dysderoidæ agree with the Tristicta not only in the direction in which the claw of the mandibles moves, and in the number of the joints of the inferior spinners, but also in their having only *one* pair of air-sacs—a character which, as I have already remarked, ought to have been, more particularly with Bertkau, of the most essential importance, and ought to have prevented him from separating the Dysderoidæ from the other Dipneumones and uniting them with the Tetrapneumones. That the Dysderoidæ have, in their general habitus, a striking resemblance with many Drassoidæ, cannot well be denied.

A character which, in Dr. Bertkau's classification, is of a certain importance for the limitation of the *families*, is taken from the different number (and the form) of the female's *receptacula seminis*. Thus the Tetragnathoidæ (Pachygnathidæ, Bertk.) differ from the Epeiroidæ and the Theridioidæ in having *three* such receptacles, not *two* only (A, p. 401). Their common opening is situated, together with the orifice of the oviducts, far (more or less) behind the spiracles; and this

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characterization of the different spider-groups, the chief stress on anatomical features, as this reason may to many persons seem to be of great weight, viz., the practical difficulties of determining, by means of such features, the systematic place of an unknown spider. And that these difficulties really exist, is seen, for instance, from the fact that many of the statements concerning the structure of the respiratory organs &c. given by such an experienced anatomist as Menge are, by Bertkau, shown to be erroneous. Moreover, it will, with the method in question, often be necessary to destroy the specimen that is to be determined, even in those cases where it belongs to a very rare species, or is a "unicum," and this is also a drawback of practical importance. But it may be objected against these remarks, that the aim of a natural system is not that of facilitating the determination of the different species, but of giving an expression of their real affinities; and this is true—though there might perhaps be found some means of reconciling both these claims. At least it would seem that if an anatomical feature really is of great systematic importance, there exists also some external feature that corresponds to it.

\* In *Tegenaria domestica* also the ovaries form, even till shortly before the maturity of the animal, a perfect ring (see Dahl, "Analytische Bearbeitung, etc.," *loc. cit.* p. 4).

"vulva" is not chitinized, but destitute of those horny parts which in descriptive works is generally called *epigyne* (*saro*, Menge). As this character in the female corresponds with a peculiarity in the shape of the male palpi (their tarsal joint has in *Tetragnatha* and *Pachygnatha* a long movable hook jointed to its base, which is absent in the males of the true Epeiroidæ\*), it may be reasonable to separate the Tetragnathoidæ, Menge, with *Pachygnatha*, from the Epeiroidæ, as a separate family. *Pachygnatha* is, however, on the other hand, very nearly related to certain spiders generally included in the genus *Meta*; this is shown, for instance, by the *Pachygnatha Vethii*, Van Hass.†, which is not a *Pachynatha*, but a true Epeiroid. An unchitinized vulva is also found in all Territelariæ, Dysderoidæ, Filistatoidæ, and Scytodoidæ, the males of which groups are distinguished by their simple, completely chitinized palpal bulb; but the bulb has this same structure also in certain Epeiroidæ, as *Nephila* and *Nephilengys*, the females of which have a chitinized vulva; and these modifications in the organs of copulation appear therefore, curiously enough, to be of rather subordinate importance.

As we have already seen, Bertkau divides his Tristicta into two great groups, *Cribellata* and *Meromammillata*, according as they are provided with, or destitute of, the unpaired spinning-organ called by Blackwall *cribellum*, the presence of which is always united with that of a number of peculiarly formed and symmetrically disposed hairs on the metatarsi of the last pair of legs, forming the organ called by Blackwall the *calamistrum*. All spiders which possess these organs were by Blackwall united into one family, the Ciniflonidæ, and Bertkau has now not only gone back to Blackwall's opinion of the systematic value of the organs in question, but has raised the Ciniflonidæ or Cribellata into a group of higher rank, divided into no less than nine families (*B*, p. 337)—Zoropsididæ, Miagrammopidæ, Filistatidæ, Œcobiadæ, Dinopidæ, Uloboridæ, Dictynidæ, Eresidæ, and Amaurobiadæ. Now it may at first view appear strange that not all, or at least many, of those arachnologists who have occupied themselves with the classification of the Spiders have maintained Blackwall's Ciniflonidæ as a family, or even as a group of higher rank; more especially as the cribellum and calamistrum are not only of importance in the economy of these animals, but the cribellum, as Bertkau remarks (*B*, p. 339), "is not an ordinary pair of spinners,

\* See Emerton, "New England Spiders of the Family Therididæ," in Transactions of the Connecticut Academy, vi. pp. 297, 298 (1884).

† Midden Sumatra, Reizen en Onderzoekingen der Sumatra Expeditie, etc. iv. 11, *A. Aranæ*, p. 32 (1882).

but an organ of quite a peculiar nature, and at the same time brings along with it the presence of another organ, the calamistrum." But notwithstanding this, and though it is by no means difficult to ascertain the presence or absence of the organs in question, the difference in this respect has not, in general, been considered a character of greater value than those on which subfamilies and genera are founded. The reason appears to be not only that of two in other respects closely allied species the one may possess, the other want the cribellum and calamistrum, but also that the other parts of the spinning-apparatus have been found to vary most materially within very nearly allied groups of spiders. The number of the spinners may in fact vary in the most extraordinary way. Within the family Theraphosoidæ (= *Theraphosini*, Auss.), which is characterized, among other things, by having only four spinners, there is, however, as has been said above, one genus, *Hexathele*, Auss., which has six spinners; within the genus *Storena* of the family Zodarioidæ (one of the most natural families in the whole order) there are not only species with all the six spinners well developed, but others in which the intermediate ones are rudimentary, or wanting, in one of the sexes alone; in some Zodarioidæ both sexes appear to be destitute of the intermediate spinners. In most Zodarioidæ the inferior spinners are much longer than the superior, in others these four spinners are of about the same length; sometimes (not always) the two inferior ones are fixed on a common basal part. In the Agalenoidæ the superior spinners are in general much longer than the inferior, and their second joint provided with tubuli textorii along its whole underside; but in some cases the superior spinners are only of the same length as, or shorter than, the inferior, and are provided with tubuli textorii only at the apex; sometimes (*Cybæus*) their second joint is rudimentary, &c. That the spiders which are provided with cribellum and calamistrum do not form a natural unit is admitted even by Bertkau (*A*, p. 386). Nor does he deny that spiders belonging to the two different groups Meromammillata and Cribellata may show an "outer resemblance" to each other—and it would indeed be difficult to deny that *Zora* is like *Zoropsis*, or that *Cælotes* and *Cybæus* resemble *Amaurobius*; but, says he, "this external resemblance does not prove anything as to the natural affinity more than the habitual resemblance of the shrew to the mice, or that of the blind-worm or the eel to the serpents, &c." (*B*, p. 340)—expressions which appear to me strange, to say the least. Or can it really be Dr. Bertkau's opinion that the presence or absence of a cribellum and calamistrum is of the same systematic

importance as the radical differences in the *anatomy*, and even in the external appearance, that exist between a fish and a reptile, between the eel and the serpent? To me it seems impossible to prove that the presence of the spinning-organs in question is a surer indication of affinity in those spiders which possess them than are most other structural features, anatomical or external. Rather the reverse might be supposed to be the case, from the fact that it is only the adult female and the young of both sexes of the Cribellata that are provided with the cribellum and calamistrum, whereas in the *adult males* these organs are rudimentary or totally wanting. The cause of this dissimilarity is of course this, that the adult males have no need of the apparatus in question, as they do not construct a web. And this again appears to me to prove that the cribellum and calamistrum are organs that have originally belonged to the order of Spiders in general, and have in the course of time been reduced and lost in a part of them, those namely which no longer wanted them; and this quite independently of their greater or less affinity. Thus it is easy to understand why we find these organs still in existence in spiders belonging to very dissimilar groups, and also why they are *always wanting in those spiders which lead a roving life and make no webs*. The possibility of explaining, on this hypothesis, the presence of the cribellum and calamistrum in spiders which in all other particulars are widely different from each other has not escaped Bertkau. "The systematic significance of the above-mentioned organs," says he, "might only be doubted in case that *all* spiders had possessed this fourth pair of spinnerets, but had, with the exception of some few genera, lost them in the course of time" (*B*, p. 339). But he does not show why this *cannot* be the case, nor does he say anything more on the subject.

For my part, then, I cannot acknowledge in Bertkau's Cribellata and Meromammillata two *natural* or systematic units; but I think that these denominations may, nevertheless, be of practical utility for designating the spiders in which the cribellum (and calamistrum) is present or is wanting. It would perhaps be better, however, to call them (*Araneæ*) *Cribellateæ* and *Ecribellatæ*—the Cribellata possessing jointed spinners, or being "*meromammillata*"\* quite as much as the other spiders. As to the families into which Bertkau has divided his Cribellata, some of them are no doubt so closely related to certain ecribellate families, that they could well be united with them. But on the ground of the modern, more and

\* I suppose, in fact, that the word *Meromammillata* is formed of *μέρος*, part (joint), and *mammilla*. The term *Ecribellatæ* is formed in analogy with *elapidatus*, *exoneratus*, &c. Compare also *Evertebrata* and *Vertebrata*.



more increasing splitting up of the older families into numerous new groups of the same denomination, it may perhaps not be inappropriate to regard the presence or absence of the cribellum and calamistrum as a character sufficient to distinguish families; and it must then be admitted that all the cribellate families adopted by Bertkau are good systematic units, though I, for my part, should prefer to unite his Dictynidæ and Amaurobiadæ in one family, Dictynoidæ, these two groups being only distinguished by the different development of their tracheæ. Now as to the distribution, among the generally received tribus, of Bertkau's nine cribellate families, they must be referred partly to the Orbitelariæ, partly to the Tubitelariæ; as yet there is no example of a cribellate spider belonging to any of the other tribus. To the Tubitelariæ belong the Zoropseoidæ, which are closely allied to the Drassoidæ; the Dictynoidæ (inclusive of the Amaurobiadæ, *Bertk.*), which are nearly related to the Agalenoidæ; the Eresoidæ, which, though very peculiar, may, as Bertkau thinks, be placed in the neighbourhood of his Amaurobiadæ; the Cæcobioidæ, which appear to have their nearest allies in the Urocteoidæ; and probably also the Filistatoidæ, which among the Cribellatæ are completely isolated, and have their allies among the Ecribellatæ, approximating in some respects to the Drassoidæ and the Scytodoidæ, and even to the Territelariæ.—There remain to be taken into consideration the Dinopoidæ, Miagrammopoidæ, and Uloboroidæ. The Dinopoidæ, whose systematic position has been so contested, and which I had formerly placed in the neighbourhood of the Agalenoidæ, would seem, on the strength of the important reasons alleged by Bertkau (*B*, p. 353 *et seq.*), to have their nearest allies in the Miagrammopoidæ and Uloboroidæ; as an additional reason for assigning this place to this family may be adduced the presence (at least in *Dinopis camelus*, Thor.) of so-called accessory or auxiliary tarsal claws, which, so far as I know, have only been observed in the Orbitelariæ and in part of the Retitelariæ. That the Miagrammopoidæ are allied to the Uloboroidæ is generally admitted. It therefore only remains to show that the Uloboroidæ should be placed in the tribus Orbitelariæ; for if this is settled, the two last-named families will, of course, follow along with them. Now it is in the first place a fact (which Bertkau, however, appears to doubt) that *Uloborus* is a true round-web spider\*; I have myself captured both *U. Walckenaerii* and *U. plumipes* in their circular, perfectly closed webs; and this fact is, I believe, one of the strongest proofs of the artificial

\* See for instance Thorell, "Till kännedomen om släktena Mithras och Uloborus," in Öfversigt af K. Vetenskaps-Akademiens Förhandlingar, xv. (1858), p. 194.

nature of the division of the Spiders into Cribellata and Meromammillata. Even if we do not assign, in general, any great weight in the phylogeny and classification of the Spiders to the form of their webs, it must be admitted that it is at least probable that spiders that fabricate regular or so-called geometrical webs have a common origin and belong to one and the same higher group, or, in other terms, that this industry cannot have arisen spontaneously and independently in two or more different and *natural* higher groups. What Bertkau has remarked (see above p. 322) as a proof of a close affinity between spiders with and spiders without a cribellum, may, with some modification and with more truth, be adduced as a reason for the affinity between the spiders which make circular webs. Only on the supposition that *all* spiders have originally constructed such webs, but that most of them have in the course of time lost this talent, could it be admitted that spiders belonging to radically different groups can give their webs such an artistically finished and almost identical form. But for such a supposition there is no reasonable ground. It may be uncertain which of the actual spiders are most nearly related to the original ones—whether it be the Territelariæ, or the Tubitelariæ, or another group; but that the first spiders were Orbitelariæ, nobody will, I believe, think possible. In the case before us, the form of the web appears to me to be of such importance that it can scarcely be overestimated. Moreover, the typical Uloboroidæ, *i. e.* the genus *Uloborus*, has so many *structural* features in common with the Epeiroidæ and Tetragnathoidæ, that also in this respect there is nothing that militates against the uniting the Uloboroidæ with these families in one and the same tribus. Any one who, without knowing the genus *Uloborus*, gets a specimen of this genus in his hand will, I believe, see that he has before him a spider that is related to *Epeira* or *Tetragnatha*. *Hyptiotes* deviates rather strongly both from *Uloborus* and from the Epeiroidæ, and demonstrates together with *Miagrammopes* and the Dinopoidæ, how materially even a natural group of spiders, such as the Orbitelariæ, may vary, both in its internal and external characters and in its industry.

From what I have here said, it will be seen that though I fully acknowledge Dr. Bertkau's merits in having given many most valuable contributions towards a more perfect classification of the Spiders, I cannot find that he has been successful in his attempt at laying down new principles for this classification. His chief groups, the Tetrasticta and the Tristicta, as also the Cribellata and the Meromammillata, and even the Perissonycha and the Artionycha, appear in fact to me to be rather artificial than natural units; and he has perhaps also

attributed too much importance to characters derived from the structure of some of the internal parts, especially the tracheæ.

It would of course be out of place to discuss here the value and systematic position of the different spider-families proposed of late years, and still more so to make any attempt at a complete classification of the Spiders, with an enumeration of all the different families and their characteristics; for such an attempt it is necessary to possess far richer materials, collected in all parts of the world, than are at my disposal. With the modifications for which we are indebted to Bertkau, and with those which I have permitted myself here to propose, the principal traits of the classification which, I think, would answer to our present knowledge of this Order of animals may, however, be seen from the following scheme, in which I have included as examples, besides the (recent) European families, only a few exclusively exotic ones.

Ordo ARANEÆ.

Subordo I. TETRAPNEUMONES.

Tribus I. TERRITELARIÆ.

- Fam. 1. Liphistioidæ.
- 2. Theraphosoidæ.
- 3. Atypoidæ\*.
- &c.

Subordo II. DIPNEUMONES.

Tribus II. TUBITELARIÆ.

- |                     |                       |
|---------------------|-----------------------|
| <i>Ecribellatæ.</i> | <i>Cribellatæ.</i>    |
| Fam. 1. Dysderoidæ. | Fam. 2. Filistatoidæ. |
| 3. Palpimanoidæ.    |                       |
| 4. Myrmeciodæ.      |                       |
| 5. Drassoidæ.       | 6. Zoropseoidæ.       |
| 7. Argyronetoidæ.   |                       |
| 8. Agalenoidæ.      | 9. Dictynoidæ.        |
|                     | 10. Eresoidæ.         |
| 11. Zodarioidæ.     |                       |
| 12. Hersilioidæ.    | 13. Ecobioidæ.        |
| 14. Urocteidæ.      |                       |
| &c.                 |                       |

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\* The denominations Atypoidæ, Epeiroidæ, and Thomisoidæ ought to be changed (see Thorell, "Studi sui Ragni Malesi e Papuani. IV. Ragni dell' Indo-Malesia," *loc. cit.*). That in the names of the families the termination *-oidæ*, which was used by, for instance, Cuvier, is preferable to *-idæ*, I have shown in 'Remarks on Syn.' p. 590, as also in "Descrizione di alcuni Aracnidi inferiori dell' Arcipelago Malese," in *Annali del Museo Civico di Storia Nat. di Genova*, xviii. p. 35 (19) (1882).

## Tribus III. RETITELARÆ.

- Fam. 1. Scytodoidæ.
- 2. Pholcoidæ.
- 3. Theridioidæ.
- &c.

## Tribus IV. ORBITELARÆ.

*Cribellate.*

- Fam. 1. Dinopoidæ.
- 2. Miagrammopoidæ.
- 3. Uloboroidæ.

*Ecribellatæ.*

- Fam. 4. Tetragnathoidæ.
- 5. Epeiroidæ.
- 6. Celænioidæ.
- 7. Cryptotheloidæ.
- &c.

## Tribus V. LATERIGRADÆ.

- Fam. 1. Heteropodoidæ.
- 2. Stephanopoidæ.
- 3. Thomisoidæ.
- &c.

## Tribus VI. CITIGRADÆ.

- Fam. 1. Lycosoidæ.
- 2. Oxyopoidæ.

## Tribus VII. SALTIGRADÆ.

- Fam. 1. Attoidæ.

XXIX.—*Notes from the St. Andrews Marine Laboratory (under the Fishery Board for Scotland).*—No. IV. *On a Male Tunny* (*Orcynus thynnus*, L.). By Prof. M'INTOSH, M.D., LL.D., F.R.S., &c.

[Plate XI.]

THE specimen was captured on the 16th October, 1885, by one of the ships of the General Steam Fishing Company of Granton, when trawling in the "Fluke-hole" or Traith in the Forth, off Pittenweem, in 15 fathoms, and was most courteously sent to the Marine Laboratory and the University Museum by Mr. Scott, the manager, who states that the fish was dead when the trawl (which had been down about four hours) was brought on board. A powerful fish like this would probably make desperate efforts in the net; yet the stout fins, though