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A SINGULAR ARACHNID (*KÆNENIA MIRABILIS* GRASSI) OCCURRING IN TEXAS.¹

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IN 1886 Battista Grassi² described as the representative of a new order a remarkable arachnid which he found near the base of Mt. Ætna in the campagna of Catania, Sicily. Grassi's description was imperfect and seems to have excited little interest in his discovery till Dr. H. J. Hansen in 1893 collected a number of specimens of the same species in southern Italy (near Palmi and Scilla in Calabria) and together with Dr. W. Sörensen published a careful description of the external anatomy, with some good figures of the animal.³

During the past spring, while collecting specimens of Iapyx, Campodea, and Scolopendrella, in the vicinity of Austin, Texas, I

¹ *Contributions from the Zoölogical Laboratory of the University of Texas*, No. 8.

² I Progenitori dei Miriapodi e degli Insetti. Mem. V. Intorno ad un nuovo Aracnide Artrogastro (*Kænenia mirabilis*) rappresentante di un nuovo ordine (Microthelyphonida), *Bull. d. Soc. entom. Italiana*, pp. 153-172. Anno 18. Firenze, 1886.

³ The Order Palpigradi Thor. (*Kænenia mirabilis* Grassi) and its Relationship to the other Arachnida, *Entomol. Tidskr.*, pp. 223-240. Årg. 18 H. 4, 1897. Taf. IV.

found a minute arachnid which at first sight resembled the whip-tailed scorpions (*Thelyphonus*), but on closer inspection proved to be something very different. Text-books were consulted in vain, with the single exception of Lang's *Vergleichende Anatomie*, which put me on the track of the *Microthely-*

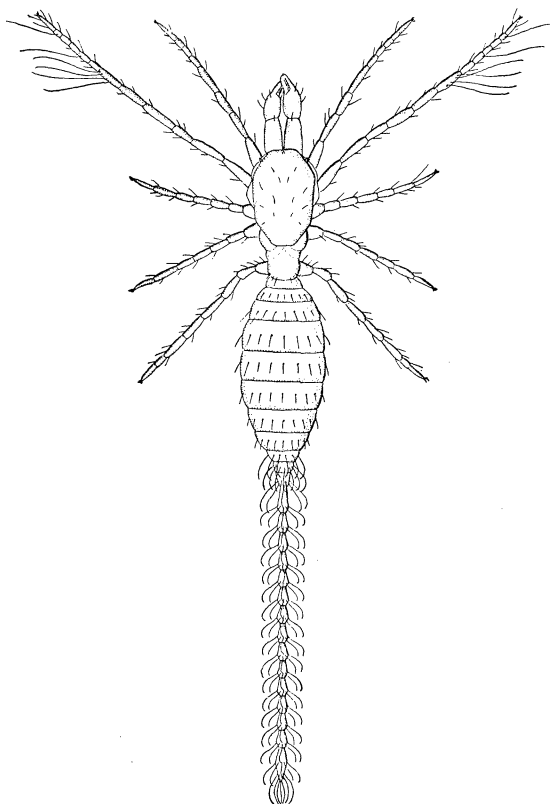


FIG. 1.

phonida of Grassi. Then, through the kindness of Drs. Hansen and Sørensen, I received a copy of their paper on *Kœnenia mirabilis*. To my surprise the Texan form proved to be identical with the Sicilian species !

In the following pages I shall consider, first, the external structure and systematic affinities of *Kœnenia* ; second, its habits and habitat ; and, third, its singular geographical distribution. If I repeat many of the statements in Hansen

and Sørensen's paper, this is because I have confirmed nearly all of their observations, published in a journal that may not be accessible to the reader, and because I am able to add a few facts of interest. An account of the internal anatomy, by Miss Augusta Rucker and myself, is reserved for future publication.

The observations of Grassi and Hansen and Sørensen refer only to the female *Køenenia*, as the male was quite unknown to these investigators. In more than a hundred specimens I find only one which may, perhaps, be the male of this arachnid. To this I shall return in the sequel, after describing the female.

The general appearance of the female is correctly shown in Fig. 1, although in life the first pair of appendages, the chelicerae, have their chelæ bent down so that they are not visible from above, and the caudal filament, or flagellum, is turned up over the back, or at least carried obliquely upwards. The length of the body varies from .7 to 1.25 mm.; the length of the caudal flagellum nearly equals that of the body. The animal is of a translucent white color except for the blades of the chelicerae, which have the yellow tint of thickened chitin. The general chitinous integument is very thin and transparent, scarcely differing in thickness in the segmental and intersegmental, and on the dorsal and ventral regions of the body. The body and limbs are sparsely covered with bristles, which have a characteristic arrangement. They are delicately plumose under a high magnification.

The trunk proper consists of the head, thorax, and abdomen. The head, comprising at least four segments, as indicated by its four pairs of appendages, is covered dorsally with an elongate octagonal cephalic plate, or shield. This is broadest in the region of the coxæ of the third pair of limbs. It is abruptly declivous in front to the insertions of the chelicerae. There are no traces of eyes, but Hansen and Sørensen have discovered two pairs of minute sense organs "as if in compensation" for the lack of visual structures.¹ "The foremost of these couples is situated in the median line of the body and on

¹ *Loc. cit.*, pp. 230, 231.

the front of the head, close above the first pair of limbs (chelicerae); it consists of two flat, lancet-shaped bodies, which by a common basal part are attached to the head, against which they are pressed. The second couple forms two blades, which are placed close up to the sides of the head above the coxæ of the second pair of limbs, and which, though deviating somewhat in shape, in quality very much resemble the first couple of blades; they turn, at least when in repose, horizontally forward and outward. As they are articulated to the head, it is not unlikely that they can move. Morphologically they are hairs." Hansen and Sørensen do not pretend to have demonstrated the sensory function of these structures.

The Danish investigators have also given an accurate account of the mouth of *Kœnenia*.¹ "It is simpler than in any other arachnid, nay, than in almost all other Condyllopods, no limbs at all participating in its forming, and we are of opinion that in this respect the mouth of *Kœnenia*, simple and plain as it is, presents great interest. It has the shape of a downward sloping protruding knot, and its opening consists of a relatively large split extending not quite up to the base of the mouth eminence. Seen from below, this split is slightly crescent-shaped and curves towards the front. It is bordered by two flaps which along its margins are furnished with a rather strongly chitinized "list" or frame, which seems to become somewhat weaker towards the corners of the mouth. The foremost or uppermost of these flaps no doubt constitutes the organ which in other Arachnida one of us (William Sørensen) calls the labrum (or, when divided into two parts, the clypeus and the labrum), but which otherwise (according to the different authors) goes by rather varying names (rostrum, epistoma, camerostoma). . . . We entertain some doubts as to how the lower or hindmost flap is to be understood from a morphological point of view. So for the present we will call it *hypostoma*, as we consider this name morphologically tolerably indifferent. It is furnished outwardly with very tiny backward turning hairs placed somewhat less close together than those on the labrum. The labrum, as well as the hypostoma, is

¹ *Loc. cit.*, pp. 226, 227.

movable, so as to allow the mouth to open and close. The muscles, which, by the bye, we have not examined more closely, are very strong."

The thorax, which is quite distinct from the head, consists of two separate segments, each bearing a pair of limbs. In this respect *Køenenia* resembles the *Tartarides* and *Solifugæ*, the only other arachnids with a bisegmental thorax.

The six pairs of limbs are, with the exception of the first pair, or chelicerae, of a remarkably simple structure. Even the chelicerae are of a primitive type, in that they consist of three joints. They are said by Hansen and Sørensen to "correspond entirely with the type appearing in the *Opiliones*," except in their minuter characters. The insertions of their long and powerful first joints are slightly to the sides of the mouth; a very significant fact, since in all the higher *Arachnida* these organs are definitely preoral. The second and third joints of each chelicera form a pair of pinchers. Each of these joints is furnished with a dense series of eight slender, pointed teeth.

The second to sixth pairs of appendages have essentially the same simple type of structure, although the pairs differ in length and in the number of joints. The formula of their lengths is as follows :

$$3 > 6 > 2 > 5 > 4.$$

The second pair have nine joints, the third twelve, the fourth and fifth each seven, the sixth eight joints. All the legs terminate in two claws and a curved pseudonychium. All are provided with a coxa, trochanter, and femur. The third to sixth pairs have a separate patella and tibia, but these two joints are represented by a single piece in the second pair. "The metatarsus is two-jointed in the second pair of limbs, four-jointed in the third pair, and undivided in the fourth, fifth, and sixth pairs." The "tarsus is three-jointed in the second and third pairs of limbs, one-jointed in the fourth and fifth, two-jointed in the sixth."¹

Although the second to sixth pairs of limbs are all used in

¹ Hansen and Sørensen, *loc. cit.*, p. 230.

running, the very long third pair are usually held aloft like antennæ when the animal is not disturbed and is moving about slowly. Some of the metatarsal and tarsal joints of this pair of appendages are provided with very long, delicate hairs of uniform thickness throughout. They are very probably sense-hairs (possibly auditory in function, as suggested by Hansen and Sørensen).

Between the insertions of the legs the ventral surface of the head and thorax presents a series of sternal plates to which the Danish arachnologists have called particular attention. The lower surface of the head has two of these plates, a larger anterior one just behind the mouth and corresponding to the second and third pairs of appendages, and a smaller piece corresponding to the third pair of limbs. Farther back there are two more sternal plates, one to each of the thoracic segments. The condition of the sternal apparatus of the head is emphasized "as a curiosity, as it is quite unique in Arachnida, which otherwise show no trace of independence in the segments constituting the head."¹

The abdomen is elongate elliptical in outline, without any traces of dorso-ventral flattening, and consists of eleven segments. The first is short and narrow, and on this account may be readily overlooked. The ninth, tenth, and eleventh are very much narrower than the preceding segments. The last bears the anus on its ventral surface. To its posterior surface the caudal flagellum is attached. The dorsal surfaces of the abdominal segments each presents a single row of bristles which are inserted rather far apart and near the middle of their respective segments.

Hansen and Sørensen have failed to give a satisfactory account of the ventral surface of the abdomen. The conditions are not so easily studied as might at first sight be supposed. Nor am I certain that my analysis of this region is complete, as my specimens differ considerably in the clearness with which they show certain structures, notably the complicated valves surrounding the genital orifice. I am of the opinion that segments two to six are each provided with a

¹ Hansen and Sørensen, *loc. cit.*, p. 226.

pair of appendages, presumably the serial homologues of the cephalic and thoracic limbs. The appendages of the second and third segments have come together in the median line to form four peculiar setigerous valves surrounding the genital orifice lying between these segments. The shape of the valves and the characteristic arrangement of their bristles are shown in Fig. 2. The anterior pair, which I regard as the appendages of the first segment, are arcuate and closely applied to each other in the mid-ventral line. Their posterior edges are raised on either side into six papillæ, each capped with a strong bristle. The posterior pair are flattened and enclose the orifice of the chitinous genital conduit between their bases. Their posterior edges are fringed with a series of graduated bristles. A profile view of the abdomen shows that the genital duct runs forward into the second abdominal segment. Thus *Kœnenia* would seem to agree with other Arachnida in having the reproductive orifice on the second abdominal segment.

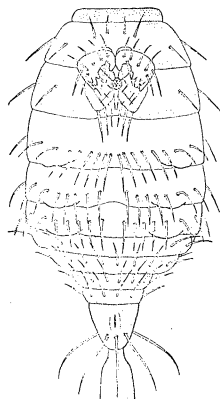


FIG. 2.

The ventral portions of the fourth, fifth, and sixth segments are nearly alike in structure. Each is provided with a single row of powerful bristles, which, though more or less interrupted in the median line, are nevertheless far more closely aggregated than those on the dorsal surface of the corresponding segments. On either side near the posterior edge of the segment there is a flap, the exact outline of which is not so clear as represented in Fig. 2. In many specimens a very delicate sac may be found evaginated from under the flap on all three segments. These sacs are in all probability lung-books. They appear to be the only respiratory organs of *Kœnenia*, apart from the delicate integument, which, in so small an animal, must of itself nearly suffice for respiratory purposes. I have had no better success than Grassi and Hansen and Sørensen in finding any traces of tracheæ. If I am correct in regarding the above-described sacs as lung-books,

they must represent these organs in an extremely simple form, in a form, moreover, which strongly suggests their origin from invaginated appendages serially homologous with those of the cephalic and thoracic segments. Whether these delicate organs may be everted by blood pressure and withdrawn by muscular action, like the collophoral tubes of the Collembola and the eversible sacs of Thysanura (*Machilis*, *e.g.*), remains to be determined. If this is the case, the hedge of bristles in front of the lung-book flap would seem to have a definite protective function.

Another lacuna in the observations of Hansen and Sørensen refers to the caudal flagellum. According to Grassi this organ contains altogether thirteen or fourteen joints. The greatest number of joints present in any of Hansen and Sørensen's specimens was nine, and on Grassi's authority they have added five joints of the same structure in fainter outline to the flagellum in their Fig. 1, Taf. IV. The flagellum is very easily broken, even after the animals have been transferred entire to alcohol, so that in upwards of a hundred specimens I found the structure complete in only ten individuals. Eight of these had fifteen, one had fourteen, and one had only eleven joints in the flagellum. There could be no doubt that in all these cases the flagellum was complete, as the terminal joint ends in a point and is longer and of a different shape than the preceding joints (Fig. 1). In my specimens, joints one to eleven have the structure described by Hansen and Sørensen.¹ Each "is fusiform, as if composed of two truncate cones, one long, the other short, united at their base, and adorned with two rings of backward-turning setiform hairs. In the foremost ring, situated on the widest part of it, we find, where we have been able to count the number, eight long, slightly curved hairs; in the hindmost terminal ring, sixteen much shorter, thinner, and less curved ones." In my specimens the posterior circlet of appressed bristles is lacking on the twelfth, thirteenth, and fourteenth joints. The terminal joint is twice as long as any of the preceding, fusiform in shape, and provided with two circlets of long, curved bristles.

¹ *Loc. cit.*, p. 233.

So much for the description of the female of *Kænenia mirabilis*. From this description a single specimen among my material differs so much that I am compelled to regard it either as the hitherto unknown male of Grassi's species or as an entirely new form. I choose the former alternative, since the differences are confined, so far as I am able to determine, to size, the structure of the genital valves, and the caudal flagellum. The specimen is only .5 mm. in length. The genital valves, seen in profile in Fig. 3, certainly have a very different shape from those of the female, although I am unable to form a clear conception of their structure. The caudal flagellum, represented in Fig. 4, consists of only six joints of gradually decreasing size. There are only six bristles in the larger



FIG. 3.

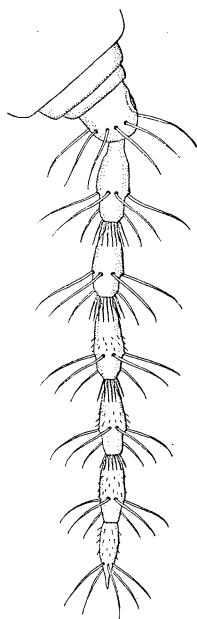


FIG. 4.

circling of each joint, and the smaller circling of appressed bristles is present only on joints one to four. In addition to the larger bristles, joints three to six have a number of minute scattered hairs. Of course we may consider the possibility of an abbreviated regeneration of the easily broken caudal flagellum, both in this specimen and in the case of the two above-mentioned females, with eleven and fourteen joints respectively. I am certain, however, that this six-jointed flagellum cannot represent merely a young stage in the development of the fifteen-jointed flagellum of the female, for I have seen several young female specimens of about the same size (.5-.7 mm.) with a large portion of the caudal filament, eight to ten joints, of the normal form.

From the description of *Kænenia* we pass to a consideration of its affinities. Grassi established it as the type of a distinct arachnid order, which he designated as *Microthelyphonida*, a term somewhat lengthy, to be sure, but nevertheless suggesting the small size of the

animal and its unmistakable resemblance to Thelyphonus, the whip-tailed scorpion. Without differing to an appreciable extent from Grassi in his conception of the taxonomic importance of Kœnenia, Thorell¹ has seen fit to change the name of the new order to *Palpigradi*. Hansen and Sørensen have adopted this name and have abandoned Grassi's. It would seem, however, that notwithstanding the aptness and brevity of Thorell's name, it can hardly be accepted without violating the law of priority in nomenclature.

Hansen and Sørensen make it clear that the Microthelyphonida are far removed from all the other orders of Arachnida, excepting the Pedipalpi. On this subject I cannot do better than to quote *in extenso* the opinion of these competent arachnologists²:

"While it is easy enough to show differences between Palpigradi and Scorpiones, Chelonethi, Solifugæ, Opiliones, Araneæ, and Acari, we confess that we should find great difficulty in detecting resemblances to these orders, except in the fact that they are all arachnids. Though, indeed, the order Pedipalpi is poor in species, its two suborders, Amblypygi (with the family Phrynoidæ) and Uropygi (with its tribes Oxopoei, the family Thelyphonoidæ, and Tartarides), exhibit great mutual differences, for instance, in the structure of the mouth. And, indeed, it is the most central of the orders of Arachnida; through Amblypygi it reveals decided affinity with Araneæ; through Tartarides with Palpigradi; and through Oxopoei, to a minor degree, with Scorpiones and Chelonethi. As stated by Thorell several years ago, Opiliones and Acari are closely related to each other, but we confess that these two, as well as the Solifugæ, must still be said to stand far apart from the others.

"As far as we can see, the most essential external characters of the different orders of Arachnida must be taken from the structure of (1) the mouth, (2) the antennæ (first pair of limbs), (3) the other limbs, and (4) the (real) number of the abdominal segments.

¹ Pedipalpi e Scorpioni dell' Arcipelago Malese, *Ann. d. Mus. Civ. d. Stor. Nat. di Genova*, vol. vi, pp. 327-428, 358, 2d Ser. Genova, 1888.

² *Loc. cit.*, pp. 236-338.

“1. The mouth of the Palpigradi (as we have already pointed out above) differs from that of all other Arachnida, nay, from that of almost all other Condylpods, in being formed exclusively by the labrum and the hypostoma. And even if *Kœnenia* did not offer other characteristics, this circumstance would, to our eyes, be sufficient to set it aside as an independent order.

“2. The antennæ (chelicerae) of the Palpigradi are three-jointed, and the two distal joints form a pair of pinchers with horizontal movement of the third joint against the prolongation of the second. In this structural feature *Kœnenia* agrees with the Opiliones and Scorpiones, and differs most decisively from the Pedipalpi, in which the antennæ are two-jointed and do not form real pinchers.

“3. The five remaining pairs of limbs are similar in all the most essential features, as none of the anterior three pairs (second, third, and fourth) are provided with maxillary lobes which help to form the mouth, but are developed exclusively as organs of movement, like the two posterior pairs of limbs which in all arachnids, where they are found at all, are merely instruments of movement. Therefore the foot (tarsus *s. lat.*) in all five pairs is divided into a metatarsus and a tarsus (*s. str.*). In the four posterior pairs of limbs patella and tibia are well developed, while in the second pair only one single joint is present.

“4. The abdomen consists of eleven segments, which are not divided into dorsal and ventral plates. In the Pedipalpi it consists of twelve segments, which (except the three hindmost ones in the Uropygi) are divided into a dorsal and a ventral plate. (Only in Amblypygi and Tartarides the first ventral plate is very sparingly chitinized.)”

The relationship of *Kœnenia* to other arachnids through the central group of the Pedipalpi is comparable to the relationship of the Thysanura (*Campodea*, *Iapyx*, *Lepisma*, *e.g.*) to other insect orders through the Orthoptera (including Dermaptera). In fact, *Kœnenia*, with its simple and generalized organization, reminds one of such phylogenetically important types as *Polygordius*, *Campodea*, *Scolopendrella*, *Amphioxus*, and *Myxine*. Like these animals, it undoubtedly combines in its organization

many simple ancestral characters with others, which, like the reduction or absence of eyes, tracheæ, etc., may be interpreted as the effects of degeneration. Till the internal structure of *Kœnenia* has been studied and compared with that of other arachnids, it is hardly possible to make more precise statements than the above concerning its phylogenetic relationships.

The statements made by Grassi and Hansen and Sørensen concerning the conditions under which *Kœnenia* lives in Sicily and southern Italy may be repeated almost verbatim for the Texan specimens. I have found them most abundant along the margin of a cedar thicket on a rocky hill (altitude about 700–800 feet), only a few minutes' walk from the campus of the University of Texas. They occur under stones rather deeply imbedded in the ground but easily overturned. The earth under these stones is of a very definite degree of moisture, which one soon learns to recognize when searching for specimens. The animals are found crawling over the surface of the stone, very rarely on the impressed soil. Sometimes four or five will be found on a single stone. They are very agile and easily escape into some crevice or under the particles of earth adhering to the stone. They are most easily captured, as Hansen and Sørensen have shown, by means of a fine brush dipped in alcohol.

In Europe *Kœnenia* was found associated with *Iapyx*, *Campodea*, *Pauropus*, and *Scolopendrella*. In Texas it is associated with the very same series of forms, excepting *Pauropus*, which I have not yet seen in this locality. I am inclined to believe that the arachnid feeds on the eggs of *Campodea* or *Iapyx*. I infer this from the fact that the intestine and its short diverticula are always filled with something very much like the yolk-bodies of an arthropod egg. Moreover, the *Kœnenia* was most abundant where the very young *Campodea* and *Iapyx* lived in greatest numbers.

The association of a group of forms like *Kœnenia*, *Iapyx*, *Campodea*, and *Scolopendrella* — all very small, primitive, and synthetic types, and all devoid of pigment and visual organs — in two localities so widely separated as Sicily and Texas, is of

considerable interest from the standpoint of ecology and geographical distribution. Although there is an unmistakable general similarity, due to similarity in climate and soil, between the southern European and the Texan faunas, this does not extend to identity of species in any case of which I am cognizant, except that of *Kœnenia*. One is at first tempted to suppose either that the arachnid is a native of Texas (and possibly also of Mexico and the West Indies) and has been introduced into Sicily and southern Italy with the century plant (*Agave*) and the prickly pear (*Opuntia*), or that, conversely, the arachnid has been introduced into America from Europe.¹ It would seem, however, that we cannot accept either of these alternatives, but are forced to the conclusion that *Kœnenia* is indigenous to both continents on account of the associated forms, for we can hardly assume that the species of *Iapyx*, *Campodea*, and *Scolopendrella* have also been imported.² It is certainly more reasonable to suppose that all these forms have a wide and disconnected geographical distribution as relicts of a very ancient fauna which have survived, like many cave forms (*e.g.*, the singular blind Menobranch Amphibians, *Proteus* and *Typhlomolge*), because they have inhabited conditions subject to little or no change during enormous periods of time. A striking instance analogous to that of *Kœnenia* has recently been brought to light in the form of a very primitive Thysanuran, *Projapyx stylifer*. This species, an *Iapyx*-like insect, with

¹ These plants, introduced since the discovery of America, are now so widely distributed in southern Italy that they form an essential part of the landscape. In Munich, several years ago, I saw a fine panorama representing imperial Rome in the days of Constantine. In this painting the artist, who had evidently studied the modern Italian landscape, had been misled into the amusing anachronism of filling out a corner of his canvas with clumps of *Agaves* and *Opuntias*! The above-suggested introduction of *Kœnenia* into Europe gains slightly in probability from the fact that a species of *Schizonotus*, a genus of minute Tartarids inhabiting Ceylon and Venezuela and somewhat resembling *Kœnenia* in structure and habits, has been introduced into Europe in connection with exotic plants (*teste* Pocock. The Geographical Distribution of the Arachnida of the Orders Pedipalpi and Solifugæ, *Natural Science*, vol. xiv, No. 85, March, 1899, pp. 213-231, 217).

² The American species of these Symphyla and Thysanura are certainly very similar to the corresponding European forms, and may yet be proved to be identical in the light of study as thorough as that which has been devoted to the taxonomy of some other groups of insects.

eleven-jointed cerci in the place of the more specialized anal forceps, was discovered by O. F. Cook in Liberia. Very recently the same form was taken at Federacion in the Argentine Republic by Silvestri.¹

COLEBROOK, CONN., August 14, 1900.

¹ Anche *Projapyx stylifer*, O. F. Cook, nella R. Argentina. Nuovo genere di Polyxenidæ, *Zool. Anzeiger*, Bd. xxiii, Nr. 609, March 5, 1900, pp. 113, 114.