

Publié par l'Académie Polonaise des Sciences et des Lettres.  
Rédacteur: Jan Stach, Directeur du Musée d'Hist. Natur.

Publié le 20 décembre 1945.

Drukarnia Uniwersytetu Jagiellońskiego pod zarządem Karola Kiecia  
M-05442

## The species of genus *Arrhopalites* Börn. occurring in European caves.

By

JAN STACH

Director of Natural History Museum, Kraków, Poland.

(Plates I—X)

The representatives of the genus *Arrhopalites* Börn. belong to the common *Collembola* occurring in European caves. This genus is not rich in the species in general and in Europe only two species namely *Arrhopalites coecus* (Tullb.) and *Arrhopalites pygmaeus* (Wank.), more often noted under the name *Arrhopalites binoculatus* (Börn.), have been described properly up to date.

The first species *Arrhopalites coecus* (Tullb.) were found in 1871 by Tullberg (15) under flowerpots in Sweden. This species is apparently very well characterised and easily recognised by its macro furnished with a „globular” end and its name is unchanged.

The second species, which for the modern requirements of the systematization was even less exactly defined was treated as a kind of lumber-room, in which were placed all the forms which resembled *Arrhopalites coecus* (Tullb.), but different from it in the absence of the „globular” end on the macro. But rarely is a more remarkably distinct form of this group taken out and differently named, for example the subspecies *Arrhopalites pygmaeus aggtelekiensis* Stach described by me (14).

Dr Denis has already remarked (8) on the difference in the form of the subanal appendages of females in animals grouped by various authors under the name *Arrhopalites binoculatus* Börn. and has given the opinion, that this species represented a group of the various forms. In 1937 he wrote (9) upon this species: „Il est possible que l'espèce soit a démembrer”.

The rational division of this group into an independent species is not, however, a simple matter because we lack the data which would enable us to state with complete certainty that one form represents an independent species while another does not.

At all events, however, we may state, that the European forms of the genus *Arrhopalites* Börn. and probably certain of the American and Australian forms also, may be divided into two groups namely the smaller *coecus*-group and the *pygmaeus*-group, which is much richer in forms.

I use for the second group the name *pygmaeus*, since I am wholly convinced, that on the ground of priority-principles this name and not *binoculatus* should be used. There is no doubt that the specimens collected by Wankel in the Moravian caves and called by him (17) *Dicyrtoma pygmaea* were a species of this second group of genus *Arrhopalites*. Indeed there are in the description of the animals by the author (18) and in the added drawings, incorrect details, for example that the abdomen of the animals is furnished with „jederseits zwei Sprungfäden“. These were certainly parts that had become attached to the body of the animal, probably the legs of another animal. But the other figures (pl. I, fig. 13 and 14) and the characteristics of the animal described, as for example the existance of only one black pigmented eye on each side of the head and the fourth antennal segment subdivided into five joints, make it possible to define the animal described by Wankel quite definitely as *Arrhopalites* namely as belonging to the second group of this genus. In 1899 Absolon described (1, 2) the animals from the same Moravian caves more extensively. This description is not indeed faultless either, but one can conclude from it, that in these animals the terminal bristle on the empodial appendage of the first foot were long and there was a strong spine on the dens near the basis of the macro. In 1907 also Absolon wrote (p. 342) explicitly (4) that the animals described by Wankel and by himself were identical with the *Sminthurinus binoculatus* established by Börner (6) in 1901. That these animals agree even to the form of the subanal appendages in the female is a fact not to be excluded. Absolon wrote, that in the animals studied by him, there was

on the last abdominal segment „ein mächtiger Dorn aus einer fleischigen Erhöhung hervorragt“. This „Dorn“ was naturally the one subanal appendage; the second „Dorn“ was not observed by Absolon and he has incorrectly remarked, that the males are furnished with these spines. Since Börner wrote, that his *S. binoculatus* has the subanal appendages also „borstenförmig mit abgestumpfter Spitze“, so it is very probable that the animals described by both these authors are identical.

Both the groups *coecus* and *pygmaeus* differ conspicuously from one another in one constant characteristic, namely that in *coecus*-group on the dens near the base of the macro the spine is situated on the under-side, and in *pygmaeus*-group on the outer-side. To these may be added also certain other differences in characteristics, namely the presence of small spines on the anal lobes in the *coecus* and their absence in the *pygmaeus*; a different clothing of the dentes with bristles especially on their under side; the different length of the terminal bristles on the empodial appendages and other minor characters. But none of these differences is so remarkable and so important in the division of the species into these groups as the first difference.

However in each of the groups which exist in Europe there are forms, which in the characteristics of their bodies are also quite stabilised and which seem to differ even more within their own main group, than the two groups do from each other.

There lives, for example, in the great Hungarian cave near Aggtélek one interesting form, in which the fourth antennal segment is not divided into 5 joints as usual in the *pygmaeus*-group but into 9 or 10 joints; on the empodial appendages all the legs have not long but short terminal bristle; and on the outside of dentes only one single spine is present. So much for the independent species, which differs in many characteristics from the principal form of the *pygmaeus*-group.

Again in the Lanbardaso-cave in Spain there lives a form, which has characteristic forked subanal appendages, a conspicuous sense papilla on the base of third antennal segment and long untoothed empodial appendages.

Or conversely the form from the Postumia-cave is furnished with leaf-like, definitely broadened and toothed subanal appendages, a fourth antennal segment divided into 7 joints and toothed empodial appendages.

Or there is the form only living free in nature with broom-like richly branched subanal appendages, without a sense papilla on third antennal segment.

But all the forms here mentioned and still anothers placed with them in the same group, have a constant characteristic, namely the presence of the outer spine on the dens near the base of the mucro.

In what genetical and systematical relations do these forms stand to each other?

Some of these forms often live in one single cave, while others live in caves situated not far from each other. Probably we must consider each of the forms arising there as distinct modifications of one species caused by different conditions of life. So they would be elements of the one race-group of the one species. Some of them have many common characteristics, which make it possible to class them together in the one species. Other of these modifications have become so far removed from their original type, that to-day they seems to be an independent distinct species. The line between these modifications and distinct species is not easy to draw.

The classification of forms of the genus *Arrhopalites* at which I have aimed and which is based on animals carefully examined by me, may therefore be regarded as a trial, the aim of which is to make it easier to classify other forms for geographical and systematic purposes.

The animals studied by me come from numerous caves of various countries in Europe. When the ancestors of these animals went into these caves, it is difficult to say; it stands in relation to the time of the origin and of the geographical site of these caves. The forms of the *coccus*-group belong to the troglophil animals, which have probably not lived in some caves for long, because to-day they are also found, mostly under flowerpots in dwellings. One cannot find any remarkable difference between the animals collected in the caves and those living outside.

On the other hand among the species belonging to the *pygmaeus*-group, there are many which always live only in caves, like the real troglobionte, and which appear to to have become so adapted to the conditions of life in the interiors of these caves, that to-day they would probably be unable to live on the surface of the earth, outside. One species of this group namely *Arrhopalites principalis* lives outside the caves, but only in the North and in chains of mountains; it is therefore a boreoalpine form. The distribution of the boreoalpine forms usually stands in a certain relationship to the diluvial period. Some descendants of this species of *Arrhopalites* probably moved into the caves during the warm arid period of the post diluvial-time and there underwent modifications. The occurrence of some forms which are more distinctly different from *Arrhopalites principalis* in the caves, which were further removed from the direct influence of the glacial-period, as for example in the Postumia-cave in Jugoslavia or in the Spanish caves, seems to indicate the longer period of time for which they lived in these caves. It may also be, that these forms are descendants of the one Southern European species, which once lived above ground and were distinct from the northern form.

The genus *Arrhopalites* seems to be an archaic element of the fauna and its representatives live in all the continents.

#### Genus *Arrhopalites* Börner 1906.

The genus *Arrhopalites* was established by Börner (7) in 1906 as the only species known in Europe at the time. He characterised this genus as follows: „Analsegment selbständig, meist durch das einen Sattel bildende Genitalsegment mit dem Furcalsegment verbunden, Genitalsegment selten dorsal mit diesem verschmolzen, jederseits nur mit 1 Bothriotrich. Tibiotarsen endwärts ohne Keulenhaare, Antenne IV bei erwachsenen Tieren (immer?) gegliedert, dorsale Mucronalränder gleichartig“.

These characteristic were enlarged but also narrowed afterwards by various authours. So in 1912 Linnaniemi added (12), that „Ant. IV bei erwachsenen Individuen deutlich

sekundär gegliedert ist". Bonet (5) in 1932: „Sin órgano tibiotarsal, ojos en número reducido, mucrones sin láminas, regularmente dentados". Womersley (19) in 1932: „Antennae III with or without peg-like organ". Denis (8) in 1933: „3 paires de trichobothries sur le grand abdominal, pas d'égots, toujours moins de 4 yeux par côte". And Mills (13) in 1934: „Eyes and pigment usually reduced, dentes dorsally and laterally with conical pegs".

According to the characteristics given by Börner the genus *Arrhopalites* differs from another related genera principally in the absence of the clavate tibiotarsal hairs, in the division of the fourth antennal segment and in the form of the mucro, which is equal on both sides. In this description nothing was said of the number of the eyes, the presence of spines on the dentes, the serrated edges of the mucro and so on. We can naturally, therefore, accept or reject various after-additions to this description made by later authors.

I have no intention of considering here the known species of *Arrhopalites* from various continents, for some of them have been very incompletely described, as Denis has already remarked in his fine work on the Collembola of Costa Rica.

But it also seems to me that some of the species of the genus *Arrhopalites* described lately do not fit into the limits of this genus. As for example:

*Arrhopalites adelaidica* Womersl. (20) from South Australia, which has its fourth antennal segment subdivided in to 20—25 joints; 7 (8?) eyes on each side of the head; no spines on the dentes; and to judge from fig. 1 e — untoothed edges of the mucro. The subanal appendages are not described.

*Arrhopalites auratiaca* Womersl. (21) also from South Australia with eight eyes on each side of head; without spines on the dentes; and with only one, inner edge of the mucro serrated (fig. 5 h). The subanal appendages are not described.

Also the *Arrhopalites diversus* Mills 1934 described by Mills (13) from Iowa (U. S. A.) cannot be classed in this genus. Their fourth antennal segment is not subdivided; and this species has an unusual form of claw for the genus *Arrhopalites*,

which is furnished with „a long, spine-like inner tooth inserted on the posterior face" and is reminiscent of the form of the claw in *Megalothorax* or *Oncopodura*. In my opinion it is necessary to establish a distinct genus for this species and this I propose to name *Pseudarrhopalites* nom. nov.

Because up to date we are not able to place for certain in the genus *Arrhopalites* Börn., all the forms which have eight eyes on each side of the head, it is my in opinion generally best to accept the limitations given by Börner and Denis and place in this genus only those forms, which have a reduced number of eyes (at the present time mostly 1+4) and both edges of the mucro serrated.

The description of the genus *Arrhopalites* Börn. run as follows: „The anal segment separated, on each side has only one bothriotrich; the genital segment has mostly a saddle-like form; the great abdomen furnished with 3 pairs of the bothriotricha. The female has differently shaped subanal appendages. On the basis of the third antennal segment there may or may not be wart-like sense papilla; the fourth antennal segment is more or less distinctly subdivided. Mostly only one pigmented or unpigmented eye; at all events a reduced number of eyes (at this time the greatest number of eyes on each side of head is 4). The clavate tibiotarsal hairs are absent. The dentes with one or more spines. Both the edges of the mucro are serrated. Mostly troglobiont or troglophil animals".

The species which belong here are divided at the present time into two groups:

1. — *coecus*-group with only one spine on the under-side of the dens situated near the base of the mucro and with some small thorns on the anal lobes;

2. — *pygmaeus*-group with the outer spine of the dens situated near the base of the mucro and without the thorns on the anal lobes.

#### Key to species of the genus *Arrhopalites* Börn studied by me.

1. — The spine on the under-side of the dens near the basis of the mucro present; no spine on the out-side of the dens ..... *coecus*-group 2

- 1'. — No spine on the under-side of the dens; one strong spine on the out-side of the dens near the basis of the mucro present ..... *pygmaeus*-group 3
2. — The subanal appendages strong; the claws with distinct inner tooth; empodial appendage of all the legs with tooth ..... *Arrhop. coecus* (Tullb.)  
Troglphil, wide spread in Europe
- 2'. — The subanal appendages thin; the claws with a very small inner tooth; the empodial appendage of the third leg untoothed ..... *Arrhop. tenuis* Stach  
Troglbiont; Westfalen (Hülloch-cave)
3. — On the dens only one spine, namely the outer spine... 4
- 3'. — On the dens besides the outer spine still other spines... 5
4. — The IV antennal segment subdivided into 6 joints; the III antennal segment without the sense papilla; the subanal appendages straight, on the tip 4 to 5 very small teeth ..... *Arrhop. boneti* Stach  
Troglbiont; Spain (Aitzquirri-Hernialde-, S. Adrian-cave)
- 4'. — The IV antennal segment subdivided into 9 to 10 joints; the III antennal segment with the sense papilla; the subanal appendages branched at the point .....  
*Arrhop. aggtelekiensis* Stach  
Troglbiont; Hungary (Aggtelek-cave)
5. — The III antennal segment with the distinct sense papilla ..... 6
- 5'. — The III antennal segment without the sense papilla ..... 7
6. — The subanal appendages with the point deeply split into two branches ..... *Arrhop. furcatus* Stach  
Troglbiont; Spain (Landarbaso-cave)
- 6'. — The subanal appendages strongly branched .....  
*Arrhop. ornatus* Stach  
Troglbiont; Spain (Castillo-cave near Puent Viesgo).
7. — The subanal appendages leaf-like broad, with serrated edges ..... 8
- 7'. — The subanal appendages not broad ..... 9

8. — The IV antennal segment subdivided into 6 to 7 joints; three times as long as the III antennal segment; the subanal appendages broad ... *Arrhop. postumicus* Stach  
Troglbiont; Jugoslavia (Postumia-cave)
- 8'. — The IV antennal segment subdivided into 5 joints, only two and a half times as long as the III antennal segment; the subanal appendages narrower .....  
*Arrhop. canzianus* Stach  
Troglbiont; Jugoslavia (S. Canziano-cave)
9. — The subanal appendages only split into 2—3 branches or unbranched, and only serrated on the edges ..... 10
- 9'. — The subanal appendages broomlike, split into numerous branches ..... 11
10. — The subanal appendages unbranched at the tip, serrated on the edges ..... *Arrhop. pygmaeus* (Wank.)  
(= *Arrhop. binoculatus* Börn. nec Linnaniemi)  
Troglbiont; common in the caves of many lands.)
- 10'. — The subanal appendages split into 2—3 branches .....  
*Arrhop. bifidus* Stach  
Troglbiont; common on the caves in Poland and Germany
11. — The subanal appendages broom-like split into more branches; branches curved at the top .....  
*Arrhop. principalis* Stach  
(= *Arrhop. binoculatus* Linnaniemi nec Börner).  
Outside of the caves, wide spread.

### *Coccus*-group.

#### *Arrhopalites coecus* (Tullberg 1871)

*Arrhopalites coecus* was established in 1871 by Tullberg (15) and in the following year two more drawings (pl. III, fig. 24, 25) were added by the author (16) to the short description of this species in which appear, the furca and the characteristic broadening at the tip of the mucro.

This „kugelförmige” globular broadening at the tip of the mucro was afterwards accepted as the decisive mark in the identification of this species and while the data given by

most authors about this species are usually founded on observations of specimens living under flowerpots, where they generally live, these determinations are probably correct, although the globular broadening at the tip of the mucro is not exclusive to this species, but is found also in the species living free in nature.

An accurate description of the species and some figures are given by Linnaniemi in 1912 (12).

The animals are mostly white, unpigmented; more rarely the ferruginous pigment appear on the body in scattered spots.

The body is very sparsely covered with short hairs, especially on the fore-part of the abdomen; on the hind part the hairs are somewhat longer, but not longer than the claw on the third pair of feet.

Antennae longer than head diagonal, as 10 : 7, distinctly shorter than in the other species of this genus. Antennal segments I : II : III : IV = 1,5 : 3,5 : 5,4 : 10,5; the fourth antennal segment is at the most but only in a few cases as long as the third. The third antennal segment without the wart-like sense papilla, but with subapical sensory organ; this consists of two straight sense rods parallel to each other, situated in a shallow pit. The fourth antennal segment indistinctly subdivided into 5 joints; this subdivision is often so indistinct, especially after usage of the potage-buck, that the fourth antennal segment seems undivided. In rare cases or in young animals this antennal segment may really be not divided.

On each side of the head behind the antenna one eye, elliptical and always unpigmented; it is smaller than in the other species of the genus *Arrhopalites*.

A claw always with one distinct inner tooth, occurs on the first pair of legs a little above the middle of the ventral lamella, and on the second and third legs in the middle. The claw of the first pair of legs is longer and more slender than that of the second and especially of the third leg, where it is distinctly shorter, broader and more curved. The wholly different statement given by Linnaniemi (12) seems to be at fault. The empodial appendages on all the pairs of the legs are differently formed. On the first foot this is furnished with a distinct

tooth near the basis on the inner lamella; the both lamellae, but especially the outer are narrow, whereas the apical bristle is pretty long, slightly overreaching the inner tooth of claw. The empodial appendage of the second foot is also furnished with a large tooth on the inner lamella, yet this standing distinctly higher than on the first foot; the outer lamella is broader, less bent and without the apical bristle. In the empodial appendage of the third foot the inner lamella is bowed and furnished with a fine tooth situated high up and without the apical bristle.

The dens is about (1,4)—1,5 times as long as the mucro. It is very characteristically covered with hairs; namely here the spines, existing in the other species of the genus *Arrhopalites* on the outer and inner side of the dens are absent, whilst the one strong spine on the under-side to the dens near to base of the mucro is always present. This species may be recognised at once by its spine. On the each side of this spine on the under-side to the dens stands one short fine bristle and behind this one pair of longer bristles and further still proximally 3 longer bristles one after another in one long-row. Dorsally on the outer-side of the dens there stands sideways near the basis of the mucro one short thicker bristle and further again proximally in one long-row one after another 4 sharply pointed bristles the base of which is so thick that they appear similar to the spines; the bristle standing more widely near the basis of the dens is longer than the 4 standing before, but not so thick, unlike the spine. The bristles on the inner-side to the dens are of the usual form, only the one standing near the basis of the mucro is a little thicker, but short.

The mucro is narrow, gutter-like, densely serrated on both edges, at about 2/5 of its length it distinctly and abruptly narrows, at the tip it broadens into the form of a shovel. This broadening at the end of the mucro seen in side view is „globular”.

The tenaculum has 3 barbs on the ramus, the club-shaped appendage, and two fine bristles on the tip of pars anterior.

The anus is surrounded with some long, strong, bristles lying close to the body; these bristles are often a little broader near their base. Between the strong bristles there also stand

some shorter setae and on the each side on the upper and under part of the anusvalves (1)—2 short fine spines.

The female subanal appendages in side view are straight and gradually narrow towards the tip; viewed from above they are straight, equally thick throughout their length, at the tip indistinctly and weakly serrated (with 4—5 fine teeth).

The length of the body in the largest adult specimens is usually not 1 mm.

*Arrhopalites coecus* (Tullb.) is the most easily distinguished from the other species of this genus by the presence of the one thick spine on the under-side to the dens near to basis of the mucro; by the absence on the strong, stumpy spine on the outer-side of the dens; farther by the short apical bristle on the empodial appendage of the first foot; by the absence of the pigment in the eye; by the indistinct subdivision of the fourth antennal segment; and the presence of the short fine spines on the anus valves.

*Arrhopalites coecus* (Tullb.) is one of the commonest collembolous, occurring in dwellings under flowerpots in great abundance. It more rarely lives in caves often together with the other species to the genus *Arrhopalites*. Yet more rarely a single or a few specimens occur in the open and then not only near human settlements, but also in places far distant from them, as for instance in mountains under stones or mostly under the loose bark on the trunks of old trees in mountain-forests, for example in the Tatra chain of mountains or in the East-Carpathian mountains (Czarnohora-chain of mountains).

*Arrhopalites coecus* (Tullb.) seems to be, at least in Europe, widely spread. As this species in the various lands, where it has been recorded, was found nearly exclusively under flowerpots, where the other species of *Arrhopalites* do not occur, it may be accepted, that nearly all the definitions of it as *Arrhopalites coecus* are correct.

But there are also some cases, where the identification of this species, in my opinion, is not perfect in all points.

It seems for example, that the one described by Folsom (10) in 1896 *Smynturus benitus* Fols. is not identical with *Arrhopalites coecus* (Tullb.), although it was taken by Guthrie, Linnaniemi and other authors to be the same

as this species. To judge from the description of this species by Folsom, the great length of the fourth antennal segment in relation to the third antennal segment (9 : 3,5); the dens differently clothed with hairs and the unusual occurrence of the animals in ants-nests, gives colour to the theory, that in this case it is another species.

Neither do the animals determined by Guthrie (11) *Arrhopalites caecus* (Tullb.) from Minnesota (U. S. A.) belong to this species. They have not the spine on the underside of the dens whereas there is one strong spine on the outside. This species undoubtedly belongs to the *pygmaeus*-group.

It also seems that the animals described briefly by Womersley from Australia are not — to judge by the drawings — of this species. Indeed the animals — according to the description have — „The mucrones with serrated edges and a clubbed apex”, but in the drawing (fig. 4 e) the edges of the mucro are quite smooth, the tip of the mucro not „globular” broadened and the dens is differently clothed with hairs from those in *Arrhopalites coecus* (Tullb.).

Perhaps the *Arrhopalites coecus* found by Linnaniemi in Finland is not identical with this species, as they have „bandförmige, am Ende etwas gedrehte” subanal appendages. In the original-specimens described by Linnaniemi the clothing of the dens with hairs and the form of the claws and of the empodial appendages must be examined. The specimens sent me by Prof. Linnaniemi, which were collected under flowerpots in a house in Finland, have the subanal appendages not screwlike („gedreht”), and the hairs of the dentes, the form of the claws and of the empodial appendages wholly resemble those in the animals occurring in other lands.

The animals studied by me were found:

- Poland. — Kraków, under flowerpots in a house, 12. VI. 1913;  
 — Korabniki near Skawina, under flowerpots in a house,  
 18. VIII. 1916;  
 — Czarny Dunajec, under flowerpots in peasant house, 5. VII. 1919,  
 9—13. VIII. 1920, 4. VIII. 1921;  
 — Zakopane, under flowerpots in peasant house in Krzeptówki,  
 17. VIII. 1932, 28. VII and 3. VIII. 1933;

- Poland — Tatra-mountains: Koscieliska-valley, under mouldering wood on the Kopki-declivity, cca. 1100 m, 11. VII. 1933;  
 — Beskid-mountains; Krynica, on the summit of a hill under a stone near pine-forest, cca. 700 m;  
 East Carpathian mountains. — Zaroślak in the Czarnohora chain of mountains, under semi-detached bark of a large pine-trunk, lying on the ground, cca. 1350 m;  
 — on the basis to the Dancierz-peak in Czarnohora chain of mountains, under a stone on the upper limit of the pine-forest, cca. 1600 m;  
 Finland. — Under the flower-pots in a house, 28. III. 1929, leg. Prof. (Axelsson) Linnaniemi;  
 Sweden. — Tyllinge (distr. Kalmar) in a green-house, leg. H. Schödt;  
 Germany. — Franconian caves; Marderloch near Artelshofen, leg. Spoecker;  
 Hungary. — Aggtélek-cave, the interior of the cave, 31. X. 1929, leg. Prof. E. Dudich.

### *Arrhopalites tenuis* n. sp.

The animals preserved in alcohol are unpigmented, white.

The body is clothed very sparsely with short setae, especially on the fore part of the abdomen; on the hind part the hairs are a little longer, but shorter than the claw of the third pair of feet.

Antennae longer than the long-diagonal of the head, about 10 : 7, distinctly shorter than in another species of the *pygmaeus*-group. Segments I : II : III : IV = 1 : 3 : 5 : 10; the fourth antennal segment is therefore twice as long as the third. The third segment without sense papilla in the middle of the length to the segment; the subapical sensory organ has two straight parallel sense rods situated in a shallow pit. The fourth antennal segment indistinctly subdivided into 5 joints; this subdivision is often so indistinct, especially after the use of the potash-buck, that the fourth antennal segment seems to be undivided.

On each side of the head behind the antenna is a small, unpigmented eye.

The claw has one very small fine inner tooth, which on the first pair of feet may be lacking altogether; on the claw of the second and third pair of feet this tooth is situated in the lower half of the ventral lamella near the middle. The claw on the first pair of feet is distinctly more slender and

longer than that of the third pair. The empodial appendage on all the pairs of feet is of a different form. On the first pair of feet it is definitely prolonged, with one distinct corner-tooth on the inner lamella, a narrow outer lamella and an apical bristle, which is shorter than the claw. The second pair of feet is also furnished on the inner lamella of the empodial appendage with one larger corner-tooth, which is situated a little higher than on the first pair; the outer lamella is straight, pretty broad and the empodial appendage is acutely pointed. The empodial appendage of the third pair of feet is broad lancetlike, with bow-like untoothed inner lamella and without apical bristle.

The dens is about 1,5–1,6 times as long as the mucro. The dens is covered as in *Arrhopalites coecus* (Tullb.); on the under side of the dens is situated near the base of the mucro one strong spine, on each side of this spine stands one short seta, behind them one pair of longer setae and more widely proximally 3 longer bristles side by side in one long-row. Dorsally on the outer-side to the dens is situated at the side near the basis of the mucro one short thicker bristle and more widely in one long row one after another 5 longer, acutely pointed bristles; the sixth bristle situated near the basis of the dens is longer than the one standing before, but not so thick; on the inner side of the dens the setae are not very characteristic.

The mucro is narrow gutter-like, densely serrated on both edges, near its centre it distinctly narrows and at the tip broadens into the form of a shovel as in *Arrhopalites coecus* (Tullb.).

The tenaculum has 3 barbs on the ramus, with club-shaped appendage and with two fine bristles on the tip of the anterior pars.

The anus is surrounded by some long strong bristles lying close to the body; some of these broaden out sideways a little at the base. Between the strong bristles stand some shorter ones and on each side on the upper and under part of the anus-valves 0–2 short fine spines; usually there are on each side on the upper valve 2 spines and on the under valves 1; sometimes there is one spine on one undervalve and the other may have none.

The female subanal appendages viewed from the side are straight, gradually narrowed towards the tip; viewed from above they are straight, almost the same thickness throughout their length, remarkably thin and undistinctly serrated at the tip.

The length of the body in the large adults of the specimens is 1 mm.

The *Arrhopalites tenuis* resembles the *Arrhopalites coecus* (Tullb.) in so much, that it may be taken for a local form of this species. It is similar to the above in the covering of the dentes, in the presence of fine spines on the anus-valves, and in the similar form of the empodial appendages. But differs from it in that the subanal appendages are remarkably thin; the form to the empodial appendages is somewhat different (for example the empodial appendage on the third pair of feet is untoothed); and the inner teeth on the claws are very indistinct.

To day this species is only found in one single cave, namely in Hülloch-cave near Krispe in Westfalen.

Place in which found:

Germany. — Westfalen, Hülloch-cave near Krispe (dist. Altona) IV and X. 1931, I. IV, 1933, leg. Dr. W. Griepenburg.

### *Pygmaeus*-group.

#### *Arrhopalites boneti* n. sp.

The colour of the animals preserved in alcohol is white, without a trace of the pigment.

The body is sparsely clothed with hairs and on the fore part of the abdomen it is short; on the hind part the hairs are relatively long, they are twice as long as the claw on the third pair of feet.

The antennae are very long, about 2,25 times longer than the long diagonal of the head (16 : 7). Segments I : II : III : IV = 2 : 4 : 6,5 - 7 : 19; the fourth antennal segment is as much as 2,7 - 2,9 times longer than the third. The third antennal segment has no sense papilla in the basal half; the subapical sensory organ has two straight parallel sense rods situated in a shallow pit. The fourth antennal segment is distinctly sub-

divided into 6 joints; the relation of the joints is as follows: bas. 5 : 2,3 : 2,25 : 2,25 : 2 : 5. All the joints are clothed with long hairs.

On each side of the head behind the antenna is a circular, unpigmented eye.

The claw has one distinct inner tooth, which is situated at the base in the third ventral lamella. All the claws are slender and of nearly equal length. The empodial appendage on all the pairs of feet is differently formed. On the first pair of feet it is on the inner lamella with a distinct, thin corner-tooth and has a long apical bristle, which distinctly overtops the tip of the claw. On the second pair of feet the tooth on the ventral lamella is situated a little higher than on the first pair of feet and the apical bristle is a little shorter than the claw. On the third pair of feet the empodial appendage is lancetlike, with a narrow outer lamella and a broad bow-like untoothed inner lamella; the apical bristle is very short, fine and brittle.

The dens is one third longer than the mucro. The hairy-clothing of the dens is as follows: On the outer side of the dens near the basis to the mucro stands a strongly, sharply pointed spine; besides this spine there are no others on the dens. Behind the spine on the outer-side in a long-row stand 5 - 6 setae, they are pretty long, but not especially thick. Dorsally in the medial-line of the dens, proximally near the basis of the dens stands a long seta, an other is near the basis of the mucro. On the inner side of the dens are situated in a long row 5 setae, they are a little shorter than the outer setae; the first of these setae, which stands near the base of the mucro and a little more to the side, is a little thicker, but not like the spine. On the under side of the dens there stand in a diagonal-row 3 pretty short setae, behind these a longer pair and more proximally 2 longer setae one after another in a row.

The mucro is narrow and gutter-like, densely serrated on both edges, near the middle it is a little narrowed and at the tip a little spoonlike and broadened.

The anus is surrounded with some long, strong, bristles lying close to the body; the bristles are not broadened at the

sides of the base. Between the strong setae stand some shorter, but the fine short spines on the anal-valves are not present here.

The female subanal appendages are straight in side view; viewed from above they are straight, nearly equally thick throughout their length and at the tip furnished with 4 -5 fine small teeth.

The length of the body in the adult animals is 1 mm.

This new species is an interesting form of the genus *Arrhopalites*, since in its characteristics it seems to be a transition from the *coecus*-group to *pygmaeus*-group. Namely it has no spine on the under side of the dens characteristic in *Arrhopalites coecus* (Tullb.), whereas it has the spine on the out side of the dens near the base of the mucro, characteristic in the *pygmaeus*-group. In the species from the *pygmaeus*-group there are usually besides this outer spine still other spines, namely still the one on the out-side of the dens and 3 spines on the inner side, in this species these are absent as in *Arrhopalites coecus* (Tullb.). Also the subanal appendages in this new species have a similar form to that in *Arrhopalites coecus*. The other characteristics, such as the long antennae with a distinctly subdivided fourth antennal segment, the long apical bristle on the empodial appendage of the first pair of feet, the absence of the fine short spines on the anal valves, shows however that the new species seems to be more closely related to the species from the *pygmaeus*-group, than to *Arrhopalites coecus* (Tullb.).

The form from some Spanish caves resembling this one has been described by Bonet (5) under the name *Arrhopalites pygmaeus* (Wankel). Among these caves he also mentions Cueva de Hernialde (Tolosa, prov. de Guipúzcoa). I also have studied the animals from this cave collected by Prof. Stammer. They showed the characteristics here described. Since they must be separated from the old species *Arrhopalites pygmaeus* (Wankel), I name them after a deserving Spanish collembologist Dr. F. Bonet *Arrhopalites boneti* n. sp.

At this time this species is known only in the caves here mentioned. Probably it belongs to the group of troglobiont animals.

The specimens studied by me are found:

- Spain. — Cueva de Aitzquirri near Onnate (prov. Guipúzcoa), large pool of the water from the stalactits; 13. X. 1935, leg. Prof. H. J. Stammer;
- Cueva de Hernialde near San Sebastián (prov. Guipúzcoa), on the edge to the tymp, 11. X. 1935, leg. Prof. H. J. Stammer;
- Cueva de San Adrian near Otzaurte (prov. Guipúzcoa), little tymp of the water from the stalactits, 14. X. 1935, leg. Prof. H. J. Stammer.

### *Arrhopalites aggtelekiensis* Stach.

Syn.: *Arrhopalites pygmaeus aggtelekiensis* n. ssp. — Stach, 1929.

One interesting form as regards its bodily characteristics is *Arrhopalites aggtelekiensis* described by me (14) in 1929 as a subspecies of *Arrhopalites pygmaeus* (Wankel).

The colour of the animals preserved in alcohol is white or tinged rust-red by pigment more or less strongly especially on the sides of the great abdomen.

The body is sparsely clothed with hairs and on the fore part of the abdomen the hairs are short; on the hind part they are longer, but even the longest are only by 1/3 longer than the claw of the third pair of feet.

The antennae are long, as much as 2,5 times longer than the long-diagonal of the head (15,5 -17 : 7). Segment I : II : III : IV = 3 : 5 -6 : 9 -10 : 29,5-31; the fourth antennal segment is as much as 3 times as longer as the third. The third antennal segment has in the basal part a distinct, broad sense papilla, which resembles that in *Smynthurinus* or *Katiana*. The subapical sensory organ has two fine, relatively long, club-shaped sense rods; the base of each one is situated in a shallow pit. On the each side of the sense rods stands one fine small seta and before the sense rods, one strong seta. The fourth antennal segment is very distinctly subdivided into 9 joints; the tenth joint is undistinctly separated from the basal part. The ratio of the lengths of joints is following: bas. 10 -11,5 (event. minus 2 for the tenth joint): 2 : 2 : 2 : 2 : 2 : 2 : 2 : 5; the basal joint is as much as about twice as long as the terminal joint. All the joints are covered with long setae, which are verticillately

situated. Between these setae there are, on each joint, in pairs fine, equally thin sense hairs directed upwards.

On each side of the head behind the antenna is a circular unpigmented eye.

The claws are narrow, equally long, with one inner tooth in the basal half of the ventral lamella. This tooth is mostly very fine and may be absent, especially in the third pair of the feet. The empodial appendage to the first pair of feet is almost quite similar to the second pair; it is furnished on the inner lamella with the fine corner-tooth and on the tip with a terminal bristle. The empodial appendage together with the terminal bristle is shorter on all the feet than the ventral lamella of the claw, namely on the first pair by  $1/5$  and on the second pair by as much as  $1/3$  the length of this lamella. On the third pair of feet the empodial appendage is broad and usually has in the middle a little concave inner lamella; the lamella is usually untoothed, but in rare cases it may be furnished with a very little tooth.

The dens is by 1,55 times longer than the mucro. The hairy clothing of the dens is very characteristic, since on it there is only one single spine. But this spine stands as in the *pygmaeus*-group on the outside to the dens and not on the under-side as in *Arrhopalites coecus* (Tullb.). Behind this strong outer spine are 6 long setae standing in a long-row one after another at nearly equal distances. Dorsally in the medial line of the dens there stands one long seta near the base of the mucro and a second seta proximally near the base of the dens. On the inner side of the dens there are no spines or spine-like setae and on the under-side of the dens distally near the base of the mucro in one diagonal-row there are 3 thin short setae, behind these a pair of longer but also thin setae and more proximally 2 setae one after another, of these the proximal situated seta is shorter but a little thicker than the one standing before it.

The mucro is gutter-like not narrowed in the middle and not broadened at the tip. The edges are not quite equally formed, while the inner edge is densely serrated, so the teeth on the outside are only distinctly developed every here and there; nearer the basis of the mucro the edge seems nearly smooth.

The tenaculum has 3 barbs on the ramus; on the base is a club-shaped appendage; the globular pointed pars posterior is higher than the pars anterior. On the tip of the pars anterior are situated two fine small setae.

The anus is surrounded by some long strong bristles, lying close to the body; the bristles are not broadened at the sides of the base. Between the strong setae stand some shorter, but on the anal valves the fine small spines are absent.

The female subanal appendages are slightly curved, gradually narrowed towards the tip, slightly serrated on both sides and mostly a little split at the tip.

The whole length of the body in adult animals is 1,4 mm.

*Arrhopalites aggtelekiensis* differs from other species of the genus *Arrhopalites* in the long fourth antennal segment subdivided into 9 to 10 joints and in the presence of only one single spine on the outside of the dens. But there are also other details, in which this species is different from others, as for example the presence in it of the sense papilla on the third antennal segment, the relatively short empodial appendages on all the pairs of feet, the edge of the mucro being serrated only here and there, and other details.

*Arrhopalites aggtelekiensis* live in the interiors of the large cave near Aggtélek in Hungary as a genuine troglobiont. Besides them there occur in this cave other interesting animals and the other species of the genus *Arrhopalites*, namely *Arrhopalites pygmaeus* (Wankel). The existence besides *Arrhopalites aggtelekiensis* in the same place of still two other species of the same genus and group, also shows, that *Arrhopalites aggtelekiensis* is an independent species.

#### Places in which found:

- Hungary. — Aggtélek-cave. The insides of the cave; about bridges sifted from mouldering wood-parts and detritus. 31. X. 1929. leg. Prof. E. Dudich;
- Aggtélek-cave; from surface of the various waters, 8. II. 1929. leg. Prof. E. Dudich;
- Aggtélek-cave; from Ganymedes-well, 1. XI., 5. XII. 1928; 8. II. 29. IV. 1929. leg. Prof. E. Dudich;
- Aggtélek-cave; in the accessory-room „Paradies” caught on a bait. 19. XII. 1929. leg. Prof. E. Dudich.

*Arrhopalites furcatus* n. sp.

The colour of the animals preserved in alcohol is white, without a trace of pigment.

The body is sparsely clothed with hairs, which are short on the fore part of the abdomen; on the hind part, the hairs are relatively long, about 2,5 times longer than the claw on the third pair of feet.

Antennae are over 1,5 times longer (about 11 : 6) than the long-diagonal of the head. Segments I : I : III : IV = 1,5 : 2,5 - 3 : 4,5 - 5 : 12 - 13; the fourth antennal segment is as much as about 2,5 times longer than the third. The third antennal segment, in its basal half, has a distinct semiglobular wart-like sense papilla; a subapical sensory organ with two very small sense rods situated in a common pit. The fourth antennal segment very distinctly subdivided into 5 joints; the relation of the joints is as follows: bas. 4,75 : 1,5 : 1,5 : 1,4 : 3,5; the basal joint is only about by 1/3 longer than the terminal joint. All the joints are covered with long setae, which are verticillately situated. Between these setae there is, on each joint, a fine sense hair directed upwards.

On each side of the head behind the antenna is a circular, unpigmented eye.

The claw on the first pair of feet seems to be without an inner tooth; on the second and third pair of feet the tooth is well-developed and situated about the middle on the ventral lamella of the claw. The claws are slender and nearly almost equal. The empodial appendage is differently shaped in all the pairs of feet; only the apical bristle is equal in all the empodial appendages and remarkably long; it distinctly overtops the tip of the claw.

The dens is about 1,1 - 1,6 times longer than the mucro. The hairy-clothing of the dens is as follows: On the outer side of the dens standing near the basis of the mucro there is a strong spine, then follows a seta, after it again a spine, which is not so strong as the first and then stand widely spaced one after another 4 longer setae in a long-row. Dorsally in the medial-line of the dens there stands a seta near the base of the mucro and a second proximally nearer to these basis of

the dens. Dorso-laterally on the inner side are 4 longer setae and on the inner-side of the dens 3 spines; the strongest of these spines stands distally near the base of the mucro, but not in the same line with the large outer-spine, but a little more proximally; the two large spines are sharply pointed, a little less strong than the distal spine and are situated one after another at equal distances. On the under-side of the dens distally nearer to the base of the mucro stand 3 short setae in one diagonal-row, behind these a pair of longer ones, and more proximally one after another 2 longer setae.

The mucro is narrow gutter-like, distinctly serrated on both edges and is a little narrowed in the distal half of the length and has a narrow spatulate tip.

The tenaculum has 3 barbs on the ramus, the club-shaped appendage on the base and two setae on the pars anterior.

The anus is surrounded by some long, strong, bristles, lying close to the body; the bristles are not broadened at the side of the base. Between the strong setae stand some shorter, but the fine short spines are not present here on the anal valves.

The female subanal appendages are deeply split to about half their length, but both the branches are not of equal length, the inner branch is shorter than the outer.

The length of the body in the largest animal examined by me was 1 mm.

The new species differs from all the other species of this genus in that it has a characteristic form of the subanal appendages. But it has besides this also other characteristic features, such as the strongly developed sense papilla on the third antennal segment, the remarkably long terminal bristle on all the pairs of feet and other details.

*Arrhopalites furcatus* is a genuine troglobia, which up to date has been found in only one Spanish cave.

Place in which found:

Spain. — Cueva de Landarbaso near S. Sebastian; on the tympanum near to the water-pan in the interior of the cave. 28. IX. 1935. leg. Prof. H. J. Stammer.

*Arrhopalites ornatus* n. sp.

This new species agrees with the preceding in many characteristics.

The colour of the animals preserved in alcohol is white, without a trace of pigment.

The body is sparsely clothed with hair and on the fore part of the abdomen it is short; on the hind part the hairs are longer, about twice as long as the claw of the third pair of feet.

Antennae are about 1,7 times (10 : 6) longer than the long-diagonal of the head. Segments I : II : III : IV = 1,3 : 2,2 : 4 : 10; the fourth antennal segment is as much as about 2,5 times longer than the third. The third antennal segment in the basal half has a distinct semiglobular sense papilla; the subapical sensory organ has two very small sense rods. The fourth antennal segment is distinctly subdivided into 5 joints; the relation of the joints is as follows: bas. 4 : 1,3 : 1,3 : 1,2 : 3; the basal joint is only by 1/4 longer than the terminal joint. All the joints are covered with the long setae, these are verticillately situated. Between these setae on each joint there is a fine sense hair.

On each side of the head behind the antenna there is a circular, unpigmented eye.

The claws are furnished with one very small inner tooth about the middle of the ventral lamella. The claws are slender and nearly almost equal. The empodial appendage seems to be untoothed; the apical bristle is long and distinctly overtops the tip of the claw in all the empodial appendages.

The dens is about 1,35 - 1,43 times longer than the mucro. The hairy-clothing of the dens is as follows: On the outer side of the dens near the base of the mucro there stands a strong spine, then follows a seta, after it again a spine, and widely spaced in a long-row one after another 4 longer setae. Dorsally in the medial line of the dens stands a seta near the base of the mucro and a second proximally nearer to the basis of the dens. Dorso-laterally on the inner side are situated 4 longer setae and on the inner side of the dens 3 spines; the strongest of these spines is situated distally nearer to the base of the mucro.

but not in the same line with the large outer spine, only a little nearer proximally; the two large spines are sharply pointed and a little less strong than the distal spine and are situated one after another at equal distances. On the under-side of the dens there stand distally nearer to the base of the mucro 3 short setae in one diagonal-row, behind them a pair of long ones and more proximally one after another 2 longer setae.

The mucro is narrow gutter-like, distinctly serrated on both edges, in the distal half of its length it narrows a little more.

The tenaculum has 3 barbs on the ramus, the club-shaped appendage on the basis and two setae on pars anterior.

The anus is surrounded with long, strong bristles, lying close to the body; the bristles are not broadened at the sides of the base. Between the strong setae stand some shorter ones, but here there are no fine short spines on the anal valves.

Female subanal appendages are deep, broom-like, richly branched a little resembling those to the *Arrhopalites principalis*, but its branches are not so strongly curved upwards.

The length of the body in the animals examined by me was 0,8 mm.

The new species corresponds to *Arrhopalites furcatus* in many bodily characteristics, such as having the sense papilla on the third antennal segment, the long apical bristle on all the empodial appendages, the hairy clothing of the dentes and other details, but differs from it and also from other species of this genus in the form of the broom-like richly branched subanal appendages.

Also this species belongs to the group of troglobionts.

Place in which found:

Spain. — Cueva del Castillo near Puente Viesgo, prov. Santander; on the tympanum of the water from the stalactites at the beginning of the cave, and also on the water-tympanum at the end of the cave 6. X. 1935, leg. Prof. H. J. Stammer.

*Arrhopalites postumicus* n. sp.

The colour of the animals preserved in alcohol is white or tinged more or less rust-red by the pigment.

The body is sparsely clothed with hair which is short on the fore part of the abdomen; on the hind part the hairs are relatively long, about twice as long as the claw of the third pair of feet.

The antennae are very long, mostly twice as long as the long-diagonal of the head ((13) 14 : 7). Segments I:II:III:IV = 2 : 4 : 6 : 18; the fourth antennal segment is as much as 3 times as long as the third. The third antennal segment has no sense papilla in the basal half of the segment; the subapical sensory organ has two straight parallel sense rods situated in a shallow pit. In front of this pit stands one stronger bristle and on each side a fine short seta. The fourth antennal segment is always very distinctly subdivided into 6 joints; the seventh joint indistinctly separated from the basal joint. The relation of the length of the joints is as follows: bas. 8 - 8,5 (event. minus 2 for the indistinctly separated seventh joint): 2 : 2 : 1,6 : 1,5 : 3; the basal joint is over 2,5 times longer than the terminal joint. All the joints are covered with long setae, which are verticillately situated. Between these setae there are on both sides of each joint one fine long sense hair directed upwards.

On each side of the head behind the antenna is a circular unpigmented or black pigmented eye.

The claw on the first pair of feet has no inner tooth; on the second and third pair of feet the tooth is well developed and situated in the basal third of the ventral lamella of the claw. The claws are nearly equally long, but on the first and second pair they are distinctly narrower than on the third pair. The empodial appendage on the first and second pair of feet is almost identical; it has on the inner lamella one distinct corner-tooth and on the tip a long apical bristle, distinctly overtopping the tip of the claw. On the third pair of feet the empodial appendage is lancet-like with a narrow outer- and broad inner-lamella, half way along the length it has a fine tooth and on the tip a moderately long, brittle apical bristle.

The dens in proportion to the mucro is short, only about 1,2 times longer than the latter. The clothing of the dens is as follows: On the outer side of the dens, near the base of mucro is a strong spine. Behind this spine on the out-side to the dens

in a long-row there are some setae. The second of these setae is spine-like; it is much shorter, at the basis distinctly thicker than the neighbouring setae, but sharply pointed. Dorsally in the medial line of the dens near the base of the mucro stands a long seta, and there is a second near the base of the dens. Dorsolaterally on the innerside of the dens there are 4 setae in the long-row. The inner-side of the dens is furnished with 3 spines; the strongest of them stands near the base of the mucro, not in the same line as the long outer spine, only a little more proximally. The other two spines are acutely pointed, but are not so thick as the first spine and stand at an equal distance one after another. On the under side of the dens near the base of the mucro are 3 small short setae standing in a diagonal-row, behind them is a pair of longer setae and more proximally, one after another, 2 longer setae.

The mucro is narrow, gutter-like, densely serrated on both edges and is a little narrowed near the middle.

The tenaculum has 3 barbs on the ramus, the club-shaped appendage on the base, two setae on the pars anterior and the pars posterior is hooked at the tip.

The anus is surrounded with some long, strong bristles, lying close to the body; the bristles are not broadened at the side of the base. Between two strong setae there are some shorter ones, but the fine small spines on the anal valves are absent.

The female subanal appendices are relatively thick and cylindrical in the basal part; distally towards the tip they are pretty broadened, leaf-like, and both edges are abundantly serrated.

The total length of the body in the adult animals is 1,3 mm.

The new species differs from the other species of the genus *Arrhopalites* in the characteristic form of the subanal appendages. It differs also in the other characteristics, such as the long fourth antennal segment which is always subdivided into 6 or indistinctly into 7 joints, the untoothed claw on the first pair of the feet and the long empodial appendage with a fine terminal bristle on the third pair of feet.

*Arrhopalites postumicus* is a genuine troglobiont, which lives in the great Postumia-cave together with other troglobionts

of the Collembola-group, such as *Onychiurus giganteus* (Absol.) and *Onychiurus postumicus* Bonet. It is a near relation to the form which lives in the S. Canziano-caves. They resemble each other so closely, that they doubtless descend from a common ancestor.

Places in which found:

Jugoslavia. — Postumia-cave. Tricolorum, on the stalactites;  
 — Postumia-cave. Tartarus, on the water;  
 — Postumia-cave. Old-cave, on the water-surface, 19—27. VIII.  
 1930, leg. R. G. Spoecker.

*Arrhopalites canzianus* n. sp.

The colour of the animals preserved in alcohol is white, without a trace of pigment.

The body is sparsely clothed with hair which is short on the fore part of the abdomen; on the hind part the hairs are relatively long, about 1,5–2 times longer than the claw on the third pair of feet.

The antennae are relatively short, only by  $1/3$  longer than the long-diagonal of the head, about 6 : 9–9,5. Segments I : II : III : IV = 1,3 : 3 : 4 : 10—10,5; the fourth antennal segment is as much as 2,5 times longer than the third. The third antennal segment has no sense papilla in the basal half; the subapical sensory organ has two straight sense rods standing parallel in one shallow pit. Before this pit stands one stronger seta and on each side is a fine short seta. The fourth antennal segment is always very distinctly subdivided into 5 joints. The relation of the length of the joints is as follows: bas. 4 : 1,2 : 1 : 1 : 3; the basal joint is only a little longer than the terminal joint.

On each side of the head behind the antenna is a circular unpigmented eye.

All the claws have an inner tooth, but on the first pair of feet this tooth is so small, that it is nearly indistinguishable; on all the pairs of feet this tooth is in the middle of ventral lamella of the claw. The claws are nearly equally long, but on the first and second pair of feet they are distinctly narrower than on the third pair. The empodial appendage on the first and second pair of feet are nearly identical; on the inner lamella

it has one little corner-tooth and on the tip a long apical bristle, which distinctly overtops the tip of the claw. On the third pair of feet the empodial appendage is lancet like with very small spine near the tip and a short terminal bristle.

The dens in proportion to the mucro is short, only about 1,3 times longer than it. The covering of the dens is as follows: On the out-side to the dens near to the base of the mucro is a strong spine. Behind this spine on the out-side of the dens stand 5 setae in a long row; the second of these setae is developed like a short spine. Dorsally in the medial-line of the dens near the base of the mucro there is a long seta and a second near the basis of the dens. Dorsolaterally on the inner-side of the dens 4 setae stand in a long-row. On the inner side of the dens standing at an equal distance one after another are 3 acutely pointed spines; the first distal spine is the strongest. On the under side of the dens near the base of the mucro there are 3 small short setae standing in a diagonal-row, behind them is a pair of longer setae and more proximally one after another 2 longer setae.

The anus is surrounded with some long, strong bristles lying close to the body; the bristles are not broadened at the sides of the base. Between the strong setae stand some shorter, but on the anal valves the fine small spines are absent.

The female subanal appendices are relatively thick and cylindrical in the basal part, towards the tip they are fairly broadened leaf-like and distinctly serrated on both edges.

The length of the body of the adult animals is 1 mm.

The new species resembles the preceding very much and they are similar in many characteristics. The greatest difference existing is in the length and subdivision of the antennae. In *Arrhopalites postumicus* the fourth antennal segment is 3 times longer than the third segment and always subdivided into 6–7 joints, whereas in *Arrhopalites canzianus* the fourth antennal segment is only 2,5 times as long as the third segment and only subdivided into 5 joints. Also the development and position of the inner tooth on the claws is in this species a little different and the subanal appendages are not so broad in *Arrhopalites canzianus* as in *Arrhopalites postumicus*.

Both the species may be considered as modifications of the same species and doubtless they descend from the same ancestor. Up to date it has not been established, which form of the two is the more primitive and which has changed less, it seems best to consider both forms as different species.

*Arrhopalites canzianus* occurs in the great S. Canziano-cave and belongs to the group of troglobiont animals. It lives there with another Collembola known to exist only in this cave, *Onychiurus canzianus* Stach, which is also a troglobiont.

The place where the animals were found:

Jugoslavia. — S. Canziano-caves. Rudolf-cave, 80 m from the entrance of the cave, in a water-hole, 3. IV. 1928, leg. Prof. H. J. Stammer.

#### *Arrhopalites pygmaeus* (Wankel).

Syn.: *Arrhopalites binoculatus* — Börner 1901, nec Linna-niemi 1912.

The animals considered by me as *Arrhopalites pygmaeus* (Wankel) have the following bodily characteristics.

The colour of the animals preserved in alcohol is white or tinged more or less rust-red by the pigment. Among the specimens collected in the same place in a cave there exist some white and ranging from redish to dark rust-red.

The body is sparsely clothed with hair; on the fore part of the abdomen the hairs are short, on the hind part longer, but not especially long, about twice as long as the claw on the third pair of feet.

Antennae are 1,65—1,8 times longer than the long-diagonal of the head. Segments I : II : III : IV = 2 : 4 : 7 : 19; the fourth antennal segment is as much as about 2,4 times longer than the third segment. The third antennal segment has no visible sense papilla in its basal half, but in the place, where the papilla is present in other species there is here a distinct thickening in the corresponding part of the segment and large sense cellulae show through from the inside. The subapical sensory organ has two fine, parallel sense rods; at one side of these rods is a fine seta and before them one strong bristle. The fourth antennal segment is very distinctly subdivided into 5 joints.

The relation of the length of the joints is as follows: bas. 8—9 : 2 : 2 : 1,6 : 4,6—5; the basal joint is about 1,5—1,9 times longer than the terminal joint. All the joints are covered with long, verticillately situated setae, between these on each joint is a fine sense hair directed upwards.

On each side of the head behind the antenna is a circular, unpigmented or more or less strongly pigmented eye.

The claws on all the pairs of feet have a well-developed inner tooth, which is situated in the basal half on the ventral lamella near middle. The claw of the first pair is a little more slender and longer than that on the second and third pair of feet. The empodial appendage is a little differently formed on all the pairs of feet. On the first pair the inner lamella of the empodial appendage is weakly developed and the corner-tooth stands not far from the base. On the second pair the inner lamella is distinctly broader and longer and the corner-tooth is situated prettily high. On the third pair the inner lamella is longest and mostly untoothed, yet sometimes there is here also a small tooth, which is then situated about in the middle of the length of the lamella. All the empodial appendages have a long apical bristle, which distinctly overtops the tip of the claw.

The dens is about (1,3)—1,5—(1,6) times longer than the mucro. The clothing of the dens is as follows: On the outer side of the dens standing near the base of the mucro is a strong spine, then follows a seta, which is rarely absent; after it there is again a spine, but not so strong as the first, and standing widely apart one after another 4 longer setae in a long-row. Dorsally in the medial line of the dens near the base of the mucro is a seta and the second seta proximally near the base of the dens. Dorsolaterally on the inner side are situated 4 longer setae and on the inner side the dens 3 spines; the strongest of these spines stands distally nearer to the base of the mucro, but not in the same line with the great outer-spine, only a little more proximally; the two large spines are sharply pointed, resembling a little strong, short bristles and are situated one after another at equal distances. On the under side of the dens distally nearer to the base of the mucro are 3 short setae in one diagonal-row, behind these a pair of longer and widely spaced proximally one after another 2 longer setae.

The mucro is narrow and gutter-like serrated on both edges, but on the out-side the serration is often irregular; there exist individuals, which have this serration on the pretty long tract of the outer lamella absent. The tip of the mucro is formed like a shovel and in the distal half the mucro is not narrowed or only very indistinctly narrowed.

Both the sides of the pointed pars anterior tenaculi have one short seta. The ramus has 3 barbs and near the ramus on each side a club-shaped appendage. The pars posterior has a bean-like tip and is as long as the pars anterior or a little longer.

The anus is surrounded with some long, strong bristles, lying close to the body; the bristles are not broadened at the side of the base. Between the strong setae are some shorter, but here on the anal valves the fine short spines are not present.

The female subanal appendages are pretty thick, in side-view they resemble the thick, lightly curved bristle, or they are slightly serrated from about half their length. In the upper view they are straight, mostly equally thick in the whole length, on both edges smooth or seldom from about the middle serrated, or pretty often smooth on the outer edge and serrated on the inner edge.

The length of the body in the adult animals is mostly 1,2 mm.

I have chosen for the species here described the name *pygmaeus* given them by Wankel (17) in 1860 for the following reasons. The specimen studied by Wankel has one pigmented eye on each side of its head, the fourth antennal segment is distinctly subdivided into 5 joints, the empodial appendage is furnished with a long apical bristle, on the dens is an outer spine; it must undoubtedly belong to the group *pygmaeus*. To this group indeed belong many very different species, but Absolon says in his description of this species, that the subanal appendices are prominent like „ein mächtiger Dorn". In side view the true form of the subanal appendages of the many species of this group cannot be clearly determined and these subanal appendages usually look „borstenförmig", as Börner (6) describes them in the species, which he studied and called *S. binoculatus*. The specimens studied by Börner were

collected in a Westfalian cave (Letmathe-cave) and since in the animals occurring in some Westfalian caves the subanal appendages really have this form, it seems to me best to use the name *Arrhopalites pygmaeus* (Wankel) for the form here described in detail, and consider the name *Arrhopalites binoculatus* (Börner) as a synonymous for this species. Then the animals with broom-like subanal appendages, identified by (Axelson) Linnaniemi (12) as *Arrhopalites binoculatus* (Börn.) must be given another name.

To day it is impossible to say anything certain about the distribution of the species *Arrhopalites pygmaeus* (Wank.), as various species of this genus were described under the name *Arrhopalites pygmaeus* or *Arrhopalites binoculatus* (Börn.) by various authors. Even the data on the foundation of which the author states that the specimens examined by him had subanal appendages bristle like, does not necessarily refer to the species *Arrhopalites pygmaeus* (Wank.) as in side view it is often difficult to determine the true form of these appendages.

On the foundation of the animals studied by me it is possible to put forward the opinion, that *Arrhopalites pygmaeus* (Wank.) occurs commonly in the caves, especially of central Europe.

The place where the animals studied by me were found:

- Poland. — Caves in Ojców near Kraków, 1918, leg. Dr. K. Demel;  
 — Silesia. Wolmsdorfer-cave, 8. XII. 1934, leg. Prof. Stammer;  
 — Silesia. Salzlöcher-cave near Seitendorf (distr. Habelschwerdt), in the mouldering-leaves in the middle corridor of the cave and in damp cold rock-niches 15. V. 1936, leg. Dr. G. Frenzel;  
 Germany. — Westfalen. Rentrops-cave near Milspe. I and V. 1931, I. II. 1932, 1933, leg. Dr. W. Griepenburg;  
 — Westfalen. Hülloch-cave near Kierspe (distr. Altena), IV. and X. 1931, 1932, I. IV. 1933, 8. VIII. 1934, leg. Dr. W. Griepenburg;  
 — Westfalen. Neben-cave II near Warstein (dist. Altena), 1933, leg. Dr. W. Griepenburg;  
 — Westfalen. Feldhof-cave in Höhne-valley, IV. 1931, leg. Dr. W. Griepenburg;  
 — Westfalen. Frühlingshauser-cave in Höhne-valley, 1932, leg. Dr. W. Griepenburg;

- Germany — Westfalen. Keller-cave in Hönne-valley, 1938, leg. Rekt. Lengersdorf;  
 — Rheinland. Hard-cave near Barmen, 1932, leg. Dr. W. Griepenburg;  
 — Frankonian caves. Marderloch near Artelshofen, leg. Spöcker;  
 — Frankonian caves. Franzosenloch near Etdorf, leg. Cramer;  
 — Frankonian caves. Breitenwiener-cave near Velburg, leg. Cramer;  
 — Frankonian caves. Fischer-cave near Heuchling, leg. Cramer;  
 — Frankonian caves. Oster-cave near Trondorf, leg. Cramer;  
 — Frankonian caves. Cave in Loch, leg. Cramer;
- Austria. — Stiria. Gesäuse. Ödelstein-cave in Johnsbach, V. and 16. IX. 1940, leg. Dr. H. Franz;  
 — Stiria. Hartelsgraben-cave, ca. 1300 m alt., 20. VII. 1940, leg. Dr. H. Franz;
- Hungary. — Mánfa-cave (Mecsek-mountains), on the surface of the tympanum in the cave, 31. VIII. 1931, leg. Dr. A. Gebhardt;  
 — Abaliget-cave (Mecsek-mountains) IX. 1923, leg. Dr. Bokor;  
 — Abaliget-cave (Mecsek-mountains) 25. VIII. 1930, leg. Dr. A. Gebhardt.

*Arrhopalites bifidus* n. sp.

The colour of the animals preserved in alcohol is white or more or less reddish from the rust-red pigment; rarely specimens collected in the same place are brownish-violet, as for example the ones in Klutert-cave.

The body is sparsely clothed with hair and on the fore part of the abdomen it is short; on the hind part of the abdomen the hairs are longer, but not especially long, about twice as long as the claw of the third pair of feet.

Antennae are 1,8 times longer than the long-diagonal of the head. Segments I : II : III : IV = 2 : 4 : 8 : 20; the fourth antennal segment is as much as about 2,4—2,5 times longer than the third. The third antennal segment in the basal half besides the sense papilla visible from out-side, has the corresponding part of the segment sometimes a little thicker. The subapical sensory organ has two fine, straight sense rods, of which one stands a little higher than the other. At one side of these sense rods is a fine short seta and before them one strong bristle. The fourth antennal segment is very distinctly separated into 5 joints; sometimes, as for example in the

animals from the Klutert-cave the sixth joint is indistinctly subdivided from the end-joint. The relation of the length of the joints is the following: bas. 9 : 2 : 2 : 2 : 5 (event. 2 + 3). All the joints are covered with long, verticillately situated setae, between these on each joint are two fine sense hairs directed upwards.

On each side of the head behind the antenna is a circular, unpigmented or more or less strongly pigmented eye.

The claws on all pairs of feet have a well-developed inner tooth, which is situated in the basal half of the ventral lamella near the middle. The claw of the first pair is a little more slender and longer than that on the second and third pair of feet. Moreover small teeth appear on the lateral edges in the basal and distal part of the claws; these teeth are so small, that they only become distinctly visible in the view of the claw from the ventral side. The empodial appendage on all pairs of feet is a little differently formed. On the first pair the inner lamella is short and the corner-tooth, which in this species is relatively strongly developed, spine-like, stands on the lamella near the base. On the second the inner lamella is broader and longer and the strong corner-tooth is situated pretty high. On the third pair the inner lamella is the longest and is untoothed. On all the empodial appendages the apical bristle is long, distinctly overtopping the tip of the claw.

The dens is about (1,4)—1,5—(1,6) times longer than the mucro. The clothing of the dens is as follows: On the out-side of the dens near the base of the mucro is a strong spine, then follows a seta, after it again a spine, but not so strong as the first, and widely spaced one after another come 4 longer setae in a long-row. Dorsally in the medial line of the dens near the base of the mucro is a seta and a second seta proximally near the base of the dens. Dorso-laterally on the inner side of the dens are situated 4 longer setae and on the inner side 3 spines; the strongest of these spines stands distally near the base of the mucro, but not in the same line as the large outer spine, but a little more proximally; the two wide proximal spines are sharply pointed, a little resembling strong, short bristles and are situated one after another at equal distances. On the under-side of the dens distally nearer to the basis of

the mucro are 3 short setae in one diagonal-row, behind these a longer pair and more proximally one after another 2 longer setae.

The mucro is narrow and gutter-like, serrated on the both edges, but the serration is sometimes pretty irregular on the inner and outer edge. The tip of the mucro is formed like a shovel; in the distal half the mucro is not narrowed or only very indistinctly narrowed.

Both the sides of the pointed pars anterior tenaculi have one short seta. The ramus has 3 barbs and near the ramus at each side is a club-shaped appendage. The pars posterior is usually as high as the pars anterior.

The anus is surrounded with some long, strong bristles lying close to the body; the bristles are broadened at the sides of the base. Between the strong setae stand some shorter ones, but there are no fine short spines on the anal valves.

The female subanal appendages are pretty thick and strong. On the tip they are relatively deeply split into two or three branches. When they are three-branched the middle branch is considerably narrower than both the lateral ones and unserrated; sometimes there is in the same specimen one appendage with two and another with three branches. Both branches are serrated; but the edge of the branch, which is situated more towards the middle line of the body is much more strongly serrated. This is mostly densely furnished with teeth from the third part of the length as far as the tip.

The length of the body of the adult animals is 1,3 mm.

The new species corresponds with *Arrhopalites pygmaeus* (Wank.) in many bodily characteristics such as the form of the claws, of the empodial appendages and of the furcula; but differs in the strongly serrated subanal appendages, which are deeply split into two or three branches.

This species is a genuine troglobia and up to date has only been collected in caves.

It occurs in caves far removed from one another. In one cave namely in Rentrops-cave I have meet it with the other species *Arrhopalites pygmaeus* (Wank.), which appeared there in noticeably larger numbers.

The animals studied by me were collected in the following caves:

- Poland. — Bilcze-cave, 8. IX. 1932, leg. Bojarska;  
— Silesia, Reversdorfer-cave, 1. XI. 1934, leg. Prof. E. Pax;
- Germany. — Westfalen, Bismarck-cave in Sauerland, in winter-time and summer 1931, 11. I. 1934, leg. Dr. W. Griepenburg;  
— Westfalen, Rentrops-cave near Milspe, in winter 1931, leg. Dr. W. Griepenburg;  
— Westfalen, Klutert-cave near Milspe, 5. I. 1932, 1933, 1934, leg. Dr. W. Griepenburg;  
— Westfalen, Berghäuser-cave, IV. 1931, 31. I. 1932, leg. Dr. W. Griepenburg;  
— Westfalen, Kattenstein-cave near Kallenhardt, VIII. 1933, leg. Dr. W. Griepenburg;  
— Westfalen, Strückerberg near Schwelm, well of underground-water 7. V. 1933, leg. Dr. W. Griepenburg;  
— Franconian caves, Osterloch near Hegendorf, leg. Cramer;  
— Franconian caves, Streithberger-cave, 2. V. 1937, leg. B. Wolf.

#### *Arrhopalites principalis* nom. nov.

Syn.: *Arrhopalites binoculatus* Börn. — Linmaniemi 1912, nec Börner 1901.

The colour of the animals preserved in alcohol is usually brownish or bluish-gray. Usually the whole body with antennae, feet and dentes is brownish, the dark pigment is most strongly accumulated on the sides of the abdomen. The younger animals may however be unpigmented, or their head, the fore part of the abdomen and a narrow stripe running along the middle line of the abdomen may remain white.

The body is sparsely clothed with hair and on the fore part of the abdomen it is short; on the hind part of the abdomen the hairs are longer, but not especially long, at the most twice as long as the claw of the third pair of feet.

The antennae are about 1,3—1,6 times longer than the long-diagonal of the head. Segments I : II : III : IV = 1,5 : 2,5—3 : 4—5 : 9—12; the fourth antennal segment is as much as about 2,4 times longer than the third. The third antennal segment has no sense papilla in the basal half. The subapical sensory organ has two fine, short, straight sense rods situated parallelly in a common shallow pit. Before this pit is one stronger

seta and on each side a fine short seta. The fourth antennal segment is very distinctly subdivided into 5 or 6 joints; often, especially after the usage of the potash-lice the fifth joint does not to be distinctly separated from the sixth. The relation of the length of the joints is the following: bas. 4,5:1,3:1,3:1,2:3,75 (event. 1+2,75). All the joints are covered with the long, verticillately situated setae and between these on each joint stand two fine sense hairs directed upwards.

On each side of head behind the antenna is a circular, dark pigmented eye.

The claws on all the pairs of feet have a well-developed inner tooth, which is situated in the basal half on the ventral lamella near the middle. The claws are nearly of equal length and slender. The empodial appendage is slightly different in form on all the pairs of feet. On the first pair the inner lamella is short and the inner tooth is near the base. On the second pair the inner lamella is broader and longer and the corner-tooth is situated higher on it. On the third pair the inner lamella is longest and untoothed. All the empodial appendages have a long apical bristle which slightly overtops the tip of the claw.

The dens is about (1,3)—1,5—(1,7) times as long as the mucro. The clothing of the dens is as follows: On the outer side of the dens near the base of the mucro is a strong spine, then follow a seta, after it again a spine, still not stronger than the first, and widely placed standing one after another 4 longer setae in a long row. Dorsally in the medial line of the dens near the base of the mucro is a seta and a second seta proximally near the base of the dens. Dorsolaterally on the inner side of the dens are situated 4 longer setae and on the inner side 3 spines; the strongest of these spines stands distally near the base of the mucro, not in the same line as the great outer spine, but a little proximally; the two large spines are sharply pointed, resembling a little strong, short bristles and are situated one after another at equal distances. On the under side of the dens distally near the base of the mucro are 3 short setae in one diagonal-row, behind these a longer pair and more proximally one after another 2 longer setae. In one case I have remarked the abnormal arrangement of these setae on the under side of the dens, that is to say on the one dens the setae were situated

as usual, on the other dens there stood behind the 3 short setae not one pair of longer setae, but only one single seta, whereas behind it stood a pair of longer setae and more proximal one seta.

The mucro is narrow and gutter-like, serrated on both edges. The tip of the mucro is formed like a shovel and the distal half of the mucro seems not to be narrowed.

Both sides of the pointed pars anterior tenaculi have one short seta. The ramus has 3 barbs and near the ramus on each side a club-shaped appendage. The pars posterior is usually as long as the pars anterior.

The anus is surrounded with some long, strong bristles, lying close to the body; the bristles are not broadened at the sides of the base. Between the strong setae stand some shorter, but here on the anal valves the fine short spines are not present.

The female subanal appendages are finely split at the tip till about the distal third of the their length into two branches; these two branches are split again into numerous smaller branches and all the branches have their tips curved upwards. In the young specimens, where body does not measure 1 mm. the subanal appendages are not split at the tip; however I have observed in the young animals also the splitting of the subanal appendages, only it is not so abundant as in the full grown specimens. These juvenile specimens, which have subanal appendages as yet unbranched, seem to resemble very much the species *Arrhopalites pygmaeus* (Wank.), from which they greatly differ even when still young, in the brownish colour of the body and in their occurrence in the open, out of caves.

The length of the body in the adult animals is 1 mm.

The species described here under the new name *Arrhopalites principalis* has already been known for a long time, as to this species undoubtedly belong the animals from Finland described as *Arrhopalites binoculatus* (Börn.) by Linnaniemi (12). Also the *Sminthurinus binoculatus* Börn. ab? from Palmi by Börner seems to belong here, since it had broom-like subanal appendages. But as the name *Arrhopalites binoculatus* (Börn.) = *Arrh. pygmaeus* (Wank.) has been given by the author to the form with bristle-like subanal appendages, the same name cannot be used for the animals with broom-like

subanal appendages and I have therefore called these differently. The species could indeed be named *Arrhopalites affinis* Börn., as the animals so named by Börner were found in the open, they were probably identical with the form described here. But the animals studied by Börner were quite young, only 0,35 mm long, and Börner could not have remarked their subanal appendages. Afterwards *Arrhopalites affinis* Börn. were taken to be identical with *Arrhopalites binoculatus* Börn. In order that more serious faults should be avoided it seems to me best to introduce a new name for the animals with broom-like subanal appendages.

To judge from the great amount of material it seems that the animals with broom-like subanal appendages are only found in the open, outside caves. I have up to date found them in Poland only in the mountainous part of the country, in the long Carpathian mountain-range, as well as in the high Tatras and also in the East-Carpathian (Czarnohora-range). I have found this species only in moss, which was mostly full of water. Linnaniemi also says of the species: „ein häufiger und charakteristischer Vertreter der Moosfauna ist und ebenso häufig und zahlreich in der Hypnum-Decke des Waldes, wie in den Sphagnetten der Sümpfe vorkommt”.

According to Linnaniemi (12) this species seems „eine ausgeprägt nördliche Verbreitung zu haben”. Since this species was also found by me in Poland in the mountains it can be included in the group of the boreo-alpin animals. At all events it occurs remarkably plentifully in North and in central Europe in mountains.

The species is probably distributed in Finland, Sweden, Germany, France, Poland, Slovakia; perhaps also in Italy and America.

Places where the animals studied by me were found:

- Poland. — Tatra-mountains. „Czarny Staw” lake near Kościelcer, cca. 1750 m. alt., in moss, 6. VII. 1909;  
 — Tatra-mountains. Strążyska-valley, cca. 950 m. alt., in the very damp beech-leaves, 9. VII. 1909;  
 — Tatra-mountains. Świnica-summit, 2306 m. alt., in moss, 3. VIII. 1909;

- Poland — Tatra-mountains. „Suchy Zlebek”-valley, cca. 900 m. alt., in moss, which was full of water, 23. VI. 1934; 1. VII. 1936;  
 East-Carpathian mountains. — Czarnohora-range of mountains, in Sphagnum on turf-moor at the foot of the Breskul-mount, above the forest-limit, cca. 1400 m. alt., 30. VI. 1935;  
 — Jaremcze, in moss in the forest „Lorietka”, 11. VII. 1937;  
 Cañon of the Dniestr-river. — Near Uścieczko, sifted from the damp oak-leaf, 29. IX. 1934, leg. Dr. J. Fudakowski;  
 Germany. — Hannover-Münden. In winter time in an ant-nest (*Formica rufa* L.) in the forest, 22. I. 1930, leg. Prof. H. Eidmann;  
 Slovakia. — Garamondnői völgy, 18. VI. 1938, leg. Prof. E. Dudich.

## STRESZCZENIE

Gatunki rodzaju *Arrhopalites* Börn.,  
 żyjące w jaskiniach Europy

Autor w dalszym ciągu opracowania Skoczogonków (*Collembola*) jaskiń europejskich podaje w tej pracy wyniki swych badań nad gatunkami rodzaju *Arrhopalites* Börn. Rodzaj ten następczający trudności w określaniu form do niego przynależnych i rozróżniany w Europie tylko w dwóch gatunkach: *Arrhopalites coecus* (Tullb.) i *Arrhopalites binoculatus* (Börn.), autor rozdziela na dwie grupy, mianowicie na grupę *coecus* z dwoma gatunkami: *Arrhopal. coecus* (Tullb.), formę troglobionną, w Europie znacznie rozprzestrzenioną i *Arrhop. tenuis* n. sp. z Westfalii (jask. Hülloch), oraz grupę *pygmaeus*, obejmującą, prócz jednego *Arrhop. principalis* nom. nov. (= *binoculatus* Li. mi nec Börner) boreoalpejskiego gatunku, szeroko rozprzestrzenionego, wyłącznie gatunki jaskiniowe, troglobionty. Należą tu opisane w tej pracy: *Arrhop. boneti* n. sp. (Hiszpania), *Arrhop. aggtelekiensis* Stach (Węgry, jask. Aggtélek), *Arrhop. furcatus* n. sp. (Hiszpania, jask. Landarbaso), *Arrhop. ornatus* n. sp. (Hiszpania, jask. Castillo), *Arrhop. postamicus* n. sp. (Jugosławia, jask. S. Canziano), *Arrhop. pygmaeus* (Wank.) (= *binoculatus* Börn.), pospolity w wielu krajach i *Arrhop. bifidus* n. sp., pospolity w jaskiniach Polski i Niemiec. Do szczegółowego opisu wszystkich tych gatunków dołącza autor 10 tablic z 112 rycinami, ułatwiającymi oznaczenie tych gatunków.

## LITERATURE CITED.

- 1) Absolon K., Über die Fauna der Höhlen des mährischen Devonkalkes. — Zoolog. Anzeiger, *XXII*, Leipzig 1899.
- 2) Absolon K., Vorläufige Mittheilung über die Gattung *Dicyrtoma* und *Heteromurus hirsutus* nov. sp. aus den mährischen Höhlen. — Zoolog. Anzeiger, *XXII*, Leipzig 1899.
- 3) Absolon K., Einige Bemerkungen über die mährische Höhlenfauna (III. Aufsatz.). — Zoolog. Anzeiger, *XXIII*, Leipzig 1900.
- 4) Absolon K., Zwei neue Collembolen-Gattungen. — Wiener Entomol. Zeitung, *XXVI*, Wien 1907.
- 5) Bonet F., Estudios sobre Colémbolos cavernícolas con especial referencia a los de la fauna Española. — Memorias de la Sociedad Española de Historia Natural, *XIV*, Madrid 1931.
- 6) Börner C., Über einige theilweise neue Collembolen aus den Höhlen der Gegend von Letmathe in Westfalen. — Zoolog. Anzeiger, *XXIV*, Leipzig 1901.
- 7) Börner C., Das System der Collembolen nebst Beschreibung neuer Collembolen des Hamburger Naturhistorischen Museums. — Mittheilungen aus d. Naturhist. Museum, *XXIII*, Hamburg 1906.
- 8) Denis J. R., Collemboles de Costa Rica avec une contribution au species de l'ordre. (II Note). — Bollet. del Labor. di Zoolog. gen. ed agrar. d. R. Inst. sup. agr. di Portici, *XXVII*, Portici 1933.
- 9) Denis J. R., Aptérygotes de la Grotte de Goyet (Belgique). — Bull. du Musée royal d'Hist. natur. de Belgique, *XIII*, 1937. Bruxelles.
- 10) Folsom J. W., New Sminthurini, including myrmecophilous and aquatic species. — Psyche, 7, 1896.
- 11) Guthrie J. E., The Collembola of Minnesota. — Geolog. and Natural History Survey of Minnesota, zool. ser. *IV*, 1903, Minneapolis Minnesota, U. S. A.
- 12) (Axelson) Linnaniemi W. M., Die Apterygotenfauna Finnlands. T. II. — Acta Soc. Scienc. Fenn., *XL*, Helsingfors 1912.
- 13) Mills H. B., A monograph of the Collembola of Iowa. — Division of Industrial Science Iowa State College, Iowa 1934.
- 14) Staeh J., Verzeichnis der Apterygogenea Ungarns. — Annal. Mus. Nat. Hung., *XXVI*, Budapest 1929.
- 15) Tullberg T., Förteckning öfver svenska Podurider. — Öfvers. af Kongl. Vet. Akad. Förhandl., *XXVII*, Stockholm 1871.
- 16) Tullberg T., Sveriges Podurider. — Kongl. Svenska Vetensk. Akadem. Handlingar, *X*, Stockholm, 1872.
- 17) Wankel H., Beiträge zur Fauna der mährischen Höhlen. — Lotos. Zeitsch. f. Naturwissensch., *X*, Prag 1860.
- 18) Wankel H., Beiträge zur österreichischen Grotten-Fauna. — Sitzungsber. d. math.-naturwiss. Cl. d. k. Akad. d. Wissen., *XLIII*, I. Abt., Wien 1861.
- 19) Womersley H., The Collembola Symphypleona of Australia. — Pamphlets of the Council for Scientific and Industrial Research, nr. 34, Melbourne 1932.

20) Womersley H., On some additions to the Sminthurid Fauna of Australia. — „Stylops“ a Journal of Taxonomic Entomology, 2, Part. II, London 1933.

21) Womersley H., On some new species and records of Australian and New Zealand Collembola. — Transact. of the Royal Society of South Australia, *LIX*, 1935.

Kraków, 28. XII. 1939.

## Explanation of plates.

## Plate I.

*Arrhopalites coecus* (Tullb.).

1. Distal part of the first pair of feet of the specimen from Zakopane from the out-side; a great enlargement;
2. Distal part of the second pair of feet of the same specimen from the inner side; enlargement as fig. 1;
3. Distal part of third pair of feet of the same specimen from inner-side; enlargement as fig. 1;
4. Dens of the same specimen; upper view;
5. Dens of the same specimen from the under side;
6. Proximal bristles on the out-side of the dens; enlargement as fig. 1;
7. Distal part of the dens from the side; enlargement as fig. 1;
8. Anal segment of the specimen from Zakopane;
9. The anal bristle and the on fine spine of the same specimen; enlargement as fig. 1;
10. Subanal appendage of the same specimen from above; enlargement as fig. 1;
11. Subanal appendage of the other specimen from Zakopane, from above; enlargement as fig. 1;
12. Subanal appendage of the specimen from Finland from the side; enlargement as fig. 1.

## Plate II.

*Arrhopalites tenuis* n. sp.

1. Distal part of the first pair of feet; a great enlargement;
2. Distal part of the second pair of feet of the same specimen from the out-side; enlargement as fig. 1;
3. Distal part of the third pair of feet of the same specimen from the out-side; enlargement as fig. 1;
4. Dens and mucro from the side;
5. Under part of the anal segment with subanal appendages; enlargement as fig. 1;
6. Subanal appendage of the other specimen from the side; enlargement as fig. 1;

*Arrhopalites ornatus* n. sp.

7. Subanal appendage, upper view; enlargement as fig. 1;
8. Subanal appendage, upper view; enlargement as fig. 1;

9. Subanal appendage of the other specimen, upper view; enlargement as fig. 1.

Plate III.

*Arrhopalites boneti* n. sp.

1. Distal part of the first pair of feet of the specimen from Cueva de Aitzquirri near Onnate; a great enlargement;
2. Distal part of the second pair of feet of the same specimen; enlargement as fig. 1;
3. Distal part of the third pair of feet of the same specimen; enlargement as fig. 1;
4. Dens and mucro, upper view.
5. Dens and mucro of the other specimen from Cueva de Aitzquirri near Onnate, from the inner side;
6. Distal part of the dens from the outer side; enlargement as fig. 1;
7. Subanal appendage from the side; enlargement as fig. 1;
8. Subanal appendage of the other specimen from the side; enlargement as fig. 1;
9. Subanal appendage, upper view; enlargement as fig. 1.

Plate IV.

*Arrhopalites aggtelekiensis* Stach.

1. The third and fourth antennal segment of the female;
2. The sense papilla on the third antennal segment; a great enlargement;
3. The subapical sense organ III; enlargement as fig. 1;
4. Distal part of the first pair of feet from the outer side; enlargement as fig. 1;
5. Distal part of the second pair of feet of the same specimen; enlargement as fig. 1;
6. Distal part of the third pair of feet of the same specimen; enlargement as fig. 1;
7. Empodial appendage of the third pair of feet of the other specimen; enlargement as fig. 1;
8. Subanal appendages; enlargement as fig. 1;
9. Subanal appendage of an other specimen; enlargement as fig. 1;
10. Subanal appendage of a specimen; enlargement as fig. 1;
11. Dens and mucro from the outer side.

Plate V.

*Arrhopalites furcatus* n. sp.

1. The third and fourth antennal segment;
2. The third antennal segment of the other specimen; a great enlargement;
3. The third antennal segment of the larger specimen, from the side; enlargement as fig. 1;

4. Distal part of the first pair of feet; enlargement as fig. 1;
5. Distal part of the second pair of feet of the same specimen; enlargement as fig. 1;
6. Distal part of the third pair of feet of the same specimen; enlargement as fig. 1;
7. Dens and mucro from the inner side;
8. Distal part of the mucro of an of the specimen, from the inner side; enlargement as fig. 1;
9. Distal part of the mucro of the larger specimen, upper view; enlargement as fig. 1;
10. Subanal appendage from the side; enlargement as fig. 1;
11. Subanal appendage of the other specimen, upper view; enlargement as fig. 1;
12. Subanal appendage of the larger specimen, upper view; enlargement as fig. 1.

Plate VI.

*Arrhopalites postumicus* n. sp.

1. The fourth antennal segment of the female;
2. Distal part of the first pair of feet from the inner side; a great enlargement;
3. Distal part of the second pair of feet of the same specimen from the outer-side; enlargement as fig. 1;
4. Distal part of the third pair of feet of the same specimen; from the inner side; enlargement as fig. 1;
5. Tenaculum; enlargement as fig. 1;
6. Dens and mucro from the outer side;
7. Subanal appendages, upper view; enlargement as fig. 1;
8. Subanal appendage of the other specimen, upper view; enlargement as fig. 1;
9. Subanal appendage from the side; enlargement as fig. 1.

Plate VII.

*Arrhopalites canzianus* n. sp.

1. The fourth antennal segment of the female;
2. The subapical sense organ III of the same specimen; a great enlargement;
3. Distal part of the first pair of feet; enlargement as fig. 1;
4. Distal part of the second pair of feet of the same specimen; enlargement as fig. 1;
5. Dens, upper view; enlargement as fig. 1;
6. Mucro on an other specimen from the outer side; enlargement as fig. 1;
7. The anal segment of the female with subanal appendages; enlargement as fig. 1;

8. Subanal appendage of an other specimen from the side; enlargement as fig. 1.

Plate VIII.

*Arrhopalites pygmaeus* (Wankel).

1. Distal part of the first pair of feet of the specimen from Rentrops-cave in Westfalen from outer side; a great enlargement;
2. Distal part of the second pair of feet of the same specimen; from the inner side; enlargement as fig. 1;
3. Distal part of the third pair of feet of the same specimen from the outer side; enlargement as fig. 1;
4. Empodial appendage of the third pair of feet of the same specimen from Feldhof-cave; enlargement as fig. 1;
5. Tenaculum of the specimen from Feldhof-cave in Westfalen; enlargement as fig. 1;
6. The third antennal segment of the specimen from Hülloch-cave in Westfalen;
7. Mucro of the specimen from Feldhof-cave, from the inner side; enlargement as fig. 1;
8. Mucro of an other specimen from the Feldhof-cave, from the inner side; enlargement as fig. 1;
9. Dens and mucro of the specimen from Rentrops-cave, upper view;
10. Subanal appendages of the specimen from Feldhof-cave, upper view; enlargement as fig. 1;
11. Subanal appendages of an other specimen from Feldhof-cave, upper view; enlargement as fig. 1;
12. Subanal appendages of a larger specimen from Feldhof-cave; enlargement as fig. 1;
13. Subanal appendage of the specimen from Salzlöcher-cave, from the side; enlargement as fig. 1;
14. Subanal appendage of an other specimen from Salzlöcher-cave, upper view; enlargement as fig. 1;
15. Subanal appendages of the specimen from Rentrops-cave, upper view; enlargement as fig. 1;
16. Subanal appendages of an other specimen from Rentrops-cave, upper view; enlargement as fig. 1;
17. Subanal appendage of a larger specimen from Rentrops-cave, from side; enlargements as fig. 1;
18. Subanal appendages of the specimen from Hülloch-cave; enlargement as fig. 1;
19. Subanal appendages of the specimen from Keller-cave in Westfalen; enlargement as fig. 1;
20. Subanal appendage of an other specimen from Keller-cave; enlargement as fig. 1;
21. Subanal appendage of the specimen from the cave in Ojeów near Kraków, upper view; enlargement as fig. 1.

Plate IX.

*Arrhopalites bifidus* n. sp.

1. Subapical sense organ III of the specimen from Osterloch-cave; a great enlargement;
2. Distal part of the first pair of feet of the specimen from Bismarck-cave; enlargement as fig. 1;
3. Distal part of the second pair of feet of the same specimen; enlargement as fig. 1;
4. Distal part of the claw of the first pair of feet of the specimen from Osterloch-cave, from the side; enlargement as fig. 1;
5. The claw of the third pair of the feet of the specimen from Bismarck-cave, from the side; enlargement as fig. 1;
6. The claw of the third pair of feet of the specimen from Bilze-cave, from inner side; enlargement as fig. 1;
7. Subanal appendages of the specimen from Bismarck-cave, upper view; enlargement as fig. 1;
8. Subanal appendage of an other specimen from Bismarck-cave upper view; enlargement as fig. 1;
9. Subanal appendages of the specimen from Rentrops-cave, upper view; enlargement as fig. 1;
10. Subanal appendage of the specimen from Streitberger-cave, upper view; enlargement as fig. 1;
11. Subanal appendage of the specimen from Osterloch-cave, from the side; enlargement as fig. 1;
12. Subanal appendage of the specimen from Bismarck-cave, from the side; enlargement as fig. 1;
13. Subanal appendage of the specimen from Klutert-cave, upper view; enlargement as fig. 1;
14. Subanal appendage of the specimen from Bilze-cave, upper view; enlargement as fig. 1.

Plate X.

*Arrhopalites principalis* nom. nov.

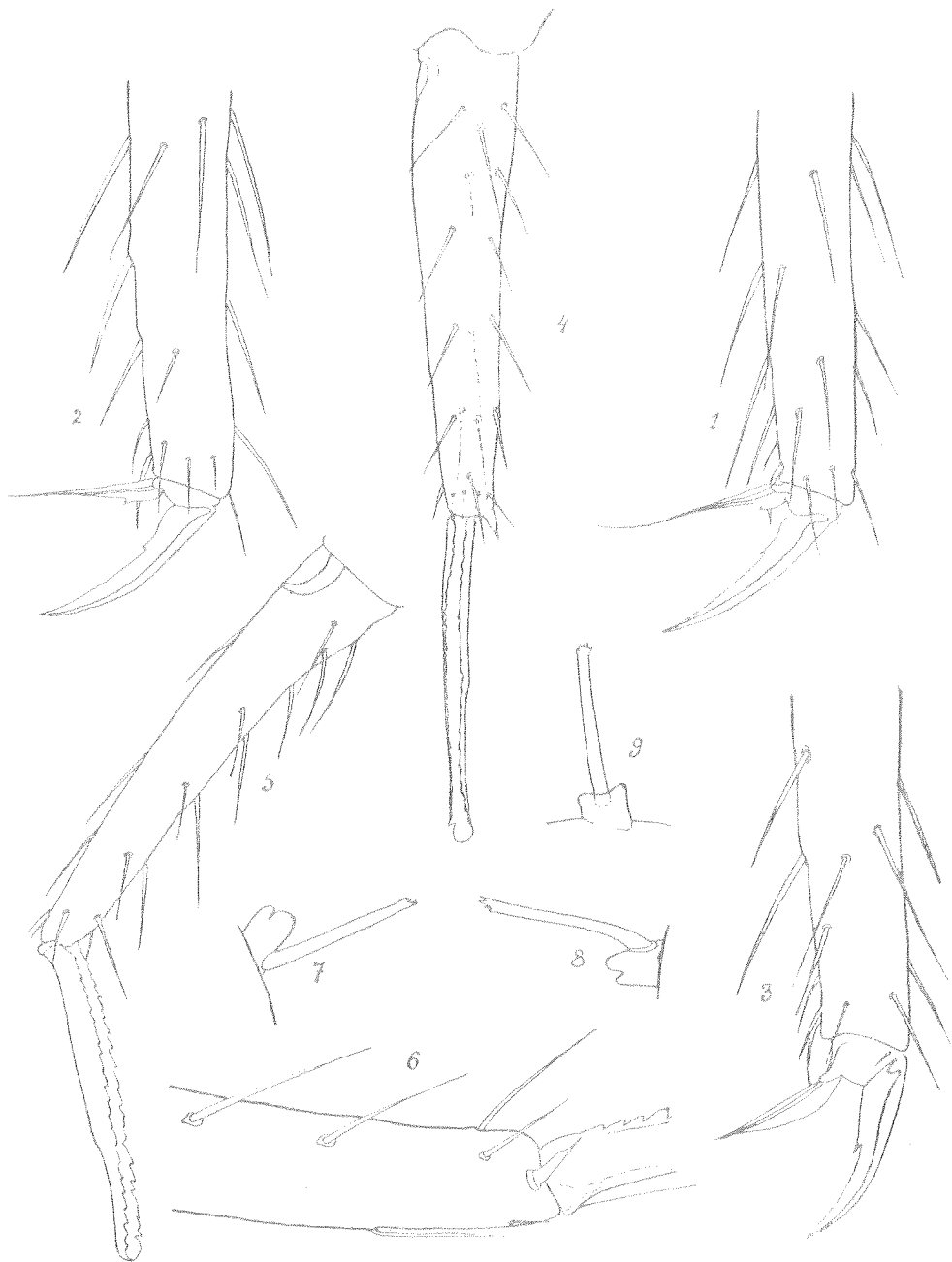
1. The fourth antennal segment of the specimen from Jaremeze;
2. Distal part of the first pair of feet of the specimen from Jaremeze from the inner side; enlargement as fig. 1;
3. Distal part of the third pair of the feet of the same specimen, from the outer side; enlargement as fig. 1;
4. Dens of the specimen from Szutromińce, upper view; enlargement as fig. 1;
5. Subanal appendages of the specimen from Jaremeze; enlargement as fig. 1;
6. Subanal appendages of the young specimen from Jaremeze; enlargement as fig. 1;
7. Subanal appendages of the specimen from Szutromińce; enlargement as fig. 1.



*J. Stach, Genus Arrhopalites.*

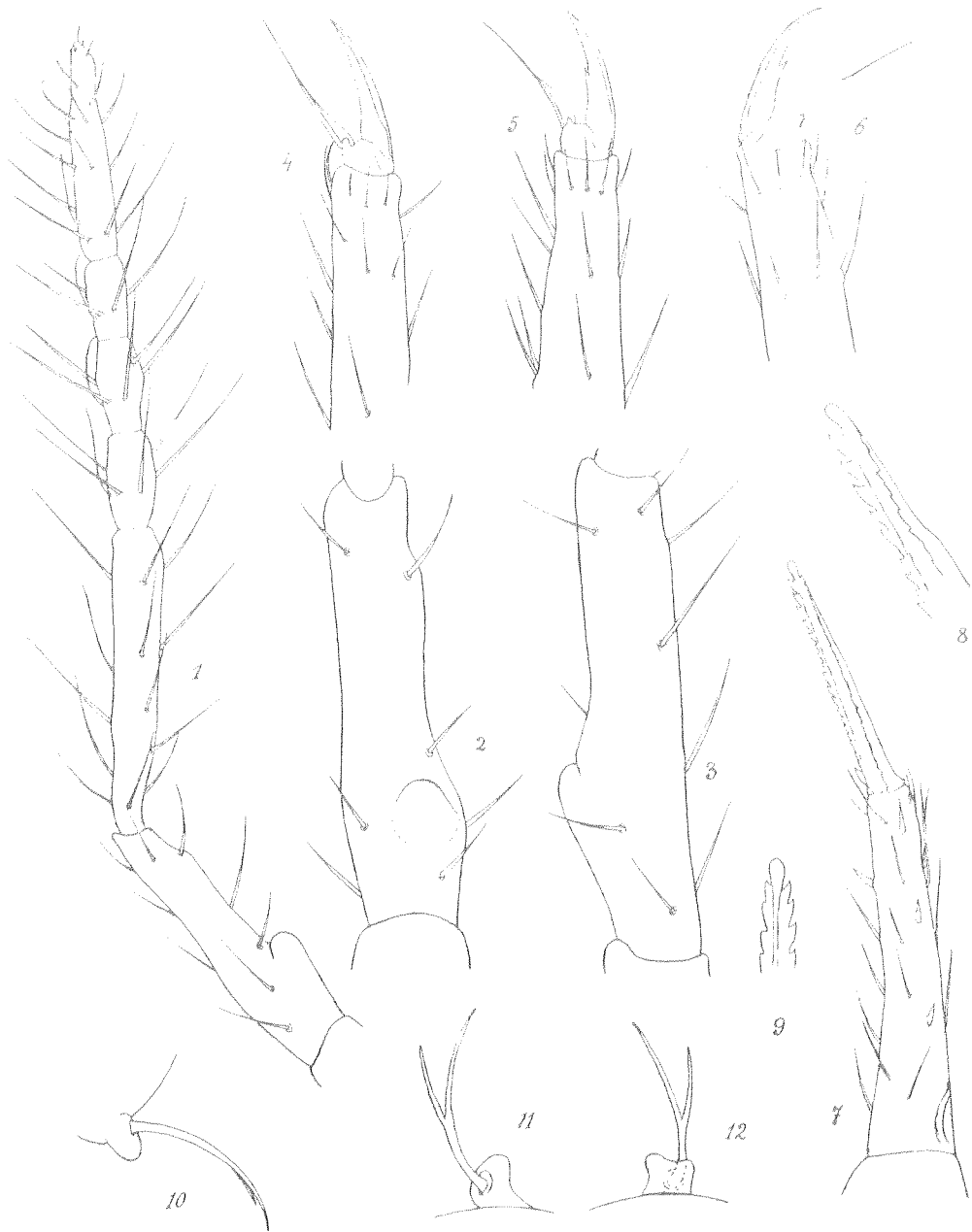


J. Stach, Genus Arrhopalites.



*J. Stach, Genus Arrhopalites.*





J. Stach, Genus *Arrhopalites*.

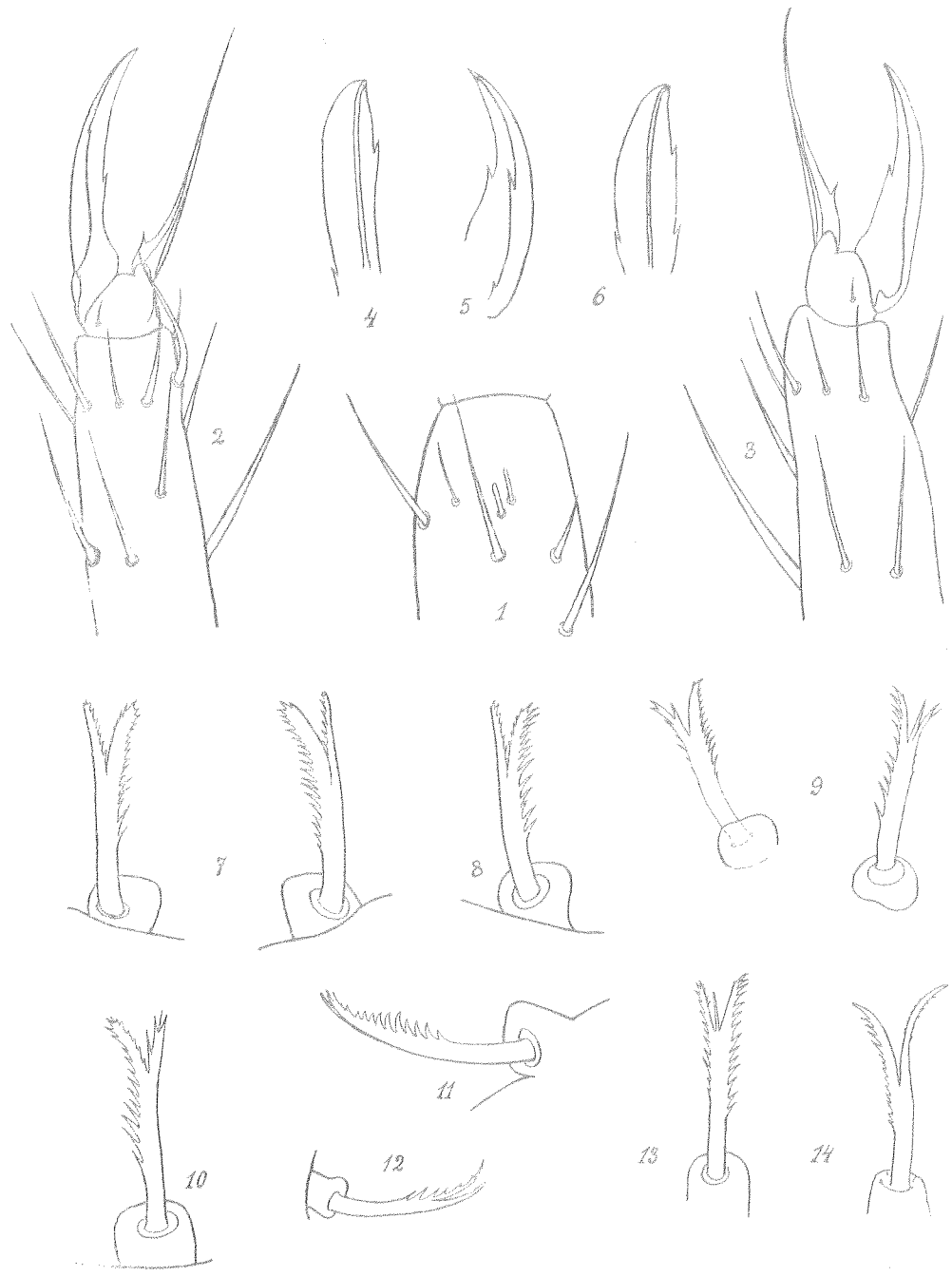


*J. Stach, Genus Archopalites.*

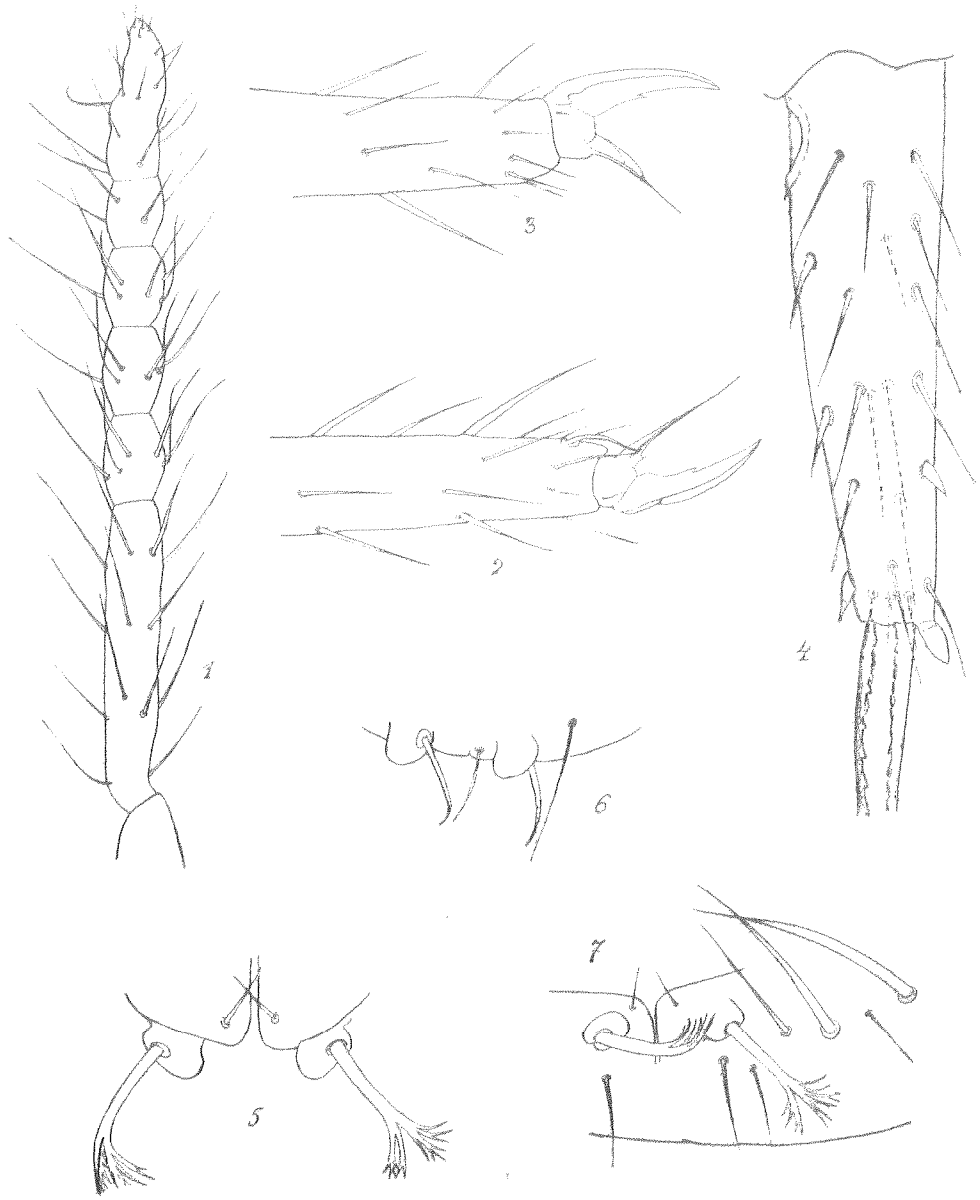


J. Stuch, Genus *Arrhopalites*.





J. Stach, Genus *Arrhopalites*.



J. Stach, Genus *Arrhopalites*.