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THE PYCNOGONID FAMILY AUSTRODECIDAE[1]

by

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CONTENTS

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[1] Thesis University of Amsterdam.

I. Introduction

Everyone who has seriously studied the Pycnogonida knows how many difficulties this small group of marine arthropods offers to the taxonomist. Some genera (e.g., *Nymphon, Achelia*) contain a considerable number ot closely related species, moreover individual species may show a wide variation range. In other cases (family Callipallenidae) there is a perplexing diversity on the generic level. The smaller families and genera also offer their particular problems.

One of these small genera, *Austrodecus* HODGSON, 1907, unique member of the family Austrodecidae, remained monospecific for a long time and only some fifteen years ago a second species was added. It must be admitted that Miss GORDON in two of her excellent papers on Antarctic Pycnogonida (1932, 1944) noticed, and described, a number of variations, but she was not able to find a satisfactory arrangement for these variations, which she provisionally indicated as var, *α*, *β*, and *γ*. Some few years ago two new species, clearly distinct from the two described already, were recorded by the present author (STOCK, 1954) from New

Zealand waters and a year later he described another new species from Tristan da Cunha, the isolated island in the South Atlantic. Thus the genus comprises at present five species : *A. glaciale* HODGSON (the type species with three unnamed varieties), *A. breviceps* GORDON, *A. gordonae* STOCK, *A. frigorifugum* STOCK and *A. trisanense* STOCK.

The family Austrodecidae was established by STOCK, in 1954, for the single genus *Austrodecus* which is distinguished from all other Pycnogonida by the curious, annulated, tubular proboscis and by the structure of the ovigers. As a rule the terminal segments of the ovigers are laterally compressed and bear special spines on the ventral surface. In *Austrodecus*, on the other hand, they are flattened dorso-ventrally, with simple spines on the distal inner (median) margin. Moreover, in *Austrodecus* the ovigers are much reduced in *both* sexes, not in the female only as is the usual trend in Pycnogonida. The rudiments of the ovigers in the males of recent Austrodecidae are so minute, and their structure is so unsuitable, that there can be no doubt that they no longer serve the purpose of egg bearing. The female ovigers are still more reduced. Apparently they no longer act as cleaning organs, which function is important in several pycnogonid families, e.g., Nymphonidae. The rudimentary ovigers would seem to be completely functionless in both sexes of the Austrodecidae.

The taxonomy of this morphologically interesting family is in a chaotic state, and the small number of forms described — five species and three varieties — gives a wrong impression of the bewildering variation that exists. The bulk of the material present in the museums of the world has hitherto been referred to *A. glaciale*, though nearly every author has emphasized the wide variation within this "species". The result is the present, quite unpleasant, situation that it is totally impossible to define *A. glaciale*, and that material considered to belong to this species was collected from purely antarctic waters, as well as from temperate waters off New Zealand.

In the present paper, I shall try to disentangle the taxonomy of the Austrodecidae. For this purpose all *Austrodecus* material present in the larger museums of the free world has been examined. Though this material is fairly extensive, I feel sure that my work shows some gaps since of several forms only a single, or at most very few, specimens were available.

The greater part of the samples studied came from the British Museum (Natural History), London. The author wishes to ackowledge his indebtedness to Dr. Isabella GORDON, curator of the Pycnogonida, for her help in providing the material. Valuable additional lots came from the Unites States National Museum, Washington ; the Musée d'Histoire Naturelle, Paris ; the Zoologisk Museum, Copenhagen ; the Kgl. Norske Videnskabers Selskab Museet, Trondheim ; the Naturhistoriska Riksmuseet, Stockholm ; the Zoologisches Museum der Universität, Berlin ; the Universitetets Zoologiske Museum, Oslo ; the Zoologisches Staatsinstitut und Museum, Hamburg ; and the Dominion Museum, Wellington. I wish to express here my best thanks to the authorities of all these Institutions, without whose help it would have been impossible to complete this study.

Although I am far from a splitter, I cannot help describing a considerable number of new species. Some of the forms raised to specific rank were considered already by GORDON (1944) as distinct varieties but several others have not been recognized in the past. The reasons why obviously new species were not recognized as such are quite clear :

(1) The earlier descriptions are, with a few exceptions, sufficient to identify the *genus* with certainty but are inadequate to show the *specific* differences. (2) The specific features seem to be quite unimportant as compared with the strongly defined generic featrues of *Austrodecus*. (3) The smallness and the rarity of some forms have contributed to the confusion. (4) As a general rule, the more a genus is studied, in particular when it is monographed, the more obvious become the differences between the individuals which comprise it. (This has the result — some might say the disadvantage — that more and more species tend to be recognized in that genus, and that several of these species tend to become smaller

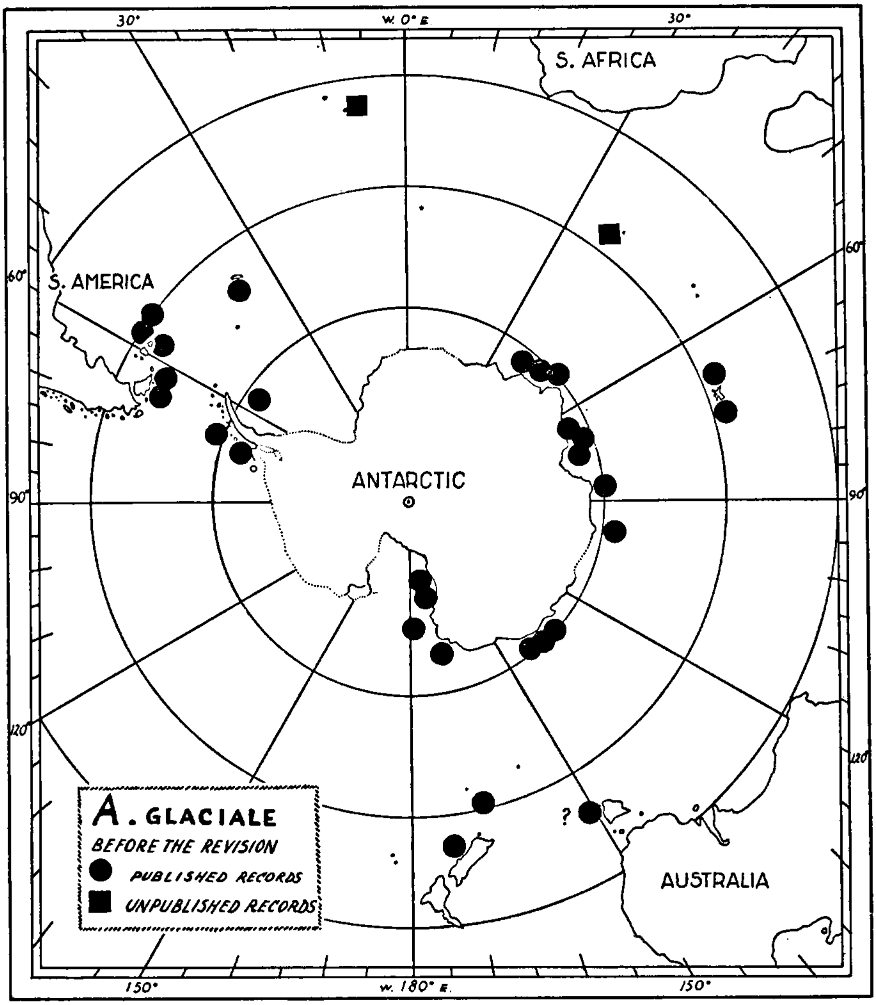

FIGURE 1. The distribution of the (collective) species *A. glaciale* HODGSON in the unrestricted sense as it was used before the present revision. The "species" shows an unreasonably large range from the glacial zone to within the warm-temperate region. The basic chart in this and the following figures after Discovery Reports 24, pl. I, 1944.

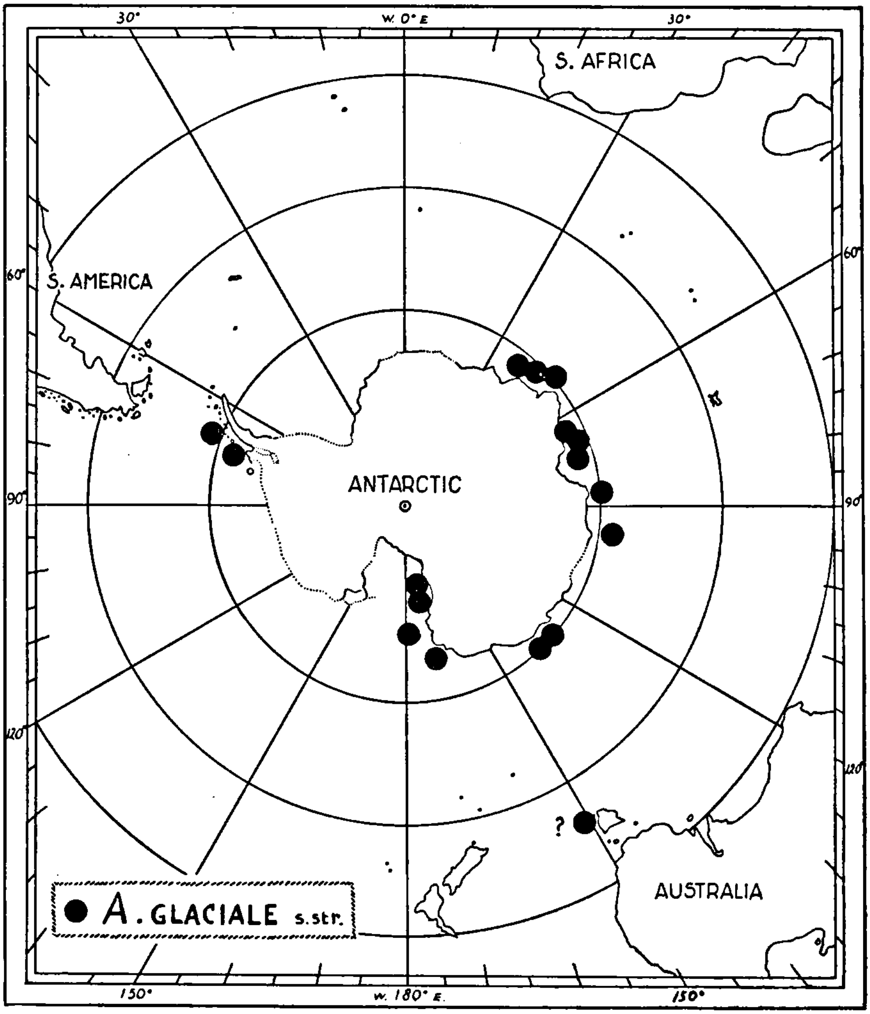

FIGURE 2. The distribution of *A. glaciale* in the restricted sense proposed in this paper. No more zoogeographical inconsistencies exist. As to the dubious Tasmanian record, cf. footnote 10, p. 46.

and smaller in value and distinction). (5) Obviously, the favourable circumstances in which the monographer works, with sufficient material from all parts of the range available, greatly facilitates the recognition of the actual taxonomic status. (6) Finally, there is an important psychological factor which explains the fact that so few species have been described hitherto in the genus *Austrodecus*. Genera which remained monospecific for a long time, like *Austrodecus*, have the disadvantage of being respected by tradition instead of being studied critically. One will hesitate to create a new species in a traditionally monospecific genus (*Austrodecus*), rather than in a genus which comprises dozens or hundreds of species (*Nymphon*). Moreover, in genera rich in species, which are parenthetically usually the genera possessing many "structures suit-

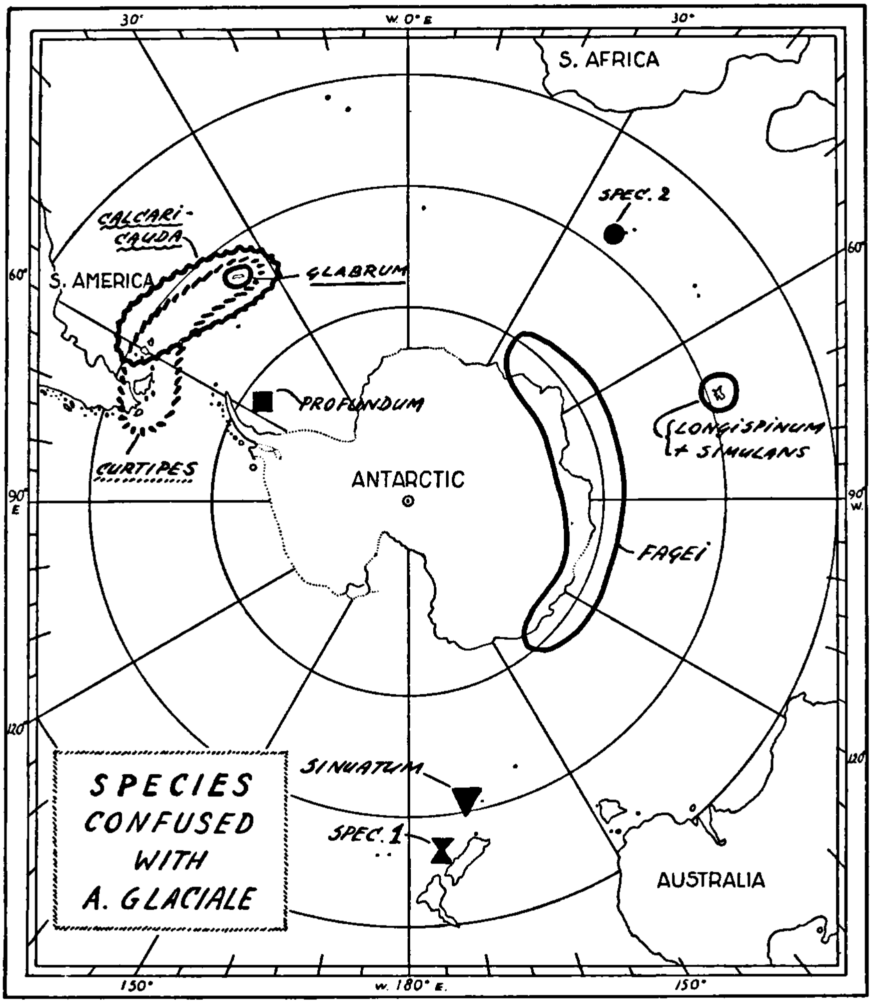

FIGURE 3. The distribution of species confused with *A. glaciale*, separated from it in this paper for the first time.

able for the taxonomist", one has to compare accurately each character with the characters of all the species described and the slightest differences will sometimes be taken to justify the creation of a new species. In monotypic genera, however, one is inclined to read over only the generic diagnosis, and if this fits the specimen examined, the specimen is identified with the genotype.

Figure 1 shows the distribution of *Austrodecus glaciale* before the present revision; it has an unreasonably large distribution, from nearly 80° S. to 40° S.

Figure 2 shows the distribution of *A. glaciale* in its restricted sense; figure 3 shows that of the species hitherto confused with *A. glaciale*. One will notice that there are no longer considerable zoogeographical inconsistencies in the dispersal pattern. Thus there is, in addition to

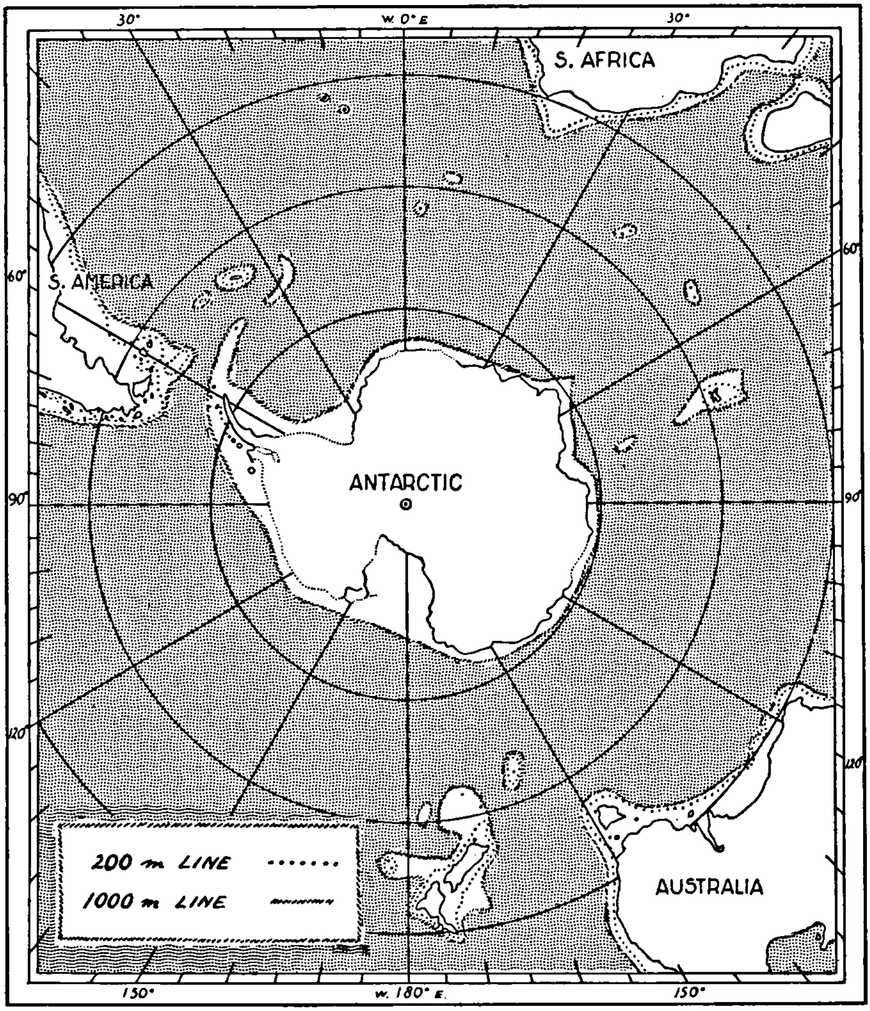

Figure 4. Chart of the Southern Ocean with the 200 m and the 1000 m line (after Schott, 1926, 1935). The narrow continental shelf is the exclusive habitat of *Austrodecus*. Not a single species has been found below a depth of 1000 m. The entire dotted part of the ocean is deeper than 1000 m and forms a pre-eminent dispersal barrier.

morphological evidence, strong zoogeographical evidence in favour of the new classification.

The genus offers a beautiful example of speciation through geographic isolation, a phenomenon long known in terrestrial animals but not so frequently described in marine organisms.

The members of the genus *Austrodecus* are strictly eulittoral and sublittoral : they live in comparatively shallow waters, from 0 to 200 m, in a single case down to 1000 m. Regions of suitable depth are, as fig. 4 shows, rather limited in the southern hemisphere and these areas of shallow waters are of an isolated nature, separated from each other by large regions of abyssal depth (usually 2500 m or more) that are uninhabitable for members of the genus, and that apparently form insurmountable dispersal barriers.

The geomorphogical nature of the seabottom inhabited by *Austrodecus* thus strongly favours the development of more or less isolated populations, with little if any geneflow between the isolates. Each of the several shallow water regions existing in the Southern Seas has its own *Austrodecus* population, a population which has developed certain deviating morphological characteristics during the time of its geographic isolation and — as will be discussed later on — they have also acquired reproductive isolation.

Consequently, we find that Kerguelen, the Prince Edward Islands, Gough, New Zealand, Macquarie Island, etc., each have their own species. The distances over abyssal depth which the species must traverse when spreading along the shortest possible route from the islands just mentioned to the nearest region of shallow waters, but without traversing a climatic boundary, are:

for Kerguelen	1350 km to Crozet Is. 1275 km to the Antarctic Continent
for Prince Edward Is.	1000 km to Crozet Is.
for Gough Id.	1800 km to Bouvet Id. (but much nearer to Tristan da Cunha which lies outside, or just on, the Antiboreal convergence).
for New Zealand	560 km to Macquarie Id.
for Macquarie Id.	1025 km to the Antarctic Continent.

On the other hand, South Georgia and the Falkland Islands, which are connected by under-water ridges, "so that the distance between the two nearest parts of the sea floor of at most a depth of 1000 m is nowhere greater than approximately 400 km" (EKMAN, 1953, p. 227), have two *Austrodecus* species in common. The Falklands lie on the continental shelf of South America and consequently have the same *Austrodecus* species as Tierra del Fuego.

Unfortunately, no *Austrodecus* is known from the South Orkneys and the South Sandwich Islands. It would be interesting to know which representatives of the genus live on these islands because they form part of a chain of shallow water connecting the South Shetlands and Palmer Peninsula with South Georgia.

It is rather remarkable that Tristan da Cunha and Gough Island (only 425 km apart) have *different Austrodecus* species. A possible explanation may be the climatological difference between Gough and Tristan: the former lies well within the antiboreal (subantarctic) zone, the latter on, or just outside, the antiboreal convergence.

Climatic factors may be responsible too for the relatively large number of different *Austrodecus*-species that occur in New Zealand. Certainly conditions are very different at the northern extremity of the North Island of New Zealand, at 34°30′ S. well within the warm-temperate zone, and the southern point of South Island, situated 12.5 degrees of latitude more to the South, consequently well within the antiboreal zone.

These conditions suggest that the speciation in *Austrodecus* is strongly influenced by the temperature. Perhaps the speciation is more active in temperate regions than in cooler ones, or the species of the genus are stenotherm, so that the rapid changes in temperature, as occur along the New Zealand shores, initiate evolutionary processes.

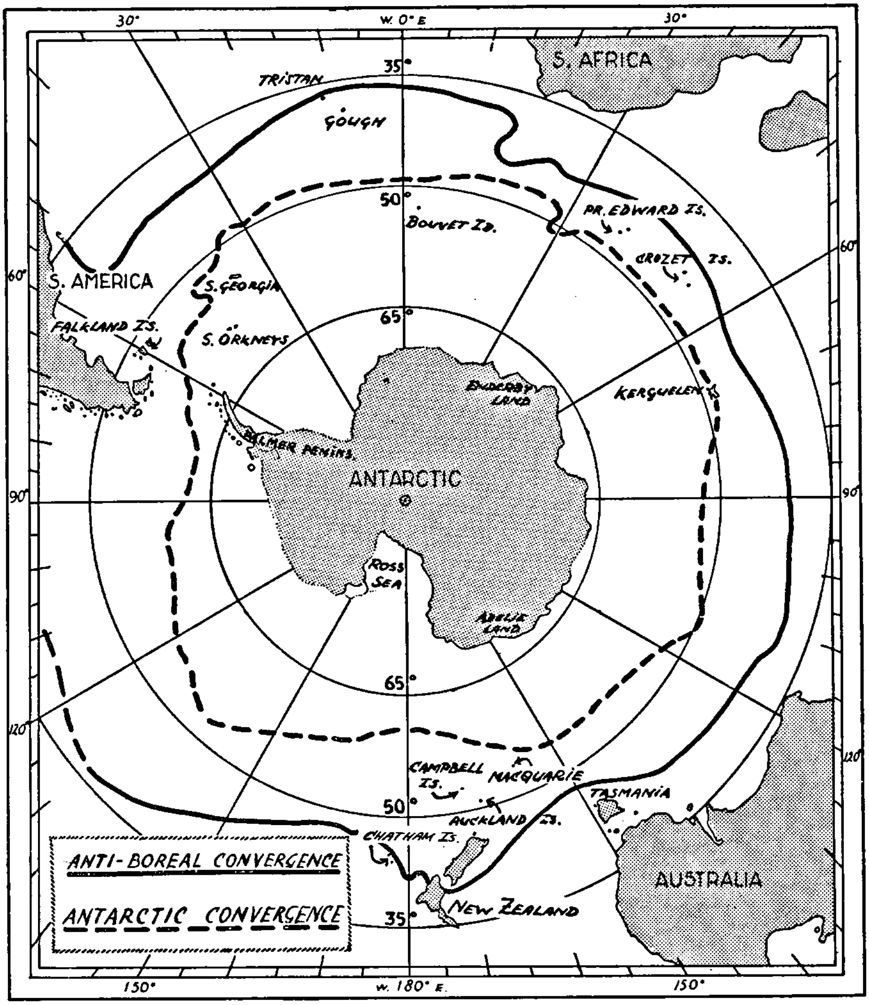

FIGURE 5. Chart of the Southern Ocean with the names of the continents, the more important islands, etc. and with the two chief temperature demarcation lines : the Antarctic Convergence and the Antiboreal Convergence (after EKMAN, 1953).

II. Geographic speciation

1. GEOGRAPHIC SPECIATION IN TWO STEPS

„Geographic speciation proceeds in two steps. During the first, a species breaks up into geographical isolates which diverge from each other genetically. The second step consists of the secondary overlap of some of these populations, without interbreeding" (MAYR, 1954, p. 11). In the genus *Austrodecus* speciation has reached the second step : we find a number of allopatric, and likewise some sympatric, species, as table I shows.

TABLE I

Genus *Austrodecus*

Section	Number of allopatric species	The additional number of sympatric species
glaciale-section	7	4
breviceps-section	2	—
tristanense-section	3	—
gordonae-section	2	1
Total	14 (= 73.3%)	5 (= 26.7%)

In the *glaciale*-section 1) more than one third of the species is sympatric and one might ask whether the "geographic speciation in two steps", as quoted above, can still be traced back here. It is evident from the distribution pattern of the *glaciale*-section (figs. 2 and 3) that this group has been diversified to such an extent that the original geographical relations became blurred. In several regions nowadays two species occur together, e.g., *longispinum* and *simulans* in Kerguelen, *glaciale* and *fagei* in the western part of the Antarctic continent, *curtipes* and *calcaricauda* in the Falklands and in one region, South Georgia, even three species live together: *curtipes, calcaricauda,* and *glabrum.*

This complicated distribution scheme may be explained by a combination of geographic speciation and multiple invasion, as worked out in the following paragraphs.

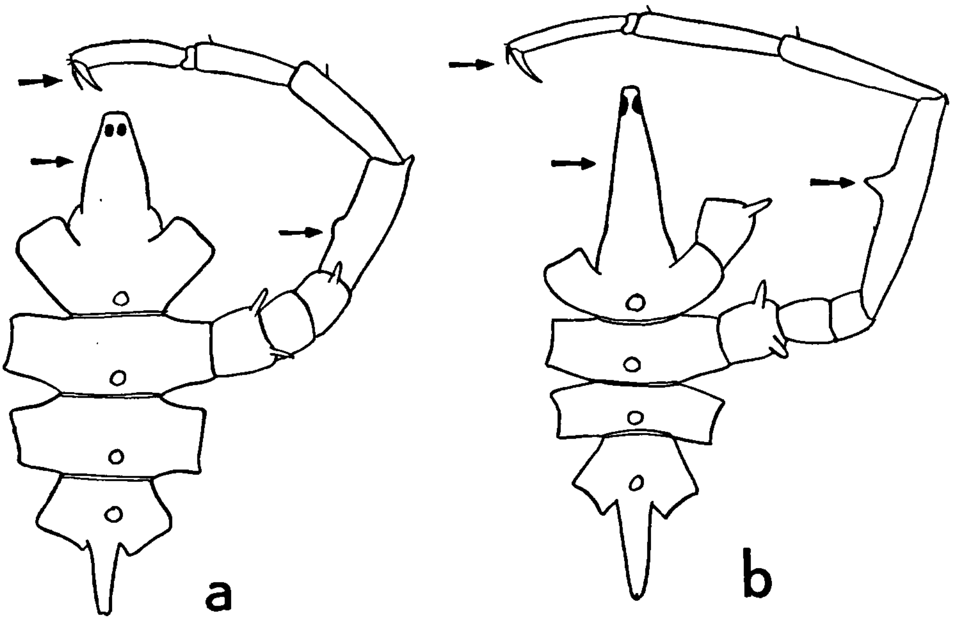

FIGURE 6. Semi-diagrammatic figure of a typically short-eyed member (a), and of a typically long-eyed member (b) of the *glaciale*-section.

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1) Both number of species and number of records of the material belonging to the three other sections are too small for a fruitful discussion of details. Therefore, the following considerations are chiefly based upon the distribution of the members of the *glaciale*-section.

2. THE ANCESTRAL LONG-EYED AND THE ANCESTRAL SHORT-EYED FORM

The *glaciale*-section of the genus *Austrodecus* falls into two quite natural groups : a short-eyed and a long-eyed group. The short-eyed group comprises the species *longispinum, curtipes, sinuatum* and the dubious specimens indicated below as spec. 1 and spec. 2, all of which agree in the following characters [2]): eye tubercle relatively short ; auxiliary claws at least half as long as the claw ; cement gland cone low, situated

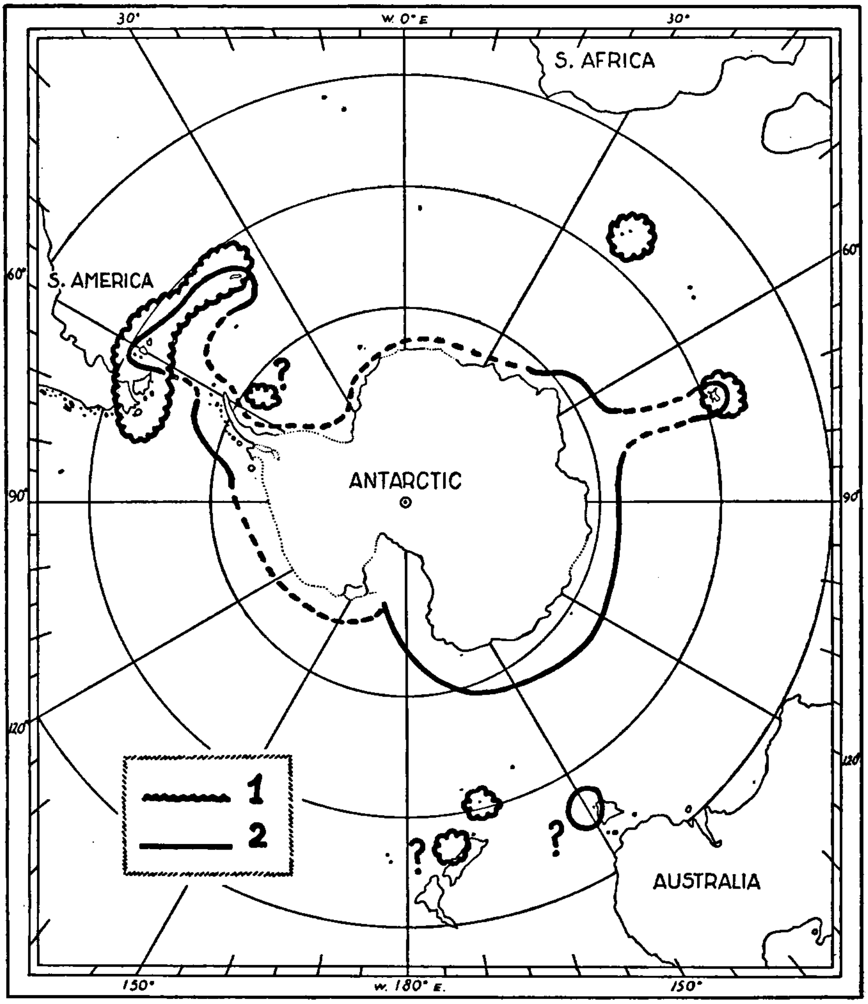

FIGURE 7. The short-eyed members of the *glaciale*-section (1) (= the descendants of the ancestral short-eyed form), and the long-eyed species of the *glaciale*-section (2) (= the descendants of the ancestral long-eyed form) are still more or less allopatric in their distribution.

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[2]) The only deep-sea species of the genus, *A. profundum*, shows a certain relation to the short-eyed group, but also possesses some deviating characters (adaptations to the aberrant habitat ?).

at about $^1/_3$ of the length of the femur (fig. 6a). The long-eyed group (*glaciale, fagei, glabrum, simulans, calcaricauda*) is characterized by a relatively long eye tubercle ; auxiliaries which are about $^1/_3$ as long as the claw ; a cement gland cone that is well-defined, situated between $^1/_3$ and $^2/_3$ of the length of the femur (fig. 6b).

Apparently all species of the long-eyed group are descended from a common long-eyed ancestor, and all short-eyed species from a common short-eyed ancestor. So, the recent members of the *glaciale*-section of the genus *Austrodecus* are to be derived from two ancestral forms, which I shall call the *ancestral long-eyed form* and the *ancestral short-eyed form* respectively.

The ancestral long-eyed form appears originally to have been purely antarctic in its distribution (as the descendants of the long-eyed form are chiefly antarctic still), the ancestral short-eyed form must have had a low antarctic or antiboreal distribution (as still have the species that developed from this ancestral short-eyed form). We thus suppose the two groups within the *glaciale*-section, the long-eyed group and the short-eyed group, to be the descendants of two originally allopatric populations, one high antarctic (the ancestral long-eyed form), the second low antarctic-antiboreal [3]) (the ancestral short-eyed form). The climatic barrier separating these two populations was apparently sufficient to prevent a constant gene-flow between the two. In course of time a divergence was brought about, resulting in reproductive isolation, so that the two populations became good species.

The most wide-spread *Austrodecus* species in recent times, *A. glaciale*, is most probably the descendant in direct line of the ancestral long-eyed form.

3. MIGRATION

The ancestral long-eyed form (the high antarctic one) and the ancestral short-eyed form (the antiboreal one), after having attained full species-rank, must have spread and occupied new regions. The long-eyed form became circumpolar around the Antarctic continent, the short-eyed form occupied a number of antiboreal and low-antarctic islands, such as Prince Edwards Islands, Auckland Islands, New Zealand.

Sometimes, however, immigrants may have arrived in a region in which colonists from some other source were already present. In several cases both invasion waves settled in the same region without mixing.

Such a multiple invasion occurred, for instance, on Kerguelen. The island was reached by a migration wave coming from the long-eyed stock and also by a wave arising from the short-eyed stock. The descendants of both sets of colonists still live side by side on Kerguelen, without interbreeding, thus behaving like good species.

A similar double invasion — one group of immigrants from the long-eyed stock, another from the short-eyed one — occurred on the Falklands.

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[3]) For the sake of brevity, "antiboreal" will be used in the sequel, in stead of "low antarctic - antiboreal".

4. ISOLATION

The situation that we find nowadays is still more complicated, owing to the peculiar climatic and geographical conditions in the region under consideration : the low antarctic and antiboreal zones consist of a number of islands lying far apart, each separated by vast deep-water regions, efficient barriers preventing a continuous gene-flow between populations of predominantly eu- and sublittoral animals like *Austrodecus*. Moreover, the climatic conditions of these islands are often very different from each other, so that it is easily understood that the populations on these islands soon diverged into vicarious subspecies, and in time became so different

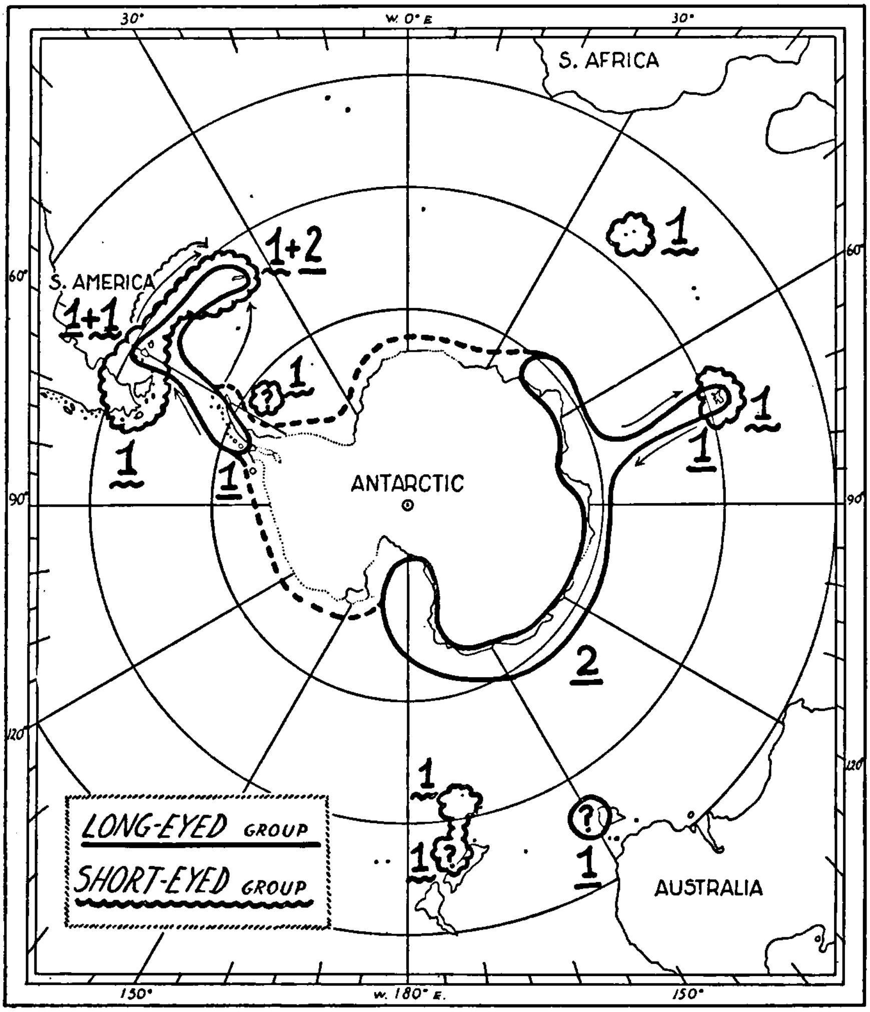

FIGURE 8. The present-day distribution of the species of the *glaciale*-section. The ancestral short-eyed form and the ancestral long-eyed form each developed through isolation into several species. The figures indicate the number of species of the short-eyed and of the long-eyed group in each region. Presumably continuous ranges are indicated by dotted lines. Supposed migration waves are indicated by arrows.

that they can now be considered as good species. In this way, the original short-eyed, antiboreal form split into a number of allopatric, antiboreal species: *A. curtipes* (Tierra del Fuego, Falklands), *A.* spec. 2 (Prince Edward Islands), *A. longispinum* (Kerguelen), *A. sinuatum* (Auckland Islands) etc.

Likewise, isolated populations of the original long-eyed form evolved in the same way and became at first subspecies and finallly full species. One migration wave of *A. glaciale*, the antarctic long-eyed stock, reached Kerguelen, became isolated there and became so different from *A. glaciale* that it has to be considered now as a good species, *A. simulans.*

Another wave of colonists arrived at the Falklands and developed into a separate species, *A. calcaricauda* ; still another wave arrived at South Georgia, there developing into the species *A. glabrum.*

The present situation is illustrated in fig. 8, in which the number of species in each region is shown.

III. Geographic variation and polytypic species

It may be objected that the phenomena described above, several species being geographically isolated (having insular ranges), point strongly towards geographic variation. In that case it would be better to replace the many monotypic species by three or four polytypic ones. How can we know that all the migration waves that colonized the antarctic and antiboreal islands developed into good species, and why don't we consider these forms vicarious subspecies of a few polytypic species ?

There are several arguments, however, in favour of our opinion that most of the forms should be regarded as full species. I shall deal with these arguments one by one.

1. SYMPATRIC FROMS

Several morphologically even very similar forms are sympatric in a part of their range. A striking example of such sympatric forms are found on South Georgia. Here a special form, *A. glabrum*, developed from the long-eyed antarctic stock by isolation. On the Falklands another descendent of this long-eyed stock arose, viz., *A. calcaricauda.* The latter species must some time have succeeded in passing the barrier between South Georgia and the Falklands and in establishing itself on South Georgia without mixing with the original inhabitant of that island. Therefore the genetic discontinuity between the immigrant and the orginal inhabitant must already have been present when the immigrant arrived. But, since both the original inhabitant and the immigrant are offshoots of one and the same species, viz., the long-eyed antarctic stock of *glaciale* and since these two became sympatric in a part of their range, without interbreeding, they have to be considered good species, not just subspecies of *A. glaciale.*

A second, more complicated, example of sympatric forms is to be found in the Kerguelen district of the Antarctic continent. In the part of the Antarctic continent facing Kerguelen we find two long-eyed forms living side by side : *A. glaciale* and *A. fagei. A. fagei* agrees in several morphological respects more closely with a Kerguelen species, *A. simulans*, than with *A. glaciale*, and may be considered an isolated offshoot of that Kerguelen form.

The Kerguelen form (*simulans*), in turn, clearly belongs to an invasion wave of *A. glaciale* that established itself on Kerguelen, and developed into a separate species.

Thus we have the following series op phenomena : The antarctic population (= *glaciale)* sent out a migration wave which established itself on Kerguelen ; geographical isolation resulting in genetic isolation (→*simulans*); the Kerguelen population (= *simulans*) re-invaded the Antarctic continent ; the invader was sufficiently distinct from the old stock of *A. glaciale* to prevent interbreeding ; the second wave of colonists developed by isolation into the form now known as *A. fagei.*

The above explanation is supported by the distribution pattern of *glaciale* and *fagei* : the former species, which according to this view is the original inhabitant of the Antarctic continent, has nowadays a circumpolar distribution, while *fagei*, which is considered a derivate of the Kerguelen species, is distributed only in that part of the Antarctic continent that faces Kerguelen.

In this case too, it is only possible to explain the phenomena if we assume that the Kerguelen form is specifically distinct from *A. glaciale*, the original antarctic form.

2. ALLOPATRIC FORMS

Several other forms, however, particularly those belonging to the short-eyed group, are strictly allopatric. Why are these forms not regarded as vicarious subspecies of a single well-characterized (short-eyed !) polytypic species ? Indeed, the fanatical advocate of the polytypic species concept would undoubtedly lump the entire short-eyed group together into one species, with a number of insular subspecies.

The wide distribution of the short-eyed group, however, and especially the interpretation of the speciation of *Austrodecus* in the Southern Seas (pp. 11—14) indicate that the insular, allopatric forms of the short-eyed group are already comparatively old, at least as old as the insular forms of the long-eyed group. Now these insular forms of the long-eyed group certainly are good species, as I have explained above under the heading "sympatric forms". It is consistent, therefore, to consider also the allopatric forms of the same age of the short-eyed group good species, because there is no reason for assuming a different speciation rate in the two species groups.

3. POLYTYPIC SPECIES

In two cases there is some morphological evidence to show that geographic representation occurs in *Austrodecus*. As our knowledge is far from complete, however, it seems premature to adhere to the polytypic species concept in this genus.

The first case in which geographic representation may exist is in the *breviceps*-section ; but the available evidence in this case (5 specimens, belonging to 2 forms are known from 2 localities, which are separated by a distance of more than 6000 km as the crow flies) is so incomplete that even the most progressive taxonomist would hesitate to consider these two forms as subspecies.

The same is true for the two forms of the *gordonae*-section, viz., *A. gordonae* and *A. tubiferum* : the morphological differences between the two are small enough to justify the assumption of subspecific status, and they are geographically well-isolated. However, of *A. gordonae* only eight specimens from a single locality in New Zealand have so far been obtained and of *A. tubiferum* only the holotype from Japan. From the interjacent region (8400 km as the crow flies) no representative of the genus is known.

IV. Summary of the interpretation of the speciation in the Austrodecus glaciale - section

(1) At least two allopatric forms must originally have been present in the southern hemisphere : an ancestral long-eyed form on the Antarctic continent, and an ancestral short-eyed form in the low antarctic-antiboreal zone. These two forms may have been developed from one species through geographic isolation.

(2) The two allopatric forms each spread : the ancestral short-eyed form occupied a number of low antarctic and antiboreal islands ; the ancestral long-eyed form became circumpolar around the Antarctic continent and sent out migration waves to the Falkland Islands, to South Georgia and to Kerguelen.

(3) There were regions where the long-eyed and the short-eyed forms or their descendants occurred together, however without mixing.

(4) The isolated populations on the low antarctic and antiboreal islands diverged from their parental stocks, developed into vicarious subspecies, and finally into full species.

(5) Round those islands where double invasions occurred (i.e., one set of colonists originating from the long-eyed stock, another set from the short-eyed stock), both sets of colonists developed independently into good species, which clearly show, however, that they are offshoots of the long-eyed, or the short-eyed, stock respectively.

(6) Some of these insular species later colonized new regions. For instance, *A. calcaricauda* and *A. curtipes* from the Falklands invaded South Georgia, whereas *A. simulans* from Kerguelen re-invaded the Antarctic continent.

(7) The first case, the invasion of South Georgia by *A. calcaricauda* and *A. curtipes,* must have been a fairly recent one, since the South Georgia populations of these species are still identical with the parental stocks.

(8) The second case, the re-invasion of the Antarctic continent by *A. simulans,* must have taken place earlier since the descendants of the immigrants have developed in the meantime into separate species (*A. fagei*).

(9) The colonizations mentioned under (6) explain the presence of two long-eyed forms round South Georgia, those mentioned under (8) of two long-eyed forms round the Antarctic continent. These forms live side by side in their respective regions without interbreeding and behave like good species.

(10) The complicated distribution pattern of the 11 species of the *glaciale*-section of the genus *Austrodecus* can be fully explained by the theory of geographic speciation.

V. Speciation in Austrodecus as compared with other pycnogonid genera

It may be asked why each isolated locality has its own *Austrodecus* species, whereas several other shelf-inhabiting pycnogonids (e.g., *Anoplodactylus australis* (HODGSON), *Tanystylum neorhetum* MARCUS, *T. styligerum* MIERS), though widely distributed in antarctic and antiboreal waters, don 't break up into subspecies. There are a number of possible reasons for the active speciation in *Austrodecus* :

1. LIMITED MEANS OF DISPERSAL.

Since most species of *Austrodecus* have very restricted ranges, it seems not unreasonable to assume that the rather active speciation is due mainly to limited dispersal facility in this genus, which leads to localization of populations and which enlarges the efficiency of natural distribution barriers.

The reasons for the limited dispersal facility in the genus are not certain. But it may be of importance to mention the mode of reproduction of *Austrodecus,* which offers some peculiar points.

2. MODE OF REPRODUCTION

Most, if not all, littoral and sublittoral Pycnogonida possess a well-developed oviger in the male sex. This appendage, implanted on the ventral surface of the first body segment, is used for carrying the eggs and the newly hatched larvae. The ovigers — male as well as female ones — are so small in *Austrodecus* that we have good reason to expect, merely on morphological grounds, that the males of this genus are no longer able to carry the eggs. In fact no ovigerous male has ever been recorded in any *Austrodecus* species [4]. It is highly probable, therefore, that the species of the genus *Austrodecus* have a different mode of reproduction from most other pycnogonids, though we have no biological data on these animals. It may easily be imagined that this mode of reproduction may favour active speciation in the genus.

3. MORPHOLOGICAL SPECIALIZATION

It must be emphasized, moreover, that *Austrodecus* is a highly specialized genus. It is the only member of the Austrodecidae, a family with uncertain affinities. The morphology of proboscis and oviger is unique among the Pycnogonida and certainly highly specialized.

It may be assumed that the morphological specialization is correlated with an ecological specialization, in other words that the remarkable morphological adaptations shown by *Austrodecus* are correlated with specialized habitat requirements.

When a population arrives by some way or another in a region in which its specialized habitat requirements cannot be completely satisfied,

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[4] „Eine grosze Anzahl an Individuen, mehr als 120, wurden an verschiedenen Daten während des Jahres 1902 und zu Anfang 1903 in Tiefen von 350—385 m bei der Gausz-Station gesammelt...... Hervorzuheben ist, dasz nicht ein einziges Exemplar Eier trägt, noch Aufschlusz über die Entwickelung liefert......" (HODGSON, 1927, p. 349 ; these notes apply to *A. glaciale* and *A. fagei* which were regarded as one species in that paper).

it is quite probable that the new set of ecological conditions in the newly invaded region will induce special adaptations [5]) and that — as soon as such adaptatons are obtained — the members of that population are unable any longer to live under the conditions they came from.

Since it is likely that an animal so specialized morphologically as *Austrodecus* also shows a pronounced ecological specialization, it is clear that even a small difference in environmental conditions will be sufficient to induce a process of specialization.

The adaptations can be realized only if the gene flow between the parental stock and the immigrant wave is small in proportion to mutation rate, genetic drift, selection, or other processes bringing about changes in the morphological and genetic variability.

A reduced gene flow, or even absence of a constant gene flow, necessary to explain geographic variation, will most probably exist in the present case, owing to the peculiar geographical and climatic conditions in the region in which *Austrodecus* occurs.

4. PECULIAR GEOGRAPHICAL AND CLIMATIC CONDITIONS IN THE SOUTHERN SEAS

The geographical conditions in the region under consideration highly favour the process of geographic variation : there are a number of very isolated oceanic islands (Tristan da Cunha, Gough, Bouvet Island, Prince Edward Islands, Crozet Islands, Kerguelen, etc.) which form as many *pieds à terre* for eulittoral and sublittoral animals. Between these islands we find vast regions of abyssal depth (2500 or more meters) uninhabitable for *Austrodecus* and, moreover, apparently also insurmountable dispersal barriers (fig. 4).

A second peculiarity of the Southern Ocean is the existence of two sharp demarcation lines, of great biological and hydrographical importance : the Antarctic and the Antiboreal convergences. These convergences are fairly narrow zones characterized by a rather sudden change in temperature of the surface layers in the north-south direction.

The position of the convergence demarcation lines changes somewhat from time to time, but the situation pictured in fig. 5 may serve as a mean (Ekman, 1953, pp. 211—212). In the zone south of the Antarctic convergence, the Antarctic zone, several islands are found : South Georgia, South Sandwich Islands, South Orkneys, Bouvet Island, and Heard Island. Just within, or near, the oscillatory region of the Antarctic convergence Kerguelen and Macquarie Island are situated. To the so-called Antiboreal zone, between the Antarctic and Antiboreal convergences, belong: Gough, Prince Edward and Marion Islands, Auckland and Campbell Islands, the South Island of New Zealand, the most southern part of South America and the Falkland Islands. Within, or just outside, the Antiboreal convergence lie Tristan da Cunha, St. Paul, and Amsterdam Island. Tasmania, Chatham Island, and New Zealand's North Island are situated within the warm-temperate belt.

Several islands which are so near each other that the distance between them will probably not act as a dispersal barrier are separated by a cli-

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[5]) The word "adaptation" is used here in the passive sense, as the result of a genetic and selective process.

matic barrier. So are, for instance, Tristan and Gough, and also New Zealand's North and South Islands, which are situated in different climatic zones and hence have different *Austrodecus* species.

Even in the cases where temperature differences and abyssal barriers do not play an important rôle, the direction and the force of the currents (the West Wind Drift!) will discourage the crossing of the various dispersal gaps. This may explain the absence of *A. tristanense* from Gough Island, and the absence of *A. glabrum* from the Falklands.

Therefore the Southern Seas offer a combination of physical and geomorphological characters realized nowhere else in the world. Each shallow water region is isolated from the next by a certain barrier (temperature, abyssal depth, unfavourable currents, etc.) and each developed its own *Austrodecus*-population which is particularly adapted to the special conditions prevailing in that region. Each population has become reproductively isolated, or in time will be so, aided by limited dispersal facilities (preventing a constant gene flow between the two isolated populations), aided also by the particular ecological preferences developed (preventing geneflow to a certain degree, even when the two populations are in constant contact with one another).

Eventually the populations will have been evolved to full species. If the region with about the same conditions is fairly small, the species will remain restricted to a small area (e.g., *A. tristanense*). If vast continuous areas with about the same conditions are available, the species will occupy this entire area (e.g., *A. glaciale*).

5. COMBINATION OF FACTORS

Each of the factors mentioned under 1 to 4 working alone may to some effect influence the process of speciation. In the case of *Austrodecus* the combined effect of some, or all, of these factors will no doubt be considerable.

Particularly in a region like the antarctic-antiboreal zone, with its many isolated oceanic islands, reduced means of dispersal will effectively protect a population against extrinsic gene flow once it is established on such an island.

One can hardly overestimate in this connection the value of the aberrant reproduction in the speciation process of *Austrodecus*. As pointed out, *Austrodecus*-males, unlike those of most other pycnogonids do not carry the eggs and the larvae on the ovigers. We can hardly assume that *Austrodecus* has pelagic eggs or larval stages. It is highly probable, that the females of this genus lay their eggs free on the substratum, or that the eggs are laid inside some invertebrate host. The advanced larval stages do not seem to be endoparasitic, at least if my opinion is correct that the pycnogonids described under the name of *Boehmia dubia* do represent the larval stages of *Austrodecus* (cf. p. 27).

Since the number of eggs carried by one ovigerous male may be considerable (often one hundred, or more), the transport of a single ovigerous male on drifting seaweed may theoretically suffice to found a new colony on an isolated island. In the case of *Austrodecus*, however, where the males are not egg-bearing, only if a considerable number of adults of both sexes were transported would the population stand a chance of establishing itself.

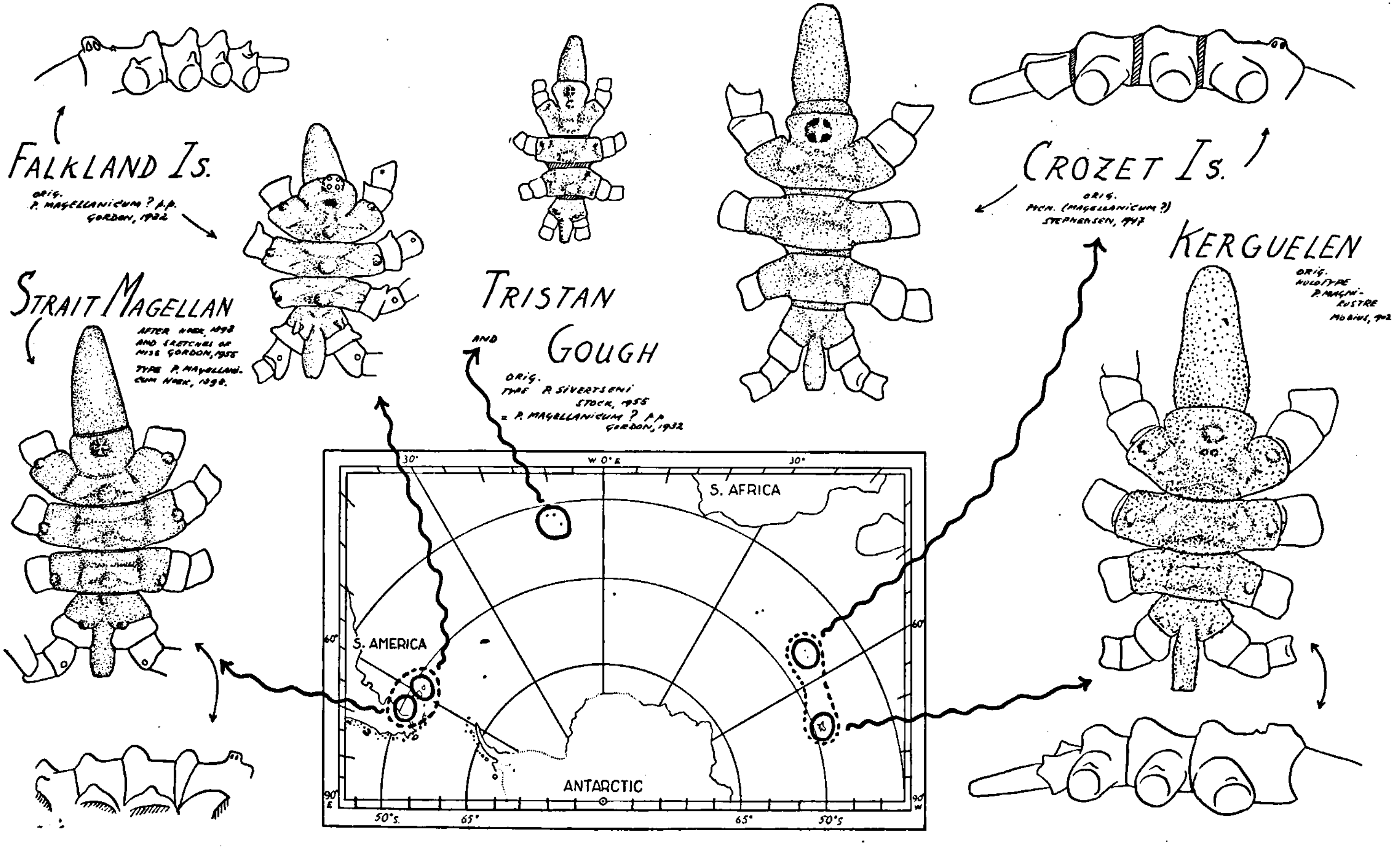

FIGURE 9. Geographic speciation and/or variation in the *Pycnogonum magellanicum*-complex. Explanation see text. All figures have been drawn to the same scale.

6. GEOGRAPHIC SPECIATION AND VARIATION IN OTHER ANTARCTIC-ANTIBOREAL PYCNOGONIDS

As pointed out in the previous paragraph, the detailed speciation in *Austrodecus* can be explained by the combination of several factors. Some of these factors, the physical and the geomorphological ones, act equally for all creatures. Therefore it may be expected that "normal" Pycnogonida — those that carry the eggs and larvae on the male ovigers — will also show a certain amount of geographic variation. However, the present state of our knowledge of the Pycnogonida is far too imperfect to enable us to apply modern zoogeographical principles to them.

This may be demonstrated by table II in which the percentages of new species of Pycnogonida recorded from some important South Polar Expeditions are given. Our incomplete knowledge is clearly shown, I think, by the relatively high numbers of new *species* established even in recent times. A table showing the number of *specimens* of each species found would perhaps be still more instructive. HEDGPETH, 1950, p. 147, remarks that "although the Antarctic waters are remote from the rest of the world, many elements of their fauna ...... are better known than those of more accessible parts of the globe. This is especially true of the Pycnogonida ......" Nevertheless the percentage of new species still being discovered is surprisingly high.

TABLE II

Author, year	Expedition	Total number of species and 'varieties' recorded	Number of forms new to science	Percentage of new forms
Bouvier, 1906	Expédition Antarctique Française	8	2	25.0%
Hodgson, 1907	National Antarctic Expedition	28	23	82.1%
Hodgson, 1908	Scottish National Antarctic Exp.	16	6	37.5%
Bouvier, 1913	Deuxième Exp. Antarctique Française	27	12	44.4%
Hodgson, 1914, 1915, 1927	"Gauss"	29	16	55.2%
Calman, 1915	"Terra Nova" Exp.	45	11	24.4%
Gordon, 1932	"Discovery"	65	15	23.1%
Gordon, 1938	Australasian Antarctic Expedition	44	2	4.5%
Gordon, 1944	B.A.N.Z.A.R.E.	65	11	16.9%
Hedgpeth, 1950	U.S. Navy Antarctic Exp.	22	1	4.5%
Fage, 1952a, b	Terre Adelie	18	1	5.6%

It will be clear from this table that conclusions based on data on pycnogonid distribution and taxonomy must be provisional. Nevertheless, there is some indication that geographic variation and speciation exist not only in the genus *Austrodecus*, but also in the genera *Pycnogonum* and *Ammothea*. As to *Ammothea*, it suffices to refer to a later paragraph (p. 26) in which the analogies between the distribution-pattern of *Austrodecus* and *Ammothea* are considered. The example taken from the genus *Pycnogonum* will be discussed in detail here.

There are several antarctic and antiboreal *Pycnogonum* species, most of them morphologically very distinct and obviously good species. Difficulties for the taxonomist arise, however, with *Pycnogonum magellanicum* HOEK, 1898, and its allies. *P. magellanicum* was described from a single specimen dredged by the "Challenger" at the eastern entrance to the Straits of Magellan. A few years later MÖBIUS (1902) described a species which had been found at the opposite side of the antiboreal zone, Kerguelen. The name *P. magnirostre* was proposed for this Kerguelen form, also known from one single specimen. GORDON (1932) found among material of the "Discovery" two new samples, each consisting of two specimens. Though she clearly showed the existence of certain differences between these specimens and the type of HOEK, she did not feel justified in separating these slightly different forms specifically. Moreover, she synonymized provisionally *magellanicum* and *magnirostre*. One of GORDON's samples came from Gough Island, the other from the Falklands.

Finally, STEPHENSEN (1947) recorded two specimens from the Crozet Islands which he referred doubtfully to *P. magellanicum*.

So we have here five allopatric forms (from Straits of Magellan, Falkland Islands, Gough Island, Crozet Islands, and Kerguelen), which, by competent authors, were all considered to belong to a single species, although the authors all expressed some doubt. Revision of the above mentioned eight specimens and also of 20 specimens collected during the Norwegian Scientific Expedition 1937—38 to Tristan da Cunha, led me to the following conclusion (cf. fig. 9):

The form from Tristan da Cunha is identical with that from Gough Island and represents a good, distinct species, which definitely differs from the other components of the *magellanicum*-complex as regards the ovigers and the auxiliary claws (STOCK, 1955). This is not surprising in view of the isolated geographical position of the Tristan group, and the milder climatical conditions as compared with other antiboreal and antarctic islands.

The form from the Falklands is undoubtedly very closely related to that from the Straits of Magellan. These two are morphologically so close to each other that most probably a taxonomic separation is not needed. This is not surprising as the Falkland Islands lie on the South American continental shelf and have about the same climate as the Straits of Magellan.

The Crozet and the Kerguelen forms also seem to be related to each other, but here the differences are more pronounced (at least judging from the very small material at hand) and they may very well be considered as subspecies. I am not sure whether or not these two forms are geographic representatives of the Magellan-Falkland populations.

At any rate the Crozet-Kerguelen form and the Magellan-Falkland form appear to be related, and it is immaterial whether these allopatric forms are already full species, or still subspecies, for it is obvious that their relationship and the origin of their differences may be explained by the theory of geographic speciation.

VI. The general evolutionary significance of the genus Austrodecus

MAYR, 1954, p. 11, as quoted before, emphasized that geographic speciation proceeds in two steps, first one in which the species breaks up into geographical isolates, which then diverge from each other genetically, and a second in which some of the originally isolated populations overlap without interbreeding. MAYR demonstrates these two steps with examples derived from the distribution of tropical shallow water sea-urchins. In the foregoing paragraphs both steps are illustrated in other shallow water animals, namely, pycnogonids of the predominantly antarctic and antiboreal genus *Austrodecus*. The sympatric forms mentioned in the discussion are all, of course, examples of the second step : viz., secondary overlap of populations without interbreeding. Whether the allopatric forms (the geographical isolates) have been, or have not been, diverged from each other genetically is immaterial in this consideration. From the general distribution pattern it is quite clear that geographic isolation, followed by morphological (and genetical) differentiation, occurred abundantly among these pycnogonids. A general survey throughout the Pycnogonida, not carried out in detail here, except for a single example taken from the genus *Pycnogonum*, will certainly show that geographic speciation is traceable in many more cases. On the other hand, it is hard to believe that the entire speciation in the Pycnogonida is simply and solely due to *geographic* speciation. The presence of so many sympatric sibling species in a (geologically speaking) fairly young genus like *Nymphon* cannot be explained merely by geographic speciation. For instance, in the atlantic part of the boreal-arctic region more than 20 Nymphon species occur, in the antiboreal-antarctic oceans about 40 representatives of *Nymphon* are found. Since, moreover, the species of *Nymphon* are apparently far less stenobath and stenoclimatic than those of *Austrodecus*, it is difficult to explain this distribution pattern on the sole basis of geographic speciation. I believe that the abundance of *Nymphon* species in the Southern Seas can be explained only on the assumption of a kind of explosive sympatric speciation.

HEDGPETH (1947) in analysing the interrelationships between certain cognate octopodous and decapodous pycnogonids, indicates a possible environmental cause for the origin of an aberrant mode of speciation. In analogy with with these arguments, there seems to be evidence that species flocks in pycnogonids, and in several other groups of marine animals, are particularly abundant in areas that overlie tectonic arcs, areas of stress in the earth's crust where negative anomalies in gravity may occur. Together with submarine volcanic eruptions, these and other physical phenomena associated with stress in the earth's crust may positively influence the mutation-rate. If within a population, under the influence of some physical cause, a certain gene-mutation is regularly pushed on, and if this gene-mutation falls usually within (or, is usually associated with) an inverted part of the chromosome, the sympatric development of two cognate forms can be understood, provided that the inversion is important enough to reduce the chance of crossing over. Small differences in ecological preference between the mutant and the parental stock will act strongly in favour of this mode of sympatric speciation, even if the habitats are in continuous contact with one another.

Summarizing, we may state that geographic speciation has been proved to occur among Pycnogonida, and that this mode of speciation is suf-

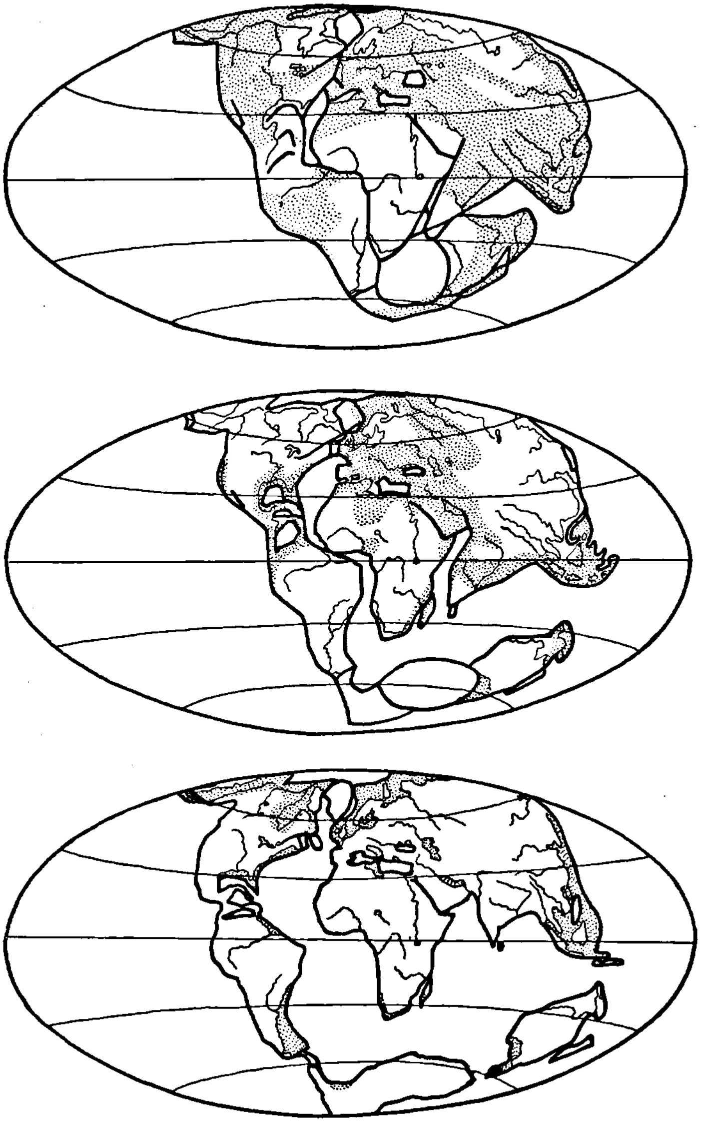

FIGURE 10. The continental drift. After WEGENER, 1936. (dotted areas = shallow seas; present-day outlines, latitude and longitude only for purpose of identification).

ficient to give a complete explanation of the actual state of affairs in the genus *Austrodecus*. But other distribution patterns, even in "young" genera, are too complicated to be explained merely on the basis of geographic speciation ; hence, another mode of speciation must be assumed to exist at the same time in pycnogonids.

VII. The Pycnogonida and the continental drift

The theory of continental movement or drift, intimately — perhaps even too intimately — linked with the name of Alfred WEGENER, the author of the suggestive book „Die Entstehung der Kontinente und Ozeane", received a large amount of attention from biologists trying to explain the present distribution of living organisms over the world.

As is well known, the theory postulates that the present continents of the world during the early palaeozoic era formed one enormous land mass, called Pangaea. Subsequently, the continents separated and drifted apart to the positions they occupy nowadays.

Objections against the evidences on which the theory of drift was based are numerous and no one adheres to the drift theory in the litteral sense of Wegener. But the improved forms of the theory, summarized by DU TOIT (1937) are strongly supported by a great variety of arguments, stratigraphical, tectonic, volcanic, palaeomagnetic, physiographic, palaeoclimatic, geodetic, etc. and explain to an indeed very complete degree the present distribution of living organisms.

The theory has been used chiefly to explain the distribution of terrestrial organisms, but it must be admitted that it would likewise explain the present distribution pattern of the (marine) genus *Austrodecus*. The genus seems to have had its origin along the southern margin of Pangaea. Though the South Pole was not always situated where it lies to day, in the centre of the Antarctic continent, it seems sound to assume that cold temperatures predominated along this southern margin of Pangaea. Originally, according to the theory, South America, the Falklands, South Georgia, the South Orkneys, Palmer Peninsula, the Antarctic continent, Tasmania, and New Zealand formed one uninterrupted coast-line from West to East. Since these regions are essentially those in which *Austrodecus* now occurs, this suggests that the dispersal of *Austrodecus* is due in large measure to continental drift. The originally regularly and continuously distributed *Austrodecus* population was divided into several isolates that drifted apart "on the back of the continents".

Especially the occurrence of *Austrodecus* in New Zealand could be explained in this way, likewise the absence of the genus in South Africa and Western Australia, both regions that did not belong to the southern margin of Pangaea, and consequently were not originally inhabited by *Austrodecus*.

On the other hand, if continental drift is accepted as the cause, or as one of the causes, of the dispersal of *Austrodecus*, the genus must be a rather old one. Expressed more exactly : the genus must have had a wide distribution already at the time when the southern coast-line of Pangaea was still uninterrupted, i.e. in the earlier tertiairy peroid (WEGENER) or even earlier (DU TOIT). In this period the representatives must have been distributed already from South America in the West to New Zealand in the East, so that the origin of the genus must be postulated at least as far back as the Palaeocene. This is not in disagreement with our knowledge of the age of the Pycnogonida. Fossil pycnogonids are known from the Lower Devonian (cf. HEDGPETH, 1954) and the numerous examples of zoogeographical phenomena like Tethys-distribution, circumtropical distribution, and distribution at both sides of the Isthmus of Panama, illustrate clearly that the group as a whole is a comparatively old one.

It cannot be denied that some features in the distribution of *Austrodecus* (e.g., the occurrence in Japan) cannot be explained by the theory of continental drift, but in general this theory provides the desired explanation of the *Austrodecus*-problem.

In this connection it is interesting to mention the analogy between the distribution of *Austrodecus* and of another pycnogonid genus, *Ammothea*. The genus *Austrodecus* has its centre of distribution in shallow waters of the antarctic and antiboreal zone, with some species extending along the New Zealand coast and one unique Japanese species (which differs in one character, the cement gland aperture, from all other members of the genus). Differences in the type of cement gland are often considered as generic differences in the Pycnogonida. The genus *Ammothea* LEACH (= *Leionymphon* MÖBIUS) likewise has its centre in shallow waters of the antarctic and antiboreal zone, and it likewise has some species in eastern Australia and New Zealand, and also a unique Japanese species (which differs in one character, the reduced chelifore, from all other members of the genus). In addition, a form hardly distinguishable from this Japanese species has been found along the west coast of North America. The character in which these Japanese and American forms differ from *Ammothea* s.str., viz., the reduced chelifore, in the past has been considered a character of generic importance (cf. STOCK, 1956).

The agreement in the distribution and the taxonomy of these two genera is such that it can hardly be considered merely accidental. In both cases continental drift followed by geographic speciation would give a good explanation of the phenomena.

VIII. Morphology and taxonomy of the genus Austrodecus

1. CHARACTERS OF MORPHOLOGICAL IMPORTANCE IN THE GENUS

The five species of the genus described by earlier authors (*glaciale, breviceps, frigorifugum, gordonae,* and *tristanense*) differ principally in the presence or absence of auxiliary claws, and in the number of segments of ovigers and palps, all characters the specific, or even generic, value of which no one would like to deny. But apart from these characters, the species differ considerably from each other in the armature of the dorsum and the coxae and in the length of the ocular tubercle, abdomen, and proboscis. This suggests that these characters also are of specific, and not as was hitherto assumed of varietal, importance only.

The arrangement of the spurs on the dorsum and the legs is one of the principal characters on which the new classification has been based ; this arrangement proved to be exactly correlated with other characters, such as the length of the ocular tubercle and abdomen, the relative length of the second tibia, the length of the auxiliary claws and the shape and position of the cement gland tubercle. Very important characters, never used before in the taxonomy of the genus, are the number of genital pores and the structure of the ovigers.

Each of the characters mentioned is subject, within the groups of individuals considered in this paper as species, to a certain variation, but every species described here can be separated by more than one character from its allies, and moreover, no transitional forms between the species are known ⁶). Although for the inexperienced student the morphological diversity within each species seems sometimes greater than the differences between related but separated species, there is good reason to believe that the described forms are "valid" species.

Examples of the intraspecific variability are:
(1) The position of the cement gland cone in the male is distinctly more distal on the anterior, than on the posterior legs (fig. 16, p_1—p_4) but it is usually constant on the corresponding legs of different specimens belonging to the same species.
(2) The relative length of the eye tubercle and abdomen changes with the age of the animals; in general young animals have the eye tubercle and abdomen more robust than older ones.
(3) The space between the lateral processes of the trunk becomes larger with age.
(4) The number of spines on the legs (particularly on the propodal sole) is subject to considerable variation.
(5) The armature of the terminal oviger segment, though often very characteristic, may vary to a considerable extent; moreover several specimens show accidental anomalies.

In general, however, the variation is far less than the pertinent literature suggests. Often true species were considered mere variations as may be illustrated by one example only:

SOCK, 1954, p. 153, in his description of *Austrodecus gordonae* states: "...these (dorsal) tubercles are low, as figured. In one specimen, however, the tubercles are high, sharply conical and laterally armed with spines..." A figure clearly illustrates this "extreme case of these variations in the dorsal trunk tubercles" (p. 156). Revision of the original material showed that the long-spined specimen did not belong tc *A. gordonae* at all, but to another species, even belonging to another section of the genus.

2. LARVAL STAGES OF *AUSTRODECUS*

HEDGPETH (1950) described two young pycnogonids found by the U.S. Navy Antarctic Expedition in the Ross Sea under the name of "(?) *Boehmia dubia* new species". He remarked that his animals, although resembling *Boehmia* (a genus endemic to tropical south-east Africa) in general aspect, differed materially in other respects, but he was not able to classify his material definitively since he only had juveniles at his disposal.

Quite accidentally, I found among material sent to me for examination on two different occasions some new specimens of an animal strongly resembling HEDGPETH's (?) *Boehmia dubia*.

Two specimens, larvae with only the two anterior pairs of legs well-developed whilst the third pair is represented by still unsegmented buds, were found at South Georgia, Royal Sound, Moltke Harbour (54°30′ S. — 36°00′45″ W.), in a depth of 14 fathoms, August 28, 1883. The collector, Dr. von den Steinen, wrote on the label: colour dirty-grey, clinging on ophiurid. The material is in the Zoological Museum, Hamburg, cat. nr. K 17593.
One other specimen, collected by the B.A.N.Z. Antarctic Research Expedition, likewise a juvenile, is present in the British Museum (Natural History).

⁶) Except perhaps a single male specimen from Discovery Station 1563 (British Mus., Nat. Hist.), which resembles *longispinum* in most characters, but which has also some features recalling *curtipes*. Since, however, only a single specimen is known, and since the locality in which it was taken is a very isolated one (Marion Island!), it is quite well possible that it represents a new species, instead of being a "transitional form".

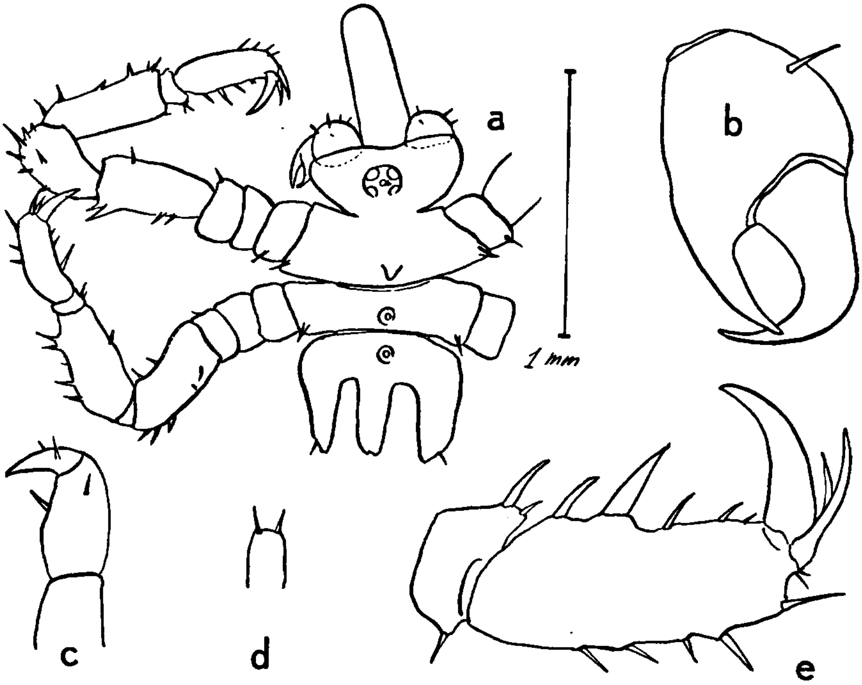

FIGURE 11. Postlarval stage of *Austrodecus* (the so-called *Boehmia dubia*). Z.M.A. coll. no. Pa 1287.
a. The animal in dorsal view ; b. chela ; c. palp ; d. oviger ; e. tarsus and propodus of the first leg.

I consider these specimens of HEDGPETH's (?) *Boehmia dubia* to be larval stages of *Austrodecus*. Especially the shape of the proboscis in these juveniles supports my supposition : it is already tube-shaped and curved downward as in the adults. The absence, or strong reduction, of ovigers in "(?) *Boehmia dubia*" is no longer surprising if we consider the very feeble development of the ovigers in adult *Austrodecus*.

The young stages — *"(?) Boehmia dubia"* — are still rather different in aspect from the adult and this certainly is the reason why they were not recognized as being only development stages of a genus already well-known.

The specimens in the Hamburg Museum from South Georgia are the youngest stages of *Austrodecus* known at present.

3. LIST OF AND KEYS TO THE SECTIONS AND SPECIES OF THE GENUS *AUSTRODECUS*

The species of the genus *Austrodecus* fall quite naturally into four sections (fig. 12):

A. Ovigers 6-segmented. Auxiliary claws present. *glaciale*-section.

B. Ovigers 6-segmented. Auxiliary claws absent *breviceps*-section.

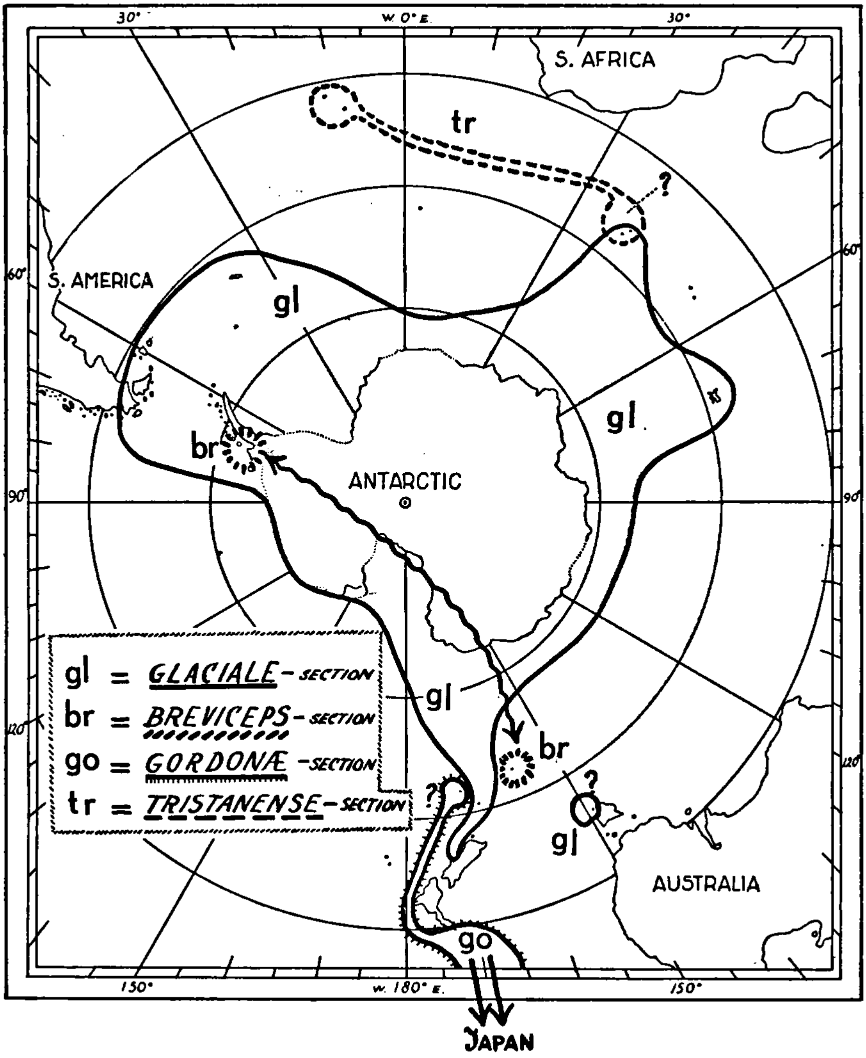

FIGURE 12. The distribution of each of the four sections of the genus *Austrodecus*.

C. Ovigers 4-segmented. Auxiliary claws present. *tristanense*-section.

D. Ovigers 4-segmented. Auxiliary claws absent (or vestigial). *gordonae*-section.

The *glaciale*-section

The *glaciale*-section comprises 11 species: *A. glaciale*; *A. fagei*; *A. glabrum*; *A. longispinum*; *A. simulans*; *A. calcaricauda*; *A. curtipes*; *A. sinuatum*; *A. profundum*; *A.* spec. 1; *A.* spec. 2.

The following is a key to their determination :

Females[7])

1a) Genital pores on legs 1 to 4 .... 2.
b) Genital pores on legs 1 to 3 .... 5.

2a) Eye tubercle short. Median trunk tubercles high. Auxiliary claws about half as long as the claw .... 3.
b) Eye tubercle long. Median trunk tubercles low, or — if fairly long — they are rather robust. Auxiliary claws less than half as long as the claw .... 4.

3a) Eye tubercle broad. Coxa 1 of leg 1 with 2 dorsal spurs. Coxa 3 of all legs with 1 dorsal spur. *A. longispinum*, p. 50
b) Eye tubercle narrow. Coxa 1 of leg 1 with 1 dorsal spur. Coxa 3 without spurs. *A. curtipes*, p. 36

4a) Lateral processes armed with low tubercles. Second tibia at least 7 × as long as wide. Median trunk tubercles low. *A. fagei*, p. 39
b) Lateral processes smooth. Second tibia 6 ×, or less than 6 ×, as long as wide. Median trunk tubercles high. *A. simulans*, p. 54

5a) Median line of trunk armed with strong spurs. Coxa 1 of leg 1 with 1 dorsal spur. 6.
b) Median line of trunk armed only with inconspicuous tubercles. Coxa 1 of leg 1 with 2 dorsal spurs. *A. glabrum*, p. 42

6a) Tibia 2 short and robust. Coxa 1 of legs 2 and 4 with 1 dorsal spur. .... 7.
b) Tibia 2 very slender. Coxa 1 of legs 2 and 4 with 2 dorsal spurs. *A. glaciale*, p. 45

7a) Eye tubercle long. Abdomen distally with a low spur. *A. calcaricauda*, p. 34
b) Eye tubercle short. Abdomen without spur. *A.* spec. 1, p. 57

Males[8])

1a) Femoral cement gland cone badly defined, low (less than half the femoral diameter), situated at about 1/3 of the segment .... 2.
b) Femoral cement gland cone well-defined, strong, situated more distally .... 5.

2a) Coxa 1 of leg 1 with 2 dorsal spurs. Coxa 3 of all legs with 1 dorsal spur. Femoral cement gland cone still fairly well developed, angular in outline. *A. longispinum*, p. 50
b) Coxa 1 of leg 1 with dorsal spur. Coxa 3 without spurs. Femoral cement gland cone marked only as a rounded expansion of the segment .... 3.

3a) Abdomen with a dorsal spur. Coxa 1 of legs 2 and 4 with 1 dorsal spur. Median trunk tubercles fairly robust .... 4.
b) Abdomen without spurs. Coxa 1 of legs 2 and 4 with 2 dorsal spurs. Median trunk tubercles very slender. .... *A. curtipes*, p. 36

4a) Eye tubercle short, robust. Auxiliary claws about half as long as the claw. *A. sinuatum*, p. 56
b) Eye tubercle long, slender. Auxiliary claws less than half as long as the claw. *A. calcaricauda*, p. 34

5a) Cement gland cone acutely pointed, longer than wide. No distinct median processes. .... 6.
b) Cement gland cone rounded triangular, as long as wide, or wider than long. Distinct median trunk processes .... 7.

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[7]) Females of *profundum*, *sinuatum*, and *A.* spec. 2 unknown.

[8]) Male of *A.* spec. 1 unknown ; *A.* spec. 2 not included in the key.

6a) Median line of trunk with inconspicuous tubercles. Eye tubercle long. Propodus slender. Auxiliary claws about $^{1}/_{3}$ as long as the claw. *A. glabrum*, p. 42
b) Median line of trunk smooth. Eye tubercle short. Propodus short. Auxiliary claws more than half as long as the claw. *A. profundum*, p. 52

7a) Lateral processes armed with small tubercles. Cement gland cone situated in the distal half of the femur. *A. fagei*, p. 39
b) Lateral processes smooth. Cement gland cone situated at $^{1}/_{3}$ to ½ of the femur. 8.

8a) Cement gland cone low, situated at the middle of the femur. Second tibia 6 ×, or less than 6 ×, as long as wide. *A. simulans*, p. 54
b) Cement gland cone high, situated at $^{1}/_{3}$ to ½ of the femur. Second tibia at least 7 × as long as wide. *A. glaciale*, p. 45

The *breviceps*-section

This section contains two species, *A. breviceps* and *A.* spec. 3, which may be distinguished as follows:

a) Tibia 2 shorter than the propodus. *A. breviceps*, p. 59
b) Tibia 2 longer than the propodus. *A. spec.* 3, p. 61

The *tristanense*-section

The three species thought to belong to this section (*A. tristanense*, *A. goughense*, and *A. elegans* (?)) can be distinguished as follows:

1a) Auxiliary claws strongly reduced, at most $^{1}/_{5}$ as long as the claw. *A. elegans*, p. 68
b) Auxiliary claws well-developed, at least $^{1}/_{3}$ as long as the claw .... 2.

2a) Femoral cement gland cone inconspicuous. Spurs on coxa 1 low. Propodus strongly curved. *A. tristanense*, p. 66
b) Femoral cement gland cone highly conical. Spurs on coxa 1 high. Propodus nearly straight. *A. goughense*, p. 63

The *gordonae*-section

Three rather different species belong to this section. They can be distinguished as follows:

1a) Palpi short, 5-segmented. *A. frigorifugum*, p. 72
b) Palpi long, 6-segmented .... 2.

2a) Cement gland opening through a slender duct, as in *Pallenopsis*. *A. tubiferum*, p. 75
b) Cement gland opening on the tip of a low elevation. *A. gordonae*, p. 73

Species *incertae sedis*

Two species cannot be referred with certainty to any of the sections mentioned above, since the number of oviger segments is not known. In *A. confusum* (p. 69) a two segmented oviger exists, but it is uncertain whether this is the normal condition for the species (in which case a special section should be created for it), or an abnormal or incomplete development. In this case the species would most probably belong to the *tristanense*-section, in which it is provisionally included (p. 63), though omitted from the key.

Of *A.* spec. 4 only a single juvenile with ovigers still undeveloped is known (p. 77).

4. DISTRIBUTIONAL SCHEME

The distribution of the species of the genus *Austrodecus* which, as we have seen, have restricted ranges is shown in the following synopsis.

Antarctic region	
High Antarctic	
Antarctic continent	*A. glaciale* *A. fagei*
Palmer Peninsula	*A. glaciale* *A. profundum* *A.* spec. 3
Low Antarctic	
South Georgia	*A. glabrum* *A. curtipes* *A. calcaricauda*
Transitional region ("subantarctic", sensu Ekman, 1953)	
Kerguelen	*A. longispinum* *A. simulans*
Antiboreal region	
Tierra del Fuego, Patagonia	*A. curtipes*
Falkland Is.	*A. curtipes* *A. calcaricauda*
Macquarie Id.	*A. breviceps*
Campbell Is.	? *A. frigorifugum*
Auckland Is.	*A. sinuatum*
Prince Edward Is.	*A. elegans* *A.* spec. 2
Gough Id.	*A. goughense*
Tristan da Cunha	*A. tristanense*
Warm-temperate region	
(Tasmania	doubtful record of *A. glaciale*)
New Zealand	
South Id.	*A.* spec. 1
North Id.	*A. gordonae* *A. frigorifugum* *A. confusum* *A.* spec. 4
Japan	*A. tubiferum*

5. SURVEY OF THE SYNONYMY

The following is a list of all references from the literature to species of the genus *Austrodecus*. In the second column the name according to the new classification is indicated. I have seen all this material, except for the single specimen described by Hodgson (1907a) and for the lots recorded by Gordon (1938) which were not available to me.

Author, year	*Old name*	*New name*
Hodgson, 1907a	A. glaciale	A. glaciale
Hodgson, 1907b	A. glaciale	A. curtipes
Bouvier, 1911 ; 1913	A. glaciale	A. glaciale
Hodgson, 1913; 1914	A. glaciale	A. glaciale A. fagei

Author year	*Old name*	*New name*
CALMAN, 1915	A. glaciale	A. glaciale
LOMAN, 1923b	A. glaciale	A. profundum A. curtipes A. glabrum
HODGSON, 1927	A. glaciale	A. glaciale A. fagei
GORDON, 1932	A. glaciale	
	group IA1	A. glaciale
	group IA2	A. calcaricauda
	group IB	A. curtipes
	group II	A. glabrum
GORDON, 1938	A. glaciale	? A. glaciale
	A. breviceps	A. breviceps
MARCUS, 1940	A. glaciale	A. curtipes
GORDON, 1944	A. glaciale typical	A. glaciale A. fagei A. simulans
	var. α	A. longispinum
	var. β	A. glaciale A. fagei
	var. γ	A. glabrum
HEDGPETH, 1950	A. breviceps	A. spec. 3
	A. glaciale	A. curtipes A. glaciale
FAGE, 1952a; 1952b	A. glaciale	A. fagei
STOCK, 1954	A. gordonae	A. gordonae A. confusum A. tubiferum
	A. frigorifugum	A. frigorifugum
	A. spec.	A. spec. 4
	A. glaciale	A. spec. 1
	A. glaciale var. ?	A. sinuatum
STOCK, 1955	A. tristanense	A. tristanense

6. DESCRIPTION OF THE SPECIES

In the following descriptive part the species are arranged according to the sections to which they belong. Within each section, the species are arranged alphabetically. Material of uncertain taxonomic rank has provisionally been indicated as "*Austrodecus* spec. 1", "*A.* spec. 2", etc. Such forms will be found at the end of the sections to which they belong. At the end of the paper some forms *incertae sedis* are described.

I have seen specimens of all species mentioned in this report. The drawings are all original made from material at my disposal with the aid of a camera lucida. The drawings and descriptions of the appendages (palps, ovigers, legs) have always been made from mounted isolated appendages. As it sometimes proved to be very difficult to find the minute ovigers, especially in the females of the *gordonae*- and *tristanense*-section, I used a mixture of 10 g chloral hydrate, 10 g phenol, and 1 g glycerine, which yielded satisfactory results in making the animal's body translucent, so that the ovigers could more easily be detected. The adventage of this mixture over other clearing-media, like KOH, eau de Javelle, etc., is that its effect is reversible : brought back into water, alcohol or glycerine, the animal becomes opaque again and returns to the original state.

As stated already in another paper (STOCK, 1954), I can strongly recommend the so-called "Faure's medium" (or "Faure's liquid") for mounting pycnogonid appendages. REYNE's modification of the medium (Entomolog. Berichten no. 297, part XIII, 1950, pp. 37—42), which hardens in a few days and needs no sealing, is really excellent for this purpose.

It should be kept in mind that in several instances the descriptions are based on one or very few specimens of one sex only. Moreover, it will certainly be possible to find new species, particularly in temperate regions (New Zealand !) and on isolated oceanic islands (Bouvet Island, Marion Island ......). The present report offers all I could find by examining the collections of many zoological institutions and museums all over the world.

A. The *glaciale*-section

Eleven species belonging to this section are known at present. Their distribution is illustrated in figs. 2 and 3. The species can be identified with the aid of the key on p. 30.

Austrodecus calcaricauda n.sp. Fig. 13.

A. glaciale group I A 2, Gordon, 1932, p. 117.

Material: 1 male (holotype), 1 male and 3 females (paratypes). Discovery Stat. W.S. 228. 50°50′ S. — 56°58′ W. Commercial otter trawl. 229—236 m. June 30, 1928. British Museum (Nat. Hist.).

2 females. Discovery Stat. 123. Cumberland Bay, South Georgia. 230—250 m. Dec. 15, 1926. British Museum (Nat. Hist.).

Distribution: The two records mentioned above are the only ones known. The type-locality is N.E. of the Falkland Islands, the other locality is in South Georgia.

Diagnosis: Long eye tubercle; long abdomen. *Five* mid-dorsal trunk tubercles. Coxa 1 of leg 1, 2, and 4 with 1 dorsal spur. Cement gland tubercle low, situated at about $1/4$ of the femur. Tibia 2 shorter than either tibia 1 or the propodus.

Description: Trunk rather narrow. Dorsal spurs not very slender. Tip of abdomen also provided with a distinct spur, which is about half as long as those of the trunk.

Proboscis long.

Ovigers 6-segmented. Terminal segment long ; that of male with about 10 distal spinules and a single spine on the inner margin of the segment, at about $^2/_3$ of its length. The terminal segment of female oviger with 3 slender terminal setae and 1 subterminal slender spine.

Coxa 1 of legs 1, 2, and 4 with only 1 dorsal spur, which is slightly shorter than the spurs of the trunk. Coxa 1 of legs 3 with 1 strong anterior spur, and 1 low posterior spur, Femur of male with a low, rounded

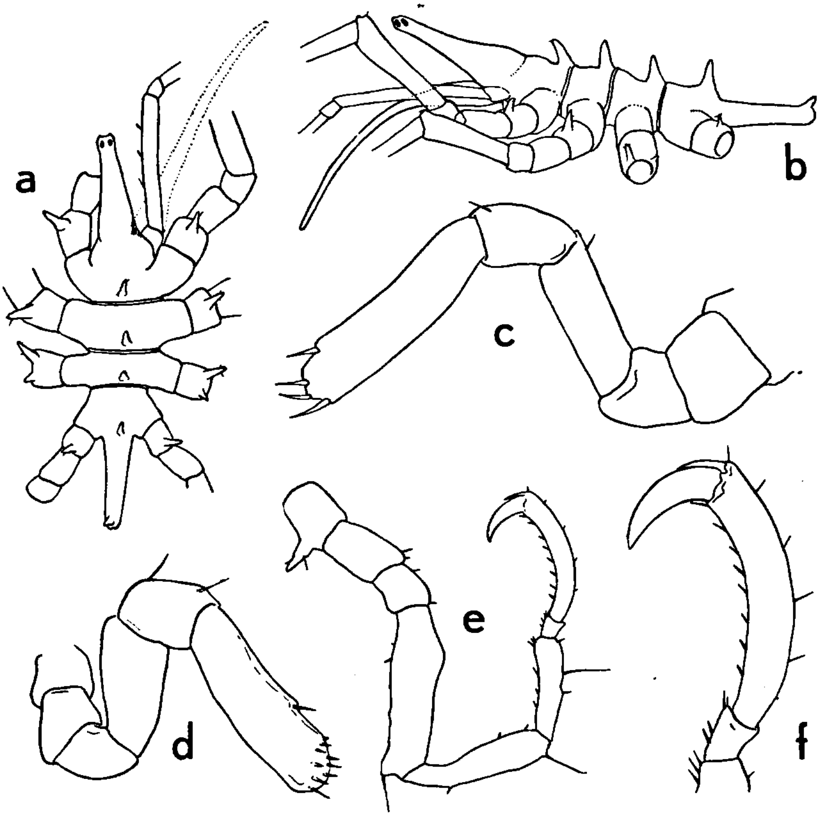


FIGURE 13. *Austrodecus calcaricauda* n.sp. (Discovery Stat. W.S. 228). a, Dorsal view of female ; b, lateral view of female ; c, oviger of female ; d, oviger of male ; e, fourth leg of male ; f. distal segments of the leg.

cement gland cone, at about ¼ of its length. Propodus curved, sole with 6 to 10 spinules. Auxiliary claws $^1/_3$ as long as the main claw.

Remarks: This species and *A. simulans* alone combine a long eye tubercle and a short second tibia. The peculiar arrangement of the coxal spurs and the presence of a tubercle on the abdomen are other characteristics of *A. calcaricauda*. It is to the latter character that the proposed specific name refers (*calcaricauda* = with a spur on the tail). The arrangement of the coxal spurs and the spurred abdomen are found also in *A. sinuatum*, but in other respects that species is very different from *calcaricauda*.

Measurements in mm of Falkland specimens:

	male	*female*
Length (tip eye tubercle to tip abdomen)	1.9	2.4
Width across the 2nd lateral processes	0.67	0.80
Length cephalic segment	0.90	1.10

Fourth leg of male — first coxa 0.17 ; second coxa 0.22 ; third coxa 0.15 ; femur 0.60 ; first tibia 0.50 ; second tibia 0.37 ; tarsus 0.07 ; propodus 0.47.

Austrodecus curtipes n.sp. Fig. 14.

A. glaciale, Hodgson, 1907b (non 1907a !), pp. 16—17.
A. glaciale, Loman, 1923b, p. 31 (part.).
A. glaciale group I B, Gordon, 1932, p. 117, fig. 63c. (Cf. Gordon, 1944, p. 66, group B).
A. glaciale, Marcus, 1940, p. 108.
A. glaciale, Hedgpeth, 1950, p. 154 (part., only the Falkland records).

Material examined:

12 females, 9 males (incl. 1 male holotype, and 1 female allotype). Discovery Station 53. Port Stanley, East Falkland Islands. Hulk of 'Great Britain'. Mussel rake. 0—2 m. May 12, 1926. British Museum (Nat. Hist.).

1 female. Discovery Stat. WS 88. 54°00'00" S. — 64°57'30" W. Trawl. 118 m. Apr. 6, 1927. British Museum (Nat. Hist.).

3 females. Discovery Stat. WS 33. 54°59' S. — 35°24' W. 1 m horizontal tow-net (net touched bottom). 130 m. Dec. 21, 1926. British Museum (Nat. Hist.).

1 female Uschuaia Bay, Beagle Channel (Magellan Straits) Dec. 9, 1892. Collected by Michaelsen. Zoologisches Museum, Hamburg, K 17637.

1 female. Port Stanley (Falkland Islands), 1 fathom. Apr. 14, 1927. Collected by W. L. Schmidt. U.S. National Museum, 80933.

1 male. Port Stanley (Falkland Islands). 8—10 fathoms. March 20, 1927. Collected by W. L. Schmitt. U.S. National Museum, 80934.

1 female. North side of Port William (Falkland Islands). 14—15 fathoms (oyster dredge, off lighthouse). Apr. 9, 1927. Collected by W. L. Schmitt. U.S. National Museum, 80935.

1 juvenile. Discovery Stat. WS 753. 50°58.5' S. — 61°04' W. 73 — 106 m. Sept. 20, 1931. British Museum (Nat. Hist.).

1 male. Swedish Antarctic Exp. 1901—1903, Stat. 3. 54°43' S. — 64°08' W. 36 m. Jan. 6, 1902. Naturhist. Riksmus., Stockholm, cat. no. 66.

1 male. Swedish Antarctic Exp. 1901—1903, Stat. 39. 51°40' S. — 57°41' W. Port William, Falkland Islands. 40 m. July 4, 1902. Naturhist. Riksmus., Stockholm, cat. no. 101.

1 female. Swedish Antarctic Exp. 1901—1903, Stat. 53. 51°40' S. —57°47' W. Port William, Falkland Islands. 12 m. Sept. 3, 1902. Naturhist. Riksmus., Stockholm, cat. no. 102.

Distribution: Tierra del Fuego, Burdwood Bank, Falkland Islands, off South Georgia.

Bathymetrical range: 0—130 m.

Diagnosis: Eye tubercle short, but slender ; abdomen and proboscis of medium length ; tall mid-dorsal protuberances ; coxae 1 of legs 2 to 4 with 2, of leg 1 with 1 dorsal protuberance. Femoral cement gland tubercle inconspicuous. Tibia 2 shorter than tibia 1 and than the propodus. Auxilary claws half as long as the main claw. Female genital pores on legs 1 to 4.

Description. In addition to the characters mentioned in the diagnosis, the following may be added :

Eye tubercle with a particularly slender distal half. Abdomen reaching slightly beyond the distal end of the second coxae of the fourth leg. The lateral processes are separated usually by about half their diameter, though the space between the lateral processes may be rather variable.

The ovigers are 6-segmented. The female oviger bears 5 to 7 slender spines on the distal third of its last segment ; two of these spines occur on the margin of the segment the other are terminal or subterminal. The sixth segment of the oviger is fairly slender and shows a feeble, but distinct, curve about halfway. The male oviger has a robust distal segment, armed with about a dozen slender spines, about four of these spines being placed on the inner margin of the segment, occupying distal two-thirds of that margin.

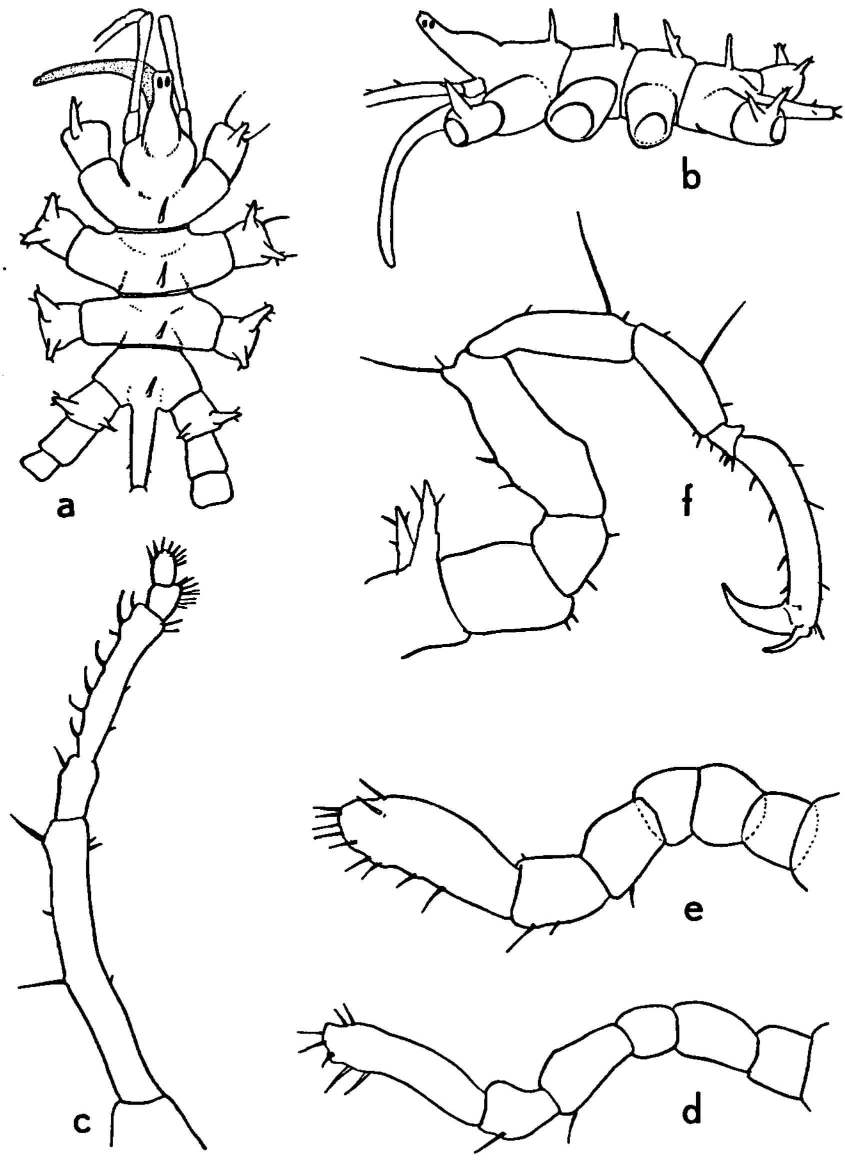


FIGURE 14. *Austrodecus curtipes* n.sp. (Discovery Stat. 53). a, Female in dorsal view; b, female in lateral view; c, palp of female; d, oviger of female; e, oviger of male; f, fourth leg of male.

Coxa 1 with strong, spiny dorsal spurs, one on the first leg, two on each of the remaining legs. The posterior spur of leg 4, and sometimes of leg 3 also, usually shorter than the anterior one.

Cement gland cone at about $^2/_3$ of the femur, little pronounced. Tibia 2 the shorter segment. Propodus fairly slender; inner margin, particularly on the posterior legs, armed with only a few (4 to 6) spinules. Auxiliary claws nearly half as long as the main claw. Female genital openings on the ventral surface of the second coxae of all legs.

Remarks: The short eye tubercle, the tall dorsal trunk tubercles, the short second tibiae, and the long auxiliaries of the present species, reminds one strongly of *A. longispinum*. Gordon, 1944, pointed out already the resemblance between *A. longispinum* (which she called *A. glaciale* var. α) and *A. curtipes* (which was classed with group B).

Nevertheless, these two forms can easily be separated by many characters, e.g.: (1) the ocular tubercle, which is much slenderer, especially in the distal part, in *curtipes* ; (2) the first coxa of leg 1 which bears one dorsal spur in *curtipes*, two dorsal spurs in *longispinum* ; (3) the much longer abdomen of *curtipes* ; (4) the presence, in *longispinum*, of a strong dorsal spur on coxa 3 ; (5) the presence, in *longispinum*, of a number of rugosities on coxa 2; (6) the relatively shorter legs of *curtipes* (particularly distinct in the first tibia); (7) the longer cement gland tubercle of *curtipes* ; (8) the number of inner-edge spines of the distal oviger segment in male (about 4 in *curtipes* ; only 1 in *longispinum*).

One might consider the present species as a small form of typical *A. glaciale*, but on closer examination too many constant differences prove to be present, e.g., in the length of the medio-dorsal spurs of the trunk, the length of tibia 2, the length of the auxiliaries, in the armature of the male oviger, and in the number of genital pores in female.

Notes on the proposed synonymy: The specimens referred to by Gordon, Hedgpeth and Hodgson have all been checked, so that the proposed synonymy appears to be well-established.

The specimen described by Hodgson, 1907b, from Beagle Channel, Tierra del Fuego, is still present in the Zoological Museum of Hamburg, and in perfect condition. This specimen was identified by Hodgson as *A. glaciale*, and bears the indication "Type", but this indication is evidently incorrect. It must be admitted that both the original description of *A. glaciale* (in : National Antarct. Exp.) and the description of the Tierra del Fuego specimen (in: Hamburg. Magelhaens. Sammelreise) were published in the year 1907, but if we compare the texts of these two publications, there cannot be any doubt as to the specimen of the National Antarctic Expedition being the type of *A. glaciale*. Perhaps Hodgson had intended to make the Magellan specimen a paratype (or "cotype" in the terms of those days) but, since it proves to belong to another species than the holotype, it can no longer be considered a "Type !", as the label indicates.

Hodgson's statement (1907b, p. 17) that his specimen lacked the ovigers is a mistake. Actually his specimen is a full-grown female, with large genital pores on all legs, and with well-developed ovigers. As usual, Hodgson's description contains some discrepancies, for example concerning the coxal armature, but these need no correction.

Measurements in mm:

	male	female
	(Discovery	Stat. 53)
Length (tip eye tubercle to tip abdomen)	1.2	1.7
Length cephalic segment	0.57	0.73
Width across 2nd lateral processes	0.50	0.67

		male (Discovery	female Stat. 53)
Fourth leg :	coxa 1	0.17	0.18
	coxa 2	0.17	0.17
	coxa 3	0.08	0.10
	femur	0.30	0.37
	tibia 1	0.24	0.32
	tibia 2	0.18	0.23
	tarsus	0.05	0.05
	propodus	0.28	0.36

The length (in mm) of 10 females is 1.4; 1.5; 1.5; 1.5; 1.6; 1.6; 1.6; 1.7; 1.7; 1.9.
The length (in mm) of 5 males is: 1.2; 1.2; 1.2; 1.3; 1.5.

Austrodecus fagei n.sp. Figs. 15, 16.

A. glaciale, Hodgson, 1914, p. 163 (part.).
A. glaciale, Hodgson, 1915, p. 147 (part.).
A. glaciale, Hodgson, 1927, pp. 347—349, figs. (only the so-called males are specimens of *fagei*).
A. glaciale, typical (part.), and var. β (part.), Gordon, 1944, pp. 62—65.
A. glaciale, Fage, 1952a, p. 185.
A. glaciale, Fage, 1952a, p. 272.

Material examined:

1 female and 1 male (allotype and holotype). Terre Adelie, Cap Margerie. 50—60 m. Feb. 4, 1950. Collected by P. Tchernia. Museum Hist. Natur. Paris.
1 female. Gauss Winter Quarters. 380 m. Jan. 1903. Zool. Mus. Berlin nr. 268.
1 male. Gauss Winter Quarters. Feb. 7, 1903. Zool. Mus. Berlin nr. 276.
9 females, 9 males. B.A.N.Z. Antarctic Research Exp. (BANZARE) Sta. 39. 66° 10′ S. — 49° 41′ E. 300 m. British Museum (Nat. Hist.).
5 females, 8 males. BANZARE Stat. 41. 65° 48′ S. — 53° 16′ E. 209 — 180 m. British Museum (Nat. Hist.).
3 females. BANZARE Stat. 42. 65° 50′ S. — 54° 23′ E. 220 m. British Museum (Nat. Hist.).
1 female, 1 male. BANZARE Stat. 100. 65° 48′ S. — 89° 49′ E. 393 m. British Museum (Nat. Hist.).
1 male. BANZARE Stat. 105. 67° 46′ S. — 67° 03′ E. 163 m. British Museum (Nat. Hist.).
3 females, 3 males. BANZARE Stat. 107. 66° 45′ S. — 62° 03′ E. 219 m. British Museum (Nat. Hist.).
1 female. BANZARE Stat. 1741. Adelie Land. British Museum (Nat. Hist.).
1 male, 1 juvenile. BANZARE Stat. 1783. Commonwealth Bay. 15—20 fathoms. British Museum (Nat. Hist.).
1 female, labelled "coll. 1679 ? ?" British Museum (Nat. Hist.).

Distribution: Eastern part of the Antarctic continent.

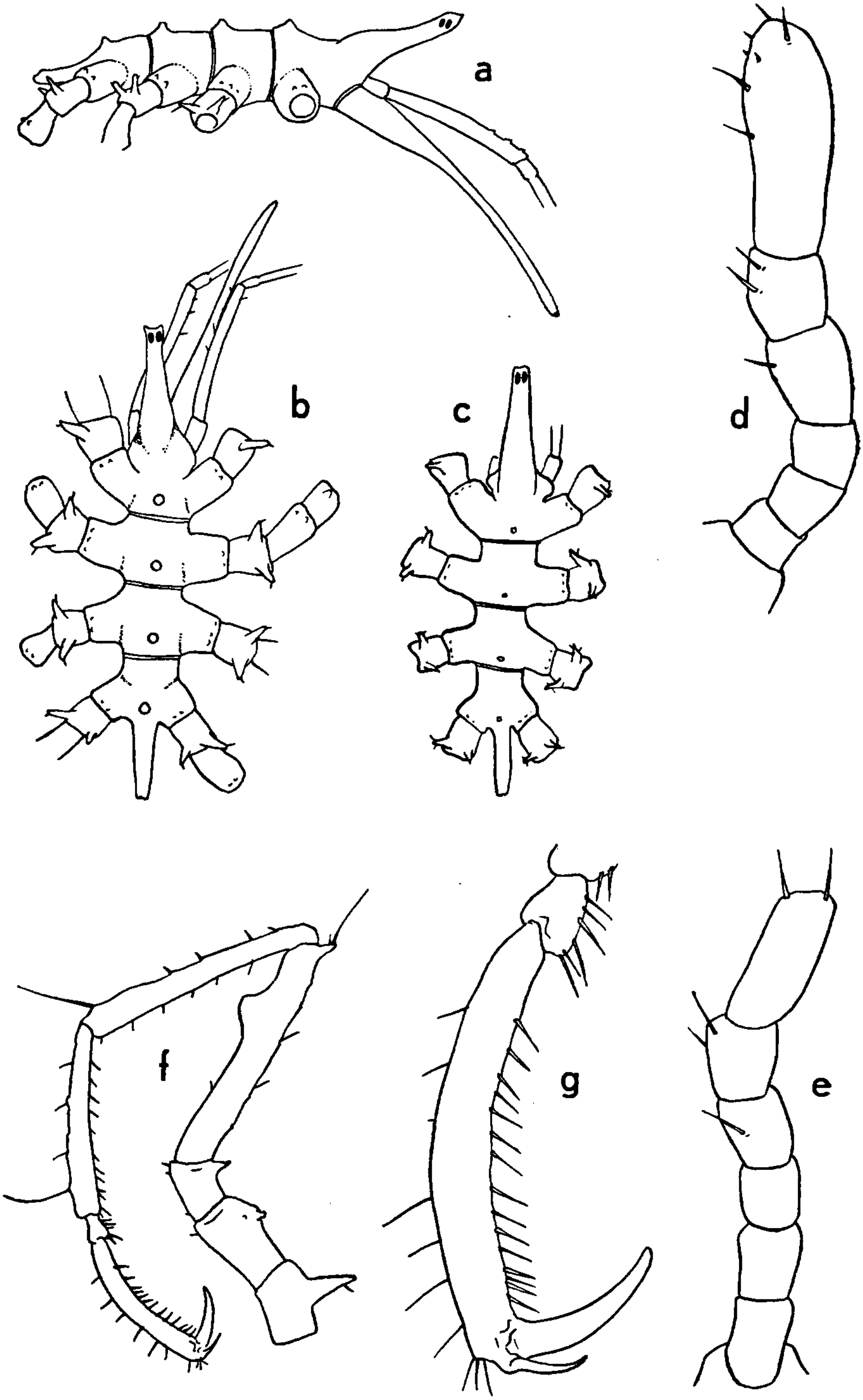
Bathymetrical range: 26—393 m.

Diagnosis: Eye tubercle long and slender. Abdomen relatively short. Lateral processes widely separated, armed with low tubercles. Mid-dorsal spurs very small. Femoral cement gland cone on the distal half of the femur.

Description: Trunk narrow. Eye tubercle slender, but abdomen relatively short, reaching at most to the distal end of the second coxa of the fourth leg.

Proboscis long.

Ovigers 6-segmented. Distal segment of the male oviger not slender, armed with 4 to 6 long spines and a few small ones. Distal segment of female oviger with 2 (sometimes 3) terminal spines; the segment is short, almost rectangular in outline.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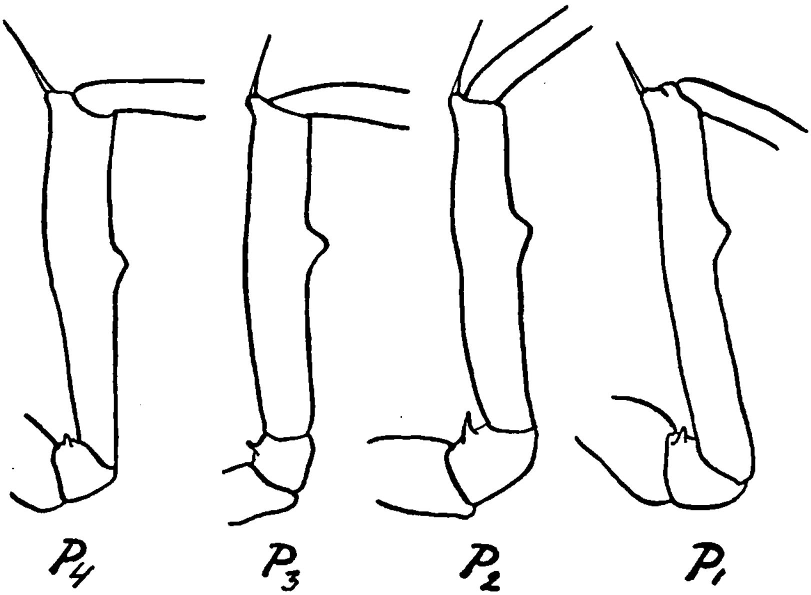

FIGURE 16. The femoral segments of legs 1 to 4 of a male of *Austrodecus fagei* n.sp., to show the different position of the cement gland cone (BANZARE Stat. 39).

Legs slender; coxal spurs arranged as in *A. glaciale* (1 spur on coxa 1 of leg 1; 2 spurs on coxa 1 of the other legs). Coxa 2 of all legs, however, with a few dorsal rugosities. Coxa 3 of all legs with 1, sometimes 2, dorsal tubercles. Femur very slender. Cement gland cone distinct, situated on the distal half of the femur, rounded triangular in ontline. Tibiae also very slender. Propodus elongate, curved; sole with many spinules. Auxiliary claws about $^2/_5$ as long as the claw. Genital pores (female) on the ventral surface of the second coxae of all legs. In two females from BANZARE Stat. 107, however, I am unable to find the genital pores on the fourth legs although at least one of these two specimens appears to be fully mature.

Remarks: Close to *A. glaciale* and *A. simulans*, and confused in the past in the most peculiar ways with these. For the differences with *A. simulans* see under that species (p. 55).

A. fagei differs from *A. glaciale* in the following respects: (1) the mid-dorsal spurs of *glaciale* are much stronger; (2) the lateral processes of *glaciale* are smooth; (3) the abdomen of *fagei* is much shorter than the abdomen of *glaciale*-specimens with the same distance between the crurigers (more compact specimens of *glaciale* have about the same relative length of the abdomen as *fagei*, but have narrowly spaced crurigers); (4) the smaller absolute size of *fagei*; (5) the cement gland cone in *glaciale* is never placed beyond the middle of

FIGURE 15. *Austrodecus fagei* n.sp. a, Female in lateral view (Discovery Stat. 42); b. the same in dorsal view; c. male, holotype, in dorsal view; d. oviger of male; e, oviger of female; f, first leg of male; g, distal segments of the first leg of male (figures d to g from material of BANZARE Stat. 39).

the femur; (6) the ovigers of both sexes of *fagei* differ from those of *glaciale* by their armature; (7) *glaciale* has the female genital openings only on the three anterior pairs of legs, *fagei* usually on all four pairs of legs.

A. fagei occurs in the same localities as *A. glaciale* and is often taken in the same haul. Hodgson (1927) seems to haven mistaken the specimens of *A. fagei* for the males of *A. glaciale*. At any rate, his note that males are much slenderer than the females points in this direction; his figure of the "male" is actually a specimen of *A. fagei* whereas his figure of the female represents *A. glaciale*. Hodgson was apparently unaware of the cement gland cone, by which males and females may easily be distinguished, for he does not mention this structure in his paper. Another indication that Hodgson considered specimens of both sexes of *A. fagei* males of *glaciale* is found in his statement that genital pores occur on all legs of his presumed males. Females of *A. fagei* do possess distinct genital pores on all legs. Moreover, a revision of Hodgson's material showed that both *fagei* and *glaciale* are present in his samples.

The new species is dedicated to Prof. Louis Fage, of Paris, who appears to have been the first to notice certain differences in the length of the abdomen between the present species and *A. glaciale* (Fage, 1952a, p. 185).

Notes on the synonymy: Gordon's samples of *A. glaciale* typical form and var. β consisted of mixed numbers of *A. glaciale* and *A. fagei*. Fage's specimens (1952a) all proved to belong to *A. fagei*.

Measurements (in mm)

	male	female
Length (tip eye tubercle to tip abdomen)	1.6	2.3
Width across 2nd lateral processes	0.47	0.75
Length of cephalic segment	0.73	0.85

Fourth leg of male — first coxa 0.18; second coxa 0.23; third coxa 0.12; femur 0.62; first tibia 0.47; second tibia 0.43; tarsus 0.05; propodus 0.40.
Length of 10 males: 1.5—1.9 (mean 1.74) mm.
Length of 10 females: 1.8—2.3 (mean 2.03) mm.

Austrodecus glabrum n.sp. Figs. 17, 18.

A. glaciale, Loman, 1923b, p. 31 (part.).
A. glaciale, group II, Gordon, 1932, p. 117, fig. 64b.
A. glaciale var. γ, Gordon, 1944, p. 66.

Material examined:

1 female. Swedish Antarctic Expedition 1901—1903. South Georgia, Cumberland Bay, May creek. May 5, 1902. Naturhist. Riksmus. Stockholm.

Further the following Discovery specimens, all preserved in the British Museum (Nat. Hist.):

2 females, 5 males. Discovery Stat. 27. South Georgia, West Cumberland Bay, 3.3 miles S 44° E of Jason light. Large dredge. 110 m. Mar. 15, 1926.

1 female (allotype). Discovery Stat. 39. South Georgia, East Cumberland Bay, from 8 cables S 81° W of Merton Rock to 1.3 miles N 70° E of Macmahon Rock. Large otter trawl. 179—235 m. Mar. 25, 1926.

1 female, 2 males. Discovery Stat. 42. South Georgia, off mouth of Cumberland Bay, from 6.3 miles N 89° E of Jason Light to 4 miles N 39° E of Jason Light. Large otter trawl. 120—204 m. Apr. 1, 1926.

6 females, 3 males. Discovery Stat. 123. South Georgia, off mouth Cumberland Bay, from 4.1 miles N 54° E of Larsen Point to 1.2 miles S 62° W of Merton Rock. Large otter trawl. 230—250 m. Dec. 15, 1926.

4 females, 1 male. Discovery Stat. 144. Off mouth of Stromness Harbour, South

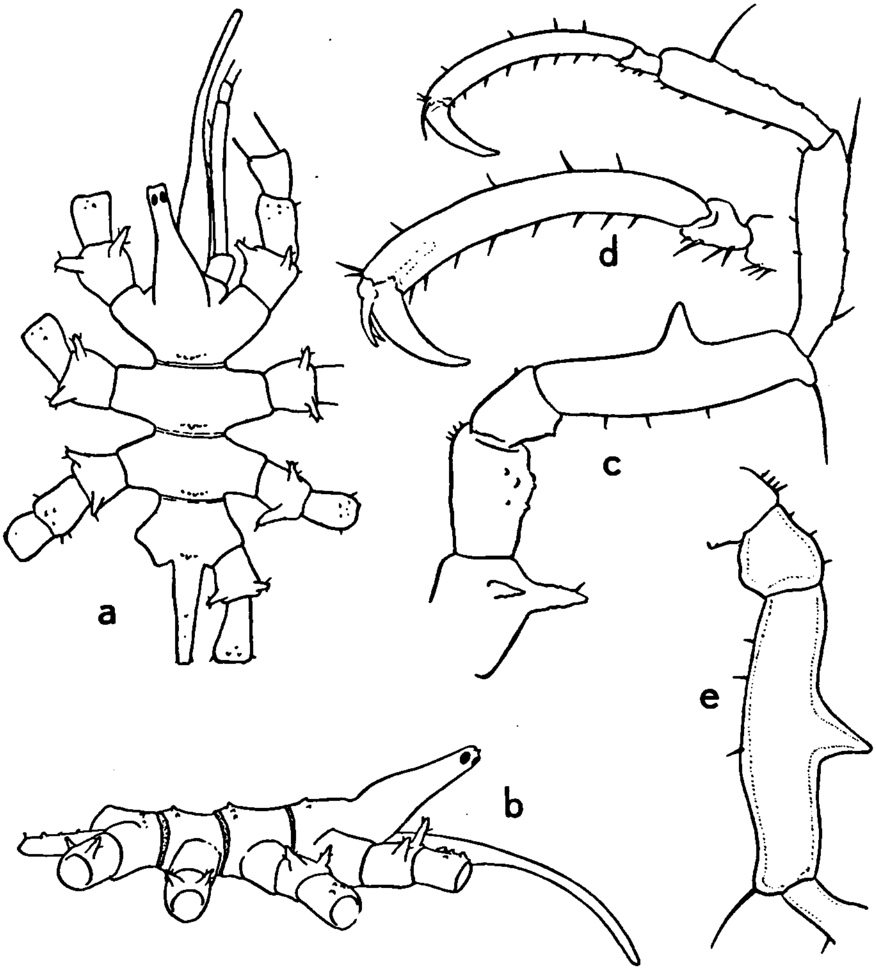

FIGURE 17. *Austrodecus glabrum* n.sp. (Discovery Stat. 27). a, Male in dorsal view; b, male in lateral view; c, leg of male; d, distal segments of a male leg; e, femur with cement gland cone.

Georgia, from 54° 04′ S. — 36° 27′ W. to 53° 58′ S. — 36° 26′ W. Large otter trawl. 155—178 m. Jan. 5, 1927.

4 females, 11 males. Discovery Stat. WS 27. South Georgia, West Cumberland Bay. 106—109 m. Dec. 19, 1926.

1 female, 2 males. Discovery Stat. WS 33. 54° 59′ S. — 35° 24′ W. Horizontal tow net — net touched bottom. 130 m. Dec. 21, 1926.

1 male (holotype). Discovery Stat. MS 14. South Georgia, East Cumberland Bay, from 1.5 miles SE × S to 1.5 miles S ½ W of Sappho Point. Small dredge. 190—110 m. Feb. 17, 1925.

1 juvenile. Discovery Stat. MS 65. South Georgia, East Cumberland Bay, 1.6 miles SE of Hobart Rock to 1 cable N of Dartmouth Point. Small beam trawl. 39 m. Feb. 28, 1926.

1 juvenile. Discovery Stat. MS 66. South Georgia, East Cumberland Bay, 2¼ miles SE of King Edward Point Light to 1½ cables W × N of Macmahon Rock. Small beam trawl. 18 m. Febr. 28, 1926.

4 females, 2 males, 1 juvenile. Discovery Stat. MS 71. South Georgia, East Cumberland Bay, 9¼ cables E × S to 1.2 miles E × S of Sappho Point. Small beam trawl. 110—60 m. Mar. 9, 1926.

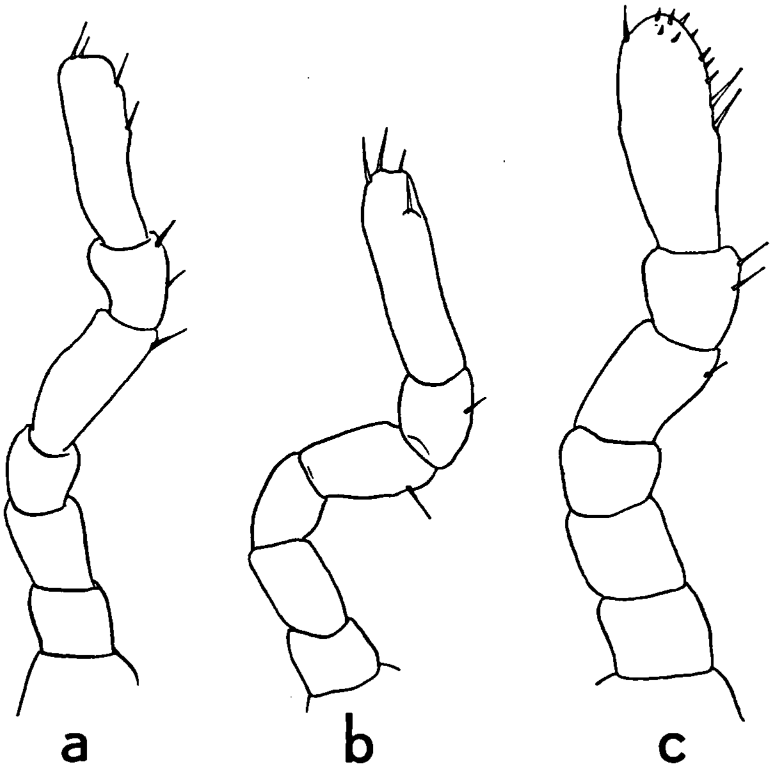

FIGURE 18. *Austrodecus glabrum* n.sp. a, Oviger of female (Discovery Stat. 27); b, oviger of female (Discovery Stat. 42); c, oviger of male (Discivery Stat. 42).

3 males, 1 juvenile. Discovery Stat. MS 74. South Georgia, East Cumberland Bay, 1 cable SE × E of Hope Point to 3.1 miles SW of Merton Rock. Small beam trawl. 22—40 m. Mar. 17. 1926.

Distribution: Shelf around South Georgia.

Bathymetrical range: 18—250 m.

Diagnosis: Dorsum without spurs, but with a row of small tubercles at the posterior margin of each trunk segment. First coxa of all legs with two dorsal spurs. Femoral cement gland cone strong. Auxiliary claws $^1/_3$ as long as the main claw.

Description: Animal slender. Trunk narrow, lateral processes separated by intervals which are slightly smaller than their diameter. Eye tubercle slender, long. Abdomen also slender, though reaching only to the distal end of the second coxa of the fourth leg; armed dorsally with some minute tubercles.

Proboscis a little shorter than the thrunk.

Ovigers 6-segmented. Terminal segment relatively short; in male armed with 2 slender inner-edge spines, 1 slender terminal spine and between these about 10 short conical spinules; in female there is also 1 inner-edge spine, the position of which is variable (cf. figs. 18 a, b), further there are 2 terminal spines and between these 1 spine which may be either terminal or subterminal.

Coxa 1 of all legs with 2 long dorsal spurs, though the second spur of the coxa of leg 4 may sometimes be rather small. Coxa 2 dorsally with some scattered, small tubercles. Coxa 3 with only a single small tubercle. Cement gland cone narrowly pointed, about $^2/_3$ as long as the diameter of the femur, situated at, or slightly beyond the middle of the segment. Tibia 2 slender. Propodus very slender, curved; sole with 6 to 12 spinules. Genital pores (female) on the ventral surface of coxa 2 of legs 1, 2 and 3.

Remarks: The characters mentioned in the diagnosis are absolutely distinctive of *A. glabrum*. In shape and position of the cement gland cone and in the absence of strong mid-dorsal spurs[9] it agrees with *A. profundum*, which, however, is otherwise very different (see under that species, p. 53).

Notes on the synonymy: Gordon, 1932, 1944, distinguished this form already from other *Austrodecus* material. At first, she classified the specimens belonging to this species with "Group II" (1933), but later she raised it to varietal rank, as "var. γ" (1944). In my opinion, there can hardly be any doubt as to its status as a full species.

As I have ascertained by re-examination of the original material, Loman's (1923b) specimen of "*A. glaciale*" from Cumberland Bay actually belongs to *A. glabrum*.

Measurements (in mm):

		male	female
Length (tip eye tubercle to tip abdomen)		1.9	2.4
Length cephalic segment		0.65	0.83
Width across the 2nd lateral processes		0.83	0.90
Fourth leg —	coxa 1	0.27	0.25
	coxa 2	0.30	0.30
	coxa 3	0.18	0.18
	femur	0.68	0.70
	tibia 1	0.60	0.62
	tibia 2	0.47	0.48
	tarsus	0.08	0.08
	propodus	0.55	0.55

Length of 10 males: 1.6—2.1 (mean 1.81) mm.
Length of 10 females: 1.6—2.7 (mean 2.32) mm.

Austrodecus glaciale Hodgson. Figs. 19—21.

A. glaciale Hodgson, 1907a, p. 53, pl. VIII fig. 1.
A. glaciale, Bouvier, 1911, p. 1140.
A. glaciale, Bouvier, 1913, pp. 147—149, figs. 96—97.
A. glaciale, Calman, 1915, pp. 66—67, fig. 20.
A. glaciale, Hodgson, 1914, p. 163 (part.).
A. glaciale, Hodgson, 1915, p. 147 (part.).
A. glaciale, Hodgson, 1927, pp. 347—349, figs. (only the so-called female specimens are specimens of *glaciale*).
A. glaciale, group I A 1, Gordon, 1932, pp. 115—117, fig. 64a.
A. glaciale, Gordon, 1938, p. 25.
A. glaciale, typical + var. β (part.), Gordon, 1944, pp. 62—66, figs. 24 a—b, 25 a, al.
A. glaciale, Hedgpeth, 1950, p. 154 (part.).

Material examined:

1 female, 1 male. "Terra Nova" Stat. 220. Off Cape Adare, mouth of Robertson's Bay. 45—50 fathoms. Jan. 3, 1912. British Museum (Nat. Hist.).

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[9] The specific name, *glabrum*, alludes to this character.

2 males. "Terra Nova" Stat. 339. Ross Sea, entrance to Mc Murdo Sound. 140 fathoms. British Museum (Nat. Hist.).

3 females. Deutsche Südpolar Exp. („Gauss"). Winter Quarters, 380 m. Jan. 1903. Zoolog. Mus. Berlin nr. 268.

1 young male. „Gauss" Winter Quarters. 380 m. Jan. 12, 1903. On a seaurchin (*Rhynchocidaris triplopora* Mrtsn.). Zoolog. Mus. Hamburg.

2 females, 2 males. "Pourquoi-Pas?". Ile Pietermann. Shore, under small stones covered with sponges. Nov. 1, 1909. Mus. Hist. Natur., Paris.

2 females, 3 males. Discovery Stat. 1660. 74° 46.4′ S.—178° 23.4′ E. 351 m. Jan. 27, 1936. British Museum (Nat. Hist.).

8 females, 11 males. B.A.N.Z. Antarctic Research Exp. Stat. 39. 66° 10′ S.—49° 41′ E. 300 m. Jan. 17, 1930. British Museum (Nat. Hist.).

1 female, 1 male. BANZARE Stat. 40. 66° 12′ S.—49° 37′ E. 300 m. Jan. 17, 1930. British Museum (Nat. Hist.).

14 females, 14 males. BANZARE Stat. 41. 65° 48′ S.—53° 16′ E. 209—180 m. Jan. 24, 1930. British Museum (Nat. Hist.).

6 females, 5 males. BANZARE Stat. 42. 65° 50′ S.—54° 23′ E. 220 m. Jan. 26, 1930. British Museum (Nat. Hist.).

4 females, 4 males. BANZARE Stat. 90. 66° 21′ S.—138° 28′ E. 640 m. Jan. 7, 1931. British Museum (Nat. Hist.).

2 males. BANZARE Stat. 100. 65° 48′ S.—89° 49′ E. 393 m. Feb. 3, 1931. British Museum (Nat. Hist.).

2 females. BANZARE Stat. 103. 67° 03′ S.—74° 29′ E. 437 m. Feb. 10, 1931 British Museum (Nat. Hist.).

2 females, 1 male. BANZARE Stat. 105. 67° 46′ S.—67° 03′ E. 163 m. Feb. 13, 1931. British Museum (Nat. Hist.).

8 females, 2 males. BANZARE Stat. 107. 66° 45′ S.—62° 03′ E. 219 m. Feb. 16, 1931. British Museum (Nat. Hist.).

1 male. BANZARE Stat. 113. 42° 40′ S.—148° 27½′ E. 122 m. Mar. 23, 1931. British Museum (Nat. Hist.).10).

1 female. U.S. Navy Antarctic Expedition, coll. no. 43 11). 62° 25′ S. 101° 13′ E. 100 fathoms. Jan. 14, 1948. U.S. Nation. Mus. 87345.

1 female, 1 male. U.S. Navy Antarct. Exp., coll. no. 234 11). Marguerite Bay. 40 fathoms. Feb. 22, 1948. U.S. Nation. Mus. 87346.

1 male, 1 juvenile. U.S. Navy Antarct. Exp., coll. no. 238 11). Marguerite Bay. 40 fathoms. Feb. 22, 1948. U.S. Nation. Mus. 87347.

Distribution: Antarctic continent, probably circumpolar.

Bathymetrical range: 0—640 m.

Description: Trunk variable in slenderness (cf. fig. 19). Lateral processes separated by intervals varying from ½ to 2 times their diameter. Median trunk tubercles robust, not very tall. Eye tubercle long to very long. Abdomen in compact forms rather short, in slenderer forms much longer.

Proboscis not very long.

Palps rather slender, not very spiny, but otherwise without peculiarities.

Ovigers 6-segmented. Male ovigers with many small conical spinules and, as a rule, also 1 or 2 longer spines along the distal and inner margin of the terminal segment. This terminal segment is elongately eliptical in outline. Distal segment of the female oviger much more slender, with parallel margins, armed with 2 distal and 2 inner-margin spines, which are restricted to the distal two-thirds of the segment.

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10) "I am doubtful of the validity of this northern locality...... Probably taken at Stat. 107 in 219 meters on 16th February, 1931, and remaining entangled in the net at the time it was next used (Stat. 113)" (GORDON in BANZARE Reps., vol. V, pt. 1, p. 6).

11) The collection numbers were cited as Station numbers by HEDGPETH, 1950. (FERNER A. CHACE, Jr., *in litt.*).

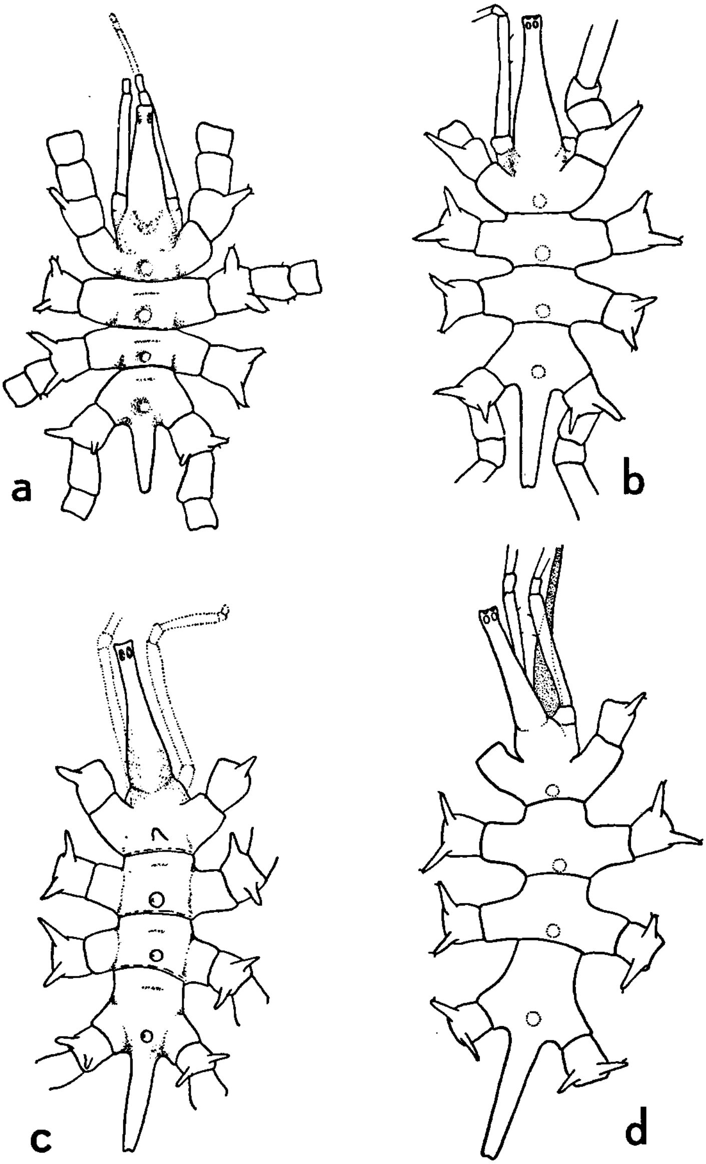

Figure 19. *Austrodecus glaciale* Hodgson. a, Male (Terra Nova Stat. 220); b, female (Banzare Stat. 39); c. female (Banzare Stat. 107); d. female (Banzare Stat. 90).

Coxal spur arrangement constant: 1 spur on the dorsal surface of coxa 1 of leg 1; 2 such spurs on the remaining legs, though the posterior spur of coxa 1 of leg 4 sometimes is much smaller than the other spurs. Coxa 2 and 3 with inconspicuous dorsal tubercles. Femur very slender; cement gland cone broad and strong, rounded at tip, placed between $^1/_3$ and $^2/_5$ of the length of the femur in the compact forms, almost median in the slender forms. Tibiae and propodus also very slender.

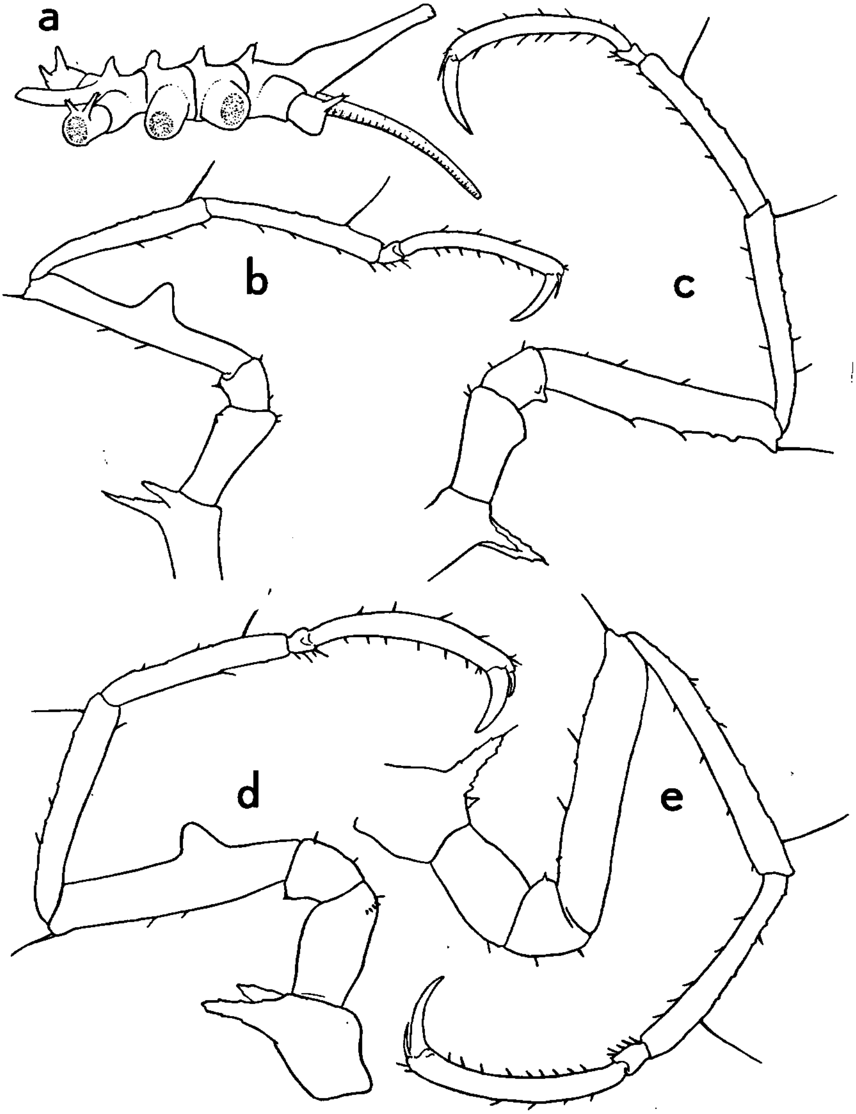

FIGURE 20. *Austrodecus glaciale* HODGSON. a, Lateral view of male (Terra Nova Stat. 220); b, fourth leg of male (BANZARE Stat. 103); c, fourth leg of female (BANZARE Sat. 103); d, fourth leg of male (BANZARE Stat. 42); e, fourth leg of female (BANZARE Stat. 42).

Auxiliary claws at most $1/3$ as long as the claw. Genital pores (female) on the ventral surface of the second coxae of legs 1, 2, and 3.

Remarks: I unite under the name *A. glaciale* a number of forms of very different slenderness. The more compact forms agree with the holotype of *A. glaciale*, the majority of the more slender forms were described as var. β by GORDON, 1944. The extremes of the series of forms considered here to belong to *glaciale* differ so much from each other in

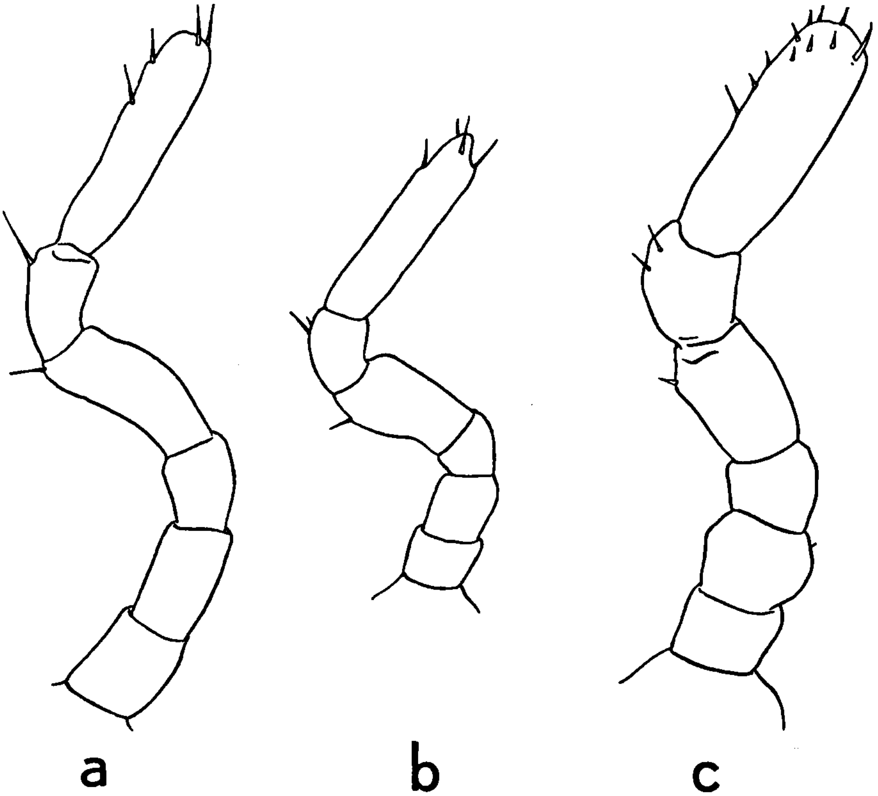

FIGURE 21. *Austrodecus glaciale* HODGSON. a, Oviger of female (BANZARE Stat. 42); b, oviger of female (BANZARE Stat. 103); c, oviger of male (BANZARE Stat. 90).

general aspect that I have felt considerable doubt as to their taxonomic status. There are, however, some reasons which make it likely that all these forms belong to a single, variable species. Firstly, the structural details of all forms, irrespective of their slenderness, are practically identical. Thus, the coxal spur arrangement, the shape of the median trunk tubercles, the shape and position of the cement gland cone, the slenderness of the long joints of the legs, the relative length of the auxiliary claws, the structure of the ovigers and the number of genital pores are fairly constant throughout. Secondly, the compact and slender forms have exactly the same distribution pattern, and are often obtained together in the same haul of the dredge. Thirdly, at some stations (e.g., BANZARE Stat. 107, BANZARE Stat. 39), in addition to typical specimens of the "forma typica" and of the "var. β", all intergradations have been found as well. These three phenomena (no structural differences; no differences in distribution; all intergradations known) have induced me to refer the great variety of forms to a single species. The attention of the taxonomist is called to this complex species, so that it may be more carefully analyzed when additional material becomes available. In general, it seems to me that the littoral and shallow water specimens tend to be more compact than the deep water specimens, but there are exceptions.

Measurements (in mm):

	"typical form"		"var. β"	
	male (BANZARE 42)	female (BANZARE 42)	male (Discov. 90)	female (Discov. 103)
Total length (tip eye tubercle to tip abdomen)	2.3	2.8	2.3	2.8
Length cephalic segm.	1.0	1.2	0.90	1.1
Width across 2nd lateral processes	0.67	0.85	0.72	0.83
Fourth leg —				
coxa 1	0.25	0.32	0.28	0.25
coxa 2	0.35	0.32	0.38	0.33
coxa 3	0.17	0.18	0.17	0.17
femur	0.73	0.82	0.83	0.88
tibia 1	0.70	0.77	0.68	0.77
tibia 2	0.55	0.67	0.60	0.67
tarsus	0.08	0.08	0.08	0.08
propodus	0.55	0.65	0.57	0.63

Length of 10 males 2.3—2.5 (mean 2.35) mm.
Length of 10 females 2.6—3.0 (mean 2.80) mm.

Austrodecus longispinum n.sp. Figs. 22, 23.

A. glaciale var. α, Gordon, 1944, p. 64, figs.

Material examined:

23 males, 10 females (incl. 1 male, holotype, and 1 female, allotype). B.A.N.Z. Antarctic Research Expedition Stat. 47. 49° 50′ S. — 69° 33′ E. 150 m. Feb. 7, 1930. British Museum (Nat. Hist.).

3 males. BANZARE Stat. 64. 49° 28′ S. — 70° 33′ E. 91 m. Mar. 2, 1931. British Museum (Nat. Hist.).

Distribution: Shelf of Kerguelen Island.

Bathymetrical range: 91—150 m.

Diagnosis: Eye tubercle robust and short. Abdomen short. Proboscis of medium length. Mid dorsal spurs long and slender. First coxae of all legs with 2 dorsal spurs; third coxae of all legs with 1 dorsal spur. Second tibia much shorter than the first tibia and than the propodus. Auxiliary claws nearly half as long as the claw. Cement gland tubercle low but distinct, situated at $^1/_4$ to $^1/_3$ of the length of the femur. Genital pores of female on all legs.

Description: In addition to the diagnostic characters just mentioned, the 6-segmented oviger shows some peculiarities. The male oviger has a rather slender distal joint, with 6 to 10 long, distal spines and a single long spine on the inner margin, slightly distally of the middle of the joint. The female oviger has 4 to 6 distal spines and usually 1 inner-edge spine, which varies in position.

The legs show several characteristics, viz., the presence of spurs on coxae 1 and 3 and of numerous small dorsal tubercles or rugosities on coxa 2; the very short second tibia; the not very slender, curved propodus.

In some specimens, the abdomen bears a small dorsal prominence which is, however, much smaller than the tubercles on the abdomen of *A. calcaricauda* or on that of *A. sinuatum*.

The palps bear on segment 2, instead of the usual spines or spinules, some strong spine-like protuberances.

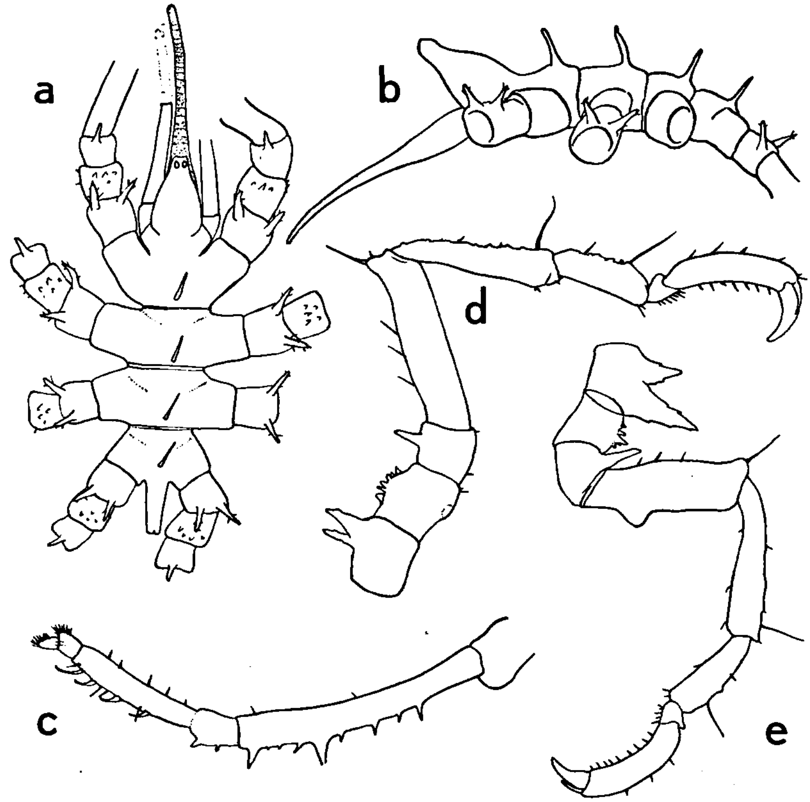

Figure 22. *Austrodecus longispinum* n.sp. (Bazare Stat. 47). a, Female in dorsal view ; b, female in lateral view ; c, palp of female ; d, third leg of female ; e, second leg of male.

The dorsal spurs of the thrunk in some specimens are not slender and long, but short; they have probably been damaged.

Remarks: A distinct species, which differs from the other members of the *glaciale*-section by the robust, short eye tubercle and the presence of strong spurs on coxa 3. The only species with which it can be confused is *A. curtipes*. For differences with that species see remarks under *curtipes* (p. 38).

The proposed specific name refers to the long, spine-like spurs on the dorsum and on the first and third coxae.

Measurements (in mm):

Female — length (tip eye tubercle to tip abdomen) 1.9
width across the 2nd lateral processes 0.87
length cephalic segment 0.93
third leg — first coxa 0.27; second coxa 0.25; third coxa 0.17; femur 0.67; first tibia 0.57; second tibia 0.37; tarsus 0.08; propodus 0.35.
Male — second leg — first coxa 0.25; second coxa 0.22; third coxa 0.17; femur 0.57; first tibia 0.52; second tibia 0.35; tarsus 0.07; propodus 0.42.

Length of 10 males 1.5; 1.5; 1.6; 1.6; 1.6; 1.7; 1.7; 1.7; 1.7; 1.8.
Length of 4 females: 1.9; 1.9; 2.0; 2.2.

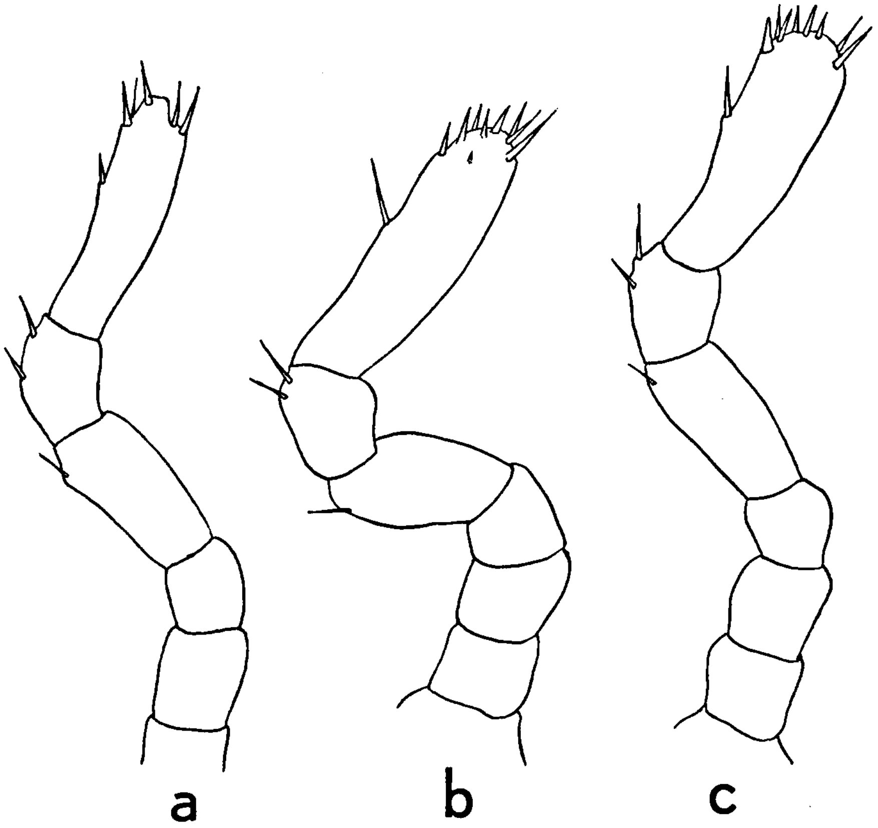

FIGURE 23. *Austrodecus longispinum* n.sp. (BANZARE Stat. 47). a, Oviger of female b, c, oviger of male.

Austrodecus profundum n.sp. Fig. 24.

A. glaciale, Loman, 1923b, p. 31 (part.).

Material examined:

1 male (holotype). Swedish Antarctic Expedition 1901—1903, Stat. 7. 65° 56′ S. — 54° 35′ W. 920 m. Bottom: mud and stones. Jan. 22, 1902. The type is in the Naturhistoriska Riksmuseum, Stockholm.

Distribution: Known only from the type locality, which is in the Graham Region of the Antarctic zone.

Diagnosis: No dorsal spurs on the trunk. Eye tubercle short and robust. First coxa of legs 1 and 4 with 1 dorsal elevation. First coxa of legs 2 and 3 with 2 such elevations. Femoral cement gland cone very tall. Tibia 2 much shorter than tibia 1. Propodus robust. Auxiliary claws more than half as long as the main claw.

Description: Lateral processes separated by narrow intervals. Abdomen reaching to the distal end of the second coxa of the fourth leg. In addition to the intersegmental sutures, the trunk shows some other marks, particularly at the bases of the lateral processes.

Proboscis not very short, without peculiarities.

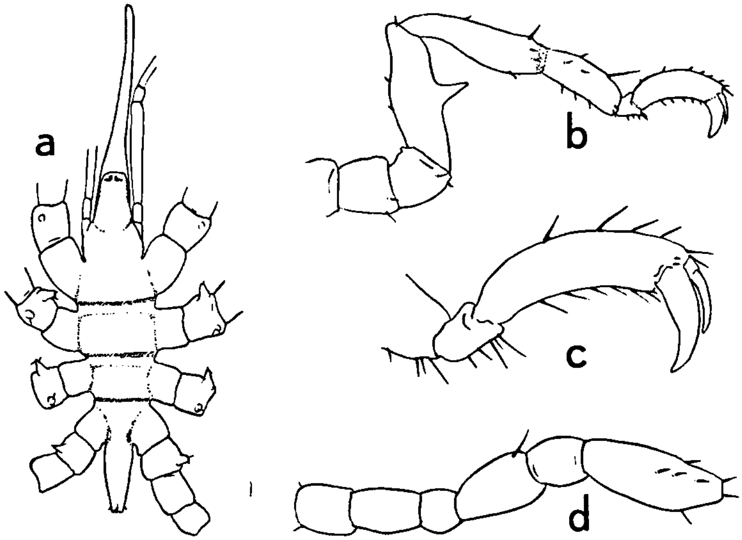

FIGURE 24. *Austrodecus profundum* n.sp. (male, holotype). a, Dorsal view; b, first leg; c, distal segments of first leg; d, oviger.

Palps normal.

Ovigers 6-segmented (only known sex: male). Distal segment rather elliptical, armed with 7 slender spines, 2 of which are placed at the truncated distal end of the joint.

Coxa 1 with low dorsal tubercles: 2 on legs 2 and 3, the posterior one being the smallest, and 1 on legs 1 and 4. Femoral cement gland cone tall and narrow, particularly on the posterior legs, situated slightly beyond the middle of the segment. Tibia 1 the longest segment. Tibia 2 much shorter than tibia 1. Propodus curved, not slender; propodal sole with about half a dozen spinules. Claw robust. Auxiliary claws distinctly more than half as long as the main claw.

Remarks: The only other species which possesses a smooth or nearly smooth dorsum is *A. glabrum*, which also resembles the present form in the shape and position of the femoral cement gland cone. In other respects, however, *glabrum* differs markedly from *A. profundum*: (1) in the length of the eye tubercle; (2) in the arrangement of the coxal spurs; (3) in the length of tibia 2; (4) in the slenderness of the propodus; (5) in the relative length of the auxiliary claws; etc.

This is the only *Austrodecus* species recorded from the deep sea[12]); it has quite a number of distinctive characters and the great length of the auxiliaries is unique in the genus.

Remarks on the synonymy: Only a single specimen of this species is known and it was studied and measured[13]) in detail by LOMAN (1923b). He apparently was impressed by the strong femoral cement gland cone of the animal and considered all his other specimens females. Actually several of them are males, though males of other species

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[12]) The specific name refers to the habitat.

[13]) In the measurements given by LOMAN, l.c. there are apparently some mistakes.

(e.g., *curtipes*) in which the cement gland cone is much less developed. LOMAN's original material, which I have re-examined, is in the Naturhistoriska Riksmuseum, Stockholm.

Measurements of the holotype (in mm)[13]):

Total length (tip eye tubercle to tip abdomen)	1.4
Width across the 2nd lateral processes	0.55
Length of cephalic segment	0.66

First leg — first coxa 0.17; second coxa 0.18; third coxa 0.15; femur 0.42; first tibia 0.45; second tibia 0.28; tarsus 0.05; propodus 0.27.

Austrodecus simulans n.sp. Figs. 25; 26; 37 b, d.

A. glaciale, typical (part.), Gordon, 1944, pp. 62—65, figs. 24c, d, 25 b (part., only the Kerguelen records !).

Material examined:

29 females, 35 males. B.A.N.Z. Antarctic Research Expedition Stat. 47. 49° 50' S. — 69° 33' E. 150 m. Feb. 7, 1930. British Museum (Nat. Hist.).

3 females. BANZARE Stat. 63. 49° 28½' S. — 70° 20' E. Royal Sound, Kerguelen. Mar. 2, 1930. British Museum (Nat. Hist.).

4 females, 3 males (incl. 1 male holotype, and 1 female allotype). BANZARE Stat. 64. 49° 28' S. — 70° 33' E. Off Kerguelen. 91 m. Mar. 2, 1930. British Museum (Nat. Hist.).

Distribution: Shelf around Kerguelen.

Bathymetrical range: 91—150 m.

Diagnosis: Slender eye tubercle and abdomen. First coxa of legs 1 and 4 with only 1 dorsal spur. Second tibia not very slender, at most 6 times as long as wide. Cement gland cone distinct, situated at the middle of the robust femur.

Description: Eye tubercle long and slender; abdomen also slender, reaching to the distal end of the third coxa of leg 4. Dorsal spurs of the trunk fairly long, narrower than those of *A. glaciale*, longer and wider than those of *A. fagei*. Lateral processes smooth; separated by distinct though narrow intervals.

Proboscis rather short. Palp as represented in fig. 37b, d.

Ovigers 6-segmented. Terminal segment (male) strong; armed in its distal fourth with numerous spines. Terminal segment in female club-shaped, with 4—5 distal spines, apex truncate, inner margin rather concave (fig. 25 d—f).

Legs variable. The coxa 1 of leg 1 always with 1 spur; the coxa 1 of legs 2 and 3 always with 2 spurs. The coxa 1 of leg 4 usually with 1 dorsal spur but 7 out of 64 specimens from BANZARE Stat. 47 possess a second, quite rudimentary, spur; I have seen 3 other specimens with a second vestigial spur on one side only[14]). Femur not very slender. Cement gland cone low (less than half the diameter of the femur), but distinct, situated at about the middle of the segment. Tibia 2 variable in length, sometimes very short but never more than 6 times as long as wide[14]). Propodus not very slender, slightly curved. Propodal sole armed with a highly variable number of spinules. Auxiliary claw $^1/_4$ to $^1/_3$ as long as the main claw. Genital pores (female) on the ventral surface of the second coxae of all legs.

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[14]) Specimens with aberrant coxal armatures and with fairly long second tibiae are usually females.

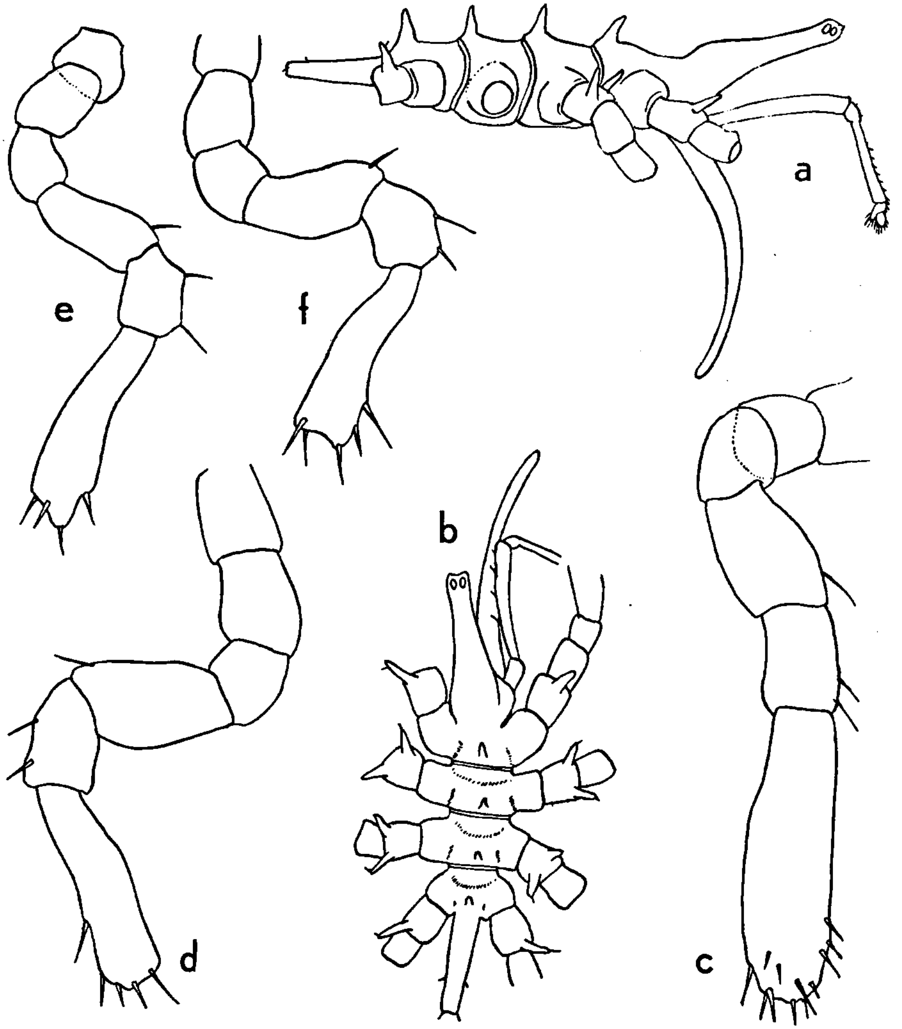

FIGURE 25. *Austrodecus simulans* n.sp. (BANZARE Stat. 47). a, Female in lateral view; b, male in dorsal view; c, oviger of male; d, e, f, ovigers of females.

Remarks: As the specific name indicates, this form closely resembles some other species of the genus, particularly *A. glaciale* and *A. fagei*. GORDON (1944) even included it in her "*A. glaciale*, typical form". Nevertheless, I believe it is distinct from both *glaciale* and *fagei* although it is not so easy to define their differences.

The dorsal trunk spurs of *simulans* are less robust than those of *glaciale*, more robust than those of *fagei*. The short, robust second tibia and the short propodus separate *simulans* from the other two species. There are 2 dorsal spurs on coxa 1 of leg 4 in *fagei* and *glaciale*, though the 2nd spur on these coxae may sometimes be very small. The cement gland tubercle is slightly more pointed in outline than that of *glaciale*, and its position at the middle of the femur is intermediate between that of *fagei* and of *glaciale*. The female oviger is very characteristic and separates

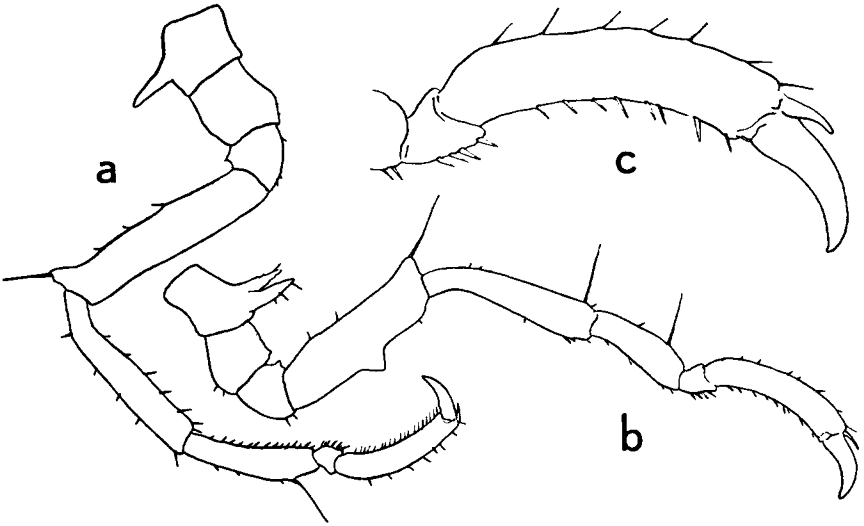

FIGURE 26. *Austrodecus simulans n.sp.* (BANZARE Stat. 47). a, First leg of female; b, third leg of male; c, distal segments of third leg of male.

simulans distinctly from its allies. *A. simulans* possesses genital pores (female) on all legs as in *fagei,* but *glaciale* has pores only on the anterior 3 pairs of legs. From *fagei, simulans* can be separated also by the smooth lateral processes.

Measurements of male (in mm):

Length (tip eye tubercle to tip abdomen)	2.0
Width across the 2nd lateral processes	0.58
Length cephalic segment	0.90

Fourth leg — first coxa 0.15; second coxa 0.22; third coxa 0.12; femur 0.50; first tibia 0.45; second tibia 0.33; tarsus 0.67; propodus 0.42.
Length of 10 females: 2.3—2.5 (mean 2.40) mm.
Length of 10 males: 1.7—2.1 (mean 1.95) mm.

Austrodecus sinuatum n.sp. Fig. 27.

"*A. glaciale* Hodgson var ?", Stock, 1954, p. 160, fig. 78.

Material examined: 1 male (holotype). Masked Island, Carnley Harbour (Auckland Islands). Rocky coast, from Melobesia. Dec. 3, 1914. Dr. Th. Mortensen's Pacific Exp. Collection Zoologisk Museum, Copenhagen.

Distribution: Only known from the type locality.

Diagnosis: Robust. Five mid-dorsal tubercles. Coxa 1 with 1 dorsal spur only. Tibia 2 short. Femoral cement gland cone very indistinct.

Description: Eye tubercle very short, robust, rounded. Abdomen also robust. Lateral processes separated by narrow intervals. There are 5 strong, low, spiny dorsal trunk tubercles; that on the abdomen is hardly smaller than those of the trunk segments.

Proboscis not very long.

Palps not very spinose; without peculiarities.

Oviger (male) 6-segmented. Terminal segment with a strong concavity at about $^1/_3$ of its length; distal half armed with 12 or more slender spines.

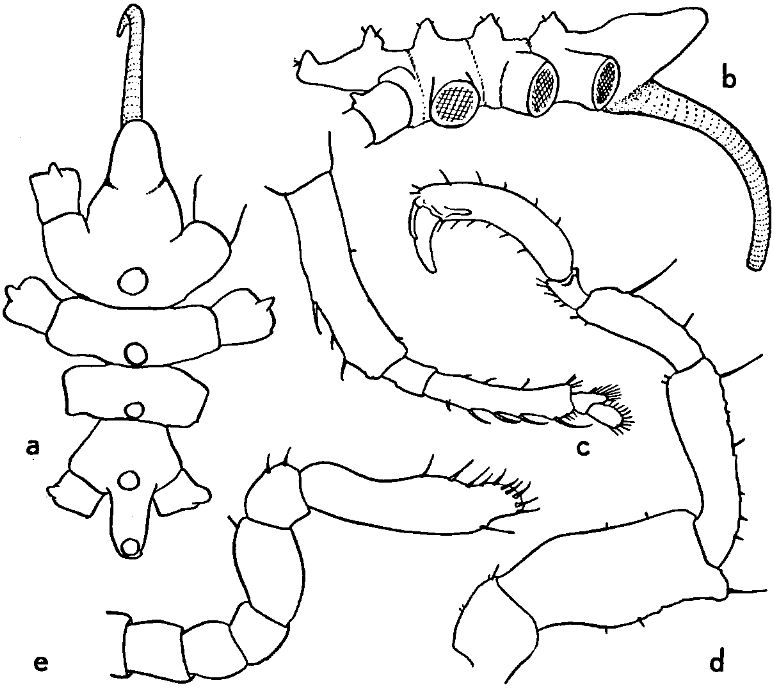

FIGURE 27. *Austrodecus sinuatum* n.sp. (male, holotype). a, Dorsal view; b, lateral view; c, palp; d. third leg; e, oviger.

Coxa 1 of legs 1, 2 and 4 with only one, low, small dorsal tubercle (coxae 1 of the 3rd leg lacking in the unique specimen at my disposal). Femur short; cement gland cone marked only as a rounded swelling at about $^1/_4$ of the segment. Tibia 2 much shorter than tibia 1, and also shorter than the propodus. Propodus curved; sole with half a dozen spinules. Auxiliary claws nearly half as long as the main claw.

Remarks: *A. calcaricauda,* the only other member of the genus with a strong abdominal spur, is very different from the present form in the structure of the oviger, length of the eye tubercle and of the abdomen, length of the auxiliaries, etc. *A. calcaricauda* and the present form are the only species that have a single coxal spur on legs 1, 2, and 4.

The proposed specific name, *sinuatum,* refers to the concave distal oviger segment.

Measurements (in mm) of the holotype, male:

Length (tip eye tubercle to tip abdomen)		1.2
Third leg,	coxa 3	0.15
	femur	0.42
	tibia 1	0.37
	tibia 2	0.25
	tarsus	0.05
	propodus	0.37

Austrodecus spec. 1.

A. glaciale, Stock, 1954, p. 159.

Material: 1 female. Akaroa Harbour (New Zealand). 6 fathoms. Bottom: mud. May 1897. Collected by H. Suter. Zoologisk Museum, Copenhagen.

Remarks: This one female specimen presumably belongs to a new species but, since it does not offer very striking features and since no males are available, I refrain from naming it.

Its characteristics are: small size (total length 1.4 mm); eye tubercle as in *curtipes*; abdomen a trifle more robust than in *curtipes*; only a single dorsal spur on each first coxa; length of the mid dorsal and coxal spurs nearly as in *calcaricauda*; tibia 2 very short; auxiliary claws about $^{1}/_{3}$ of the main claw; oviger 6-segmented; lateral processes nearly in contact with each other; no spur on the abdomen; genital pores (female) on the ventral surface of the second coxae of the anterior three pairs of legs.

The combination of a short eye tubercle and short auxiliaries is not commonly met with in the genus.

The Zoological Museum, Hamburg, possesses another specimen collected by H. Suter near Lyttelton, New Zealand, 1900, in 4—8 fathoms. This specimen agrees with the female described in the preceding paragraph in the length of the eye tubercle and the length of the auxiliaries, but it differs in several other respects. The spurs are much more robust, and the coxal armature is 1 short spur on leg 1, 2 short spurs on legs 2, 3, and 4.

The discovery of this specimen does not make the problem any easier. It agrees in a good number of respects with the female specimen from Akaroa but it also shows many differences. More material from New Zealand localities is urgently needed.

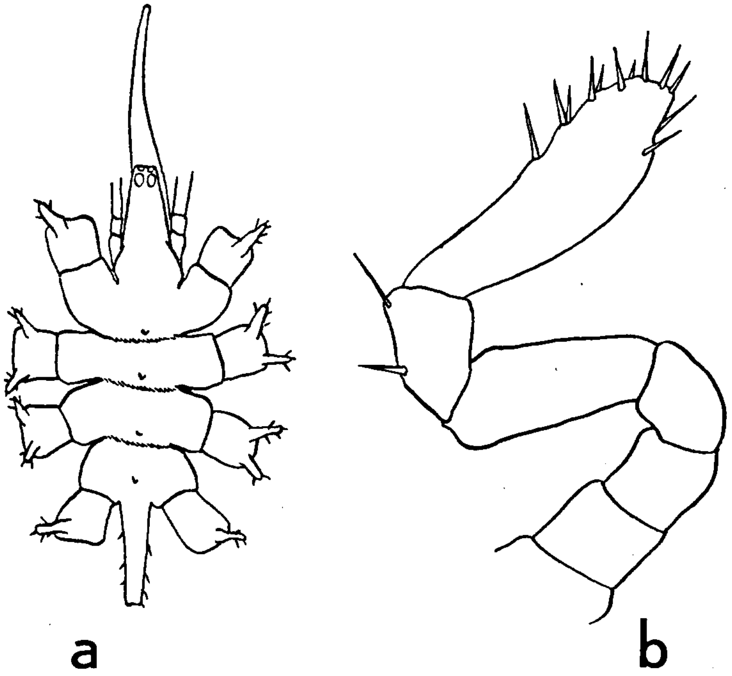

FIGURE 28. *Austrodecus* spec. 2 (male, BANZARE Stat. 1563). a, Dorsal view of trunk; b, oviger.

Austrodecus spec. 2. Fig. 28.

Material: 1 male. B.A.N.Z. Antarctic Research Expedition Stat. 1563. 46°48.4′ S. — 37°49.2′ E. Large dredge. 113—99 m. Apr. 7, 1935. British Museum (Nat. Hist.).

Distribution: Only known from the station mentioned; the locality is just north of Marion Island (Prince Edward group).

Remarks: This species is in some ways intermediate between *A. longispinum* and *A. curtipes.* The eye tubercle is more robust than in *curtipes,* but less robust than in *longispinum.* The legs agree with *longispinum* but have a much shorter process on the third coxae. The arrangement of the spurs of coxa 1 is different from that of both *curtipes* and *longispinum* : leg 1 and 4 have each 1 spur, leg 2 and 3 each 2 spurs. The spurs are very spiny. Abdomen rather long. Palps without peculiarities. Median trunk tubercles very low, nearly absent (!). Oviger with a very slender distal joint (!).

Most probably this form represents a new species, characterized by the rudimentary dorsal trunk spurs, by the very compact trunk (lateral processes touching) and some other features. The isolated position of the locality in which it is found also suggests that it is a separate species. The Prince Edward group is at least 1500 km distant from the nearest continent (South Africa) and 1350 km from the nearest group of islands (Kerguelen).

The material at hand, however, is insufficient to analyze completely its differences from close relatives.

Measurements (in mm):

Length (tip eye tuberrale to tip abdomen)	1.8
Width across the 2nd lateral processes	0.72
Length cephalic segment	0.80

B. The breviceps-section.

A key to the two species (or one species with a subspecies, cf. p. 17) is to be found on p. 31. One form is known from Macquarie Island, the other from Palmer Peninsula (fig. 29).

Austrodecus breviceps Gordon. Figs. 30, 31 b, 32 c-d.

A. breviceps Gordon, 1938, pp. 25—26, figs. 7—8.

Material examined: 1 male. B.A.N.Z. Antarctic Research Expedition Stat. 1736. Macquarie Island. Below low tide. British Museum (Nat. Hist.).

Distribution: The species has been recorded only from 4 stations on Macquaric Island.

Bathymetrical range: Littoral (0 m).

Diagnosis: Eye tubercle, abdomen, and proboscis short. Spurs on the lateral processes and the dorsum. Palps "bifid" at the apex. Ovigers 6-segmented. No auxiliary claws.

Description: The species is characterized by many curious features which are clearly described by GORDON.

The eye tubercle is short, rounded. There are 4 strong dorsal spurs in the median line of the trunk. The lateral processes are armed each with equally strong spurs. These spurs, particularly those of the first pair of lateral processes, are not borne at the distal end, but rather halfway along the lateral process; each spur is spinose.

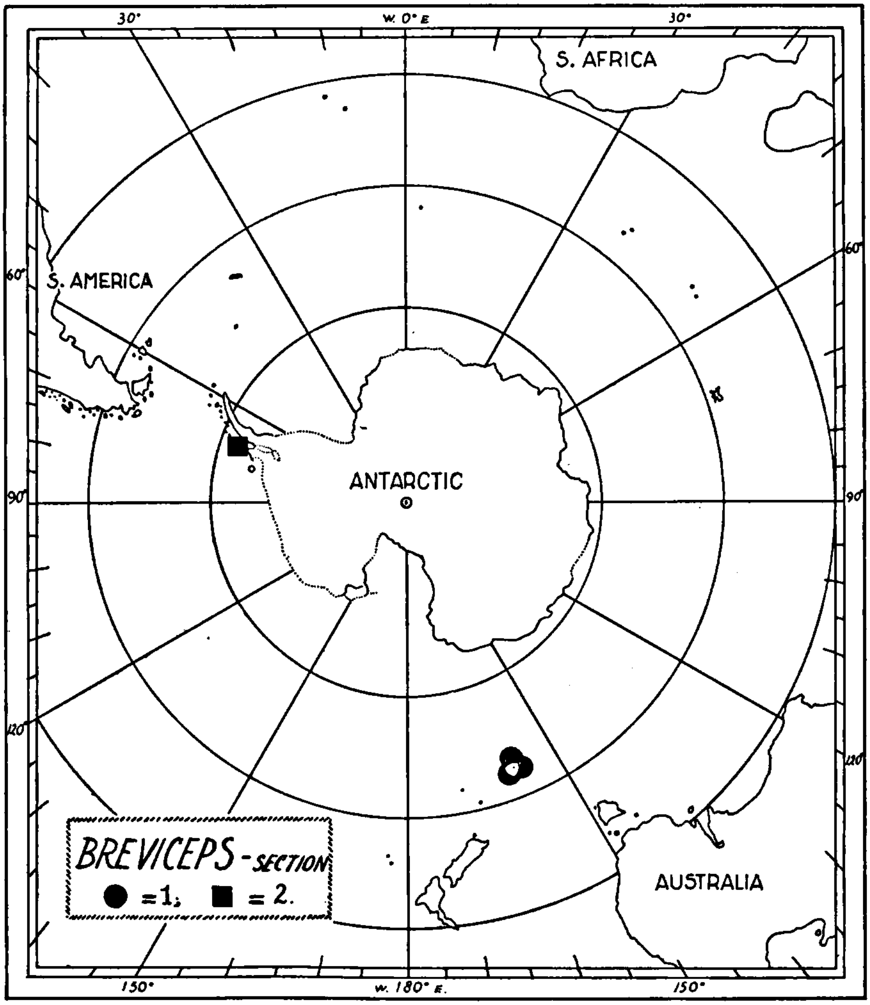

FIGURE 29. The distribution of the species of the *breviceps*-section (1 = *A. breviceps*; 2 = *A.* spec. 3).

The palps, with their strong spines on segment 4 and with the laterally expanded segment 5, are very peculiar.

The oviger (male) has a short, egg-shaped distal segment, armed with a considerable number of small conical spines.

Legs spiny, even the femora bear distinct prominences tipped with spines. The first coxae bear a strong anterior spur and small posterior one. Femoral cement gland tubercle not apparent. Tibia 2 about $^2/_3$ of tibia 1. Propodus equal to tibia 1, strongly curved, robust. Claw robust, without auxiliaries. Genital openings (according to Gordon) on coxa 2 of leg 1 (female), and on coxa 2 of leg 4 (male).

Remarks: The type material, like the present specimen, was collected below low tide at Macquarie Island. It will be noticed that the measurements of the specimen examined by me are practically the same

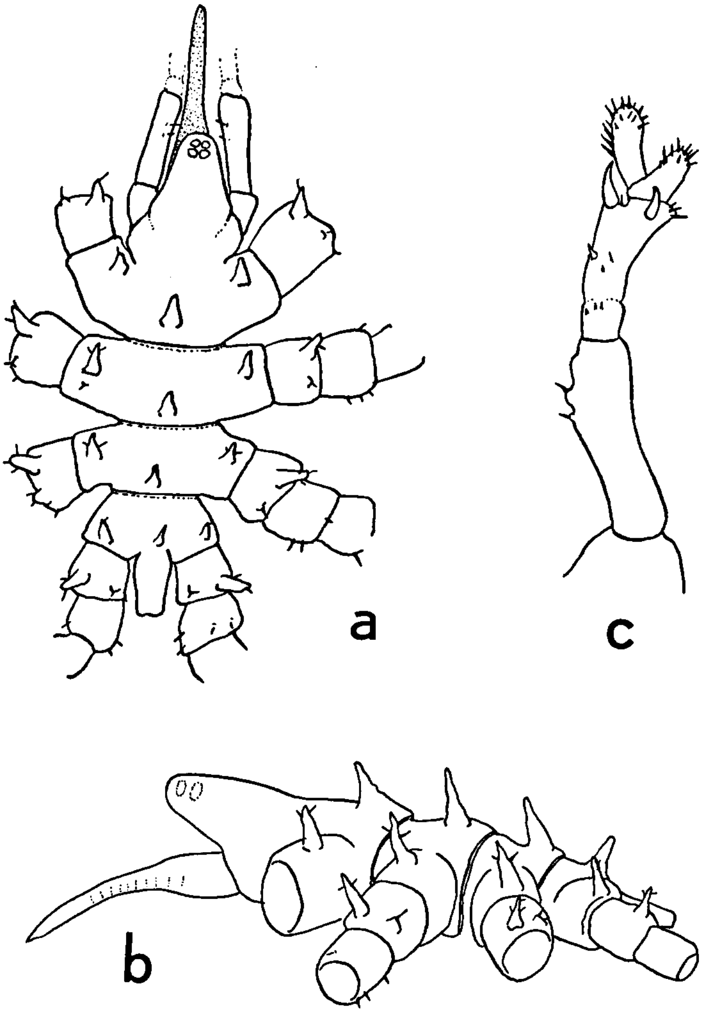

FIGURE 30. *Austrodecus breviceps* GORDON (male, BANZARE Stat. 1736). a. Dorsal view ; b, lateral view ; c, palp.

as those of Gordon's type material. This fact is of importance in connection with the next form, as will be discussed there.

Measurements (male) in mm:

Length (tip eye tubercle to tip abdomen)	1.53
Length cephalic segment	0.63
Width, across the 2nd lateral processes	0.63

First leg — first coxa 0.18 ; second coxa 0.18 ; third coxa 0.13 ; femur 0.33 ; first tibia 0.33 ; second tibia 0.23 ; tarsus 0.07 ; propodus 0.35.

Austrodecus spec. 3. Figs. 31 a, 32 a-b.

A. breviceps, Hedgpeth, 1950, p. 154.

Material examined: 1 male. Marguerite Bay (Palmer Peninsula). Bottom dredge haul; 35 fathoms. Feb. 20, 1948. Collected by D.C. Nutt. U.S. National Museum 87334.

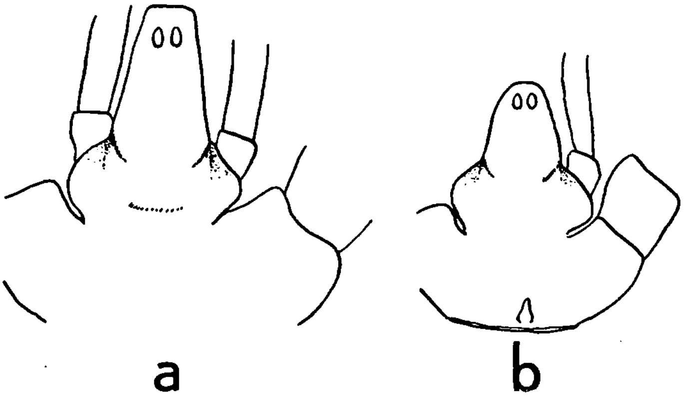

FIGURE 31. Cephalic segment of (a) *Austrodecus* spec. 3 (Marguerite Bay) and of (b) *Austrodecus breviceps* GORDON (BANZARE Stat. 1736). Both figures on the same scale.

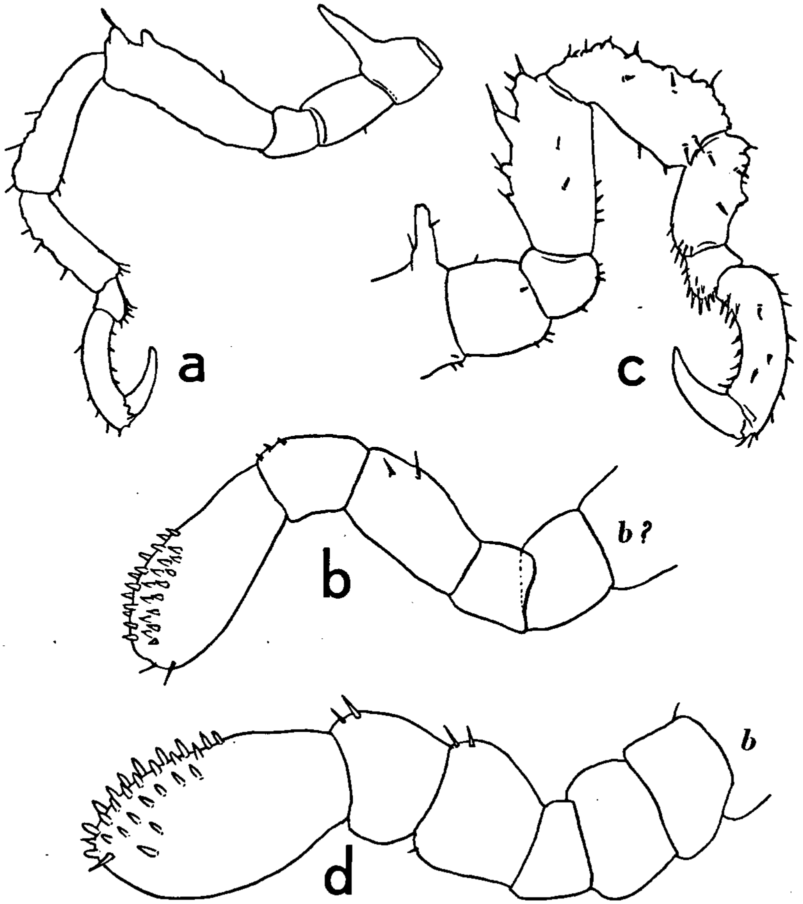

FIGURE 32. a-b, *Austrodecus* spec. 3, first leg of male, and oviger of male ; c-d, *Austrodecus breviceps* GORDON, first leg of male, and oviger of male (*b* = *basal protuberance*).

Diagnosis: In general much like *A. breviceps*, but much larger. Legs longer; tibia 2, particular, much slenderer. Spurs on the trunk larger.

Remarks: HEDGPETH reported a single male, under the name of *A. breviceps*, from Marguerite Bay. I re-examined this specimen and found that it resembles in many points the Macquarie representatives of *A. breviceps*. But in other respects, the Marguerite and Maquarie specimens differ so materially, that I do not venture to consider the two identical. Moreover, the locality (Marguerite Bay) is purely Antarctic whereas the type locality of *breviceps* has more temperate climatic conditions.

The number of specimens of *breviceps* and of the present form (viz., one of each) is totally insufficient to judge whether the Marguerite Bay population represents a distinct species, a subspecies, or falls within the variation range of the typical form. I shall merely point out the differences that exist between *A. breviceps* and the Marguerite specimen in order to turn the attention of future students of the genus to this form.

The body is about 1½ times as long as that of *breviceps*, but the legs in particular are much longer (cf. the appended measurements) and slenderer. The second tibia, which is shorter than the first tibia, and also much shorter than the propodus in *A. breviceps*, is only slightly shorter than the first tibia, and distinctly longer than the propodus in the present form. The spine-like processes (spurs) on the dorsum of the trunk, the lateral processes, and the coxae, are slenderer than in *breviceps*. The eye tubercle, which is rounded in *breviceps*, is shaped like a truncated cone in the present form (cf. fig. 31). Unhappily, my mounting of the oviger of the Marguerite Bay specimen is not too good but, as far as I can judge, only 5 segments and a basal protuberance are present. If this observation is correct, the oviger would be clearly distinct from that of *breviceps* which possesses 6 segments and a basal protuberance.

Measurements of male (in mm):

Length (tip eye tubercle to tip abdomen)	2.20
Length cephalic segment	0.83
Width across the 2nd lateral processes	0.90

First leg — first coxa 0.26; second coxa 0.28; third coxa 0.17; femur 0.73; first tibia 0.60; second tibia 0.53; tarsus 0.09; propodus 0.45.

C. The *tristanense*-section

Only 2 species belong with certainly to this section: *tristanense* and *goughense*. A third species, *A. elegans*, is known only from a single specimen having very curious ovigers. It is not certain, however, whether this oviger structure is normal or due to an anomality. *A. elegans* is, therefore, only provisionally included in the present section. A third form, *A. confusum*, is placed with still greater reserve in the *tristanense*-section. In this case also, it is not clear whether or not the oviger-development is normal.

Austrodecus goughense n.sp. Fig. 34.

Material: 1 male (holotype). Discovery Stat. 399. 1 mile SE of SW point of Gough Island. 141—102 m. May 18, 1930. Type in British Museum (Nat. Hist.).

Distribution: This is the only known record of the species.

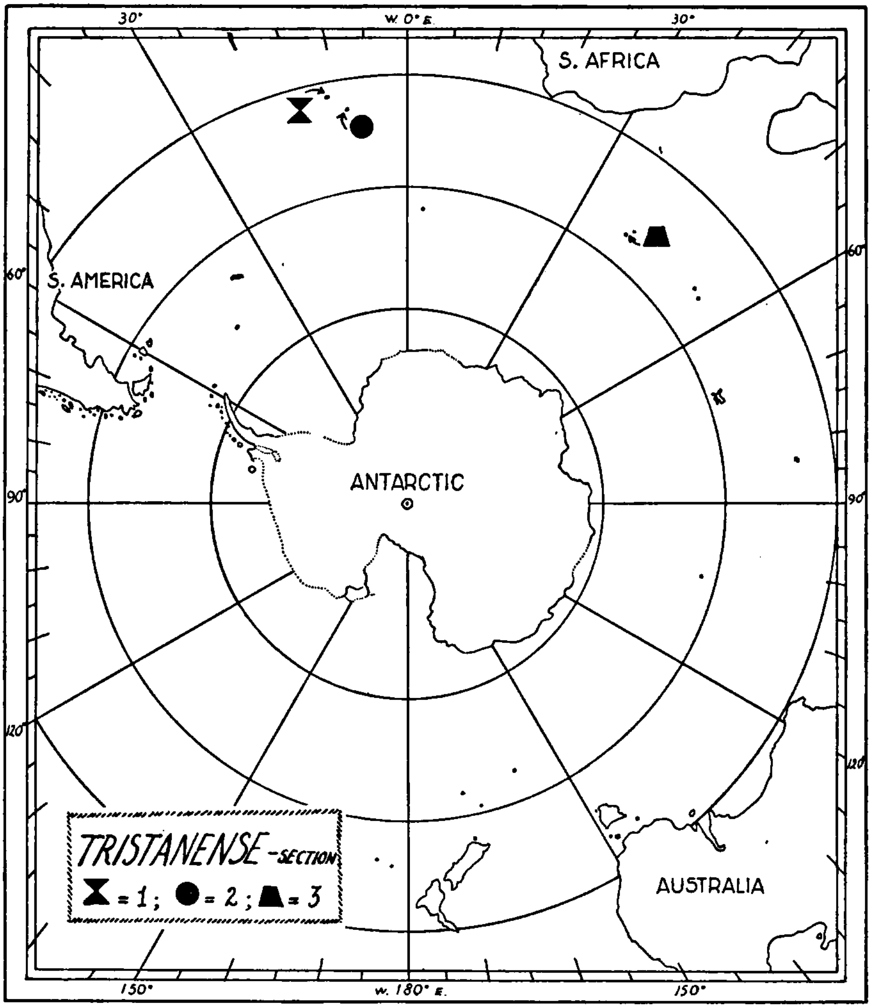

FIGURE 33. The distribution of the species of the *tristanense-section* (1 = *A. tristanense;* 2 = *A. goughense*; 3 = *A. elegans*). The classification of *A. elegans* with the *tristanense*-section is merely provisional (cf. p. 63).

Diagnosis: Eye tubercle moderately long ; abdomen very long. Ovigers 4-segmented. Cement gland cone strong. Propodus slender. Auxiliary claws slightly less than half as long as the main claw.
Description: Trunk fairly slender. Mid dorsal spurs rather feeble. Lateral processes smooth, separated by narrow intervals. Abdomen reaching to the distal end of the third coxa of the fourth leg. Proboscis long.

Palps without peculiarities.

Ovigers 4-segmented (male); distal segment slender, armed at its tip with about 10 slender spines.

Coxa 1 of leg 1 and leg 4 each with 1 dorsal spur ; coxa 1 of leg 2 and leg 3 each with 2 dorsal spurs. The coxal spurs are longer than the mid dorsal spurs. Coxa 2 with some dorsal rugosities, coxa 3 with a low dorsal tubercle. Femur slender; cement gland cone strong, about $^2/_3$ as long as the diameter of the joint, situated slightly beyond the middle of the femur. Tibia 1 about as long as the femur; tibia 2 slender, but shorter than tibia 1. Propodus shorter again, slender, feebly curved; propodal sole with 6—8 spines. Auxiliary claws not quite half the length of the main claw.

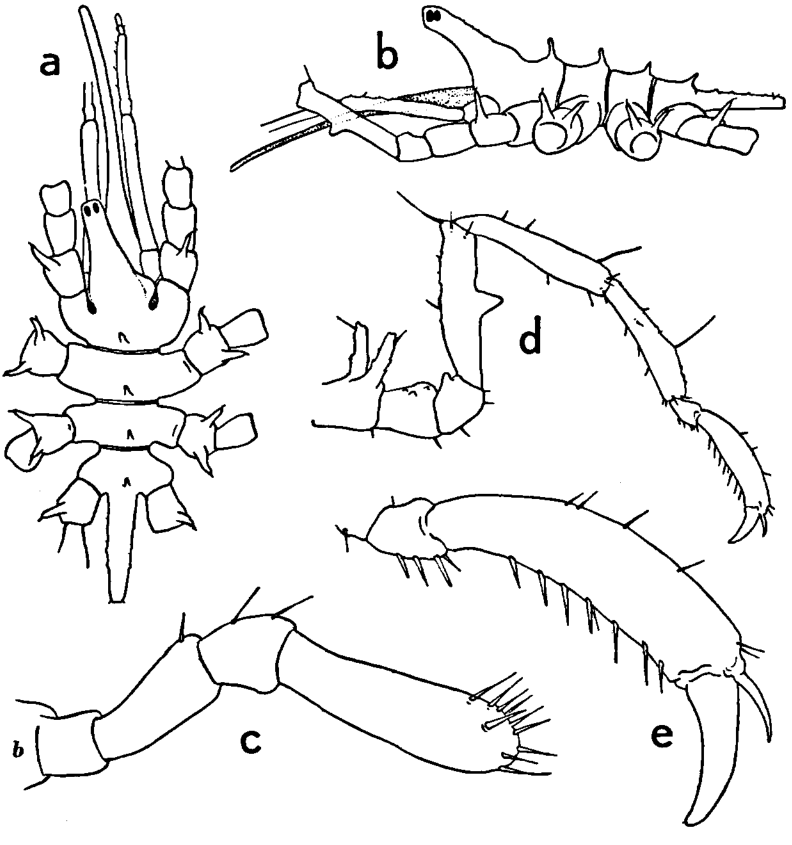

FIGURE 34. *Austrodecus goughense* n.sp. (male, holotype). a, Dorsal view; b. lateral view; c, oviger (*b* = basal protuberance); d, third leg; e, distal segments of third leg.

Remarks: *A. goughense* can be confused only with *A. tristanense*. For the differences see remarks under the latter species (p. 67).

Measurements of the holotype (in mm):

Length (tip eye tubercle to tip abdomen)	1.3
Length cephalic segment	0.60
Width across the 2nd lateral processes	0.45
Length abdomen	0.38

Third leg — first coxa 0.15; second coxa 0.15; third coxa 0.10; femur 0.35; first tibia 0.33; second tibia 0.27; tarsus 0.05; propodus 0.23.

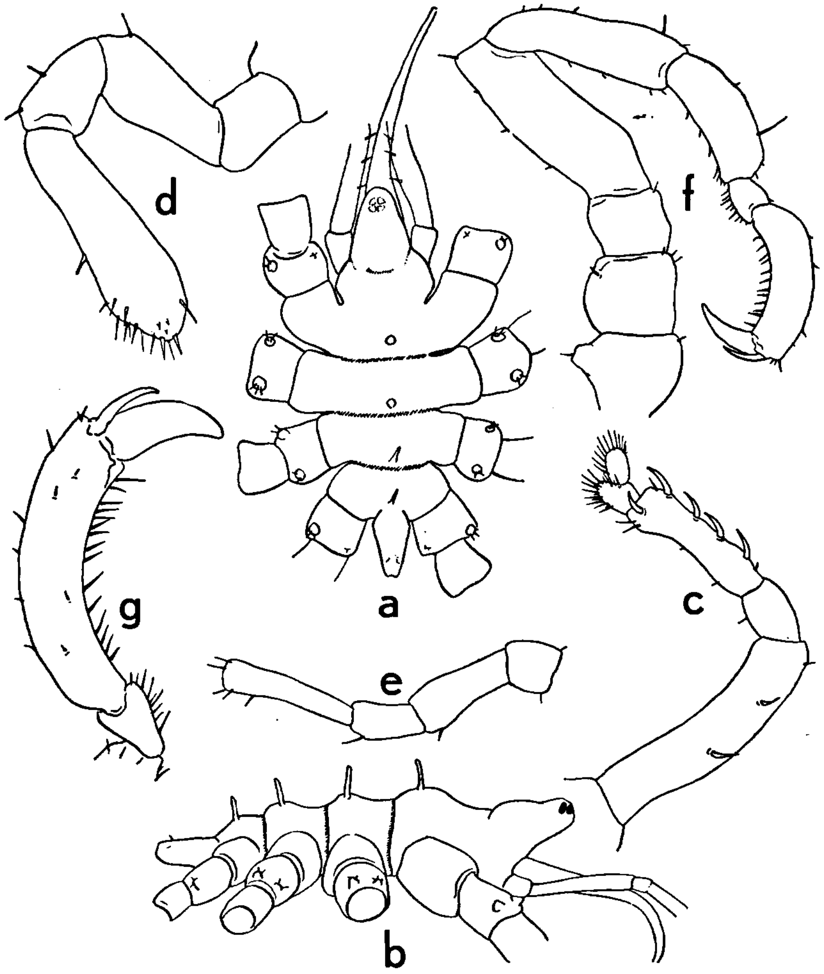

FIGURE 35. *Austrodecus tristanense* STOCK (Norwegian Sci. Exp.). a, Male in dorsal view (Stat. 118); b, female in lateral view (Stat. 117); c, palp of male (Stat. 47); d, oviger of male (Stat. 47); e, oviger of female (Stat. 47); f, second leg of male (Stat. 47); g, distal segments of second leg of female (Stat. 54).

Austrodecus tristanense Stock. Fig. 35.

A. tristanense Stock, 1955, pp. 5—7, fig. 2.

Material examined: The Norwegian Scientific Expedition 1937—38 brought home many specimens of this species, from:
TRISTAN DA CUNHA (Stat. 47, 1 male; Stat. 51, 1 female and 1 juvenile; Stat. 54, 1 female; Stat. 68, 1 female; Stat. 71, 1 male and 1 juvenile; Stat. 167b, 1 juvenile).
NIGHTINGALE ISLAND (Stat. 113, 1 female, 2 males, 3 juveniles; Stat. 115, 1 male, holotype, and 1 female, allotype; Stat. 117, 1 female; Stat. 118, 2 males).
INACCESSIBLE (Stat. 154, 1 female).
All these specimens are in „Det Kgl. Norske Videnskabers Selskab Museet", Trondheim, except the material from Stat. 47, and Stat. 54, which is in the Zoological Museum, Amsterdam (no. Pa. 1238—1239).

Distribution: The species is known exclusively from the larger islands of the Tristan da Cunha group.

Bathymetrical range: 0—55 m.

Diagnosis: Eye tubercle and abdomen short. Proboscis of medium length. Mid dorsal spurs of trunk tall. Ovigers 4-segmented. First coxa with 2 low dorsal elevations. Auxiliary claws nearly half as long as the main claw. Tibia 2 much shorter than tibia 1. Genital pores (female) on all legs.

Description: Trunk robust, with 4 extremely tall mid dorsal spurs, which are, however, easily broken off. Lateral processes hardly separated, smooth. Eye tubercle short, rounded. Abdomen reaching to the middle of second coxae of the fourth leg, of a curious elongate triangular outline.

Proboscis of medium length, curved downward.

Palps *distinctly* 6-segmented (3rd and 4th segment are clearly articulated). Segment 2 the longest, with 2 or 3 claw-like spines on the inner margin. Segment 4 with 4 to 7 similar spines. Distal segment articulated subterminally.

Ovigers 4-segmented, with basal protuberance. The female oviger is very feeble; segment 1 and 3 are short, segment 2 and 4 elongated; segment 4 being the longest, bearing 3 to 4 terminal spines, and 1 inner-edge spine not far from the tip. The male oviger is much more robust than that of the the female; the distal segment bears numerous fairly slender spines at the inner-distal margin.

Legs not very slender. Coxa 1 of legs 2 and 3 each with 2 low dorso-distal protuberances. The first coxae of legs 1 and 4 have only the posterior, or the anterior protuberance respectively developed. The other protuberance is vestigial or absent. Each of the protuberances is armed with some spinules. Femoral cement gland cone very inconspicuous. Tibia 2 distinctly shorter than tibia 1, and slightly shorter than, or about as long as, the propodus. The propodus is strongly curved. Auxiliary claws nearly half as long as the main claw. Genital pores (females) situated on the ventral surface of the second coxae of all legs.

Remarks: This is the most robust and compact species of the genus. The combination of a 4-segmented oviger and well-developed auxiliaries is shared only with *A. goughense*15) which is, however, much slenderer, with strong dorsal spurs on the first coxae, a strong cement gland tubercle and a rather straight propodus. Though the localities Tristan da Cunha and Gough Island are not far apart, these two *Austrodecus*-species are quite well-defined.

Measurements (in mm):	female (Stat. 54)	male (Stat. 47)
Length (tip eye tubercle to tip abdomen)	1.6	1.3
Width across the 2nd lateral processes	0.63	0.68
Length caphalic segment	0.70	0.67
Second leg — coxa 1	0.17	0.17
coxa 2	0.17	0.18
coxa 3	0.13	0.15
femur	0.42	0.42
tibia 1	0.40	0.40
tibia 2	0.30	0.27
tarsus	0.07	0.07
propodus	0.33	0.33

Length of 7 males (in mm): 1.1; 1.1; 1.2; 1.2; 1.2; 1.3; 1.3.

Length of 7 females (in mm): 1.4; 1.4; 1.4; 1.5; 1.5; 1.6; 1.6.

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15) And perhaps with the two species *incertae sedis, elegans* and *confusum*.

Austrodecus elegans n.sp. Figs. 36; 37a, c.

Material examined: 1 female (holotype). Discovery Stat. 1563. 46°48.4 S. — 37°49.2′ E. Large dredge. 113—99 m. Apr. 7, 1935. Type in British Museum (Nat. Hist).

Distribution: Only known from the type locality, just North of Marion Island (Prince Edward group).

Diagnosis: Eye tubercle and abdomen very slender. Fifth palp segment with prominent lateral expansion. Coxa 3 with a dorsal spur. Auxiliary claws very short, at most $^1/_5$ as long as the main claw.

Description: Very slender. Lateral processes separated by about their own diameter. Dorsal trunk tubercles low.

Proboscis long.

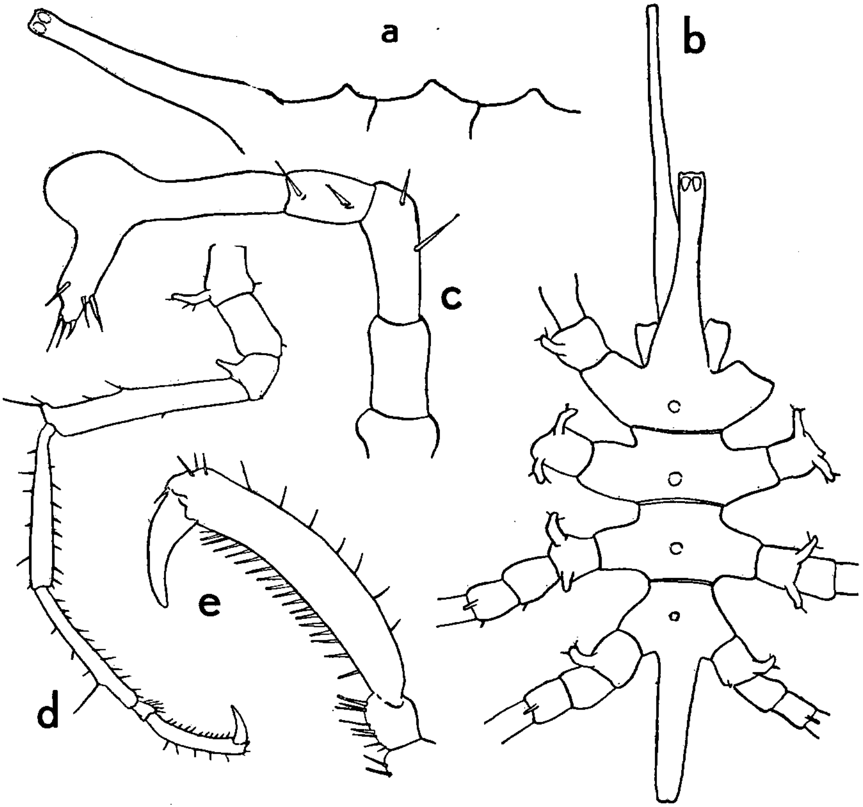

FIGURE 36. *Austrodecus elegans* n.sp. (female, holotype). a, Contour of the dorsum; b, trunk in dorsal view; c, oviger; d, first leg; e, distal segments of first leg.

Palps 6-segmented, 3rd and 4th segment distinctly articulated. Fifth segment with a more prominent lateral expansion than in any species of the *glaciale*-section.

Ovigers 4-segmented. I am not sure, however, that their structure is not due to an anomality, e.g., partial regeneration. At any rate, the curious globular lateral outgrow of the distal segment (cf. fig. 36c) is very unlike the pattern found in the other species of the genus.

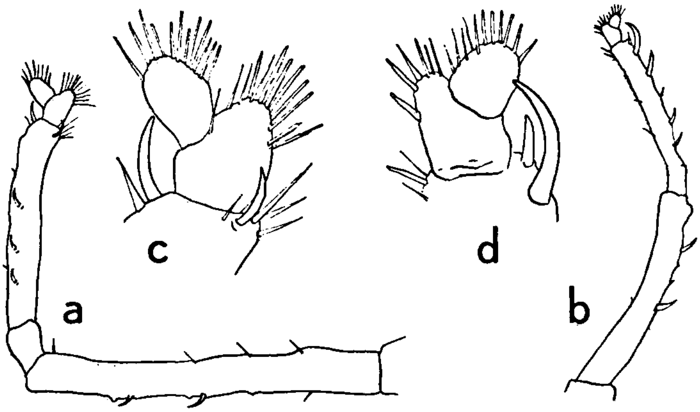

FIGURE 37. The palp and its distal segments, of *Austrodecus elegans* n.sp., female (fig a, c), and of *A. simulans* n.sp., female (fig. b, d).

Legs slender. Coxa 1 of leg 1 with 1 dorsal spur. Coxa 1 of leg 4 with 1 large spur, and 1 rudimentary spur, present only on the right side. Coxa 1 of legs 2 and 3 with 2 dorsal spurs. Coxa 3 of all legs with a slender dorsal spur. Auxiliary claws minute. Genital pores (female) on the ventral surface of the second coxae of all legs.

Remarks: As already stated I am in doubt concerning the specific value of the oviger structure as exhibited by the holotype. For this same reason the species is referred tentatively to the *tristanense*-section. *A. elegans* is, however, clearly distinguished from all other members of the genus by the combination of very short auxiliary claws, a lateral expansion of the 5th palp segment, and a dorsal spur on coxa 3.

The lateral expansion of the palp, as well as the reduction of the auxiliaries seems to indicate that this species has followed the same line of development as the *gordonae*-section. Also the presence of a spur on coxa 3 is a character which is commonly met with in that section.

A. elegans is one of the slenderest species of the genus; the name *elegans* alludes to this character.

Measurements of the female holotype (in mm):

Length (tip eye tubercle to tip abdomen)	2.4
Length cephalic segment	1.0
Width across the 2nd lateral processes	0.77

First leg — first coxa 0.23; second coxa 0.27; third coxa 0.17; femur 0.80; first tibia 0.77; second tibia 0.62; tarsus 0.07; propodus 0.38.

Austrodecus confusum n.sp. Fig. 38.

A. gordonae, part., Stock, 1954, pp. 153—156, fig. 75c (non fig. 75 a, b, d, e, 76).

Material examined: 1 female, holotype. Three Kings, North of New Zealand. Dredge. 65 fathoms. Hard bottom. Jan. 5, 1915. Collected by Th. Mortensen. Type in Zoologisk Museum, Copenhagen.

Distribution: Only known from the type locality.

Diagnosis: Eye tubercle and abdomen slender. Tall mid-dorsal spurs on the trunk. Coxa 1 of legs 2 to 4 with 2 tall dorsal spurs; coxa 1 of leg 1, and coxa 3 of legs 1 to 4 each with 1 tall dorsal spur. Auxiliary claws half as long as the main claw.

Description: Trunk robust. Lateral processes separated by nar-

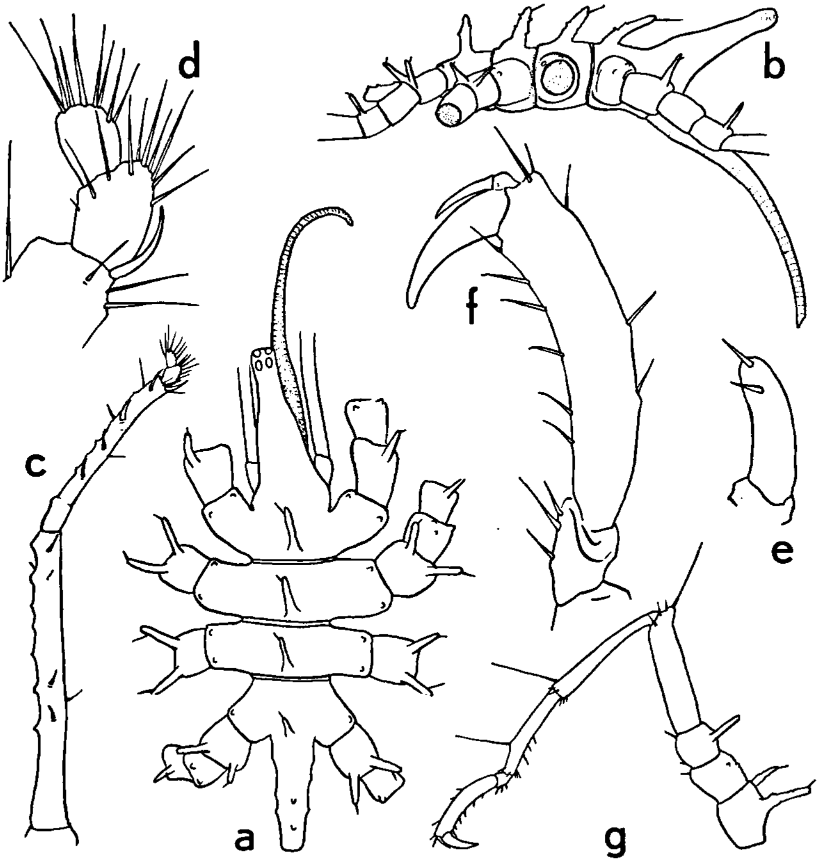

FIGURE 38. *Austrodecus confusum* n.sp. (female, holotype). a, Dorsal view ; b, lateral view ; c, palp ; d, distal palp segments ; e, oviger ; f. distal segments of the second leg ; g, second leg.

row intervals, each armed with 1 or 2 small dorsal tubercles. Abdomen reaching to the distal end of coxa 3 of leg 4; armed dorsally with a few minute tubercles. Mid dorsal spurs of trunk tall, tuberculate, armed with a spine.

Proboscis long.

Palp 6-segmented; second segment with many acute tubercles; fifth segment without strong lateral expansion, but sixth segment implanted subterminally.

The ovigers constitute a point of considerable doubt. They are present as minute (0.05 mm long) 2-segmented stumps, bearing distally 2 spines. It is possible that they are not yet fully grown out but, on the other hand, the type does not seem to be far from mature; there is no reason to assume that a mature female would not have full-grown ovigers.

The legs are moderately slender. Coxal armature as stated in diagnosis. The 2nd coxae bear some small tubercles on the dorsal surface. Tibiae very slender; tibia 2 the shorter joint. Propodus slightly curved; sole with about half a dozen spinules. Genital pores: probably only on the first pair of legs.

Remarks: The specimen that now constitutes the type of *A. confusum* was mentioned twice by me (1954, p. 153, 156), and even figured, but not recognized as specifically distinct from *A. gordonae*. Nevertheless, there cannot be the slightest doubt about its distinctness. Apart from the oviger structure, which remains dubious (cf. description), the following differences are obvious between *A. gordonae* and *A confusum*: (1) the slender mid dorsal spurs of *confusum*; (2) the longer eye tubercle of *confusum*; (3) the absence of auxiliary claws in *gordonae*; (4) the absence of a lateral expansion of the 5th palp joint in *confusum*.

The only other species, apart from *gordonae*, that agree with *confusum* in the presence of a long spur on coxa 3 are *A. longispinum* and *A. elegans*. *A. longispinum* has, however, a short eye tubercle and a short abdomen; a short, robust second tibia; 2 dorsal spurs on coxa 1 of leg 1, etc.; whereas *A. elegans* differs from *confusum* in the palp structure and the auxiliary claws.

Though *A. confusum* appears to be a well-defined species, there remain several points which need further investigation: the oviger structure; the position of the genital pores; the secondary sexual characters of the male.

Measurements of the female holotype (in mm):

Length (tip eye tubercle to tip abdomen)	1.4
Length cephalic segment	0.67
Width across the 2nd lateral processes	0.58

Second leg — first coxa 0.15; second coxa 0.13; third coxa 0.10; femur 0.38; first tibia 0.37; second tibia 0.30; tarsus 0.05; propodus 0.27.

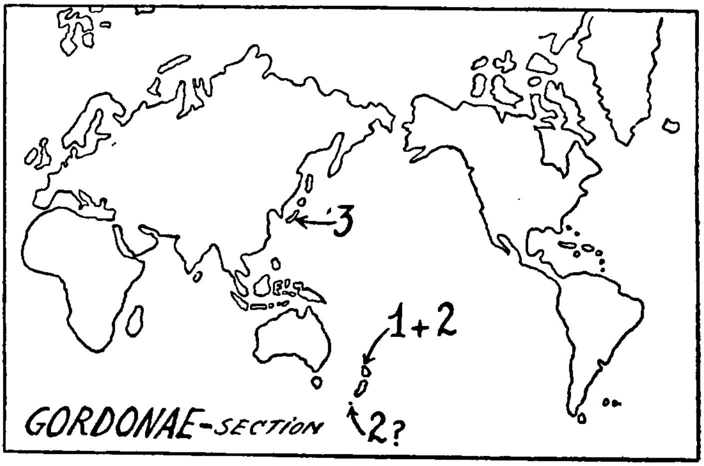

FIGURE 39. The distribution of the species of the *gordonae*-section (1 = *A. gordonae*; 2 = *A. frigorifugum*; 3 = *A. tubiferum*).

D. The *gordonae*-section

Of the three species actually belonging to this section (cf. key on p. 31), one is interesting on account of the morphology of the cement gland opening. In all other species of the genus the cement glands open through pores situated at the tip of more or less marked swellings or cones but, in the species in question, *A. tubiferum*, it opens through a long duct, situated at the top of a distinct swelling. *A. tubiferum* is also remarkable from a zoogeographical point of vue since it is the only species of the genus known from the northern hemisphere.

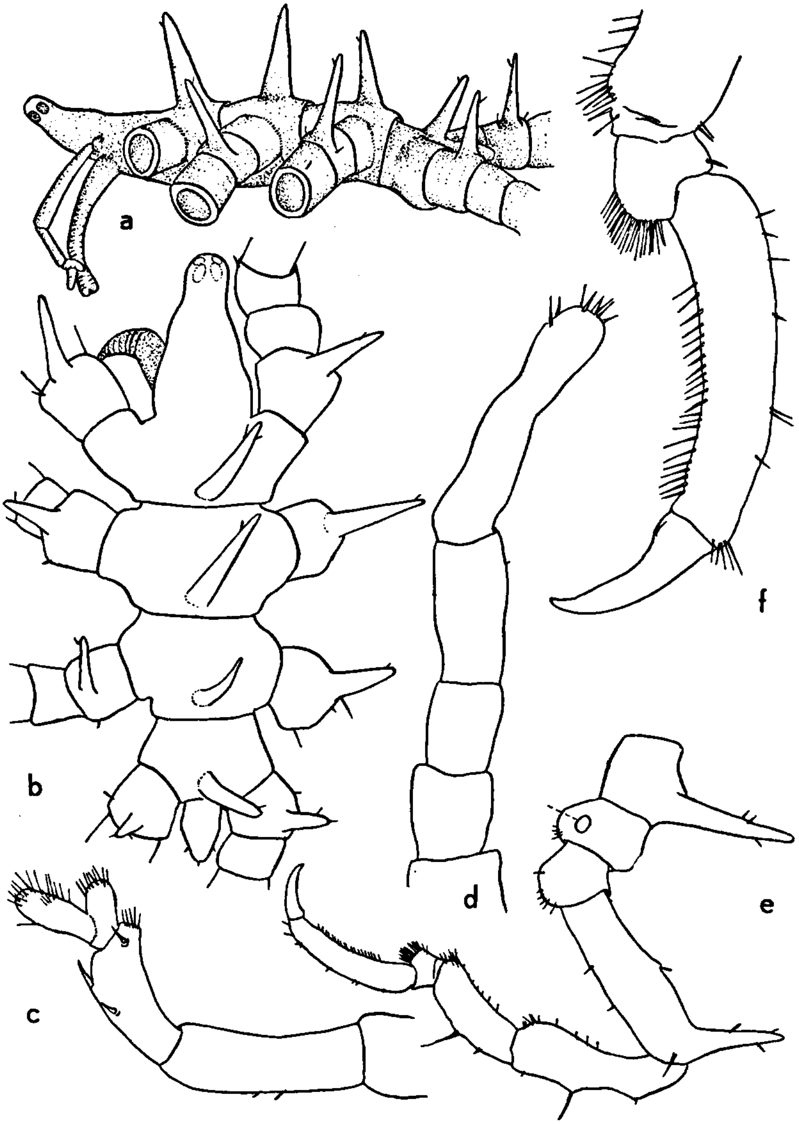

FIGURE 40. *Austrodecus frigorifugum* STOCK. (female, holotype). a, Lateral view; b, dorsal view; c, palp; d, oviger; e, first leg; f, distal segments of first leg.

Austrodecus frigorifugum Stock. Fig. 40.

A. frigorifugum Stock, 1954, pp. 156—159, fig. 77.

Material examined:

2 females (holo- and paratype). Three Kings, North of New Zealand. Dredge. 65 fathoms. Hard bottom. Jan. 5, 1915. Collected by Th. Mortensen. Types in Zoologisk Museum, Copenhagen.

1 juvenile, possibly belonging to this species. Campbell Islands, Perseverance Harbour. Under stone, low tide. Dec. 8, 1914. Collected by Th. Mortensen. Zoologisk Museum, Copenhagen.

Distribution: With certainty only known from Three Kings, North of New Zealand.

Diagnosis: Palps 5-segmented, "bifid" at the tip. Oviger 4-segmented. Femur with strong distal spur. No auxiliary claws. Genital pores (female) on the ventral surface of coxa 2 of leg 1.
Remarks: For a detailed description of the species, see the original description (STOCK, 1954).

The holotype is certainly an adult female but the sex of the paratype is uncertain. The paratype does not show any conspicuous cement gland tubercle and hence has been refered provisionally to the female sex. However, this evidence is not too strong, as *A. breviceps* is known to lack a cement gland cone in male.

The young specimen from the Campbell Islands also has the curious "bifid" palp and the short proboscis of the types, but still lacks any strong processes on the dorsum and the legs. Its identification is merely tentative.

Measurements of female (in mm):

Length (tip eye tubercle to tip abdomen)	2.00
Length abdomen	0.27
Length eye tubercle	0.67
Width across the 2nd lateral processes	0.64

First leg — first coxa 0.28; second coxa 0.23; third coxa 0.17; femur 0.67; first tibia 0.57; second tibia 0.40; tarsus 0.07; propodus 0.44.

Austredecus gordonae Stock. Figs. 41, 42.

A. gordonae (part.) Stock, 1954, pp. 153—156, figs. 75 a, b, d, e; 76 a-d (excluding fig. 75 c, which applies to *A. confusum*, and excluding the Okinose record, p. 153, fig. 76e, which applies to *A. tubiferum*).

Material examined: 4 females, 3 males, 1 juvenile (holo- and paratypes). Three Kings, North of New Zealand. Dredge. 65 fathoms. Hard bottom. Jan. 5, 1915. Collected by Th. Mortensen. Types in Zoologisk Museum, Copenhagen.

Distribution: Only known from the type locality.
Diagnosis: Low, rounded dorsal spurs in the median line of the trunk. Coxa 1 of leg 1 and of leg 4, and all third coxae, with 1 dorsal spur; coxa 1 of legs 2 and 3 with 2 dorsal spurs. Articulation of distal palp segment strongly subterminal, fifth palp segment with a strong disto-lateral expansion. Ovigers 4-segmented. Auxiliary claws absent or vestigial.
Remarks: Not much has to be added to the original description. The original figures, with some slight alterations, are reproduced in this paper. The femoral cement gland cone, not figured hitherto, is situated distinctly beyond the middle of the femur and is fairly low, in some specimens even lower than represented in fig. 41f.

The ovigers are subject to considerable variation, probably in relation with the age of the individuals. Some different oviger types are represented, at the same scale, in fig. 42. It should be noted that the ovigers of the adult females attain about the same absolute size as those of the adult male (since the female is, however, larger than the male, the relative size of the female oviger is smaller than that of male). The distal oviger joint is more or less elongately oval in both sexes, but is armed in the male with more numerous, usually stronger, spines.

The specimen mentioned in the original description under the heading "variability", represents quite another species, *A. confusum*, as became clear during the revision of the types.

In my 1954 paper, I referred with some doubt a Japanese specimen to

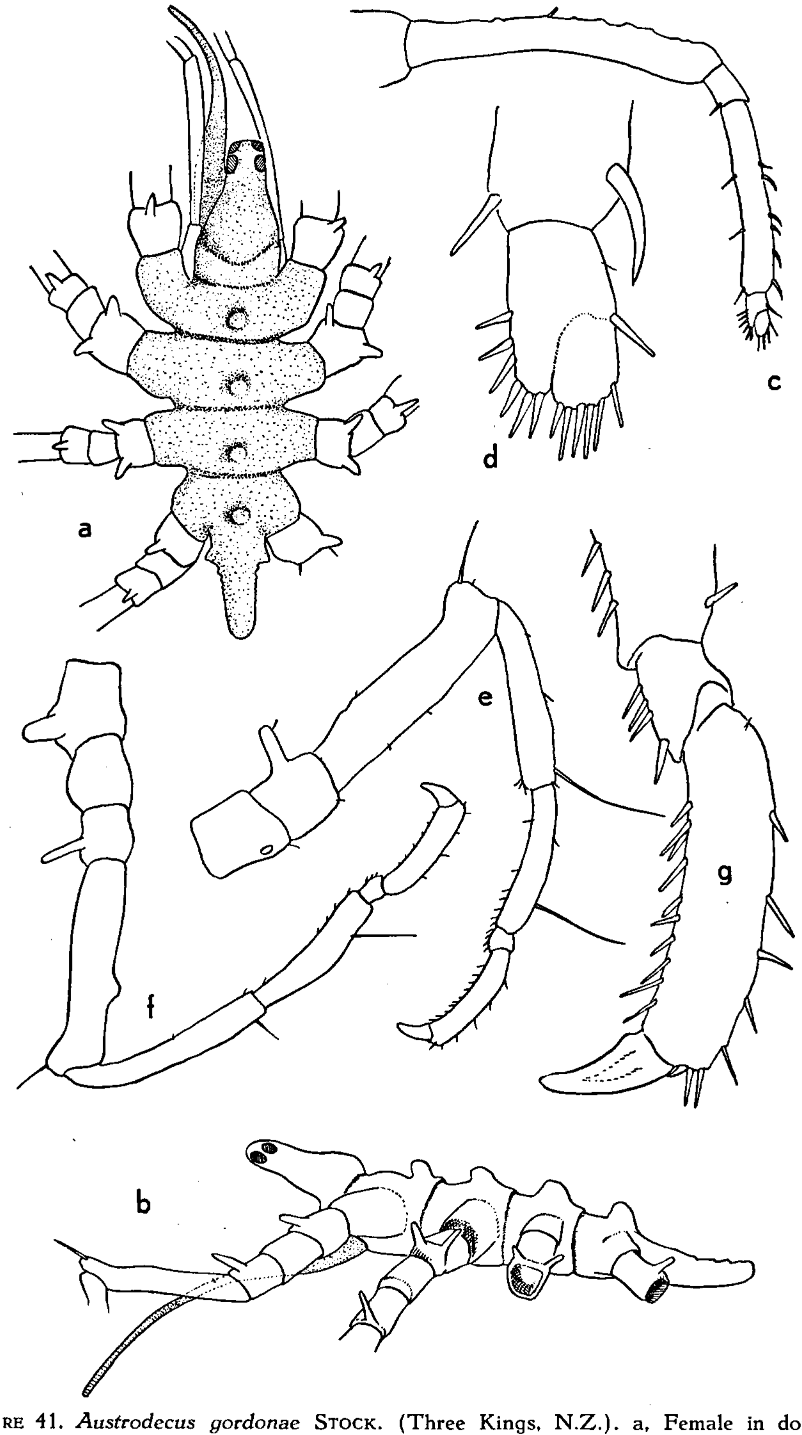

FIGURE 41. *Austrodecus gordonae* STOCK. (Three Kings, N.Z.). a, Female in dorsal view ; b, female in lateral view ; c, palp of female ; d, distal palp segments of female ; e, first leg of female ; f, first leg of male ; g, distal segments of first leg of female.

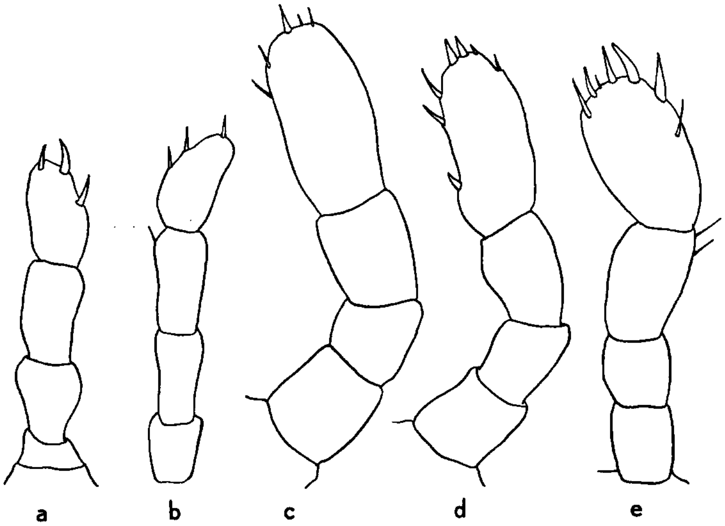

FIGURE 42. *Austrodecus gordonae* STOCK. (Three Kings, N.Z.). a, b, Ovigers of young females; c, oviger of adult female; d, e, ovigers of males (all figures on the same scale).

A. gordonae. Re-examination of that specimen has convinced me that my opinion was incorrect. The Japanese material belongs to a separate species, described here as *A. tubiferum*.

Measurements of female (in mm):	
Length (tip eye tubercle to tip abdomen)	1.60
Length abdomen	0.25
Length eye tubercle	0.38
Width across the 2nd lateral processess	0.65

First leg — first coxa 0.20; second coxa 0.20; third coxa 0.13; femur 0.50; first tibia 0.45; second tibia 0.32; tarsus 0.05; propodus 0.27.

Austrodecus tubiferum n.sp. Fig. 43.

A. gordonae (part.), Stock, 1954, p. 153, fig. 76e (only the Japanese record).

Material examined: 1 male, holotype. Okinose, Sagami Sea. Dredge. 100 fathoms. Hard bottom. Apr. 26, 1914. Collected by Th. Mortensen. Type in Zoologisk Museum, Copenhagen.

Distribution: Only known from the type locality.

Diagnosis: In general aspect and spination of the coxae resembling *A. gordonae*. Distal oviger segment very slender. Cement gland: tube-shaped, placed on an elevation at about the middle of the femur.

Description: It will suffice to summarize the points in which *A. tubiferum* differs from *A. gordonae*. The eye tubercle differs slightly in shape; the abdomen is longer[16]. The median spurs of the trunk are longer; one of the spurs (on the third trunk segment) in the only specimen available is even very tall.

The palps are of the same pattern as in *gordonae*.

The ovigers differ markedly in the much slenderer distal segment which bears 3 strong terminal spines and some setae.

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[16] The ratio length of trunk : length of abdomen is in *tubiferum* 3.4, in *gordonae* 6.4. The ratio length of abdomen : width of abdomen is in *tubiferum* 2.75, in *gordonae* 1.92.

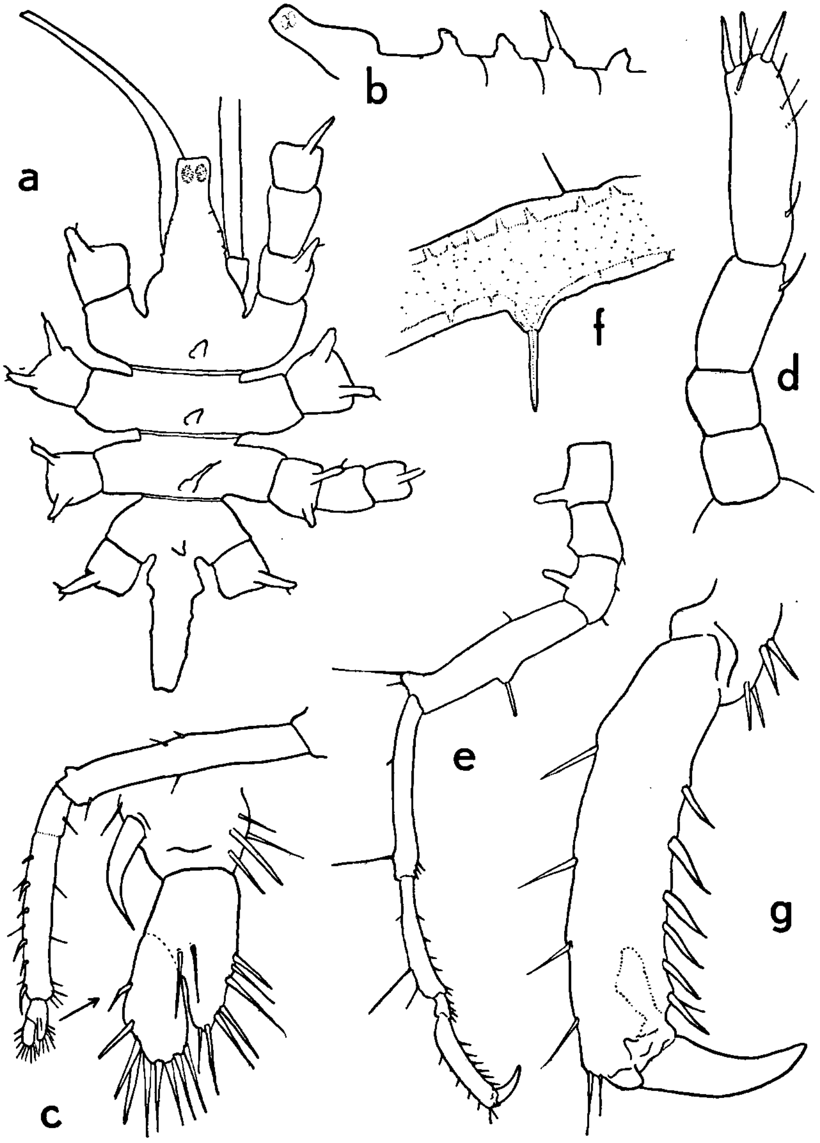

FIGURE 43. *Austrodecus tubiferum* n.sp. (male, holotype). a, Dorsal view; b, contour of het dorsum; c, palp; d, oviger; e, first leg; f, optical section of the femur of the first leg, with the cement gland opening; g, distal segments of first leg.

Coxal armature as in *gordonae*. The femoral cement gland offers the most easily observable difference with *A. gordonae*: (1) in place — at, or slightly before, the middle of the femur (in *gordonae* distinctly beyond the middle of the segment); (2) in shape — on an elevation a slender duct is implanted (in *gordonae* no duct is present). The propodal sole bears stronger spines than in *gordonae*, and the claw is markedly more slender. Genital pores (male), as far as I was able to

ascertain, on the ventral surface of the *third* coxae of all legs. The length of the long segments of the legs (femur, tibia 1, tibia 2, propodus) is in *tubiferum* 0.58 - 0.52 - 0.38 - 0.32, in *gordonae* 0.45 - 0.38 - 0.30 - 0.23.
Remarks: STOCK, in his description of *A. gordonae*, already mentioned the specimen which now is the type of the new species, *tubiferum*, without noticing, however, the curious cement gland structure, which is unique in the genus. He expressed the opinion that "this record (of *tubiferum*) ... may be ignored; the specimen may have been accidentally introduced into the tube ..." Now having recognized the specific rank of the specimen, I no longer doubt the correctness of the locality on its label. Other things needing correction are: (1) the apparently incorrect statement that the specimen would be a female, and (2) the figure of the oviger, on which all setae were omitted, only the strong spines being represented.

Measurements of the male holotype (in mm):

Length (tip eye tubercle to tip abdomen)	1.6
Length cephalic segment	0.68
Width across the 2nd lateral processes	0.65
Length abdomen	0.47
Basal diameter abdomen	0.17

First leg — first coxa 0.22; second coxa 0.18; third coxa 0.13; femur 0.58; first tibia 0.52; second tibia 0.38; tarsus 0.05 propodus 0.32.

E. Species incertae sedis

Two or three species could not be referred with certainty to any of the sections treated in the preceding pages. Two of these, *A. confusum* and *A elegans*, have provisionally been treated under the *tristanense*-section but one further species, only known from a young specimen must be mentioned. There can hardly be any doubt that this specimen represents another undescribed species of the genus *Austrodecus* but, in the absence of adult material, I refrain from naming it definitely.

Austrodecus spec. 4.

Austrodecus spec., Stock, 1954, p. 159.

Material examined: 1 juvenile. Three Kings, North of New Zealand. Dredge. 65 fathoms. Hard bottom. Collected by Th. Mortensen. Zoologisk Museum, Copenhagen.

Remarks: "This solitary specimen, a juvenile with still unsegmented ovigers ... resembles *A. glaciale* is the structure of the palps, and in possessing auxiliary claws, but differs from that species in having a long spur at the distal end of the femur, just like in *A. frigorifugum*. The ocular tubercle is rather tall, resembling the pattern described in *A. glaciale* ..." (STOCK, 1954, l.c.).

In addition to these notes we may remark that the arrangement of the coxal spurs agrees with that of *frigorifugum*, but that the species posseses a long abdomen, ending in a conspicuous spur. The dorsal trunk tubercles are fairly tall. The auxiliary claws are about half as long as the main claw.

IX Samenvatting

DE PYCNOGONIDEN-FAMILIE AUSTRODECIDAE

Toen mij, in 1954, uit Oslo een verzameling Pycnogonida van de „Norwegian Scientific Expedition to Tristan da Cunda 1937—1938" ter bewerking werd opgezonden, kon ik niet vermoeden dat deze kleine collectie aanleiding zou geven tot een uitgebreide revisie van een gehele familie. In het Noorse materiaal van Tristan da Cunha bevond zich evenwel één *Austrodecus* soort, die sterk geleek op een reeds beschreven vorm van de Antarctische *Austrodecus glaciale*. Om geheel zeker te zijn van de determinatie vroeg ik enig vergelijkingsmateriaal van deze vorm ter leen aan het British Museum (Natural History) te London. Tot mijn verrassing bleek niet alleen het materiaal van Tristan da Cunha tot een andere soort te behoren, doch bleek ook het Antarctische materiaal veel minder uniform te zijn dan ik had verwacht. Dr. Isabella Gordon, conservatrix van de afdeling Pycnogonida in het British Museum, zond mij desgevraagd welwillend het gehele, zeer grote materiaal op, verzameld tijdens de Discovery Expedition en de British - Australian - New Zealand Antarctic Research Expedition. Het bleek nu al spoedig dat een algehele revisie van de familie Austrodecidae nodig was. Hiertoe werd van een aanzienlijk aantal instituten materiaal geleend, zodat ik van alle soorten exemplaren onder ogen kreeg.

Alle soorten zijn beschreven of opnieuw beschreven en afgebeeld (pags. 33—77) en hun verschilmerken opnieuw op hun waarde onderzocht (pags. 26—27). Naast deze biosystematische revisie, werd veel aandacht besteed aan de waarschijnlijke wijze van ontstaan van de soorten der Austrodecidae.

Tegenwoordig wordt meer en meer aangenomen dat geographische isolatie één der belangrijkste factoren is bij het soortvormingsproces. Bij op het land levende organismen is reeds bij herhaling aangetoond dat de morphologische en genetische samenstelling der populaties die tezamen een soort vormen, varieert met de landstreek door die populaties bewoond. Indien de soort in zijn areaal zeer continu verspreid is, uit zulke geographische variatie zich meestal in geleidelijke veranderingen in de morphologische en genetische samenstelling. Is daarentegen de verspreiding discontinu, bijvoorbeeld doordat geïsoleerde populaties van een soort op eilanden voorkomen, dan kunnen er sprongsgewijze veranderingen aantoonbaar zijn. In het algemeen worden zulke afwijkende populaties ondersoorten genoemd. Als zo'n ondersoort het contact met de overige populaties verliest, zal zij, door toedoen van allerlei processen zoals mutatie, selectie, adaptatie, „genetic drift" ..., haar eigen weg gaan. In de loop van de tijd zal zij zodanige verschillen met de oorspronkelijke soort gaan ontwikkelen, dat zij als een aparte soort dient te worden opgevat. Behalve morphologische verschillen zijn er dan ook genetische verschillen ontwikkeld, zodat kruisingen tussen de oorspronkelijke soort en de daarvan afgeleide niet meer mogelijk zijn.

Dit proces nu wordt soortvorming door geographische isolatie, of ook wel geographische speciatie, genoemd. Bij zeedieren, die in den regel meer continu verspreid zijn dan landdieren, treedt isolatie zoveel moeilijker op. Soortvorming door geographische isolatie is daarom slechts zelden aangetoond bij zeedieren. Het is derhalve interessant dat werd gevonden dat deze wijze van soortvorming bij de zeespin-familie Austrodecidae een zeer belangrijke rol heeft gespeeld.

Zoals bekend, geschiedt geographische speciatie in twee stappen. Tijdens de eerste stap valt de aanvankelijk continu verspreide soort uiteen in een aantal geïsoleerde populaties. Als geen uitwisseling van genenmateriaal tussen deze populaties plaatsvindt, zullen deze populaties van elkaar divergeren, tot ondersoorten worden en daarna tot soorten. Tijdens de tweede stap kunnen sommige van deze allopatrische populaties weer in elkaars verspreidingsgebied terecht komen, doch zij zullen hier naast elkaar kunnen blijven voortbestaan omdat zij tijdens hun geographische isolatie tevens een voortplantingsisolatie hebben verkregen.

De Pycnogoniden-familie Austrodecidae nu, levert een aantal fraaie voorbeelden van beide stappen (pags. 10—14). Als mogelijke redenen waarom de soortvorming door middel van geographische isolatie in deze familie zo actief is (is geweest), worden o.a. aangewezen : de merkwaardige geographische en klimatologische condities in de zuidelijke zeeën (pags. 20—21), de zeer gespecialiseerde morphologische bouw der Austrodecidae, die waarschijnlijk met een gespecialiseerde levenswijze gecorreleerd is (pag. 19) en de afwijkende voortplanting (pag. 19).

De familie Austrodecidae omvatte vóór de revisie slechts vijf soorten, waarvan er één met drie (onbenoemde) varieteiten. Ná de revisie is dit aantal uitgebreid tot 17 zekere soorten en een viertal onzekere. De verspreiding dezer soorten is nogal merkwaardig : een aantal bewoont de Antarctische wateren (het Antarctische continent, South Georgia), terwijl verscheidene andere de, eveneens koude, wateren der Antiboreale zone (Vuurland, Patagonië, Falkland eilanden, Macquarie eiland, Campbell en Auckland eilanden, Prince Edward eilanden, Tristan da Cunha en Gough eiland enz.) bewonen. Via de eilanden-reeks ten oosten van Australië (Macquarie eiland, Campbell en Auckland eilanden, Nieuw Zeeland) dringen een niet onbelangrijk aantal soorten naar het noorden door tot ver in de warm-gematigde zone.

Het is in dit verspreidingspatroon opvallend, dat de heden ten dage door de Austrodecidae bewoonde kusten onderling sterke klimatologische verschillen vertonen en vaak door grote afstanden van elkaar gescheiden zijn. Bij nadere beschouwing valt het echter tevens op, dat vrijwel al deze kusten volgens de theorie van de Drift der Continenten vroeger één kustlijn zouden hebben gevormd (pag. 25). Vergelijken wij de kaarten die A. Wegener heeft vervaardigd ter illustratie van de drifttheorie (fig. 10) dan zien wij dat practisch het gehele huidige verspreidingsgebied van de Austrodecidae, van Patagonië in het westen tot Nieuw Zeeland in het oosten, deel uitmaakte van de continue zuidelijke kustlijn van Pangaea, het oercontinent voordat de continenten uit elkander geweken waren. De verspreiding van de Austrodecidae kan dus met de theorie van de Drift der Continenten goed in overeenstemming geacht worden.

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