# CRUSTACEA TANAIDACEA FROM DEPTHS EXCEEDING 6000 METERS

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# A. INTRODUCTION

E. F

During the Galathea Expedition 1950-52 three species of Tanaidacea were collected at depths greater than 6000 m; this corresponds rather well to the number of species of Isópoda (twelve) and of Amphipoda (thirteen) from similar depths, when the restricted total number of tanaid species is taken into account. However, no species was recorded from the greatest depths (about 10.000 m) in the Philippine Trench, from where one species of isopods and one of amphipods was collected.

All three species are of a considerable size, in fact amongst the very largest ever recorded. There is, however, no reason to suggest that small or even microscopic species may have escaped our attention. In all deep-sea hauls on the Galathea HAN-SEN's (1913, p. 3) method of collecting, as used on the Ingolf Expedition, was practised, and all tanaids, even very small specimens, would certainly have been retained during the painstaking sifting of the bottom material in the bucket at the cod end of the trawl.

Till now the deepest recorded species of Tanaidacea were taken by the Siboga Expedition (Apseudes sibogae and weberi, 4391 m) and the Challenger Expedition (Typhlotanais brachyurus and kerguelenensis, and Bathytanais bathybrotes, 3750 m). In order to include the records in the present paper I have recently described six new abyssal species of Neotanais, collected by the Galathea, one of which (N. robustus) was found between depths of 4390 and 4570 m (WOLFF 1956b). So far no records of tanaids from the Russian deep-sea expedition to the Kurile-Kamtchatka Trench have – as far as I know – been published.

As in my report on the Isopoda (1956a) I have studied a number of related species, mainly kept in this Museum. In some cases I found it necessary to include a redescription of such species. Unfortunately, some rather doubtful species only exist in one specimen, the type, and could therefore not be borrowed and examined.

The bottom-temperatures at the Galathea Stations are according to BRUUN & KILLERICH (1955). In those cases where the Expedition did not obtain records of bottom-temperature from exactly the depth at which the tanaids were dredged, the average figures and graphically interpolated figures in the above paper have been used. The salinity was constantly found to be 34.7  $\% \pm 0.2 \%$ . The Hydrographic Department of the Danish Fisheries Investigations (Charlottenlund Slot) has kindly supplied me with records of bottom temperatures, not otherwise obtainable.

With Professor K. LANG, Stockholm, I have discussed several taxonomic questions; for help and advice I wish to express my gratitude. Also to Dr. A. F. BRUUN, the Leader of the Galathea Expedition, my thanks are due for valuable discussions on deepsea problems.

Fig. 21 was drawn by the artist POUL H.WINTHER, all the remaining illustrations by the author. Where nothing else is stated in the legends of the figures the drawings are based on the type specimen. Mrs. AGNETE VOLSØE has kindly revised the English text.

The type specimens are kept in the Zoological Museum of the University, Copenhagen.

# **B. TERMINOLOGY**

The terminology of the external morphology of Tanaidacea was recently considered by LANG (1953 a). Since I find it very essential as soon as possible to reach a final decision regarding the appellation of the various body segments, appendages, etc. within related groups, I shall also put forward some suggestions. They aim at obtaining a still greater simplicity in the repeated naming of these features of systematic value. The suggestions and the amendments to LANG's proposals have been considered by Dr. I. GORDON and Professor K. LANG, both of whom I thank for valuable help.

1. One of the major difficulties is the terminology of the thoracic segments and their corresponding appendages. As is well known, in all Malacostraca the head is followed by eight thoracic segments, of which the first is always coalesced with the head. The remaining seven may be all free or all coalesced with the head (and the first segment) or some may be free and some coalesced.

In the Peracarida, the Amphipoda and the Isopoda have the first (and very rarely the second) thoracic segment coalesced with the head, while in the Tanaidacea the first and the second segments are constantly coalesced with the head. This difference in coalescence both in these three orders and in other Malacostracan groups is the main reason for the confusion.

If the terms "thorax" and "thoracic" are used the only correct appellation would be "the first, second, third . . . eighth thoracic segment (or somite)" or "thoracic segment (or somite) 1, 2, 3 . . . 8". Since, however, the first segment (with the maxillipeds) is always fused with the head in Isopoda and Amphipoda, almost all authors tacitly consider the seven succeeding, free, thoracic segments as equivalent with the total thorax and name the first free segment: "segment (somite) 1", etc. In Tanaidacea, with two coalesced segments, the descriptions are almost always encumbered with the long and circumlocutory terms "first free thoracic segment (somite)", etc., which is of course necessary when confusion is to be avoided.

But why not use instead the term peraeon<sup>1</sup>? This word was first introduced by SPENCE BATE who in his treatise on Amphipoda (1856, p. 27) wrote: "Thoracic segments (Pereion). The seven annules which posteriorly follow the cephalic portion . . ." Originally pereion (or peraeon) is thus equivalent with the last seven thoracic segments (2-8). In Isopoda and Tanaidacea the numbering of the corresponding legs is generally in accordance with this terminology, peraeopod 2 being for instance the leg of the second peraeon segment. In Decapoda and Amphipoda, however, there are only five pairs of peraeopods which in Decapoda follow maxillipeds 1-3 and in Amphipoda maxilliped and gnathopods 1-2. Almost all authors use peraeopods (or pereiopods) 1-5 (or I-V) in these two groups – except for instance CHEVREUX & FAGE (Amphipodes, 1925, Faune de France) who use gnathopods 1-2 followed by pereiopods 3-7.

It is therefore not quite correct when LANG (1.c., p. 341) writes: "Strictly speaking, the maxillipeds 1. The spelling of the word will be discussed below. are the first pair of legs, and the following pair of legs is the second pair of peraeopods." Actually, they are the *second* pair of thoracic legs but the *first* pair of peraeopods. This is also according to the definition of "Peraiopoden (Pereiopoden)", given by ZIMMER in Handbuch der Zoologie (1927, p. 303): "Thorakelfüsse, die der Lokomotion dienen, im Gegensatz zu den Maxillipeden". On the other hand, ZIMMER's statement "Peraion (Pereion) = Thorax" is not correct. Peraeon is equivalent only with thoracic segments 2-8.

The peraeon segments should thus be numbered 1-7. But instead of using in descriptions over and over again the term "the first peraeon segment" or "peraeon segment 1" I suggest to call the single segments "peraeonite 1, peraeonite 2", etc., corresponding to the terminology and numbering of the peraeopods in Isopoda and Tanaidacea.

2. Likewise the pleon segments may be called "pleonites". In Tanaidacea we consequently find pleonites 1-5, followed by the pleotelson (where reduction has not taken place).

3. Of course it is also more simple to distinguish the peraeopods by means of their different cipher (number). In order to avoid confusion I suggest to give their cipher in Roman letters. This has been used for a considerable time by many carcinologists working on Decapoda. In Isopoda it was introduced recently by BOCQUET & LEVI (1955) and was also used by me (WOLFF 1956a). Thus, in Isopoda there are peraeopods I-VII and in Tanaidacea chelipeds (= peraeopods I) and peraeopods II-VII.

I am fully aware of the regrettable fact that in Decapoda, Cumacea and Amphipoda peraeopods I-V (or 1-5) will correspond to peraeopods III-VII in Isopoda and Tanaidacea. I do not think there is much to do about this. It would only add to the confusion to adopt the same numbering in Isopoda and Tanaidacea. On the contrary, I would consider it very useful if the terminology of at any rate the Amphipoda could be changed so as to follow that of Isopoda and Tanaidacea as already done for instance in the Faune de France (1.c.).

4. In accordance with the convention in current use (amongst carcinologists) for the Decapoda the

pleopods are numbered 1-5; the last pair of appendages are called uropods.

5. The spelling of the words peraeon (pereion), peraeopod (pereiopod) and peraeonite is not a matter of great importance but may deserve a little more consideration than given to it by LANG (1.c.).

The two former words were, as mentioned above, introduced by SPENCE BATE (1856). He writes (footnote, p. 27): "From πεςαιόω, to walk about: pereion, part which supports the walking legs". This is, however, not correct. The word means "bring to the other side" or - in the medial and the passive voice - "cross", and the transliteration should have been "peraioo" (if transcribed letter to letter), "peraeoo" (if transcribed according to the Latin rules) or "pereoo" (in the mediëval-latinized form). The last mentioned way of transcribing is by far the most common in English. Since, however, the form "pereon" is never used, it is more correct to adopt the spelling "peraeon", although the original terminology was based on a misunderstanding. This form was also used constantly by STEBBING and CALMAN.

6. The proper use in English of joint, segment and somite is complicated. Originally "joint" only meant articulation or hinge (elbow and knee joint). But now-a-days it has also acquired the meaning of for instance a separate subdivision of an appendage (see The Concise Oxford Dictionary). A similar, but reverse development has taken place in the Scandinavian languages.

Since the latter meaning of joint is now firmly established in current English scientific literature I prefer to use "joint" for the subdivision of appendages, "segment" for the subdivision of the body, and "articulation" for the connection between joints or segments, thus rejecting entirely the word somite. I do so for two reasons: (1) "Segment" is exclusively used in Vermes and almost exclusively in Insecta etc. to indicate sections of the body. (2) In repeated use in descriptions "joint" is the shorter, especially for instance "three-jointed" or "3-jointed."

I fully agree with the remaining proposals put forward by LANG, e.g. his terminology of carapax and the joints of the chelipeds and the other peraeopods.

#### **1. APSEUDIDAE**

# Notes on the postmarsupial development of Apseudes spinosus

Before describing the new species of *Apseudes*, collected by the Galathea, I have found it useful first to consider for comparison the development of *Apseudes spinosus* M. Sars.

Some years ago LANG (1953b) showed that the Tanaidacea possess a long row of postmarsupial stages. For Heterotanais antarcticus he enumerates six preadult and a great many adult stages. In the latter, the stages with brood-pouch are constantly preceded by two intermediate stages the first of which lacks rudimentary oostegites, while these are present in the second intermediate stage. The same developmental pattern is found in other species of Paratanaidae and probably also in Tanaidae. In Apseudidae he suggests the same number of preadult stages, but regards it as probable that in the adult cycle each brood-pouch stage is preceded by one intermediate stage only, which is provided with rudimentary oostegites. He bases this opinion partly on Apseudes hermaphroditicus Lang (without giving any details) and partly on A. spinosus M. Sars. Of this species he studied 333 adult females, 309 of which were non-eggbearing, and he found that all these had rudimentary oostegites.

In the Copenhagen Museum there is also a fine collection of *spinosus*, comprising 64 adult females from about 20 localities. 20 females have fully developed brood-pouch with or without eggs, and 39 females have rudimentary oostegites. The size of the females of these two groups is very varying, and they no doubt represent several stages. The smallest female with brood-pouch is 8.6 mm long, the smallest with rudimentary oostegites 7.7 mm and two other specimens of this group are 8.2 mm. A careful study disclosed that amongst the rather comprehensive material of small females without oostegites there were five specimens of the following lengths: 7.9 - 8.1 - 8.1 - 8.2 and 8.5 mm.

It will be seen that the shortest female with rudimentary oostegites is shorter than all these five specimens without rudimentary oostegites. Besides, two of the females with rud. oostegites are exactly as long (8.2 mm) as one of the females without (and two other females without are only 0.1 mm shorter). The three equally long females are from three different localities: North Atlantic, 280 m (one female with rud. oostegites); North Atlantic, 358 m (the other female with rud. oostegites - and the smallest female with rud. oost.); Skagerrak, 395-425 m (the female without oostegites). Accordingly, we do not find - at any rate in the first adult stages - in spinosus the same fine correlation between length and stage as in Heterotanais antarcticus where the various stages evidently correspond to fixed size-groups without overlapping. However, even if the lengths of females of the same stage certainly vary from one locality to another, it is difficult to believe that a female which has rudimentary oostegites, but is only 7.7 mm long, is older than a female which has no oostegites, but is 8.5 mm long.

During his investigations in the Gullmar Fjord (Bohuslän, Sweden) Dr. H. LEMCHE, on my request, kindly collected a fine material of *Apseudes spinosus*. It consists of 49 males and 42 females (Smörkulla, 16. Jan. 1956, 40-50 m). There are altogether 17 females without oostegites (I), 17 with rudimentary oostegites (II), 7 females with eggs in the broodpouch (III), and 1 more with fully developed oostegites but without eggs (IV). The total lengths of the females are as follows (in mm):

I	7.4 7.6 7.6 7.7 7.9 7.9 8.0 8.1 8.1 8.2 8.3 8.4 8.4 8.5 8.6 8.9 9.1	I
II	8.1 8.1 8.2 8.2 8.4 8.4 8.4 8.4 8.4 8.6 8.6 8.6 8.7 8.7 8.7 8.7 9.0 9.2	II
III	9.3 10.0 10.3 10.4 11.2 11.3 12.1	III
IV	12.3	IV

In this case all the females are from the same locality and collected at the same time. Here again we find a considerably greater length (9.1 mm) of the largest female without rudimentary oostegites than of the smallest females with rud. oostegites (8.1 mm). At the same time it is surprising that none of the females with rud. oostegites are larger than any of the females with fully developed oostegites. The apparent lack of size-groups in females without and with rudimentary oostegites does not allow any suggestion of the number of stages represented in the present material.

Thus, both the material from different localities and the rather big collection from one locality seem to indicate that prior to the first egg-bearing stages of *spinosus* come not only a stage with rudimentary oostegites, but also one without oostegites. In the later stages there is certainly only one intermediate stage, since neither LANG nor I have found any large females without oostegites.

In his material of A. spinosus LANG found 17 specimens which all belonged to the same manca stage. This is characterized by being furnished with both rudimentary peraeopods VII and pleopods, the former being in accordance with the photograph on pl. 3, fig. 5 (l. c.). In the material from the Copenhagen Museum there are five specimens which probably belong to the same manca stage. The rudimentary peraeopods (fig. 1a) have four distinct joints; the penultimate one is very faintly divided by a transverse seam. The pleopods (fig. 1b) have two setae on each ramus. Besides, there is in the material one specimen in an earlier manca stage, which is devoid of both pleopods and peraeopods VII and thus probably corresponds to the stage of a young specimen of A.gracillimus, mentioned by LANG (1. c.) The length of the youngest specimen is 3.3 mm, and of the five firstnamed specimens: 4.1 - 4.4 - 4.4- 5.0 and 5.0 mm. A close examination did not reveal any differences in the five specimens with rudimentary peraeopods VII and pleopods (except some variation in number of joints in the endopodites of the uropods). Nevertheless, it is difficult to believe that all the five specimens belong to the same manca stage, when the great difference in size is considered, the more so since the smallest of the five is closer in size to the specimen of a younger stage (3.3 mm) than it is to the two longest specimens of the same appearance. The representatives of the first youth stage (with all peraeopods and pleopods fully developed) are only 5.6 mm long; again the interval in length between specimens belonging to two different stages is smaller than the interval between the



Fig. 1. Apseudes spinosus M. Sars, manca stage; a, peraeopod VII; b, pleopod. longest and shortest of the five specimens. On the other hand, one should expect morphological differences, although small, between the later manca stages, but in the present material I have looked for them in vain. So far it can only be said that *spinosus* possesses at any rate two manca stages – and probably four, as proved for the Paratanaidae.

The specimen in the youngest manca stage has 5 joints in the exopodite of the uropod and 12 in the endopodite, while the five specimens in the older manca stage(s) have 6 and 18-22 joints respectively.

#### Apseudes galatheae n. sp.

#### Material:

St. 658, Kermadec Trench (35°51'S, 178°31'W), 6730-6770 m, 20. Feb. 1952. Gear: 6 m sledge trawl. Bottom: brown sand with clay and stones. Bottom temperature: 1.3°C. – 5 adult females (one with rudimentary oostegites); 2 adult males; 2 preadult specimens.

St. 664, Kermadec Trench ( $36^{\circ}34'S$ ,  $178^{\circ}57'W$ ), 4510-4570 m, 24. Feb. 1952. Gear: herring otter trawl. Bottom: brown sandy clay with pumice. Bottom temp.:  $1.1^{\circ}C. - 3$  adult females.

Description of female type (from St. 658):

Body (figs. 2 & 3a) extremely elongate, being 9.3 times longer than broad (measured from anterior end of rostrum to posterior end of pleotelson and across the first free peraeonite<sup>1</sup> which is the broadest). Only *A.gracilis* Norman & Stebbing and *gracillimus* Hansen are about as elongated. The decrease in width from peraeonites 2 to 7 is slighter than in most other species. Integument considerably less calcified than for instance in *spinosus*.

*Carapax* (fig. 3a) a little broader than long (excl. the rostrum). The dorsal surface is rather vaulted, with a distinct transverse furrow and two longitudinal impressions in front of it. Rostrum prominent, triangular, with almost straight margins and no lateral projections at the base; its dorsal surface is quite flat and it is not deflexed. The eye lobes are strongly produced and excavated in front; they are perfectly without visual elements. The lateral processes are shaped like the eye lobes but somewhat smaller and more excavated in front. Epistome with a short and rather thick spine, directed obliquely forwards (fig. 2).

*Peraeonites* increase in length from 2 to 5 and 6 which are equally long while peraeonite 2 is half as long as these. Peraenite 7 almost as long as 4. The  $\overline{1}$ . For explanation of this term see p. 189.



Fig. 2. Apseudes galatheae n. sp.; female type from the Kermadec Trench, 6770 m.

shape of the peraeonites almost as in *gracillimus* (HANSEN 1913, pl. 1, 3 a), but the spines on the lateral processes of peraeonites 6 and 7 are in *gracillimus* like the preceding ones, while in the type of *galatheae* those on 6 are rather small and those on 7 have totally disappeared, leaving only a rounded process. The coxal plate of peraeopod II almost triangular, having only an acute denticle on the terminal angle as in *gracillimus*. The coxal plate of the following peraeopods small and rounded. The dorsal surface of peraonites 2-5 with more or less conspicuous transverse and longitudinal furrows (fig. 3a). The hyposphenians (the spine-like processes on the



Fig. 3. Apseudes galatheae n.sp.; a, female type; b, male D; c, carapax of female type from below.

peraeon sternites) are present on all segments (fig. 2), the one on peraonite 2 being almost twice as long and stout as the remaining ones. They are always situated a little behind the middle of the segments.

*Pleon* (fig. 2) almost as long as the first four peraeonites together. The five pleonites are perfectly identical, cylindrical and a little longer than broad. Pleotelson almost three times as long as each of the preceding segments and three times longer than broad. It is also regularly cylindrical, being only slightly swollen towards the distal end when seen from above or below. An inconspicuous median

furrow is found on the outer third of the ventral side.

Antennula (fig. 3 c) more than  $1^{1}/_{2}$  times as long as carapax. The first joint is stout, subcylindrical and almost four times as long as the much narrower second joint, which is again a little longer and broader

than the third. The inner flagellum has five, the outer one seventeen joints in the type specimen.

Antenna (fig. 3c) with the first joint almost square, i.e. the antero-interior corner is not so strongly produced as is normally the case in this genus. Second joint one third longer, but much narrower. Flagellum with nine joints of which the second and the third are longer than any of the others. Squama narrow and as long as joints 1 and 2 of the flagellum. It has two stout, terminal setae.

Labrum (fig. 4a) with a short, acute process in the middle of its lower margin.

*Mandibles* more slender than usually. Left mandible (fig. 4 b) has pars incisiva and the distinct movable lacinia horny and 5-dentate, the three median teeth on the lacinia being bent at an oblique angle to the lateral ones. The bunch of spines counts six spines, most of which are bifurcated at the tip (fig. 4c). Right mandible (fig. 4d) has an almost straightly cut pars incisiva. There are also six spines but one is tribly forked, the rest doubly forked.



Fig. 4. Apseudes galatheae n. sp., ♀; a, labrum; b-c, left mandible; b, from inside; c, from anterior side; d, right mandible from anterior side.

Processus molaris of either mandible is long and tongue-like, with subparallel margins and the distal part bent somewhat backwards and outwards; the tip bears a row af small curved spines or setae. The palp is equal in either mandible, three-jointed, with one short seta on the first joint and six on the second. Joint 3 has a long and a somewhat shorter terminal seta and besides about sixteen closely set setae of which the proximal ones are the shortest.

*Maxillula* (fig. 5a) of the usual general shape. Internal endite rather short and thick, with six setae or spines on the end and short rows of very fine hairs on the inner margin. External endite with a row of fine setae along the outer as well as the inner margin. The palp is two-jointed the distal joint being furnished with ten simple, very long setae, the distal ones being the longest.

*Maxilla* (fig. 5b) of the typical shape and furnished with characteristic spines and setae according to the figure.

*Labium* (fig. 5e) only moderately provided with hairs and with two terminal setae on the lobes.

Maxilliped (fig. 5c) has, in the basal part, a very short first and a much longer second joint although not so long as in other species of *Apseudes*. Both joints unarmed, but the upper, outer margin of second joint with some low and indistinct denticles. The palp with the usual four joints of which the



Fig. 5. Apseudes galatheae n. sp.,  $\Im$ ; a, maxillula; b, maxilla; c, maxilliped (drawn after a flattened slide specimen); d, epignath of maxilliped; e, labium.



Fig. 6. Apseudes galatheae n. sp.; a-d & f, ♀; a, left cheliped; b, cutting edge of fixed finger of left cheliped; c, left peraeopod II; d-e, dactylus and claw of peraeopod V of ♀ and ♂ D; f, uropods from below.

proximal one has a triangular projection on the outer margin, furnished with a small seta and on the opposite angle with a very long and a somewhat shorter seta. The three remaining joints with many setae of which the proximal ones on joint 2 are feathered towards the end. The inner margin of the endite is bent downwards and is provided with four slender hooks which are difficult to see; the distal margin has a closely set row of stout spines. The epignath (fig. 5d) is a large vaulted plate, almost shaped as in *A. spinosus* (SARS 1899, pl. 1), but the plate is subsquarish and furnished with fine hairs along the distal margin, and the lanceolate process in the distal corner is longer and very faintly ciliated.

*Cheliped* (fig. 6a) rather slender. Coxa very small. Basis more than three times longer than wide, with a dentiform projection beyond the middle of the posterior margin. The exopodite with two joints, the second distally with four fine, feathered setae. Merus only half as long as carpus, with few setae. Carpus almost cylindrical, with a row of long setae on the posterior margin and another row along the inner margin, at right angles to the posterior row. Propus three times as long as broad, about as long as basis; the fixed finger longer than the rest of the joint; the cutting edge with a row of seta and between these a row af about twelve foliaceous lamellae (fig. 6b); only one seta between the gap of the equally long, fixed and movable fingers; the latter with a non-serrated cutting-edge.

Peraeopod II (fig. 6c) has a two-jointed exopodite with four long and thin, feathered setae. Basis four times longer than broad and almost as long as the three succeeding joints together. Merus a little shorter than carpus +- propus, which are equally long. The latter is almost oval in shape while carpus is rectangular and a little broader. Apart from the setae, merus has one spine, carpus two, and propus (of the type specimen) eight spines along the posterior margin; on the anterior margin there is one spine on carpus and two on propus. Dactylus is long and stout, with a 4-dentate margin and a very short claw.

Peraeopods III and IV (fig. 2) almost totally identical. Basis about as long as the three succeeding joints combined. Dactylus and claw as long as propus.

Peraeopod V longer and somewhat stouter than III and IV; basis is  ${}^{5}/_{6}$  of the three succeeding joints combined. Carpus long and stout, more than half as long as basis. Near the distal end it is provided with two parallel rows of forward directed, spinelike setae. Propus  ${}^{2}/_{3}$  of carpus, with a feathered ("auditory") seta on the posterior margin and two fan-shaped rows of spine-like setae on the distal end, posterior to dactylus which is short and furnished with a row of short spines on the claw (fig. 6d).

*Peraeopods VI and VII* (fig. 2) are almost alike, the only differences being that VI has a feathered seta on the posterior margin of propus, which is not present in VII, and that carpus of the latter appendage is a little more curved. These two appendages are also very similar to peraeopods III and IV, but slightly shorter, less setiferous and with a much longer and very slender dactylus which is  $1^{1}/_{2}$  times as long as propus.

Pleopods not developed.

Uropod with a slender, cylindrical peduncle (fig. 6f); exopodite has six joints; endopodite which is more than four times longer than exopodite has nineteen joints.

#### Description of male (D):

In the following description only the *differences* between the female and male are pointed out.

*Body* even a little more elongate than in the female.

*Carapax* (fig. 3b) somewhat narrower and with distinctly longer and more slender rostrum and eye lobes (the projection on the lateral process is broken off on either side). Rostrum is only 1/3 of the total length of carapax in the female, but 3/7 of its length in the male.

*Peraeonites* (fig. 3 b) on the whole shaped as in the female, but peraeonite 6 is a little shorter than 5. The lateral spines are fully developed only on the anterior peraeonites, on the three posterior being substituted by a rounded process with a minute seta. The longitudinal and transverse furrows are only present on the dorsal surface of peraeonite 2. The hyposphenians are well developed on peraeonites 2-4, but are subacute processes on 5-6 (fig. 7).

On 7 there is an unusually long and stout conical projection.

*Pleon* (fig. 7) a little longer than peraeonites 2-5 together. The five pleonites are equally long and broad, but very different from those of the female due to the presence of pleopods. There are no lateral spines on any of them (fig. 3b). Hyposphenians are present only as rounded processes.

*Pleotelson* very differently shaped. In the female it is cylindrical throughout, but in the male only the proximal half is shaped in that way. The ventral side of the distal half becomes more and more flattened towards the end. On this flattened area two longitudinal, rounded keels are found which increase in height towards the distal end of pleotelson where they are abruptly cut off. Accordingly, the presence of these keels gives the impression of a cylindrical pleotelson as in the female (fig. 7). When viewed from below they are seen to diverge and to bear two short setae on the hind margin (fig. 8a); only one could be seen on the left keel.

On the dorsal side (fig. 8 b) two longitudinal, lateral furrows distinctly divide the distal end of pleotelson into a median part and two lateral sections which serve as a base for the two attached peduncles of the uropods. The median part has a low furrow in the middle which posteriorly ends at a transverse seam; this is furnished with a backwards pointing, median bend, anterior to which there is a low convexity with a pair of setae. The apical anal opening seems to be much smaller than in the female and is difficult to detect.

Antennula (fig. 8c) with the outer flagellum longer and much stouter than in the female; each of the eighteen joints with a bunch of long, sensory hairs.

Antenna (fig. 8c) has the same shape and number of joints as in the female; the setae are only somewhat longer and more numerous.



Fig. 7. Apseudes galatheae n. sp., ♂ D; posterior end.



*Mandibles* (fig. 8 d) differ considerably from those of the female. Pars incisiva of both left and right mandible is not flattened and with terminal teeth but almost conical and with minute protuberances. Lacinia mobilis of left mandible almost as in the female, but the spines below it are totally different on either side. From a distinctly marked off basal part several extremely thin, stiletto-shaped spines of varying length emerge (fig. 8e-f). They are thus quite unlike the stout, mostly bifurcate spines of the female (fig. 4 c-d). Moreover, there are two setae on the first joint of the palp, and the row of spines on the third joint is longer and stouter. The rest of the mandible and all the remaining mouth-parts are quite identical with those of the female.

*Cheliped* (fig. 8 g) considerably more slender than in the female which is opposite to what is usually the case. Thus basis is almost four times longer than broad. The chelae are rather different; in the male they have a strongly bent and rather long movable finger which involves that the fingers cross. Propus is narrower, but the fixed finger is broader proximally. The cutting edge is absolutely straight (fig. Fig. 8. Apseudes galatheae n. sp., 3 D; a, pleotelson from below; b, distal end of pleotelson and peduncle of uropods from above; c, right antennula and antenna from below; d, left mandible from inside; e-f, lateral view of left and right mandible; g, left cheliped; h, fingers of left cheliped.

8h), without foliaceous lamellae, and there is a row of twelve setae attached below the edge. Otherwise the chelipeds are almost identical.

Peraeopod II also somewhat more slender than in the female, propus for instance being only half as broad as long instead of 4/7 in the female.

*Peraeopods III-VI* are identical in the two sexes except that the claw on V has no row of short spines (fig. 6e) and dactylus of peraeopod VI is a little shorter in proportion to propus.

Peraeopod VII rather different. In the female basis is straight, carpus and propus only slightly curved, and the latter considerably shorter than the former which is again somewhat shorter than dactylus (fig. 2). In the male basis is curved somewhat forwards, propus and especially carpus are curved the opposite way (fig. 9a) and these two joints are equally long, but shorter than dactylus.



n. sp., ♂ D; a, right peraeopod VII; b, pleopod 1.

*Pleopod 1* (fig. 9b) with naked basis and two joints in the exopodite, which is somewhat longer than the endopodite. The remaining pleopods become longer and more slender backwards.

Uropod (figs. 7 and 8a-b). The peduncle is different from what is known in all other species of tanaids. The general shape is somewhat curved, the interior and the ventral sides being convex. In the proximal, interior corner there is on the dorsal side a very prominent, hook-shaped process, which almost reaches the corresponding one on the other uropod. The endopodite has six and the exopodite eighteen joints in the present male.

### Size:

The largest female in the material is 20.8 mm long; the female type is 18.3 mm long and 1.9 mm broad across the first free peraeonite. The longest male is 15.6 mm long and 1.7 mm broad.

#### Development and variation:

Unfortunately, *A. galatheae* comprises only two preadult specimens, five adult females and two adult males.

*Preadult specimens.* In table 1 this material has been arranged according to total lengths. The smallest specimen, A, is still lacking peraeopods VII and is also devoid of pleopods. Thus it is in a manca stage which probably corresponds to that mentioned



on p. 191 (*spinosus*) and on p. 204 (*gracillimus*). On the whole, the present specimen is very similar to the adult females, having for instance the spines on the claw of pereiopod V developed. The main differences are:

Body (fig. 10) narrower, and carapax almost rectangular with a broader and shorter rostrum which is bent somewhat downwards so that it seems a little shorter in fig. 10. In this stage carapax is 18.7% of the total length while in the type it is 15.6%. This difference in the relative length of carapax is considerably less than in *Heterotanais antarcticus* in which LANG (1953 b, p. 416) found carapax to be 27.4% of the total length in the first manca stage and 24.4% in the last manca stage as against 19.1% in the first adult stage with ova. The smaller number of spines on peraeopod II

Fig. 10. Apseudes galatheae n.sp., manca stage (specimen A).



Fig. 11. Apseudes galatheae n. sp., preadult stage (specimen B).

and of joints in antennula, antenna, and uropod is shown in table 1.

The other preadult specimen, B, probably belongs either to the last manca stage or to the first youth stage. It is not possible to coordinate it directly with any of the stages of *Heterotanais antarcticus*, as given by LANG (1953 b, p. 415). In this species the last manca stage has very rudimentary peraeopod VII and pleopods (LANG's figs. 3 and 4), while these appendages are fully developed in the succeeding first youth stage. In the present specimen of *galatheae*, however, peraeopod VII is fully developed, although somewhat smaller,<sup>1</sup> while the pleopods are still perfectly rudimentary (fig. 11). Owing to the smaller size of the pleopods I regard it as most likely that the specimen belongs to the last (fourth?) manca stage.

While specimen A resembles the females in practically all the characters in which the adults show sexual dimorphism, B has apparently obtained some male characters, namely pleopods (although rudimentary) and a conspicuous projection on the sternite of peraeonite 7. The pleopods have all the joints developed but have so far only two apical and one posterior seta on the endopodite and probably none on the exopodite. In B the endopodite is the longer, in the adult male the opposite is the case. Seen from above the pleonites show a distinct convexity at the insertion of each pleopod, although by far not so big as in the adult males (fig. 3b). A similar, but very indistinct convexity, is also present on the five pleonites of the preadult specimen A (fig. 10). The projection on somite 7 is furnished with a short spine which is sometimes found also on the conical projection of adult males, but is normally broken off.

However, all the other characters, which are different in the two sexes of the adults, are female in specimen B. This applies to the shape of carapax and

1. Since only basis of peraeopod VI is preserved, it is not possible to compare VII with VI, except for the size.

No. of No. of spines No. of joints No. of joints Rudi-Total joints of uropod of antennula on lower mar-Galathea mentary of flag Specimens length gin of propus Stat. oosteof anmm of peraeopod Outer Inner Exo-Endogites tenna flag. pod. pod. Π flag. 5 9 5 10 4 6 pread. A 6.6 ÷ pread. B  $6^{1/2}$ 5 ÷ 5 16 11.5 12 8 7 7 19 14.7 5 9 ∂ ad. C ÷ 18 7 18 5 9 6 18 ∂ ad. D 15.6 ÷ 658  $9^{1}/_{2}$ ? ? 9 5 16 ♀ ad. E 18.0 + $7^{1}/_{2}$ ÷ 17 5 9 6 19 ♀ type 18.3  $7^{1}/_{2}$ ? ? 7  $^{\circ}$  ad. F c. 19.5 ÷ ? 20  $7^{1}/_{2}$  $^{\circ}$  ad. G 20.6 ÷ 15 5 9 7 18  $8^1/_2$ ÷ 5 10 8 19  $^{\circ}$  ad. H 20.8 17 9,  $9^{1}/_{4}$ 6 9 +17 10 20 ♀ ad. J 13.7  $8^{1}/_{2}$ 8 19 ♀ ad. K 14.5 +186 9 664

9

17

5

Table 1. Size and variation of the material of Apseudes galatheae n. sp.

1. The posterior spine is only half as long as the preceding six ones.

+

14.2

rostrum, the relative length of the peraeonites, the cylindrical shape of pleotelson, the inner flagellum of antennula, the shape of the right mandible (the left one was damaged and could not be studied), the cheliped (which is like that of the females F and G, mentioned below), the spines on the claw of peraeopod V, the shape of peraeopod VII (fig. 11), and, finally, the simple peduncle of the uropod, without any proximal hook.

 $\bigcirc$  ad. L

The reason for this apparent mixture of male and female characters in specimen B will be further discussed on p. 230.

Adult females. In table 1 the females have been arranged according to total length. It will be seen that the only specimen with rudimentary oostegites is E, which is the shortest, i.e. the youngest female; this is another evidence of the fact that the tanaids must have several egg-bearing stages.

At the same time the table shows that also in this species there must be two intermediate stages before the brood-pouch stage (which is lacking in the present material), namely an intermediate stage with no rudimentary oostegites (the type and F, G, and H) and an intermediate stage with rudimentary oostegites (E). This is – as shown above – probably also occurring in the first adult stages of *A. spinosus*, and is certainly the case in *A. nipponicus* in which three adult females, according to SHIINO (1937, p. 59), were devoid of rudimentary oostegites, but had "a black-coloured stripe in the part where the rudimentary oostegite is found in other females".

Similar stripes cannot be found in the present females without oostegites.

9

8

21

In table 1 is given the number of spines on the lower margin of propus of peraeopod II. The number varies from one specimen to another and is independant of the size, except that it is smaller in the preadult stages. This variation within the same population makes it risky to base a subdivision in races or subspecies on this character as recently tentatively proposed for *A.acutifrons* by LANG (1955) – to say nothing of regarding it as a specific character, as done by several former carcinologists.

Table 1 also shows that the number of joints of the outer flagellum of the antennula, the flagellum of the antenna and the exopodite and endopodite of the uropod varies, some of them being apparently independent of the size of the specimens.

The hyposphenians of the present material of females show interesting variations. The armament of the type specimen was described and figured above (p. 192, fig. 2). Table 2 gives the armament in all the preadult specimens and the females, arranged according to increasing size. There is a tendency to reduced armament with increasing size, the hyposphenians of the preadult specimen A being also about twice as long as those of the type and of E.

As will be seen, the hyposphenians are fully developed in a stage with rudimentary oostegites in *galatheae* (and also in *gracillimus* – see p. 205). This fact certainly means that TATTERSALL is nevertheless right when in his description of *Apseudes africanus* 

Table 2. Presence or absence of hyposphenians
in preadult specimens and females of Apseudes
galatheae n. sp. from St. 658.

	Armament of peraeonites						
	2*	3*	4*	5*	6	7	
pread. A	S	S	S	S	S	S	
pread. B	S	S	S	S	S	P + S	
♀ ad. E	S	S	S	S	S	S	
♀ type	S	S	S	S	S	S	
♀ ad. F	?	?	0	0	0	S	
♀ ad. G	Р	С	0	0	Р	S	
$\bigcirc$ ad. H	Р	С	0	0	Р	Р	

S = spine; P = rounded process; C = convexity; O = no traces at all. \* indicates the peraeonites on which there are rudimentary oostegites in E.

(1925, p. 80) he states that "spines are present in the  $\mathcal{Q}$  on the second and third true thoracic somites", and that at the same time the female "carries four pairs of incubatory lamellae". LANG (1953b, p. 420) identifies these incubatory lamellae with a marsupium and is no doubt justified in maintaining that hyposphenians and marsupium cannot occur simultaneously. But with his expression "incubatory lamellae" TATTERSALL probably meant rudimentary oostegites which are much more lamella-like than the foliaceous oostegites of the marsupium. If this be the case, hyposphenians can very well occur together with "incubatory lamellae", and it is not reasonable to suppose that TATTERSALL in his description confounded the mature female with the immature one of the same material. On the other hand, my table 2 clearly shows that hyposphenians cannot be used as a specific character, and TATTERSALL is not right in quoting the presence of spines in the female of A. africanus as one of the distinguishing features between this species and A. hibernicus, as already maintained by LANG (1.c.).

Apart from the above named, more general variations there are some slighter individual differences in the adult females of *galatheae*. In F and G peraeonite 4 is as long as 7, the movable finger of the cheliped is a little longer than the fixed one, and G has the rostrum bent somewhat downwards; H has all the lateral spines a little more slender and exhibits a peculiar lack of calcification of carapax and the first four peraeonites which are transparent and yellowish in contrast to the calcified and white, distal peraeonites and pleon. This is probably due to recent moulting.

Also the three females from St. 664 have been

compared very carefully to the type. They all have rudimentary oostegites and are perfectly without pleopods. Morphologically they only differ from the type in the following respects: Dactylus of peraeopod II has more teeth (from five to seven), the setae on propus of peraeopod V are still more numerous and a little longer, and female L has the first joint of the antennula one fifth shorter than in the type. As appears from table 1 the number of spines on the lower margin of propus of peraeopod II, of joints in flagella of antennula, and in exopodite and endopodite of uropod is larger than in the other adult females of this species.

Table 1 also gives the total length of the females from St. 664; they are much shorter than the five adult females from St. 658 and even shorter than the two adult males from that station. Of course the material is too small to say anything definite, but it is worth mentioning that the Galathea caught several specimens of the isopod *Ilyarachna antarctica* Vanh. in the Kermadec Trench, among others at the same two stations; also in that species the largest specimens were those caught deepest down (WOLFF 1956a, p. 111).

Adult males. I have not been able to find any greater differences between the two adult males C and D. The only ones worth mentioning are the variation in number of joints of the uropods (see table 1) and the fact that the ventral projection on peraeonite 7 is even larger in male C than in D. Both males are semitransparent and yellow like the proximal half of female H.

Female – male. While working with this species I was several times inclined to believe that the female and male specimens could not belong to the same species. The differences between them are so essential that they would normally be regarded as specific, especially regarding the shape of the mandibles. Had it not been for the fact that I – through a study of the closely related *Apseudes gracillimus* Hansen – found the same fundamental differences between the two sexes (see p. 203), I would probably have described the present females and males as belonging to two species of which males and females, respectively, were still unknown.

To sum up, the males of *galatheae* differ from the females in the following outer characters:

- (1) Carapax is narrower and rostrum and lateral projections longer and more slender.
- (2) Presence of a stout conical projection on ventral side of peraeonite 7.

- (3) Presence of two rounded, longitudinal keels on ventral side of pleotelson and of a smaller anal opening.
- (4) Inner flagellum of antennula stouter and with numerous sensory hairs.
- (5) Mandibles reduced, pars incisiva of both mandibles being conical and the spines simple and stiletto-shaped.
- (6) Cheliped more slender except propus; the fixed finger with a simple cutting edge; the movable finger considerably longer than the fixed.
- (7) Peraeopod II somewhat more slender.
- (8) Claw of peraeopod V simple.
- (9) Peraeopod VII S-curved.
- (10) Peduncle of uropod curved and with a prominent hook on the proximal, interior corner.

In order to check the sexual dimorphism of the mandibles I have studied the mouth-parts of one more female and male of the material and found them absolutely identical with those of the female type and the described male, respectively. I found only a slight difference in the number of setae on joint 3 of the mandibular palp in the males.

The question of probable protandric hermaphroditism in this species is discussed on p. 230.

#### Remarks:

Closest to *A. galatheae* are probably *A. gracillimus* Hansen and *A. gracilis* Norman & Stebbing. A comparison between these three species is given below (p. 207).

A. galatheae also shows some resemblance with Apseudes leptodactylus (Beddard)<sup>1</sup> in general shape, especially of carapax and peraeonites. Among many other things leptodactylus differs in the following: Very strong lateral spines on the distal peraeonites, extreme shortness of antenna and a strong projection on its first joint; shape of maxillula; extreme slenderness of cheliped; coxal spines on the distal peraeopods.

Also the two deep-sea species *A.sibogae* and especially *weberi* resemble *galatheae* to some extent. The former lacks, however, lateral spines on carapax and peraeonites, it has a rounded eye lobe, a strong coxal spine on peraeopod II, differently shaped mandibles and labium, etc. *A.weberi* is perhaps as close to *galatheae* as any of the two other species mentioned above, having the same general shape of body and chelipeds, labium and maxillula. The mandible figured by NIERSTRASZ (1941, pl. 2, 22) seems to be rather close to the unique mandible of the males of *galatheae* and *gracillimus* (figs. 8d-f and 17a-d); it is not unlikely that *weberi* shows others of the interesting sexual differences, found in the two former species. In this case NIERSTRASZ has overlooked the longitudinal keels on pleotelson, as HANSEN did in *gracillimus* (see below).

#### Distribution:

So far *A.galatheae* is known only from the Kermadec Trench NE of New Zealand, 4510-4570 m and 6730-6770 m;  $1.1^{\circ}$  and  $1.3^{\circ}$ C.

#### Apseudes gracillimus Hansen, 1913

In order to make possible a careful comparison between the two closely related species A.galatheae n. sp. and gracillimus Hansen I have found it necessary to give here a redescription of the latter species. In the first place the material of gracillimus originates from the Thor (included in HANSEN's Report on the results of the Ingolf Expedition, 1913, p. 15). Moreover, the Ingolf caught at St. 22 a manca stage which was not mentioned by HANSEN (see p. 204). Finally, going through the Galathea collections of tanaids from the abyssal zone, I found two males which I have also referred to this species. The data of the total material of gracillimus are given below. - I have chosen the best preserved female (with rudimentary oostegites) from the Thor as lectotype and based the following description on this specimen and on the best preserved male specimen (named E) from the same station. In the descriptions are only included features not described by HANSEN (1.c., p. 15, pl. 1, 4a-4e).

#### Material:

Taken by the Thor: St. 166, South of Iceland,  $62^{\circ}57'N$ ,  $19^{\circ}58'W$ , 957 m, 14. July 1903. Gear: dredge. Bottom temperature: 4.9 °C. – 8 adult females, 4 adult males, 3 preadult specimens, some rather damaged.

Taken by the Ingolf: St. 22, South of Greenland,  $58^{\circ}10'N$ ,  $48^{\circ}25'W$ , 3474 m, 22. June 1895. Gear: dredge. Bottom: soft grey ooze, without any sand. Bottom temp.:  $1.4^{\circ}C$ . – 1 preadult specimen.

Taken by the Galathea: St. 193, off Southeast Africa, 32°34'S, 31°52'E, 3680 m, 6. Feb. 1951. Gear: shrimp otter trawl. Bottom: Globigerina ooze. Bottom temp.: 1.1°C. – 2 adult males.

<sup>1.</sup> I fully agree with LANG (1949, p. 4) in rejecting the genus *Leiopus*.

# Description of female (lectotype):

*Body* (HANSEN's fig. 4a) almost as elongate as in *galatheae*, being 9.2 times longer than wide. Colour in alcohol yellowish.

Carapax as in HANSEN's fig. 4a, the only exception being that the spines on the lateral projections are longer and more slender. The inner margin of the eye lobe has two rounded processes, one about half way between base and apex of the lobe and in the same plane as rest of the lobe; the other is close to the base and directed somewhat upwards, forming a keel which is divided from the basal part of the lobe by a short furrow. Something similar is found in *A.gracilis* (HANSEN 1913, pl. 1, 3a), but is not so pronounced. The spine on the epistome is long and slender.

*Peraeonites* according to HANSEN's figure, but there is a distinct, slender spine on the lateral process of peraeonite 3. Peraeonites 5 and 6 are a little longer and broader than 7, but have the same shape. Peraeonite 7 is a little longer than 4 while the opposite is the case in *galatheae*. The hyposphenians are present on all peraeonites and are long and slender. On the three anterior peraeonites they are directed somewhat backwards, on the three posterior ones downwards.

*Pleon* as in HANSEN's fig. 4b, with the first pleonite a little longer than the succeeding four ones. Hyposphenians very long and slender on all five pleonites.

*Pleotelson* longer than the three preceding pleonites. The shape is cylindrical, but somewhat broadened posteriorly, with a pair of inconspicuous, rounded, ventro-lateral processes near the base, and with a low, ventral furrow distally. The distal end is regularly rounded dorsally and the posterior margin is provided with a median, rounded process (HAN-SEN's fig. 4b), which is bent downwards and has two terminal setae. Finally, pleotelson is furnished with a few lateral, spine-like setae, directed backwards and not shown in HANSEN's figure.

Antennula has nineteen joints in the right and eighteen in the left outer flagellum, and five joints in the inner flagella (in all cases with the basal, common joint included).

Antenna with the first joint almost square as in galatheae. Flagellum with altogether ten joints (inclusive the two long basal joints which HANSEN referred to the peduncle). Squama one fifth longer than joints 1+2 of the flagellum, with two long terminal setae and laterally with two shorter outer and one, equally long, inner seta.



Fig. 12. Apseudes gracillimus Hansen, Q lectotype; a, left mandible from inside; b-c, lateral view of left and right mandible.

*Mandibles* (fig. 12a-c) mainly shaped as in *gala-theae*, but with several differences: The distal part, beyond processus molaris, is very slender and with an outer, evidently "woolly" clothing of short hairs; pars incisiva of both mandibles with six, rather pointed teeth; movable lacinia with the five teeth in one plane; four spines only in the bunch of spines, three of which are doubly and one tribly forked; processus molaris long, tongue-like and with a distal bend as in *galatheae;* first joint of the palp with two long and one short seta and distal half of second joint with many short setae.

Maxillula (fig. 13 a) very close to that of galatheae, but with fine hairs on the outer margin of the internal endite instead of on the inner one and with fewer long, simple setae on the distal part of the two-jointed palp.

Maxilla according to fig. 13b; it differs from that of galatheae in the shape of some of the spines only.

*Labium* (fig. 13c) with rather long, fine hairs and with three terminal setae on the lobes.

*Maxilliped* also very close to that of *galathea* (fig. 5c, p. 193). The only differences seem to be the lack of one (both?) setae on the inner distal corner of joint 1 of the palp and the absence of feathered setae on the proximal part of joint 2.

Cheliped according to HANSEN's description and fig. 4c, except that propus has five instead of two



Fig. 13. Apseudes gracillimus Hansen, 9 lectotype; a, maxillula; b, maxilla; c, labium.

setae at the insertion of the movable finger, and the fingers are even a little longer, compared with the rest of the hand, than shown by HANSEN.

Peraeopod II as figured by HANSEN (4d). The type has 6, almost equally long spines on the lower margin of the right propus, and 6 equally long + 1 somewhat shorter spine on the left propus - as in A. hermaphroditicus (LANG 1953 a). Dactylus with four denticulations (HANSEN records three only (p. 16), but shows four in fig. 4d).

*Peraeopods III and IV* almost equal, but propus is much longer in III which has also more setae along the margins of carpus and propus.

*Peraeopod V* almost as in *galatheae*, but dactylus is much more slender, and there are fewer terminal setae on propus (fig. 14a).

Peraeopods VI and VII almost equal and both with a rather strong spine in the row of short setae along the anterior margin of propus (not shown in HAN-SEN's fig. 4e). Propus has a feathered ("auditory")



*Pleopods* (fig. 15a) considerably more slender than in the males of *galatheae*. Basis has two feathered setae. The exopodite is the shorter, and its proximal joint is only one third of the distal one.

Uropods with a simple, cylindrical, basal peduncle in both sexes. The rami are missing in the female type. In the only specimens (males H and R), in which the endopodite is preserved, it has 27 and 23 joints, respectively, and is as long as pleotelson and the three preceding pleonites together. The exopodite is preserved only in males F and R; it is half as long as pleotelson and has 8 (?9) and 7 joints, respectively.



a Fig. 15. Apseudes gracillimus;

Fig. 14. The two distal joints of peraeopod V; a-b, Apseudes gracillimus Hansen, ♀ lectotype and ♂ E; c, A. gracilis Norman & Stebbing, ♀ from Ingolf St. 10.

Fig. 15. Apseudes gracillimus; a, pleopod 1 of  $\mathfrak{P}$ ; b, right peraeopod VII of  $\mathfrak{F}$  E.

0.5 mm

## Description of male E:

A careful investigation of the males disclosed remarkable differences. I have therefore named the males, and shall in the following mention the sexual as well as the individual differences in the males at my disposal. At first the difference between male E and the female type specimen are pointed out.

*Body* more elongate, especially the posterior peraeonites.

*Carapax* a little narrower, but by far not so much as in *galatheae*, and rostrum and projections are not longer than in the female. The branchial areas are somewhat more vaulted and their outer margin more convex so that this part becomes broader than the first peraeonite.

*Peraeonites* equal in shape but the lateral processes es broader and directed outwards instead of somewhat forwards. Peraeonite 4 is a little longer than 7. The hyposphenians are present on all segments.

*Pleon* (fig. 16a) has rather short hyposphenians on the four anterior pleonites and that on 5 is rounded.

*Pleotelson* shorter and stouter, only as long as the three preceding pleonites together. The general shape is cylindrical and there are the same ventro-lateral, proximal processes and spine-like setae as in the female. But the distal end is very different from that of the female and similar to the shape in the male of *galatheae*. Ventrally the same rounded, longitudinal keels are found (fig. 16b-c), but they are shorter and lower in this species; they have two-three setae on the rounded, distal end. The transverse, ventral

seam at the distal end of pleotelson has a median convexity from which a low furrow stretches forwards (fig. 16c). As on the dorsal side in galatheae the two lateral sections which serve as a base for the peduncles of the uropods are raised and separated from the median section by a low furrow. Distally the two lateral sections are provided with three strong setae. - On the dorsal side (fig. 16d-e) the same median and two lateral sections as those ventrally are found. The median part is much more raised than in galatheae and consists of the same median convexity with two setae, but in addition of two lateral convexities. The posterior limitation is also somewhat different, being furnished with a downwards bent, rounded plate, which in a lateral view (fig. 16e) like a roof is seen to cover part of the anal opening (it is also indistinctly visible in the female); it bears two apical setae. The anal opening, finally, is like in the female, i.e. presumably much bigger than in galatheae.

Antennula has the outer flagellum longer than in the female (it reaches back to the middle of peraeonite 5, instead of to the front margin of 4). It is also much stouter, some of the proximal joints being even broader than long, and it has 25 joints, all with long, sensory hairs. The inner flagellum has six long joints.

*Mandibles* (fig. 17a-d) show almost the same sexual differences as in *galatheae*, i.e. they are somewhat reduced. Both incisive parts are nearly conical, at any rate in the left mandible. Lacinia mobilis (fig. 17b) flattened, but only faintly dentate along



Fig. 16. Apseudes gracillimus, & E; a, lateral view of peraeonites 6 and 7 and pleon; b, pleotelson from below; c, distal end of pleotelson and peduncle of uropods, obliquely from below; d, distal end of pleotelson from above; e, distal end of pleotelson and peduncle of uropods obliquely from above.



Fig. 17. Apseudes gracillimus, ♂ E; a-b, left mandible; a, from posterior side; b, distal end from inside; c-d right mandible; c, from posterior side; d, from outside.

the edge. The spines on the right mandible stilettoshaped as in *galatheae* and almost missing on the left. Palp much larger in proportion to the mandible and with only two setae on the first joint but numerous, rather stout setae on the second. The molar parts as well as the remaining mouth-parts equal in the female type and male E.

*Cheliped* even a little more slender than in the female. Relative length of fingers as in female.

*Peraeopods III-IV and VI-VII* as in the female. Thus the sexual difference in peraeopods VII (fig. 15b) is not found in this species.

Peraeopod V has a longer dactylus and no spines on the claw (fig. 14b). The arrangement of setae on propus is also somewhat different in the two sexes.

#### Size:

The largest female is 14.4 mm long; the female type is 13.9 mm long and 1.5 mm wide across peraeonite 2. The largest North Atlantic male is 11.6 mm long and 1.3 mm wide across carapax, and the largest male from the Indian Ocean is 14.5 mm long.

#### Development and variation:

The present material comprises four preadult specimens, eight adult females and six adult males.

Preadult specimens. An early manca stage of gracillimus without peraeopods VII and pleopods was described and figured by LANG (1953b, pl. 3, fig. 3-4). The specimen was caught by the Ingolf Expedition (St. 22), but was not included in HAN-SEN'S Report (1913). Professor LANG has kindly returned the specimen to me and – apart from the lack of the said appendages – it corresponds exactly to the specimens belonging to a later manca stage, mentioned below. In table 3 this specimen (A) and the remaining material of *gracillimus* has been arranged according to size.

The three largest preadult specimens (B-D) have rudimentary peraopods VII and pleopods and are in the last manca stage or perhaps in the last but one, provided that the last manca stage has fully developed, although smaller, peraeopods VII and rudimentary pleopods (see discussion p. 197). At any rate this stage certainly corresponds to that in *spinosus*, described by LANG (1953b, p. 419, fig. 5) and by me on p. 191, fig. 1. However, in *gracillimus* the rudimentary peraeopod VII has five distinct joints (fig. 18), while in *spinosus* the penultimate joint is only very faintly (or not at all) divided into two.

All four manca specimens are narrower than the adults. In A the carapax is 14.7% of the total length, in B-D 14.5%, while in the type it is 13.7% of the total length, i.e. still less difference than in *galatheae* (p. 197). The length of squama of the antenna is very varying. In the adults it is one fifth longer than the two first joints of the flagellum together, but in A it is only half as long, and in B-D it is 3/5, almost as long, and as long as the two joints combined. The hyposphenians are not relatively longer than in the adults. Finally, table 3 shows the smaller number of spines on peraeopod II and of joints in antennula and antenna. A has the rami of the uropods preserved; there are 5-6 joints in the outer and 11 in the inner ramus.

Adult females range from about 12.4 mm to 14.4 mm (Table 3). Only in two females (the type and P) was the total body preserved. In the remaining ones preferably pleon and sometimes 1-2 or more of the posterior peraeonites were lost; the actual length of these specimens could therefore be given only tentatively by measuring (by micrometer-objective) the lengths of the carapax and the preserved seg-



Fig. 18. Apseudes gracillimus, specimen B (probably last manca stage); peraeonite 7 and pleonites 1 and 2.

Species	Locality	Specimens	Total length	Oostegites	Нуро-	No. of spines on lower mar-	No. of of ante	joints ennula	No. of joints of flag. of
			mm	and eggs	sphenians	of peraeopod II	Outer flag.	Inner flag.	antenna
		pread. A	7.2	none	$S^3$	$3-3^{1/2^{4}}$	9	3	7
		pread. B	7.6	none	S	$3^{1}/_{2}$	12	4	7
		pread. C	7.6	none	S	- <u>-</u>	12	4	7
		pread. D	c. 7.8	none	S	31/2	12	4	7
		♂ ad. E	10.9	none	S	$5^{1}/_{2}-6^{1}/_{2}$	25	6	11
	j	♂ ad. F	11.1	none	S	6	24	5	10-11
snu	North Atlant	♂ ad. G	c. 11.3	none	S	6	26	5	10-11
cillin		♂ ad. H	11.6	none	S	$5^{1}/_{2}$	24	4	10
s gra		♀ ad. I	c. 12.4	none	S	5	16	4	9
ide		♀ ad. K	c. 12.7	none	S	$6^{1}/_{2}$		_	11
19Set		♀ ad. L	c. 13.3	eggs	$C^3$	7		5	11
$^{d}V$		♀ ad. M	c. 13.8	rud.1	S	$6^{1}/_{2}$	17-18	5	11
		♀ ad. N	c. 13.9	devel.2	С	6	15	_	9
		♀ type	13.9	rud.	S	$6-6^{1}/_{2}$	18-19	5	11
		$\mathcal{Q}$ ad. O	c. 14.2	rud.	S		_	-	
		$\stackrel{\circ}{_{\scriptscriptstyle +}}$ ad. P	14.4	rud.	S	-	17-18	5	11
		ad. Q	9.5	none	S	6	21	6	8
	Ind ar Oc	J ad. R	14.5	none	S	7	26	6	11
- 5	9	pread.	5.8	none	s	5	9	3	7
A. gr¢ cili	At At lant	♀ ad.	13.6	rud.	S	8	16	4	11

Table 3. Size and variation in the material of Apseudes gracillimus Hansenand A. gracilis Norman & Stebbing.

1. rud. = rudimentary oostegites.

2. devel. = fully developed oostegites.

3. S = spines; C = convexities.

4. One peraeopod with three spines, the other with four of which the posterior one is only about half as long as the remaining ones.

ments and comparing them to the intact specimens. The error should be less than  $\pm$  0.1 mm.

Also the present material shows that there must be several egg-bearing stages, since one of the smallest females (L) is egg-bearing.

According to table 3 there is the same variation in the number of spines on propus of peraeopod II and in the number of joints of antennula and antenna as in *galatheae*; these characters are presumably independent of the age of the specimens.

The hyposphenians do not show the same variation as in *galatheae*. They are present as spines in all specimens – except those in a brood-pouch stage (L and N)in which they are visible only as low convexities.

Apart from the above mentioned variations I have not been able to find any notable differences amongst adult females.

Adult males. There are six specimens which must be considered males belonging to gracillimus. Male

E was described and compared to the female type above. Besides there are five males (F-G-H and Q-R, see table 3), which are all furnished with the prominent ventral projection on peraeonite 7, a long and stout, multi-segmented exopodite on antennula and vaulted branchial areas on the carapax.

If we first consider the two males (Q and R) from the Indian Ocean we find that, apart from the great difference in size<sup>1</sup>, they are practically identical. Moreover, they agree with the males from the North Atlantic (especially E) to an extraordinary extent, when the vast geographical distance is taken into account. They differ from male E in the following respects:

A considerable difference in size of adult specimens of the same tanaid species is often found in populations from various localities – e. g. females of *Neotanais serr. serratispinosus* from the North Atlantic, dredged by the Valourus, the Porcupine, and by the Ingolf Expeditions.

Peraeonite 5 is somewhat longer, and 4 and 6 somewhat shorter than in E which has 5 and 6 almost equally long; thus, peraeonite 5 is considerably longer than 6 which is again only a little longer than 7. - The lateral spines on the peraeonites are less slender, being almost triangular in dorsal view. - Epimera of the pleonites are a little more rounded. - The longitudinal, rounded keels on the distal, ventral side of pleotelson are a little longer and stouter in male R, while in Q they are exactly as in E. - Also dorsally Q's pleotelson corresponds to that of E, while in R the downwards bent, rounded plate distally is shorter and less projecting and lacks the two apical setae; on the other hand, the two setae on the median convexity are considerably longer than in E and Q. - The left mandible has 4-5 distinct teeth on the movable lacinia and one bifid spine (together with some reduced ones) in the spine-row; the palp of male Q differs in having the third joint somewhat less than half as long as the second; apart from these features the mandibles are identical. - Maxillula has fine hairs on both margins of the internal endite. - The hand of the cheliped is not quite so elongate. - Basis of peraeopod II is much thicker and shorter, but propus is a little more elongate than in E. - Pleopod 1 has the rami equally long, and the proximal joint of the exopodite is proportionately longer than in E.

significant enough to justify a separation into two species or subspecies.

Besides E three more males (F, G, H) were caught by the Thor at St. 166 in the North Atlantic. Of these only G has the pleotelson shaped as described for E above (p. 203). In F and H it is almost cylindrical, although the distal, dorsal convexities and the ventral keels are very faintly visible in F. Besides, F's pleotelson is as long and slender as that of the females. Both in F and H the lateral processes on most peraeonites are narrower and directed forwards as in the females. Moreover, they differ in having the claw of peraeopod V shaped almost as in the females (fig. 14a), while the corresponding claw in E (G has no peraeopods V) is simple (fig. 14b). The mandibles of F and H (those of G could not be studied) are also like those in the females (fig. 12), i.e. not reduced. Finally, the exopodite of the antennula in F and H is shorter by  $\frac{1}{5}$  than in E and G and is lacking the abundance of sensory hairs.

G differs from E only in two characters: Flagellum of the antenna has only nine joints, and the squama is considerably longer, reaching to the middle of joint 3 of the flagellum instead of only about one fifth in the other males and the females (cf. the variation in length of squama in the preadults).

oportionately longer than in E. The above mentioned differences in the four males None of the above mentioned differences are from St. 166 can be summarized as follows:

Male characters	Found in males	Female characters	Found in males
Lateral processes on peraeonites stout and di-		Lateral processes slender and directed for-	
rected outwards	E, G	wards	F, H
Stout, ventral projection on peraeonite 7	E, F, G, H	Ventral spine only on peraeonite 7	
Pleotelson shorter and stouter	E, G, H	Pleotelson long and slender	F
Pleotelson with keels etc	E, G	Pleotelson without keels etc	Н
Vaulted brancheal areas	E, F, G, H	Branchial areas not especially vaulted	
Stout, multi-jointed exop. on antennula	E, F, G, H	Slender exop., and with fewer joints	
Exop. of antennula with sensory hairs	E, G	Exop. of antennula without sensory hairs	F, H
Mandibles reduced	E, ? G	Mandibles not reduced	? G, F, H
Claw on peraeopod V simple	E, ? G	Claw on peraeopod V with spines	? G, F, H

#### Intermediate character

Pleotelson with very small keels etc. . . . . F

The significance of these features will be discussed below (p. 230).

# Distribution:

South of Iceland ( $62^{\circ}57'N$ ,  $19^{\circ}58'W$ ), 960 m, South of Greenland ( $58^{\circ}10'N$ ,  $48^{\circ}25'W$ ), 3470 m, and off Southeast Africa ( $32^{\circ}34'S$ ,  $31^{\circ}52'E$ ), 3680 m; from 1.1-4.9°C.

#### Apseudes gracilis Norman & Stebbing, 1886

Male

In his report on the Ingolf Tanaidacea (1913) HANSEN separates A. gracillimus from gracilis preferably on the following characters in gracillimus: "The considerably longer inner flagellum of the antennulae, the extreme slenderness of the chelipeds, no serration or setigerous area on the fixed finger of the chela, finally the oblong fifth joint of second pair of legs". Some of these features are, however, certainly stage characters.

In the Copenhagen Museum are only kept the adult female and the manca stage of gracilis, taken by the Ingolf Expedition. I have compared the female to the material of gracillimus and found some differences which were not mentioned by HANSEN. Most of these are probably only stage characters (for instance the more slender carapax and elongate rostrum, the lateral convexity on the peraeonites in front of the lateral processes, the short and only four-jointed inner flagellum of the antennula, and the presence of only two setae on the much shorter squama of the antenna in gracilis). A few other features are possibly specific: The much shorter and very differently shaped dactylus and claw on peraeopod V in gracilis (fig. 14 c, p. 202), the differently shaped rows of spines on propus of peraeopods VI and VII - see pl. 20 in NORMAN & STEBBING (1886) and pl. 1, fig. 4e in HANSEN (1913), the considerably longer pleopods with equally long rami, and the low, extended convexity in the middle of the ventral side of pleotelson in gracilis. The number of spines on peraeopod II and of joints in antennula and antenna appears from table 3, p. 205, which also gives the length of the manca specimen and the adult female of gracilis.

The manca specimen is without peraeopod VII and pleopods. It is considerably smaller than the smallest preadult specimen of *gracillimus* (A). It differs from A especially in the following respects: Carapax and rostrum are longer, it has the same ventral convexity on pleon and shape of claw on peraeopod V as the adult female, and the lateral, distal corners of pleotelson are more projecting.

I have found it beyond the scope of the present study to try to reach to a final conclusion as to the relationship between *gracilis* and *gracillimus*. This can be done sufficiently carefully only through a comparison with at least the type material of *gracilis* which was not available to me. I can only state that *gracilis* and *gracillimus* are very closely related, but for the time being they must be regarded as separate species.

# Differences between A. galatheae and gracillimus-gracilis

As mentioned above *galatheae*, *gracillimus*, and *gracilis* are all closely related, so closely that at any rate the two former – especially owing to the peculiar

shape of the male pleotelson and the mandibles – ought perhaps to be placed in a genus or subgenus of their own. Considering the comparatively small material available and the great confusion in the systematics of the Apseudidae I have, however, omitted to do so for the present.

I regard the following characters by which galatheae differs from the two other species as the most essential and consider them of specific value: No bulbous processes at base of rostrum; transverse furrow across dorsal surface of carapax; much larger longitudinal keels on ventral side of pleotelson in male; stouter mandible and differently shaped pars incisiva and bunch of spines in both sexes; stouter chelipeds and a lateral process on its basis; differently shaped dactylus and claw on peraeopod V; lack of row of spines on propus of peraeopods VI and VII; S-curved peraeopod VII in male; differently shaped uropods, especially the peduncles in male.

#### 2. NEOTÁNAIDAE

While working with the genus Neotanais I have kept in contact with Professor LANG who was engaged on similar studies. He recently (1956) published his results establishing the new family Neotanaidae, which is placed between Apseudidae and Paratanaidae-Tanaidae. I fully agree with LANG that the mouth-parts of both sexes of Neotanais are so peculiar that the knowledge of their nature justifies the establishment of a new family. LANG was only able to examine the mouth-parts of one species (N. serratispinosus Norman & Stebbing); my recently published study of six new species of Neotanais from abyssal areas (1956b) and the present paper show a remarkable uniformity in the shape of the mouth-parts, the antennulae, the antennae, etc. and thus serve to support the correctness of LANG'S statement.

Concerning the relation between the undoubtedly primitive nature of this family and its distribution in the deep-sea only, I shall revert to this question in a later chapter (p. 235).

Besides the six recently described new species, Neotanais was known to comprise five species.<sup>1</sup> To

<sup>1.</sup> N. laevispinosus Norman & Stebbing is the male of N. serratispinosus Norman & Stebbing. On the other hand, it is rather doubtful whether the two only known specimens of N. americanus (BEDDARD 1886b, p. 126), collected by the Challenger in the North and the South Atlantic, both belong to this species. According to BEDDARD they only differ in relative length of carapax and peraeonites. However, in

these is in this paper added one more subspecies. Moreover, it has been necessary to establish a new genus on another species, collected by the Galathea Expedition. Thus, the Neotanaidae now count altogether thirteen species and subspecies, twelve of which belong to *Neotanais* and one to *Herpotanais* n. gen.

#### Neotanais Beddard, 1886

Neotanais Beddard, 1886a, p. 117

Neotanais Beddard, 1886b, p. 124

Alaotanais Norman & Stebbing, 1886, p. 111

Alaotanais Norman & Stebbing, STEBBING 1893, p. 324

Neotanais Beddard, Stebbing, 1893, p. 324

Neotanais Beddard, LANG 1956, p. 469

The fact that LANG has recently described the mouthparts of *serratispinosus* (1.c.) and that seven new species and subspecies of *Neotanais* have now become known (WOLFF 1956b and the present paper) has enabled me to give below an adequate diagnosis of this very interesting genus. Besides, a diagnosis is called for owing to the establishment of another genus of Neotanaidae (see p. 218).

#### Diagnosis:

Female. Body elongate and narrow, of approximately the same diameter. Carapax pear-shaped and slightly projecting between the antennulae; eye-lobes present, but minute, suboval in shape and without visual elements. First five pleonites (pleon segments) subequal; pleotelsonshield-shaped, ventrally rounded or with a subcarinate keel. Antennula with a threejointed peduncle and a four-jointed flagellum. Antenna with a five-jointed peduncle and a four-jointed flagellum. Mandibles without palps, broad and strong, with two spines on left, three on right mandible and a stout molar process with toothed outer margin. Maxillula well developed, exterior endite with eight to ten spines, interior with three to four setae. Maxilla with the endites furnished with setae, and the fixed endite besides with bifid spines. Labium with an oblong, antero-lateral plate. Epignath of maxilliped strongly bent, with a tuft of setae distally and a ciliated lobe anteriorly. Cheliped very stout; fixed finger broad, with strongly toothed distal margin, movable finger slender. Peraeopods subequal, extremely spinous, and some of the spines more or less serrated; dactylus of peraeopods II-IV simple, of V-VII preferably with a distal collar of spinulets; distal end of propus of last pair of peraeopods with a comb of short spines. Pleopods well developed, setiferous. Uropod with a short peduncle; exopodite short, two-jointed, endopodite with at least eight elongate joints.

*Male.* Body as in female, but each peraeonite (peraeon segment) narrower in front, broader behind. Genital openings on two protuberances on a common convexity. Antennula and antenna more elongate than in female and the former with a tuft of aesthetes on a projection on the first joint of flagellum. Maxilla with two setiferous, more or less distinct, distal lobes. Palp on maxilliped slender. Cheliped rather different from that of the female, being more slender and with much longer fingers. Peraeopods with less serrated spines. Pleopods and uropod as in female.

#### Neotanais giganteus Hansen, 1913

# Neotanais giganteus Hansen, 1913, p. 20, pl. 2, fig. 2a-2h.

In Davis Strait ( $61^{\circ}50'$ N,  $56^{\circ}21'$ W) the Ingolf Expedition collected one magnificent male of this species at a depth of 2702 m and a bottom temperature of 1.5°C. HANSEN's description is excellent except for the fact that he does not mention the mouth-parts. In order to study the relationship of the species of *Neotanais* I dissected the mouth-parts and describe them below. At the same time I include a few amendments to HANSEN's description of other features.

*Carapax.* The blunt rostrum has across its base a rather conspicuous furrow, also found in most other males of *Neotanais.* Apart from the stiff setae on the dorso-lateral keel there is one seta on the anterior vaulted area laterally.

*Peraeonites* evenly vaulted on the ventral side except the seventh which has a large convexity, crowned with two rounded tubercles, on the top of which the genital openings are visible (fig. 19a and LANG 1956, fig. C2).

*Pleonites* have on the ventral side an extended, low convexity with a rounded projection centrally which is split into two halves by a longitudinal cleft (fig. 19a).

*Pleotelson* (fig. 19b) with the uropods inserted on two conspicuous processes and posteriorly with sharp corners.

the material of *N. serratispinosus hadalis* and *H. kirkegaardi* (described below) I have not found any variation whatsoever in this character. I have not had access to the two specimens, and it is to be hoped that they will soon be carefully studied after having been dismounted.



Fig. 19. Neotanais giganteus Hansen, ♂ type specimen; a, peraeonite 7 and pleonite 1 from below; b, pleotelson from below.

Antennula according to description, but HAN-SEN'S fig. 2b on pl. 2 does not show that the enormous number of silky, sensory hairs emerge from a convexity covering the entire proximal two thirds of the first joint of the flagellum; the sensory hairs are thus not restricted to a rather limited projection as in the other males known.

*Maxilla* (fig. 20a) of the same type as in the males of the other species, but differs in having all the setae except two on the outer lobe of the movable endite inserted inside the margin of the lobes.

Maxilliped (fig. 20b) with a short first joint (with one seta) and a very broad second joint with which the endite is fused. The latter is bent somewhat upwards and the distal margin has one short seta on the further projecting part. The palp is very long, with many setae as shown in the figure. The fifth joint has more than twenty terminal setae. The epipodite (fig. 20c) is not so much bent as in H. kirkegaardi (fig. 42, p. 222). The basal part is larger and the setiferous distal part is s-curved.

*Cheliped* with one short, strong seta on the interior side of the hand at insertion of the movable finger, but only on right cheliped. Of the several setae found on the fixed and movable fingers in the males of the other species, only two minute setae are present in *giganteus* at the base of the two projections on the fixed finger.

*Peraeopods* show only a slight difference between the first three and last three pairs, viz. longer setae and shorter claws in the former. This corresponds to what is found in the other species, but *giganteus* has no row of spinulets on dactylus of peraeopod V-VII, and all setae are simple.

*Pleopods* resemble those of *serratispinosus hadalis* (fig. 29 d), but the basal joint is longer and without setae, and the inner ramus is somewhat broader.



Fig. 20. *Neotanais giganteus*, 3 type; a, left maxilla; b, left maxilliped; c, epignath of left maxilliped.

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Fig. 21. Neotanais serratispinosus hadalis n. subsp., male A; the deepest recorded tanaid (Kermadec Trench, 8210 m).

#### Neotanais serratispinosus hadalis n. subsp.

#### Material:

St. 649, Kermadec Trench ( $35^{\circ}16'S$ ,  $178^{\circ}40'W$ ), 8210 m, 14. Feb. 1952. Gear: 6 m sledge trawl. Bottom: grey clay with pumice. Bottom temperature:  $1.5^{\circ}C. - 2$  adult females + 2 adult males.

St. 651, Kermadec Trench (32°10'S, 177°14'W), 7150 m, 16. Feb. 1952. Gear: herring otter trawl. Bottom: brown clay with pumice. Bottom temp.: 1.3°C. – 1 fragment of a female.

The study of the five specimens from the greatest depths from where tanaids have so far been collected has caused me much trouble. As will appear from the descriptions given below they differ only sligthly from *N. serratispinosus* (Norman & Stebbing). With some hesitation I have therefore decided to regard them as belonging to a subspecies of *serratispinosus*; in the remarks on p. 217 I have discussed in detail the affinity of this new subspecies to *serratispinosus* and to a few other related species of *Neotonais*.

#### Description of female type:

Body (fig. 22a) only moderately elongate, being 7.3 times longer than broad. The integument is everywhere strongly calcified, giving the animal a very robust appearance. The colour is purely white. *Carapax* only a little longer than broad; it is al-

most as long as peraeonites 2 and 3 together. The dorsal surface is rather vaulted and with a low, oblique furrow on each side, shown in fig. 22a. Anteriorly is a short, blunt rostrum, and at the outside base of the antennulae the small eye-lobes are clearly visible; in side view they appear oval and a little curved in shape, with straightly cut off base (cf. fig. 43a, p. 222). At the insertion of the chelipeds there is a conspicuous coxal plate. There are four slender setae on the anterior, vaulted area laterally.

*Peraeonites* (fig. 22 a) equally wide; the longest is peraeonite 5, but 4 and 6 are almost as long, 3 is a

little shorter, 7 the shortest but one, and 2 the shortest, being  ${}^{3}/{}_{5}$  of peraeonite 5 and twice as broad as long. The shape of the peraeonites is almost quadrangular, and they are evenly rounded ventrally.

*Pleonites* (fig. 22 a) resemble those in *serr. serratispinosus* and *affinis* (WOLFF 1956b); they are short and broad and almost equally wide; ventrally they are evenly rounded.



Fig. 22. Neotanais serr. hadalis n. subsp.; a, female type specimen; b, male A.



Fig. 23. Neotanais serr. hadalis n. subsp.,  $\varphi$ ; a, pleotelson and uropods from below; b, right antennula from above; c, left antenna from below.

*Pleotelson* longer than the two preceding pleonites and 1.3-1.4 times broader than long. On the dorsal surface are a few very inconspicuous setae. The anal doors are not visible from above. They occupy a triangular area on the ventral side (fig. 23 a) which is evenly rounded. The posterior projection is furnished with three short setae. The total length of pleon is a little greater than in *s. serratispinosus*, covering the combined lengths of peraconites 7 and 6 + a little more than half of 5.

Antennula (fig. 23b). There are six horizontal setae on joint 1 and four on 2, besides five thin setae on the lower side of joint 2. The third joint is about

as long as broad. The first joint of the flagellum is considerably longer than the three succeeding ones.

Antenna (fig. 23 c) has joint 2 longer than 1, and besides the subterminal, stiff setae on joints 2, 3, and 5 there are a few thin, feathered setae on joints 4 and 5.

Labrum more tongue-shaped than in H. kirkegaardi (figs. 37b & 42f) and with a row of very short setae along the outer margin. The bulbous part smaller and with less developed lateral convexities.

*Mandibles* very broad and almost diamond-shaped in frontal view (fig. 24a), because they are furnished with a strong convexity on the anterior margin, thus



Fig. 24. Neotanais serr. hadalis n. subsp., ♀; a-d, left mandible; a, seen from inside; b, incisive part from outside; c, frontal view of movable lacinia; d, seen from the side; e-f, right mandible; e, seen from the side; f, incisive part from outside; g, outer margin of molar process of left and right mandibles.



Fig. 25. *Neotanais serr. hadalis* n. subsp., ♀; a, right maxillula; b, right maxilla; c, right maxilliped; d, right side of labium.

augmenting the size of the cavity for insertion of the muscles. Pars incisiva of left mandible (fig. 24b) with one blunt tooth. There are five teeth of varying size in the movable lacinia (c). Both spines in the spine-row with tiny hairs (d). The molar process is almost triangular in section (a) and its surface is rough with small nodules. The right mandible (e & f) has a rather pointed tooth on the otherwise almost straight incisive part; of the three translucent spines the innermost is pointed and broad, looking very much the same as the apodemes of for instance a lobster. The other two spines with short hairs. The lower distal margins of the molar processes are peculiarly serrated and not quite equal (g).

*Maxillula* (fig. 25a) has four setae on the internal endite; the three short ones are not feathered and two of them have one minute seta on the exterior side (difficult to see). Both the interior and exterior endites have fine hairs along the outer margin. No palp could be found.

Maxilla (fig. 25b) with the fixed lobe furnished



Fig. 26. Neotanais serr. hadalis n. subsp., ♀, left maxilliped; oblique view of attachment-plane, upper and anterior margin of endite and three first joints of palp.

with two forked spines and five setae; all the setae on the maxilla are very minutely feathered (only visible at great magnification). The distal part of the inner margin and the proximal part of the outer with small denticles and the outer margin besides with fine hairs.

*Labium* (fig. 25d) has two interior, rounded convexities on each side, both with short, closely set hairs. Distally on the antero-lateral plates are two peculiarly shaped setae.

Maxilliped (fig. 25c) with the first joint of the basal part very short and furnished with two very long and closely set setae. On the distal margin of the endite there are one feathered and one simple, downward bent seta and four short, stout spines at the inner corner, where there is also a tuft of delicate hairs (fig. 26). The inner margin of basis and endite is bent at right angles to the surface, thus forming a smooth attachment-plane against the other max-



Fig. 27. Neotanais serr. hadalis n. subsp.,  $\varphi$ ; a, left cheliped from the side; b, cutting edge of fingers.



Fig. 28. a, Neotanais serr. serratispinosus (Norman & Stebbing); spine on peraeopod V of  $\varphi$  from Ingolf St. 22; b-d, N. serr. hadalis n. subsp.,  $\varphi$ ; b, right peraeopod II, seen from the interior side; c, left peraeopod III from the anterior side; d-e, terminal spines on propus of peraeopods III and V, much enlarged.

illiped. Along the distal end of the upper margin of this plane are six feathered setae (fig. 26). The armament with setae on the palp is shown in fig. 25c. The epignath is completely like that of *H. kirke-gaardi* (fig. 42c-e).

Cheliped (fig. 27a) almost as in N. s. serratispinosus, barfoedi, and pfaffi; in all these forms the hand is exactly twice as long as broad. Carpus with a conspicuous row of setae. The inner half of the cutting edge of the fixed finger with very fine denticles (fig. 27b), the outer with five irregular, blunt teeth. On the movable finger the low convexities along the inner margin are irregular.

Peraeopod II (fig. 28 b) has nine rather long spines on the interior side of carpus; four of them are subterminal and serrated, and one of these only half as long as the remaining ones. There are eight slender spines with very few scattered hairs exteriorly. Propus has five interior and three long terminal spines, all of which are strongly serrated. Furthermore, there is a short, comb-shaped spine terminally, and five long and slender spines without serra-



Fig. 29. *Neotanais serr. hadalis* n. subsp.,  $\Im$ ; a, left peraeopod V obliquely from outside; b, dactylus and claw of peraeopod V; c, end of propus of right peraeopod VII from behind; d, right pleopod 5.

tion along the exterior margin. On the proximal, inner margin of propus is a row of small denticles. The claw is very short, being less than one fifth of dactylus in this and the two following peraeopods.

Peraeopod III (fig. 28c) has merus considerably shorter than in II, but carpus and especially propus are longer (in fig. 28c propus is viewed under an oblique angle so that it appears shorter than in peraeopod II). There are eight rather short, serrated spines in one oblique row on the interior-posterior side of carpus (not visible in 28c) and twelve long, slender spines on the exterior margin. Propus has altogether ten stout, strongly serrated spines along the inner margin, one short comb-shaped spine with six teeth, and next to it two long, slender spines which are extremely finely serrated (only visible at very high magnification – fig. 28d). Then follows a row of twelve closely set, long, slender spines along the outer margin.

*Peraeopod IV* only differs from III in having no less than ten serrated, inner spines and fifteen outer, forming one very long, u-shaped row.

Peraeopods V-VII have the serrated spines almost as strongly serrated as in peraeopods II-IV (fig. 28e), and thus considerably more serrated than in *s. serratispinosus* (fig. 28a). The armament on carpus and propus of V-VII is shown in fig. 29a. There are six non-serrated spines terminally on propus and they are rather short. The spinulets on dactylus are exactly as in *s. serratispinosus* (NORMAN & STEB-BING 1886, pl. 23, I prp. 4), but the claw is comparatively shorter and not serrated (29 b). Along the distal end of propus in VII is a row of very short and closely set spines (c), almost like a finely toothed comb.

*Pleopods* (fig. 29d) of the same shape as in *s. serratispinosus*, but with considerably more plumose setae (the two figures of pleopods on plate 23 in NORMAN & STEBBING 1886 are incorrect).

Uropod (fig. 23 a) rather stout,  ${}^{2}/{}_{3}$  as long as pleon and with the exopodite  ${}^{2}/{}_{3}$  of the length of joint 1 of the endopodite.

#### Description of male (A):

Only *differences* between this male and the female type are mentioned below.

*Carapax* (fig. 22b) differs greatly. It is more elongate (1.5 times longer than broad), primarily owing to the considerably long, flattened front part. The posterior margin is strongly concave. The two anterior, oblique furrows are connected posteriorly by a transverse furrow from which two diverging furrows run to the postero-lateral corners of the



Fig. 30. Neotanais serr. hadalis n. subsp., ♂ A; a, right antennula from above; b, lateral view of flagellum; c, right antenna from below.

carapax. Finally, there is an inconspicuous furrow across the base of rostrum.

*Peraeonites* (fig. 22b) narrower in front and with a strong convexity at the insertion of the peraeopods. Peraeonite 2 relatively longer than in female. Especially the anterior peraeonites somewhat excavated in front. The genital openings on peraeonite 7 are found on two low protuberances on a common convexity near the posterior margin.

*Pleonites* (fig. 22b) decreasing in width from the first to the fifth and the posterior margin becoming less concave. The first segment is a little longer than the rest.

*Pleotelson* with no setae dorsally and on the posterior projection. Ventrally, it has anus totally calcified and only marked as a longitudinal furrow as in *giganteus* (fig. 19b), but reaching forward half way to the anterior margin. From the anterior margin to the front end of the anal furrow is a low, median impression.

Antennula (fig. 30a) much more slender and with longer horizontal setae. On the underside of the first joint of flagellum there is a rather insignificant projection with not very many, but rather stout aesthetes (fig. 30b).

Antenna (fig. 30c) only a little more slender than in the female, especially joint 1 (which is rather compressed) and joint 2. There is only one, slightly feathered, ("auditory") seta on joint 4 and 5; the latter joint has some very long setae distally.



Fig. 31. *Neotanais serr. hadalis* n. subsp.; a-b, male A; a, left maxilla; b, left maxilliped; c, right maxilla of male B.

*Mandibles* reduced and totallyfused with the buccal frame (cf. fig. 43, p. 222). *Maxillula* not developed.

*Maxilla* (fig. 31 a) rather different from that of the other species in which it was described. It has two equally long, distal lobes, the outer with three and the inner with five setae, a low inner projection with two or three setae and two more, inner setae further proximally.

*Maxilliped* (fig. 31 b) with the first short joint fused with the buccal frame. The somewhat convex distal margin of the endite has one seta near the outer and one or two minute spines near the inner corner. The palp is much more slender than in the female and in most other males of *Neotanais* and with only a few, short setae; especially the fifth joint is very elongate. Epignath as in female.

Cheliped (figs. 21 and 32 a) much longer and more slender than in female. Hand almost three times



Fig. 32. Neotanais serr. hadalis n. subsp., 3, hand of left cheliped from outside; a, of male A; b, of male B.

longer than broad and very much like that in *s. serratispinosus*, but more vaulted along the proximalexterior margin, and the keel on the exterior margin is much less serrated. The fixed finger differs in having the stout, distal process in *s. serratispinosus* (NORMAN & STEBBING 1886, pl. 24, II gn.) substituted by four low, distally decreasing protuberances.

Peraeopods with the same shape and almost the same armament with spines as in the female. There are the following major differences: The very short, terminal spine on propus of peraeopods II-IV, which is comb-shaped in the female, is simple; the long and non-serrated spines on the exterior margin of carpus and propus of III and IV (fig. 28c) are considerably shorter and feebly serrated in the male,<sup>1</sup> thus resembling those of the interior row of the joint, all the more since the interior spines are not so serrated as in female; nor is the difference between the lateral and terminal spines of V-VII so great as in the female, the terminal spines are shorter, the claw is shorter, and the collar of spinulets on dactylus is minute; the comb of very short spines along the distal margin of propus of peraeopod VII is almost invisible.

#### Sice:

The female type is 15.0 mm long and 2.0 mm broad across carapax. The above described male (A) is 15.7 mm long and 2.1 mm broad; the other female from St. 649 is 15.1 mm long, the other male (B) is 15.5 mm; the female from St. 651 is about 9 mm long.

<sup>1.</sup> When light is transmitted, under high power, the outer end appears to be covered with minute prickles – as described for N. *hastiger* by NORMAN & STEBBING (1886, p. 113).

Variation in adult females:

The two females from St. 649 are practically identical. A careful examination shows that the other female varies from the type in the following respects: Antennula with only three horizontal setae on joint 2; the two spines in the spine-row of left mandible are as long as the movable lacinia, the larger is only slightly curved, and the smaller not so pointed; margin of pars molaris equal in left and right mandibles and almost corresponding to that of left mandible of the type (fig. 24 g); in maxillula the two setae on the interior endite have no visible setae on the outer side and one of the spines on the exterior endite of right maxillula is subterminal (fig. 33; this is, however, no doubt an abnormality); armament of maxillae equal in the two specimens, but the margins are more parallel, and the fixed endite more projecting in the female, which is not the type; finally, it has only five feathered setae on the upper margin of the attachment-plane of the maxillipeds. No other differences could be found.

From St. 651 is a fragment only of a female, so nothing definite can be said of the position of this specimen. It probably belongs to this subspecies, counting from the shape of body and of the five pairs of peraeopods present. However, it differs in one respect: The uropods are considerably longer (almost as long as pleon as against less than  $^{2}/_{3}$  as long as pleon in the type), with the exopodite only a little shorter than the first joint of the endopodite.

#### Variation in adult males:

As in Apseudes galatheae and A. gracillimus (p. 206) there is an even transition in many of the characters normally distinguishing males and females. The other male (B) of serratispinosus hadalis from St. 649 shows a remarkable mixture of female ( $\Im$ ) and male ( $\mathcal{J}$ ) characters, as shown in the following survey:

Carapax broad and flattened (3), but with the transverse furrow only feebly indicated. – Peraeonites almost square ( $\mathcal{Q}$ ), only the corners a little more rounded and the segments more vaulted; ventrally on peraeonite 7 a convexity with the genital openings on two low protuberances (3). – Pleonites half way between  $\mathcal{Q}$  and 3. – Pleotelson with short setae posteriorly ( $\mathcal{Q}$ ) and on the ventral side with a big, uncalcified anal face ( $\mathcal{Q}$ ), but the cleft-shaped anal opening is apparently substituted by a small round hole; an inconspicuous median furrow to-wards the anterior margin of pleotelson (3).

Antennula with the first two joints half way between  $\mathcal{Q}$  and  $\mathcal{J}$  (there are seven and three horizontal setae), but the flagellum is exactly as in male A. – Antenna half way between  $\mathcal{Q}$  and  $\mathcal{J}$ .

Mandibles show a remarkable transition from the highly specialized mandibles of the female to the calcified rudiments totally fused with the body wall, found in male A. Left mandible is broader and shorter than in  $\mathcal{Q}$  (fig. 34 a) and perfectly excavated interiorly. There is no molar process but only a rounded ridge, and in the outer surface a deep, broad, almost transverse furrow (fig. 34 b). Distally, the mandible has a rounded process and two translucent spines (a-c). The right mandible (d) is less modified; the incisive part is present and shaped as in  $\mathcal{Q}$ , although narrower; the three translucent spines are well developed, but the two narrow ones are only furnished with a few short hairs and the broad one is bifid. The molar process is present but rudimentary, and the lower, distal margin is quite different (e). There is the same broad exterior furrow as in the left mandible (d).

Maxillula not developed. - Maxilla (fig. 31 c) also



Fig. 33. Neotanais serr. hadalis n. subsp.; outer end of maxillula of the other female from St. 649.

Fig. 34. Neotanais serr. hadalis n. subsp.; mandibles of male B; a-c, left mandible;
a, seen from inside; b, lateral view; c, apex obliquely from outside; d-e, right mandible;
d, lateral view; e, distal margin of molar process.

exhibits an interesting transition between  $\mathcal{Q}$  and  $\mathcal{J}$  maxillae. The two lobes of the movable endite are fused and have three and six setae respectively. The fixed, rather insignificant endite has no forked spines but five setae of varying thickness. – *Maxilliped* very close to that of  $\mathcal{Q}$ , but the joints of the palp are a little more elongate (especially joint 5) and there is one seta less on joints 3 and 4.

*Cheliped* (fig. 32b) of the same type as in male A, but differs in the following respects: Proximal part of hand broader and more vaulted, the keel on the exterior margin not serrated and entering for a short distance the outer surface of the hand; fixed finger much shorter and with no protuberances distally, but with more setae; movable finger somewhat shorter and with one more triangular process.

*Peraeopods* also between  $\bigcirc$  and  $\Im$ : The short terminal spine on II-IV is finely combed, the non-serrated spines found in  $\bigcirc$  are all minutely serrated, an extremely fine comb of short spines distally on dactylus of VII, etc.

The question of possible hermaphroditism in this and other species of *Neotanais* will be discussed in the following chapter (p. 230).

#### Remarks:

As pointed out above the similarities between the species N. serratispinosus (Norman & Stebbing) and the five specimens from the Galathea are so striking that I chose to refer the specimens to a subspecies of serratispinosus. Of the latter species there only exist a few specimens from NORMAN & STEBBING'S collection (including the male type and only individual of laevispinosus, which LANG (1956) transferred to serratispinosus). These specimens are kept in the British Museum (Nat. Hist.), London, and in Oxford, and unfortunately I have not had access to any of them; however, Professor Lang has kindly answered various questions relating to these specimens, while he still had them on loan from London. Moreover, we have in this Museum the mature female of serratispinosus from the Ingolf Expedition (HANSEN 1913, p. 18), and besides the species is well described and figured by NORMAN & STEBBING (1886) and LANG (1956).

Based on these various sources I have undertaken a very careful comparison, which showed a striking similarity in all major features. Before pointing out the differences which in my opinion justify the separation in two subspecies I shall mention several features which are probably all non-specific, because variation is found between the NORMAN & STEBBING and the Ingolf specimens or within the same organs in *H. kirkegaardi* of which a large material was collected by the Galathea, and thus made possible a study of the variation. In the following "N. & S." refers to one or more specimens from NORMAN & STEBBING'S collection (according to literature or verbal information from Professor LANG), "Ing." refers to the mature specimen from the Ingolf Expedition and kept in this Museum, and "had." to the type specimen and male A from the Galathea Expedition.

FEMALES. Length/width of body: N. & S. and had. 7.3, Ing. 10.3 times longer than broad. - Ventral side of body: Evenly rounded in N. & S. and had., with a low subcarinate keel in Ing. - Length/width of joints of peduncle of antennula: According to my fig. 23b and LANG's fig. A 1 (1956) greatly different but another specimen from N. & S.' collection shows the same proportions as in fig. 23b. - Largest tooth on movable lacinia of left mandible: Considerably more projecting in N. &S. (LANG's fig. A7) than in had. (my fig. 24c), but the mov. lac. of Ing. is practically identical with that of had. - Spines in left mandible: Equally shaped in N.&S. and Ing., but in the latter without the short hairs; spines in right mandible: Equally shaped in had. and Ing., but in the latter without hairs; in H. kirkegaardi I have found a great variation in the shape and furnishment with hairs on the mandibular spines. - Pars incisiva of right mand.: Identical in N. & S. and Ing. and different from had. (24e), but individuals of kirkegaardi show a similar variation. - The short setae of inner endite of maxillula: Not feathered in Ing. - Fixed endite of maxilla: Three bifid spines in N. & S., two only in had. and Ing.; three feathered and one unfeathered seta in the latter specimen. - Armament with spines and setae on endite of maxilliped: Identical in had. and Ing.

I shall then turn to the *differences* between the N. & S. and Ingolf specimens on one side and the Galathea specimens on the other. According to my knowledge of variation in Neotanaidae, based on the study of altogether eight species, I consider these differences, slight as they are, sufficiently stable and significant to justify the separation of the above named specimens in two subspecies. The differences are:

#### Females.

(1) Peraeonite 2 two times broader than long in *serr. hadalis*, three times broader than long in *serr. serratispinosus*. (2) Labium of *s. had.* with two distinct, setiferous, inner convexities (fig. 25 d), of *s. serr.* with one only (LANG's fig. A 11).

(3) Number of serrated spines on all peraepods considerably larger in *s. had*.

(4) Peraeopods V-VII with much more strongly serrated spines in *s. had.* (fig. 28 e) than in *s. serr.* (28 a).

(5) A row of thirteen short spines terminally on propus of peraeopod VII in *s. had.*, nine only in *s. serr*.

(6) Uropoda in *s. serr*. very slender (NORMANN & STEBBING 1886, pl. 24, I D) and as long as pleon, in *s. had*. (from St. 649) twice as stout and at most 2/3 of pleon.

(7) Total length of fully developed females and males: QQ of *s. had.* 15-15.1 mm.,  $\Im$  15.7 mm; QQ of *s. serr.* 6.7-8.5 mm,  $\Im$  5.5 mm.

Males.

(8) Collar of spinulets on dactylus of peraeopods V-VII in males of *s. had.* considerably weaker than in females, in *s. serr.* as strong as in females (LANG'S fig. B 3).

Also the shape and armament of the male maxilla differs (my fig. 31 a and LANG's fig. B 2), but owing to the scarcity of males not only of the present subspecies, but also of other species of *Neotonais* I have not been able to study the variation in male maxillae.

The above named differences should perhaps also involve that the Ingolf specimen of *serr. serratispinosus* was separated from the NORMAN & STEBBING specimens as a new subspecies. Having, however, not had access to the latter type material I have not found it possible to consider this question sufficiently carefully.

It was very astonishing to find *N. serratispinosus* hadalis from the S. W. Pacific and from the greatest depths (8200 m) to be almost identical with a species occurring in the North Atlantic and at moderate depths (700-3500 m). Perhaps the most striking fact is that the only male known of *serr. serratispinosus* has been dredged at a bottom temperature of about  $10^{\circ}$ C., while neither *serr. hadalis* nor any of the other ten species of *Neotanais* have ever been found at temperatures exceeding  $3.3^{\circ}$ C. (see discussion on p. 232). This fact seems to indicate that what I have called two different subspecies are probably physiologically separate species, but no morphological features known to me allow a separation.

N. serr. hadalis resembles robustus in shape of the

mandibles and *barfoedi* in armament of the peraeopods (WOLFF 1956b). Both these species were also collected in the Kermadec Trench (at 4400-4600 m and at 2500-2600 m).

#### Distribution:

*N. serr. hadalis* is known only from the Kermadec Trench N.E. of New Zealand from a depth of 7150-8210 m (thus being the deepest recorded tanaid) and from temperatures of 1.3-1.5 °C.

#### Herpotanais<sup>1</sup> n. gen.

#### Diagnosis:

Female. Carapax as in Neotanais, but peraeonites and pleonites more elongate. Pleotelson with depressions ventrally. Antennula and antenna stouter than in Neotanais, and the former with a five-jointed flagellum. Mouth-parts as in Neotanais, except that the spines on the fixed endite of maxilla have a more complex shape. Appendages almost corresponding to those of Neotanais, but no comb of short spines on the distal end of propus of peraeopod VII. Pleopods reduced, with two short joints and a few short setae. Uropod with a very long, stout peduncle; exopodite very short, endopodite with at most six, rather stout joints.

*Male.* Genital openings interiorly on two short, longitudinal keels. Pleotelson with a depression ventrally. Antennula has a five-jointed flagellum, but is more elongate than in female; first joint of flagellum very large, with a distal projection furnished with aesthetes. Antenna with nine joints as in female, but more slender. Maxilla and maxilliped rather much as in *Neotanais*. Cheliped not much differing from that of the female, either in slenderness or in length or armament with teeth on the fingers. Peraeopods, pleopods and uropod almost as in female.

#### Remarks:

Even if this genus is very closely related to *Neotanais*, the totally different arrangement of the male genital openings, the number of joints in the flagellum of the antennulae, the differently shaped uropods, and the reduction of the pleopods in *Herpotanais* clearly separates it from *Neotanais*. The presence of reduced pleopods in both sexes is surprising, and as far as I know this is the first instance of reduction of the *male* pleopods in Tanaidacea.

1. From ἕρπω, creep.



Fig. 35. Herpotanais kirkegaardi n. gen., n. sp. from the Kermadec Trench, 7150 m; a, female type specimen; b, male Z. H.V. CHRISTENSEN phot.

#### Herpotanais kirkegaardi n. sp.

Material:

St. 651, Kermadec Trench  $(32^{\circ}10'S, 177^{\circ}14'W)$ , 7150 m, 16. Feb. 1952. Gear: herring otter trawl. Bottom: brown clay with pumice. Bottom temperature:  $1.3^{\circ}C. - 19$  adult females (complete) + 3 incomplete females; 4 adult males (complete), + 2 incomplete males; 11 preadult specimens; in all 39 specimens.

#### Description of female type:

Body (figs. 35 a and 36 a) extremely elongate, being 10.7 times longer than broad. It is smooth both dorsally and ventrally, with no spines and only a few minute hairs. Colour of integument purely white as in N. serr. hadalis.

Carapax pear-shaped, 1.3 times longer than broad. It is as long as peraeonite 2 and half of 3. The two oblique furrows on the dorsal surface, the eye-lobes and the coxal plates as in N. s. hadalis (fig. 43a).

*Peraeonites* of nearly the same width, except the seventh which is a little narrower. Peraeonite 6 is the longest, 4, 5, and 7 are equally long, 3 somewhat shorter and 2 only a little more than half as long as 6. The shape is almost rectangular with rounded corners and a convexity at the insertion of the legs. Peraeonite 2 has a transverse excavation in front.

*Pleonites* (figs. 35 a and 36 a) are equal in size and shape, apart from the fact that 1 and 5 are a little longer than the rest and have a lateral impression at the anterior and posterior end, respectively. On the lateral convexities at the insertion of the pleopods there are 1-3 short setae with scattered, fine hairs.

Pleotelson almost twice as long as each pleonite, with slightly divergent lateral margins to at the insertion of the uropods. Beyond these there is a strongly vaulted projection with the anal opening terminally. The posterior margin is dorsally slightly concave with a minute central pro-

Fig. 36. *Herpotanais kirkegaardi* n.sp.; a, female type; b, male Z.





Fig. 37. *Herpotanais kirkegaardi* n. sp.,  $\wp$ ; a, pleonite 5, pleotelson and uropods from below; b, base of antennulae and antennae, labrum and mouth cavity from below.

jection, furnished with a very short seta. On the ventral side (fig. 37a) the posterior margin of the projection is strongly concave so that the anal doors are clearly visible. The ventral surface of pleotelson has a pair of circular depressions between the anterior margin and the insertion of the uropods; near the latter is a row of four short setae.

The total length of pleon is like that of peraeonites 5-7 combined.

Antennula (fig. 38a) has the first joint slightly curved; it is somewhat swollen at the base and with short and fine, closely set hairs interiorly. There is a row of six long, stiff horizontal setae near the distal, outer corner. Joint 2 about one third of 1 and comparatively shorter than in N. s. hadalis; it has



Fig. 38. *Herpotanais kirkegaardi* n. sp.,  $\mathcal{Q}$ ; a, right antennula from above; b, left antenna from below.

two long and two shorter setae on the outer margin and four much thinner and somewhat shorter setae on the lower side. Joint 3 half as long as 2 and about as long as broad. It has a strong, curved seta near the distal, outer corner and a couple of small setae. The first joint of the flagellum is almost as long as the four succeeding ones; each of the latter with one terminal, olfactory hair except the last joint which bears two short setae.

Antenna is inserted directly below and posterior to the antennula (fig. 37b). It is much stouter and also comparatively longer than in the species of *Neotanais* (fig. 38b). The second joint is even shorter than the conical first one and only  $2^{1}/_{2}$  times as long as broad. This and the following joint have a long,



Fig. 39. *Herpotanais kirkegaardi* n. sp.,  $\Im$ ; a-e, left mandible; a, from inside; b, cutting edge from outside; c, frontal view of movable lacinia; d, from anterior side; e, distal margin of molar process from above; f-g, right mandible; f, from anterior side; g, cutting edge.

stiff, subterminal seta directed obliquely forwards and upwards. Joint 4 and 5 subequal and like 2, but a little shorter and narrower; joint 5 with three long setae on the distal, ventral side. There are five joints in the flagellum of the left antenna, and the usual four in the right. There are two short setae terminally.

Labrum strongly projecting, forming a bulbous closure of the front part of the oral cavity (fig. 42f). Seen from below (fig. 37b) the anterior "lip" shows its rounded terminal end, and the bulbous part has two lateral convexities which give it an almost quadrangular appearance.

*Mandibles* short and very thick in frontal view (fig. 39a). Pars incisiva of left mandible (39b) with one blunt tooth which does not project so much as the largest of the blunt teeth on the movable lacinia. Besides the large tooth, the latter has three more teeth, two of which are, however, rather inconspicuous (c). The spine-row counts two short and simple, translucent spines without hairs on the margins. The molar process is stout and has the end obliquely cut off and irregularly serrated along the lower margin (d-e). The right mandible differs in having a conspicuous denticle on the incisive part which makes it almost chisel-shaped (g); the spine-row consists of two simple, hairless spines and a broad spine as in *Neotanais* (f).

*Maxillula* (fig. 40 a) with a well developed internal endite which distally is furnished with three short



Fig. 40. Herpotanais kirkegaardi n. sp., ♀; a, right maxillula; b, right maxilla.



Fig. 41. *Herpotanais kirkegaardi* n. sp., ♀; labium; a, frontal view; b, from the anterior edge.

and a long seta, the latter with fine hairs near the tip. Proximally on the inner margin is one rather long seta and there is a row of fine hairs along the outer margin. External endite with a crown of ten spines. I was not able to find any palp which may be missing in this species.

*Maxilla* (fig. 40b) is rather longish, with small denticles on the distal part of the inner margin and fine setae and denticles on the outer. The two lobes of the movable endite have three and five unfeathered setae, respectively. On the fixed endite are three to four simple setae and two stout, furcated spines which are rather unlike the bifid spines found in *Neotanais* (fig. 51 a, p. 228). There are eleven setae in the inner row.

Labium (fig. 41 a-b) almost as in N. s. hadalis; when seen from the edge it shows an extraordinary thickness (fig. 41 b).

*Maxilliped* (fig. 42a) with two joints in the basal part; the proximal is very short, the second almost quadrate and totally fused with the endite and at the same time firmly attached to the corresponding joint of the other maxilliped. Near the outer, distal corner of the endite is a single, short seta, and on the inner corner two tiny processes and three short, oblique spines (42b). The upper margin of the attachmentplane has three feathered setae on each maxilliped. The palp with five stout joints armoured with setae (a) and with fine hairs which give the whole palp a somewhat "woolly" appearance. The epignath (c-e) curved at an angle of 90°, with a dense tuft of fine setae distally, but with no distinct lobe anteriorly as in *N. s. serratispinosus* (LANG 1956, fig. A 14).



Fig. 42. Herpotanais kirkegaardi n. sp.,  $\Im$ ; a, maxillipeds; b, inner corner of endite seen obliquely from the inner side; c-d, epignath in frontal view and from the edge; e, distal end of epignath in frontal view; f, labrum from the side (v, first joint of antenna; y, cavity for (removed) left mandible).

Cheliped (fig. 43a) very similar to that of N. s. hadalis, although more slender. The swollen basis is also still larger, being more than two thirds of the length of carpus; the latter joint has subparallel margins and is about one fifth shorter than propus. This is only a little more than twice as long as broad. Upper margin of propus with a low, sharp keel stretching from the insertion of the movable finger almost to the proximal end of the joint. At the insertion of the finger there is a seta on the in-



Fig. 43. Herpotanais kirkegaardi n. sp., ♀; a, anterior part of body, cheliped and peraeopod II; b, fingers of cheliped.

terior side. The fixed finger has the inner half of the cutting edge (43b) absolutely straight without denticles (as found in *N*. *s. serratispinosus* and *s. hadalis*), and the outer half consisting of five irregular, blunt teeth of which the two distal ones are only half as large as the remaining ones and slope downwards to base of the stout, brown-coloured terminal part; four short setae issue from the side of the finger and two near the outer base of the terminal part. The movable finger with a wavy inner margin and a long claw; a seta is found on the inner side, not far from the insertion.

*Peraeopods* with two types of spines: serrated (fig. 44a) and simple which may or may not be furnished with scattered hairs. The spines are placed in rows on carpus and propus, and their number in each row varies to some extent from one specimen to another. In the following description their exact number has been given only in the female type.

Peraeopod II (figs. 43 a and 44 a) with rather strongly curved basis. Carpus has on the interior side four short spines and three subterminal spines one of which is only half as long as the others (one only visible in 44a); besides, the joint is furnished with a row of seven long, slender spines with scattered, fine hairs. Propus with three spines on the inner margin and with three subterminal spines of increasing length; the distal half of these six spines as well as of the three subterminal spines on carpus are very finely serrated along both margins (44 a). Terminally there is on propus a short comb-shaped



Fig. 44. *Herpotanais kirkegaardi* n. sp.,  $\varphi$ ; a-f, left peraeopods; a, II obliquely from behind; b, III from the side; c, V obliquely from in front (with rudimentary oostegite); d-e, distal end of dactylus and claw of V; f, VI from the side; g, left pleopod 1.

spine almost equal to that found for instance in N. s. serratispinosus (NORMAN & STEBBING 1886, pl. 23, I gn. 2). Finally, propus bears an outer row of six long, slender spines, three of which have scattered, fine hairs. Dactylus in this and the two following peraeopods simple and the claws as short as in N. s. hadalis.

Peraeopod III (fig. 44 b) with the same proportionate lengths of joints as in N. s. hadalis. On carpus there is a row of seven-eight spines on the inner margin and a curved, subterminal row of nine long, feathered spines. Propus with eight inner spines and with the same three stouter spines and a short combshaped spine terminally as in II. There are nine long, slender spines in the outer row.

Peraeopod IV equal to III, but with eight short, inner spines on carpus. Propus with altogether ten inner, serrated spines, one short, comb-shaped and at least ten long and slender outer spines; all the spines on propus form a continuous u-shaped row, bending round the apex outside the insertion of dactylus.

Peraeopods V-VII (fig. 44c and f) have the same

general shape. On the short and stout merus there are four short exterior and two short interior spines. On carpus there are an oblique exterior and interior row of serrated spines and three-five somewhat longer spines (with scattered hairs) at the distal end of the latter row. On propus a continuous row of spines runs round the apex; there are five long, slender spines terminally, and at both ends of this row a varying number of serrated spines along the margins. No short, comb-shaped spine is found terminally. Dactylus (44d-e) with only about twelve inconspicuous spinulets at the base of the claw which is nearly as long as dactylus. Dactylus + claw almost as long as propus.

*Pleopods* (44g) reduced, with two short, thick joints only which are furnished with a number of setae (with scattered, fine hairs) as shown in the figure.

Uropod (fig. 37a) with a long, cylindrical, somewhat curved peduncle and a minute, two-jointed exopodite. The endopodite is one third longer than the peduncle and consists of five subequal joints in the type specimen. Description of male (Z):

In the following description only the *differences* between the sexes will be mentioned.

Body (fig. 35 b and 36 b) seems even more slender than in the female (probably owing to the more elongate carapax), but is actually also 10.7 times longer than broad.

*Carapax*, as mentioned, more elongate being 1.6 times longer than broad. Besides, there is a distinct transverse furrow connecting the two oblique furrows also found in the female, and a straight, inconspicuous furrow across the base of the rostrum.

*Peraeonites* (fig. 35b and 36b) with much more convex lateral margins. They all have a transverse excavation in front, and from the posterior base of the projections for the insertion of the peraeopods a distinct, although short furrow continues onto the dorsal part of the segment. The relative length of the peraeonites is almost the same as in the female.

On the posterior third of the ventral side of peraeonite 7 (fig. 45a) the paired genital openings are found, each of which is situated on the interior side of a low and short keel. *Pleonites* equal in dorsal view, but while in the female they are almost cylindrical, seen from the side, they are in the male (fig. 45a) more excavated posteriorly on the ventral and lateral sides.

*Pleotelson* of the same shape as in female, but the posterior projection and the anal doors are substituted by two closely set, ball-shaped convexities which are totally calcified. Moreover, there are no circular impressions on the ventral side, but instead a v-shaped, backwards pointing impression, running from near the antero-lateral corners almost to the mutual base of the two ball-shaped convexities. No ventral setae are found.

Antennula (fig. 45 b) considerably more slender, the first joint being for instance almost six times as long as broad and only faintly swollen at the base; there are also fewer setae. The first joint of the flagellum has a large distal projection on the outer side, furnished with a dense tuft of aesthetes which are somewhat longer than the joint. Then follow four much narrower joints of which each of the three proximal bears a long, stout olfactory hair terminally. The very minute last joint has three rather long setae distally.



Fig. 45. Herpotanais kirkegaardi n. sp., ♂ Z; a, lateral view of peraeonite 7 and pleonite 1; b, antennula from above;
c, antenna from below; e, mouth area a little obliquely from below, with maxillipeds and maxillae removed (v, projecting edge of labrum (cf. fig. 42f); x, mouth cavity; y, reduced mandible; z, proximal part of left cheliped).



Fig. 46. Herpotanais kirkegaardi n. sp.,  $\mathcal{J}$ ; a-c, male Z; a, right maxilla; b-c, right maxilliped (c, interior side); d, basal part of right maxilliped of male Y.

Antenna (fig. 45c) also more slender than in the female, but not so slender as in the males of Neotanais. Second joint more than three times longer than broad, and this and the succeeding joint each with two setae instead of one. Joint 5 with three more setae than in the female. Flagellum with four joints.

*Mouth-parts* consist of the rudimentary body of the strongly projecting, totally calcified labrum (fig. 45 d, v), the reduced mandibles (45 d, y), the highly modified maxillae, and the maxillipeds.

*Maxilla* (fig. 46a) much more expanded towards the basal part than in the female, the inner margin being strongly convex and with small denticles. There is only one distinct, distal lobe which is furnished with two groups of simple setae (three and six) and a low inner projection with four to five very short, spine-like setae.

*Maxillipeds* (fig. 46b) are so fused with the buccal frame that they are difficult to remove. There seems to be only one joint in the basal part (the first, short joint probably immovably fused with the buccal frame). There is a seta near the inner, lower corner. As in the female this joint is totally fused with the endite and has on the inner side (46c) a longitudinal, vaulted area, which is abruptly cut off at the base. The distal end of the endite differs from the female in having its greatest extension laterally; also the arrangement with spines and setae distally is somewhat different. The palp is comparatively larger, and the fifth joint is longer and narrower. There are also more spines on joints 4 and 5. Epignath as in female.

*Cheliped* (fig. 47 a) somewhat more slender than in the female, especially basis and carpus; the latter is almost twice as long as basis and more than three times longer than broad; on the proximal, lower corner of carpus there is a rounded projection.



Fig. 47. Herpotanais kirkegaardi n. sp., 3; a-b, male Z; a, left cheliped; b, fingers of left cheliped; c, movable finger of male X; d, fingers of male Y.

Propus also somewhat more slender, being  $2^{1/2}$  times longer than broad. The cutting edge of the fixed finger (47b) has a rounded tooth proximally, followed by a straight edge, which in the middle is broken off by a tiny fissure with one seta. Then follows two more very prominent teeth and yet a small tooth on the distal part of the cutting edge which is bent at right angles to the preceding part of the edge. The terminal, brown-coloured part is bent somewhat upwards. On the outer side of the fixed finger there are two more, closely set setae, on the inner side near the gap between the fingers there is one seta, and on the underside there are three setae instead of two in the female. The movable finger with five rounded teeth on the proximal part of the cutting edge and with a slightly irregular, distal part. The movable finger is not nearly so curved as in the males of N. giganteus and s. serratispinosus.

*Peraeopod II* as in the female, but there are only five long spines on carpus and they have no scattered hairs. The same applies to the long spines on propus as well as to the long spines on all the succeeding peraeopods in the male. Moreover, the three stout spines on the lower margin of propus (of II) are substituted by four slender spines, and the short, distal spine is not comb-shaped.

*Peraeopod III* only differs (apart from the above named differences) in having seven long spines on carpus and in having the short spine on propus more slender.

*Peraeopod IV* also equally shaped, except that the spines on the anterior side of propus are considerably shorter.

*Peraeopods V-VII* differ from those in the female in the following respects: carpus has about eight equally long spines and the claw is less than half as long as dactylus which has a simple apex distally, without spinulets.

Uropods in Z (and the other males) with more elongate joints (fig. 52) and with more setae on these. Most of the males also appear to have a maximum number of joints (table 4).

#### Size:

The largest female (the type specimen) is 25.0 mm long and 2.4 mm broad; the longest male (Z) is 22.8 mm long and 2.2 mm broad.

#### Development:

Apart from the adult specimens the material comprises eleven specimens which I regard as preadult. Since the development in this family was



Fig. 48. *Herpotanais kirkegaardi* n. sp., specimen A; distal end of peraeopod VI a little obliquely from below.

hitherto unknown I have described these specimens in detail below. Table 4 gives their total length as well as that of the adult specimens.

The various size groups differ from the adult females in the following respects (differences in uropods are mentioned on p. 229):

Specimens A and B. Body considerably less slender being only 7.5 times as long as broad (as against 10.7 in adults). Carapax proportionately longer and much broader than the peraeonites, which are shaped as in adult, except the seventh which is shorter. Pleonites quite cylindrical and almost four times broader than long. Antennula with only three joints in flagellum and with one long and one short lateral setae on first joint of peduncle and one long seta on second. Antenna with four joints in flagellum. Cheliped as in adult female, but shorter and thicker. Considerably fewer and shorter setae on peraeopods, and the collar of spinulets on dactylus of V and VI continuing for a very short distance only towards the base (fig. 48). Peraeopod VII and pleopods totally missing, the position of the insertion being only indicated by a low convexity.

Specimens C and D. Body 8.5 times as long as broad. Antennula with three joints in flagellum and two lateral setae on each of the two first joints of the peduncle. More setae on peraeopods than in A



Fig. 49. *Herpotanais kirkegaardi* n. sp., specimen C; peraeopods VI (setae omitted) and VII, and pleopod 1.

Table 4. Size and particulars of oostegites and
uropods in the material of Herpotanais kirkegaard
n, gen., n, sp.

ni geni, ni spi						
Specimens	Total length mm	Rudi- mentary	No. of joints in endopodites of uropods			
			left	right		
pread. A	8.1	÷	4	4		
– B	8.2	÷	4	4		
– C	11.2	÷	4	4		
– D	11.4	÷	4	4		
– E	12.7	÷	4	4 (5)		
– F	13.2		4	4		
- G	14.3	÷	5	5		
– H	14.3	÷	4	5		
– I	15.4		6	5		
– J	15.7		5	5		
- K	16.6		4	4		
$\bigcirc$ ad. L	17.6	÷	4	4		
– – M	19.6	÷	5	5		
– – N	20.4	÷	`4	4		
– – LL	20.9	+	5	5		
– – MM	21.4	+	6	6		
– – NN	21.8	+	4	4		
O	22.0	- <u></u> -	4	4		
– – P	22.5	÷	6	5		
Q	22.5	<u></u>	5	4		
– – R	22.7	·	5	5		
00	22.9	+	6	6		
S	23.4	<u>.</u>	5	5		
– – PP	23.8	+	5	4		
– – QQ	24.0		6	5		
– – RR	24.2	+	5	5		
– – SS	24.3	+	4	4		
– – TT	24.5	+	5	5		
– – UU	24.6	+	5	5		
– – type	25.0	+	5	5		
o^1 – V	18.3	÷	6	5		
– – W	c. 18.7	÷	6	6		
X	20.3	÷	6	6		
– – XX	c. 20.4	<u>.</u>	6	5		
Y	21.2	÷	6	6		
Z	22.8	÷	5	5		

and B. Peraeopod VII (fig. 49) has one long joint with an indistinct subdivision and one short, terminal joint. Pleopods bud-shaped (49).

Specimens E and F. Body almost as slender as in adult. Antennula with three horizontal setae on joints 1 and 2 of peduncle and with four joints in flagellum. Peraeopod VII with all joints developed, but less than 2/3 as long as VI; dactylus and especially claw very short, their combined length being less than that of propus. Pleopod with two joints, but the second is only half the length of the first and has only two short, terminal setae.

Specimens G and H. Although they are exactly equally long G and H show remarkable differences: In G flagellum of antennula has five joints, and the length of dactylus + claw of peraeopod VII is almost like that of VI, but the pleopods have only three simple setae each. In H the flagellum has only four joints and dactylus + claw of VII are conserably shorter than that of VI, but the pleopods have almost all the final setae present, and they are feathered.

Specimens I-J-K differ from the adults only in the following respects: Four joints in flagellum of antennula, terminal setae on propus of peraeopod VII shorter than dactylus in J and K (but as long as dactylus in specimen I – and adults), and pleopods a little shorter and in K with few setae only.

In L and M the flagellum of the antennula have five joints, and the setae on all peraeopods are fully developed, as are also the pleopods.

#### Variation in adult females:

The only differences between females with and without oostegites which I have been able to find are that the latter females are a little more slender and have a little less rectangular peraeonites than the females with oostegites. In this respect the former stand between the shape of the latter and that of the males (see fig. 36).

A thorough investigation of all the adult females present revealed only very slight differences. A few specimens have a very faint transverse furrow across carapax but by far not so marked as in the males. The same specimens have also, besides the two circular depressions on the ventral side of pleotelson, a v-chaped depression like that found in the males (p. 224). The armament with lateral setae on the first two joints of antennula varies considerably: on the first joint from six in the type to five (rarely), four (usually) and three (rarely); on the second joint there are sometimes only three, equally long setae. All other females than the type have four joints only in both flagella of the antenna, and al-



Fig. 50. *Herpotanais kirkegaardi* n. sp.; distal end of right mandible; a, specimen QQ; b, specimen RR.



Fig. 51. Herpotanais kirkegaardi n. sp.; variation in armament of fixed endite of left (1) and right (r) maxillae; a, type specimen; b-e, specimens N - RR - QQ - PP.

most all of them have two setae on the second joint of the antenna.

I have dissected the mouth-parts of four females besides the type (N, PP, QQ, and RR) in order to elucidate the variation in especially mandibles and maxillae of the family. A comparison with the type (figs. 39-42) shows the following differences: (1) *Left mandible*: Specimen N has the projecting part of pars incisiva still more pronounced, in QQ there are a few very minute hairs near the distal end of the two spines, and the furthest projecting tooth on the movable lacinia is bilobed. (2) *Right mandible*: Pars incisiva of QQ is broader (fig. 50a) and of RR somewhat differently shaped distally (50b) and with a very small but distinct nodule on the outer margin, corresponding to the one found e.g. in *s. serratispinosus* (LANG 1956, fig. A5); the inner spine of QQ (fig. 50a) and of PP is narrower and of RR broader (50b), and the outer spine of QQ has fine hairs along the outer margin. (3) External endites of maxillula all with ten spines, but in RR both endites have long and closely set hairs along the outer, distal margin; both internal endites of N have the inner, distal seta twice as long as the two other short setae. (4) Maxilla: The length of the setae on the endites is somewhat varying; the inner lobe of the movable endite of N and PP (left side) has six and both the corresponding lobes of QQ have 7 setae each, instead of the usual five; there is also a slight variation in number of setae on the fixed endite and in shape of the furcated spines (fig. 51), but their number and position are constant; in QQ the setae of the inner row are minutely bifid and in PP most of them are finely feathered; their number is always



Fig. 52. Herpotanais kirkegaardi n. sp.; variation in uropods; capital letters indicate specimens; 1 = left, r = right.

eleven. (5) *Maxilliped* with some variation in number of setae on the palps and in the size of the short spines on the inner, distal corner of the endite.

Finally, a great variation in the number and mutual length of the joints of the uropods is found, as shown in table 4. The table indicates that this variation must be quite incidental, the number of joints in this species not being influenced by the age of the specimens. In fig. 52 is shown the range of variation in the uropods of the material.

#### Variation in adult males:

In the material only six adult males are found, one of which (Z) was compared to the female type above. Of the other five males (V, W, X, XX, and Y), whose lengths are given in table 4, W and XX had no carapax preserved. V, X, and Y differ from Z in the following respects: In X and Y the outer end of maxillae were visible between endites of maxillipeds and labrum. In all three males the lower projection of the maxilla has six, somewhat longer setae, and the endite of the maxilliped is straightly cut off, with right-angled corners; in Y there are some very short setae on the margin (fig. 46d), and in X and Y two inner spines only are found; joint 3 of the palp in X and Y with only four inner setae. The different shape of the cheliped cutting edges in X and Y is shown in fig. 47; in V the shape is almost as in Z. All three specimens have only two setae on the lower side of the fixed finger. Variation in uropods is shown in table 4. Apart from these differences the four males are perfectly equal.

# Remarks:

The generic characters (see p. 218) clearly separate *H. kirkegaardi* from all species of *Neotanais*. Moreover, only *N. affinis* (WOLFF 1956b) has the pleotelson equally elongate. The species is named after JØRGEN KIRKEGAARD, M. Sc., Zoologist on the Galathea.

#### Distribution:

The Kermadec Trench, N. E. of New Zealand, 7150 m,  $1.3^{\circ}$ C.

# **D. GENERAL REMARKS**

# 1. Supposed hermaphroditism in certain species of Apseudes and Neotanais

When studying the great variety found in the males of especially Apseudes gracillimus and Neotanais serr. hadalis it at first appeared to me that this might be another instance of the "high and low dimorphism" in adult males of i. a. Tanaidacea, described by G. W. SMITH (1906). In a rich material of males of Leptochelia dubia (Krøyer) he found a variation in size between 2 and 4 mm. The large males have constantly immensely developed chelae (pl. 20, fig. 7) with a great distance between the tubercles on the movable finger but with a small comb of spines; besides, the antennulae are long (10-11 joints) and with rather few and short aesthetes. The short males have more or less reduced chelae with closely set tubercles and a comparatively larger comb; the antennulae are a little shorter (9-10 joints), but mainly with more plentiful and somewhat longer aesthetes. SMITH's table 2 (p. 339) shows that there is an even transition between large and small males and their size of the chelae. All the males have the mouthparts degenerate. The ovigerous females are about 3 mm long and with quite differently shaped chelae

and antennulae: the former are much smaller than in any male and without tubercles; the latter are short, 3-jointed and without aesthetes.

Previous to SMITH's paper FRITZ MÜLLER and A. DOHRN had described apparently similar instances. However, in the case of DOHRN who mentioned and figured (1870, p. 132, pl. 12, figs. 7 and 17) an instance of pronounced dimorphism in Tanais Savignyi (= Leptochelia dubius Krøyer) it was later shown by SARS (1886, p. 334) that the chelae belonged to males of two different species, viz. L. dubius and Heterotanais anomala Sars (1880). As far as MÜLLER is concerned he described and illustrated (1864, p. 12, figs. 3-6) a remarkable dimorphism in size and shape of the chelae of a Brazilian species which he called Tanais dubius (?) Krøyer. This difference is so great that it seems almost certain that it must be males of two different species, all the more since MÜLLER stated that although he had studied "many thousand" of the males he had found no intermediate forms between the two types. On the other hand, the difference between the antennulae of the two forms is almost identical with that found in the two forms of males of L. dubius, described by SMITH (1. c.), namely greater length of joints but fewer and shorter aesthetes in males with large chelae, and the opposite in males with small chelae. In spite of this fact I take it, however, for almost granted that a closer investigation of especially the females will disclose that MÜLLER mixed up two species.

When comparing SMITH's case of high and low dimorphism in Leptochelia dubius<sup>1</sup> with the differences found in the males of A. gracillimus and N. serratispinosus hadalis it is evident that the latter instances have nothing to do with the former. First and foremost all the males (from the same environment) are equally large (see table 3, p. 205 and p. 215). Secondly, the differing characters in the males of each of the two species represent intermediate features between male and female characters, while in L. dubius the chelae and antennulae of the two forms of males resemble each other much more than any of them resemble the same appendages of the female.

The fact that some of the males especially in Apseudes gracillimus and Neotanais serr. hadalis definitely exhibit secondary sexual characters of the respective females has induced me to suppose that at any rate some of the adults of these two (and probably several more) species of the two genera concerned are hermaphroditic. In A. gracillimus (and A. galatheae) it is highly probable that the male phase is the primary, the species thus being protandric hermaphrodites. N. serr. hadalis is more dubious; as shown below I regard it as most likely that the subspecies normally has separate sexes, but that occasionally simultaneous hermaphrodism may occur.

In 1953 LANG described the first known instance of a hermaphroditic tanaid, *Apseudes hermaphroditicus*. Apparently, all the specimens of this species have the conical projection on the sternite of the last peraeonite fully developed, and the sexual products seem to mature simultaneously. LANG (1. c., p. 350) suggests that also in gonochoristic (uni-sexual) species both kinds of sexual glands are to be found. The present instances of supposed hermaphroditism seem to speak in favour of this suggestion, and it is much to be regretted that the preservation of the material does not allow an investigation of the sexual glands.

In the present, necessarily limited, material of tanaids the following indications of hermaphroditism can be found.

#### a. Apseudes gracillimus and A. galatheae

1. The fact that no preadult stages or adult female stages in any of the two species are of the same size order as that covered by the males present from the same station (gracillimus: from Ingolf Station 22 & Thor St. 166 and galatheae: from Galathea St. 658). The gap in size between the latest preadult stages and the smallest of the adult females is considerable in both species, but is filled in by the males in a very convincing way (see table 1, p. 198 and table 3, p. 205).<sup>1</sup>

2. The presence of two distinct intermediate forms in *gracillimus*, namely males F and H which have adopted several female characters (see the list of male and female characters p. 206). The best preserved male character in F and H is the projection on peraeonite 7; this agrees with the fact that in the protandric hermaphrodite *Pandalus borealis* the appendix masculina is reduced very slowly when the transition to female takes place (JÄGERSTEN 1936, p. 15).

3. Specimen B in *galatheae* (p. 197) which is in the last manca or the first youth stage, has – together with many features found in the adult females – two distinct male characters: A conspicuous projection on peraeonite 7 and rudiments of pleopods.

#### b. Neotanais

Evidences of hermaphroditism are found in N. serratispinosus hadalis and probably in N. longimanus.<sup>2</sup>

As pointed out on p. 216 male B of N. serr. hadalis shows a remarkable transition between females and

<sup>1.</sup> The correctness of SMITH's interpretation lies beyond the scope of this paper and is therefore not considered here.

<sup>1.</sup> As often found in Tanaidacea there is, however, a considerable difference in size of the adults from one locality to another, certainly influenced by the environment. In galatheae the three adult females from St. 664 in the Kermadec Trench (from a depth which is more than 2000 m less than in St. 658) are thus a little smaller than the adult males from the deep station (unfortunately, no males were collected at St. 664), and in gracillimus one of the two adult males from the Indian Ocean (Galathea St. 193) is somewhat smaller than the males collected by the Ingolf and the Thor in the North Atlantic and the other male is even larger than the largest North Atlantic female. Moreover, the great difference in size in the two males from the same station in the Indian Ocean does not speak in favour of these males of gracillimus being protandric hermaphrodites in the said locality. Much more material is needed to solve this problem.

<sup>2.</sup> STEBBING (1893, p. 324) drew attention to the fact that BEDDARD in his definition of the new genus *Neotanais* (1886 b, p. 124), based on the two only males of *N.americanus* n. sp., mentioned the presence of well developed

male A. The following characters in male B are purely or almost purely female: Shape of peraeonites; uncalcified terminal face; shape of right mandible (except molar process) and of maxilliped. – The following characters are about half way between female and male (intermediate): Shape of pleonites and peduncle of antennulae; partial reduction of left mandible and of molar process of right; shape of maxillae and armament with spines on peraeopods. – Finally, these characters are purely or almost purely male: Presence of two genital openings on peraeonite 7; shape of carapax; ventral furrow proximally on pleotelson; shape of flagellum of antennulae; absence of maxillulae; shape of chelipeds.

Especially the fact that all males of *Apseudes* gracillimus and galatheae are smaller than the females from the same locality made me suggest above protandric hermaphroditism in those species. In the unfortunately small material of *Neotanais serr*. *hadalis*, however, the lengths are as follows:

> Pure female (type): 15.0 mm Pure female : 15.1 mm Transitional male (B): 15.5 mm Pure male (A): 15.7 mm

Moreover, the males of *Neotanais* have always the mouth-parts reduced so that they only serve respiratory purposes, have no anal opening and probably the alimentary canal reduced or absent, i.e. they exclusively live "*pour l'amour et la mort*". It is impossible to imagine that such males should be able not only to survive this period of compelled fast, but should also be able afterwards to regenerate the organs for food intake and digestion, if protandric hermaphroditism prevailed in this case as well.

The opposite, protogyne hermaphroditism, is of course possible, but very unlikely. It is extremely rarely found within the Animal Kingdom (in most Alcyonaria, the Kamptozoan *Loxosoma, Agriolimax laevis*, the Holothurian *Leptosynapta inhaerens*, and in certain salps) and is sometimes connected with unusuallylarge and therefore energy demanding male sexual organs. Nothing similar is found in this case.

I find that the most plausible explanation is that serr. hadalis is normally gonochoristic, but that



Fig. 53. *Neotanais longimanus* Wolff; ventral side of peraeonite 7 in female type; the scar-like marks are found on the two low protuberances not far from the posterior end of the segment.

simultaneous hermaphroditism (such as in *Apseudes hermaphroditicus*) may occur. Unfortunately, the scarcity of material prevented me from studying the sexual glands of especially the transitional male B which would certainly have solved the problem.

In N. longimanus (WOLFF 1956b, p. 49) I found ventrally on peraeonite 7 of the female type specimen and another female two scar-like marks on very low protuberances (fig. 53) in exactly the same place where the genital openings are found in males of other species of Neotanais (unfortunately, the small material of longimanus included no males). In a third female with fully developed oostegites (but lacking most of pleon) these marks were searched in vain. Apart from the presence or absence of marks and of oostegites I could find no other differences between the three females in question. These marks may perhaps be interpreted as the last indication of a previous simaltaneous hermaphroditic stage which is now substituted by a purely female stage. There may also be a possibility that the marks are the last trace of a previous purely male period and thus indicate protandric hermaphroditism in this species (cf. what was said above about the retarded reduction of primary male sexual characters in A. gracillimus and Pandalus borealis). In these cases it is, however, difficult to explain why the female without marks and with fully developed oostegites is only about 17.3 mm long, while the two markbearing females are 18.2 and 19.2 mm long, respectively, which certainly indicates that they are older.

mandibles. In my opinion this is due to the fact that at any rate one of the two specimens is a female, considering BEDDARD's figure of the antennulae (pl. 16, fig. 5) and his description (p. 125) in which he wrote nothing about any tuft of aesthetes which is otherwise a very conspicuous feature in males of *Neotanais*.

In *Herpotanais kirkegaardi* a few females have a very faint transverse furrow across the carapax and a ventral, v-shaped depression on pleotelson. These are otherwise male characters in that species, but since the furrow and the depression are much less marked than in the males and these females exhibit no other male characters I do not regard it as an indication of hermaphroditism, all the less since the rather large material of *kirkegaardi* shows no other differences comparable to those found in *A. gracillimus* and *N. serr. hadalis*.

It is noteworthy that some of the main secondary sexual characters, such as shape of carapax and of flagellum of antennulae (together with the primary sexual character: male genital openings) are found in all three intermediate males: F and H of *A. gracillimus* and B of *N. serr. hadalis.* Also two female characters are common to all three males, namely shape of peraeonites and none or only a rather slight reduction of the mandibles.

So far hermaphroditism has been stated - with more or less certainty - in the following species (and subspecies): Apseudes hermaphroditicus, A. gracillimus, A. galatheae, and Neotanais serr. hadalis. Common to these four species is that they occur in cold water (from  $4.9 - 1.1^{\circ}$ C.) and common to the last three ones their occurrence at great depths (1000 - 8200 m). It seems likely that at any rate constantly low temperatures may influence the development of hermaphroditism in tanaids, since it was never previously recorded by carcinologists working with tanaids from shallow water at temperate, subtropical or tropical latitudes. Some of these keen specialists (such as G. O. SARS, CLAUS, NORMAN and HAN-SEN) have studied tens or hundreds of both males and females of the same species without recording as far as I know-any instances of transition between males and females in one and the same species.

# 2. Vertical and regional distribution

#### a. Apseudes

In NIERSTRASZ' work on the Tanaidacea of the Siboga-Expedition (1913) he enumerated all the species of *Apseudes* known at that time. Since then new species or records have been added by the following authors: BARNARD (1914, 1920, 1935 & 1940), BEDDARD (1886 b), CHILTON (1924 & 1926), HALE (1929), LANG (1953 a), MENZIES (1953), MILLER (1940), MONOD (1925 & 1935), SHIINO (1937 & 1952), STEPHENSEN (1915), and VANHÖFFEN (1914), while LANG (1949 & 1955) transferred several species to other genera or demonstrated cases of synonymy. As a result, about 50 species are known today, but it is an open question whether they should all be included in *Apseudes*. For this reason I have confined myself to make only a rather superficial survey of the bathymetric range of the genus:

Fresh- c	or brackish water:	4	species
Marine,	littoral:	12	_
	c. 10 - c. 200 m:	17	
-	c. 25 - c. 1400 m:	2	_
	c. 100-1400 m:	7	-
– c.	1400 - c. 3000 m:	7	
_	1000-3700 m:	1	-
	1600-4400 m:	1	_
	4400 m:	1	*****
	4500-6800 m:	1	_

Thus only the following six species (12 %) are true abyssal inhabitants occurring only at depths greater than 2000 m and at temperatures below 4°C.: *A. simplicirostris* Norman & Stebbing, *A. tenuis* Hansen, *A. sp.* from the Antarctic deep-sea (VANHÖFFEN 1914, p. 461), *A. gracilis* Norman & Stebbing, *A. weberi* Nierstr. and *A. sibogae* Nierstr.; only one species, *A. galatheae*, is so far known to penetrate into the socalled hadal zone (BRUUN 1956).

The horizontal distribution of *Apseudes* is, as already pointed out by NIERSTRASZ (1913), cosmopolitan. The fact that more than half the species occur in the Atlantic Ocean and the Mediterranean is rather an indication of which areas are the best known than a true information about the distribution.

#### b. Neotanaidae

The vertical distribution of this very well defined family is given in table 5. It will be seen that apart from the record of one male of *N. serr. serra-tispinosus* (= laevispinosus) it is an exceedingly pronounced deep-sea and cold water family, no doubt one of the most abysso-hadal families or larger taxons of marine invertebrates to be found: except for the above mentioned specimen it has been recorded only from depths exceeding 2000 m and at temperatures below  $3.3^{\circ}$ C. The average of the total of 22 depth records is 3600 m.

The single adult male of *serr. serratispinosus* was collected by the Porcupine Expedition 1869, St. 1, in the North Atlantic (51°51'N, 11°50'W), at a depth of 370 fathoms = 677 m (NORMAN & STEB-



Table 5. Vertical distribution of Neotanaidae. The bottom temperatures are given in °C. (the not fully reliable ones are in italics).

BING 1886, p. 115). No bottom temperature was given, but the Hydrographic Department of the Danish Fisheries Investigations has kindly furnished me with the following, nearest record (obtained by the Scotia, 21. June 1951):

51°44'N, 12°00'W, 550 m: 10.36°C.

This means that the male in question was taken at a depth which is about 1300 m less than any other depth record of this family, 1800 m less than any of

the records of females of the same subspecies, and almost 3000 m less than the average depth record of the family. Still more striking is the high temperature at which the specimen was taken: almost  $7^{\circ}$ C. higher than for any other specimen of the same subspecies and the other species of the family.

Of course the possibility of wrong labelling always exists, but this is unfortunately one of the many cases where this question is impossible to solve so long afterwards.

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Fig. 54. Distribution of Neotanaidae. Depths in meters.

Another explanation might have been that the specimen was collected on a very steep part of the continental shelf where the hydrographic conditions were therefore rather embarrassing. However, according to the detailed bathymetric chart recently published by HILL (1956) the bottom configuration in the locality is not especially uneven and there is a long reach (almost 100 km) to the nearest area with depths of 2000 m and more and with temperatures below  $3-4^{\circ}C$ .

After all we are probably forced to recognize the aberrant depth and temperature records of this single male. Somehow it corresponds to the rather shallow and warm water records of two species of the 26 otherwise abysso-hadal Isopoda Ischnomesini (WOLFF 1956a, p. 141), while the only bathyal species of the abysso-hadal genus *Storthyngura* was antarctic and therefore occurred at very low temperatures (1.c., p. 142).

The females or *serr. serratispinosus* and nine more of the altogether thirteen species and subspecies of Neotanaidae have all been recorded only from depths between 2000 and 4000 m and at temperatures between 3.3 and  $0.6^{\circ}$ C. (table 5). A single species is known from 4000-6000 m, and one species and one subspecies are hadal or abysso-hadal. Even if the smaller number of trawlings between 4000 and

6000 m is taken into acount the preponderance of species between 2000 and 4000 m is evident and corresponding to the one found in abyssal isopods of five genera of Asellota (WOLFF 1956a, p. 147).

It is at present not possible to say anything definite about the vertical distribution of the single species. The fact that all the seven forms of *Neotanais*, collected by the Galathea, had to be considered new species and subspecies shows how much is left to be done in the deep-sea. On the other hand, there is hardly any doubt that the present abysso-hadal Tanaidacea are considerably less eurybathic than other characteristic groups such as Pycnogonida, Holothurians and especially Polychaetes, thus resemling what was found in the Isopoda (1.c., p. 146).

The regional distribution of Neotanaidae is given in fig. 54. To some extent the map shows at the same time the areas where the most extensive deep-sea trawlings have been operating! There are, however, two exceptions to this: (1) The North Polar Sea and (2) the antarctic parts of the three great oceans; these areas have probably been investigated as thoroughly as any of those from where Neotanaidae were recorded. It is unlikely that the comparatively very large species of Neotanaidae were overlooked here; for the time being we must consider Neotanaidae as missing in high arctic and antarctic waters, thus forming a striking contrast to the two most pronounced deep-sea genera of isopods, *Macrostylis* (with representatives in the North Polar Sea) and *Storthyngura* (with one third of the species occurring in antarctic waters).

As in the genera of Isopoda with hadal representatives the species of *Neotanais* which were recorded from equatorial areas are all abyssal, none of them having been taken at depths above 2700 m.

#### c. Distribution of the hadal Tanaidacea

Although the material of hadal tanaids is much smaller than that of hadal isopods some parallels may be drawn.

(1) One of the exclusively hadal forms is distinctly different from all hitherto known species and must even be regarded as so far the only representative of a new genus. Probably this species belongs to a special fauna, restricted to the hadal zone, as shown for the majority of the hadal isopods (WOLFF 1956a) which were described as new species (but which all belonged to known genera).

(2) One of the hadal tanaids is astonishingly similar to a species recorded several times in the North Atlantic (N. serratispinosus) and was by me regarded above as a new subspecies of the said species. Also three of the isopods which were taken by the Galathea below 6000 m in the Kermadec Trench had extremely close relatives in deep water far from the trench; these relatives were so closely related that I considered them as belonging to the same species, but probably at any rate one of them could equally well have been regarded as a different subspecies.

(3) In table 13 (1.c., p. 150) I showed that a considerably greater number of species of isopods (and amphipods) were collected by the Galathea in the Kermadec Trench than in the remaining deepsea trenches together, especially when the number of successful trawlings and bottom samlings was considered; the same preponderance of species in the Kermadec Trench was not found in hadal species of other invertebrate groups. All the three hadal tanaids, however, are from the Kermadec Trench, and in none of the four other deep-sea trenches investigated by the Galathea tanaids were recorded.

As far as I know the Russians have not yet published any records of hadal or abysso-hadal Tanaidacea in the reports on the results of their investigations in the Kurile-Kamtchatka Trench.

# 3. Relationship and possible origin of the hadal Tanaidacea

a. Apseudes. It is interesting to observe that A. galatheae seems to be most closely related to some of the deepest representatives of the genus. This applies to some extent to A. leptodactylus (Beddard) (near the Azores, 1830 m) and sibogae Nierstr. (Banda Sea, 4390 m) and more pronouncedly to weberi Nierstr. (Banda Sea, 1570 and 4390 m), gracilis Norman & Stebbing (North Atlantic, 1480-3260 m), and gracillimus Hansen (North Atlantic, 960 & 3470 m and off S.E. Africa, 3680 m). As pointed out above, the three latter species may belong to a separate subgenus or genus together with galatheae, and probably all these four abyssal coldwater species descended from the same ancestor. Also in the hadal Isopoda it was in some cases found that the evidently most closely related abyssal species were recorded extremely far from the trenches in which the hadal species were dredged.

b. Neotanaidae. Naturally N. serr. serratispinosus from the North Atlantic must be regarded as most closely related to serr. hadalis; in fact, the two subspecies are so similar that it was with some hesitation that I split them up. None of the other known species of Neotanais is particularly close to serr. hadalis.

It is not possible to say anything definite about the relationship of *Herpotanais kirkegaardi* which is so far the only representative of this genus and without special affinities to any single species of *Neotanais*.

Recently LANG (1956, p. 473) pointed out that it is very interesting that all the five species (known to him) of the genus Neotanais, which cannot be derived from any known shallow-water forms, are found in the deep-sea only. Since then another seven species and subspecies have been added by me, and the genus has been shown to have an almost cosmopolitan distribution. There is hardly any doubt that Neotanaidae is an archaic group of Tanaidacea as for instance Eryonidae and Homolodromiidae in Decapoda. But while the latter are almost exclusively bathyal and occur at temperatures above 4°C., Neotanaidae are - with one single exception - purely abyssal and thus confined to temperatures below 4°C. BRUUN (1956) is probably right in maintaining that most of the living fossils of the deep-sea (as for instance stalked crinoids and hexactinnelid sponges) are bathyal. However, Neotanaidae is a striking example of a family which units high age with an almost purely abyssal occurrence, even including one or two hadal representatives.



# Table 6. Relation between increasing depth and maximum length of most of the species of Apseudes.

It is worth mentioning that the absence of Neotanaidae in arctic and antarctic waters may be another evidence of the relict nature of the family. At any rate this absence (as pointed out above, p. 235) is different to what is found in some of the most pronounced deep-sea genera and larger groups of Isopoda, such as *Macrostylis, Storthyngura* and Ischnomesini all of which are probably of a much later origin than Neotanaidae.

# 4. Special peculiarities of the abyssal and hadal Tanaidacea

#### a. Size

In my report on the hadal Isopoda (WOLFF, 1956a, p. 152) I demonstrated that not only seems there to be correlation between increasing depth and larger size, but there may also in the isopods be a connexion between large size and southern distribution. The first of the three genera of Tanaidacea here treated supports this suggestion.

Apseudes. In table 6 I have arranged the species in accordance with increasing depth and size. The size records were found by means of the list of papers given by NIERSTRASZ (1913, pp. 9-14) and the references above (p. 232). Unfortunately, in some descriptions (especially by Miss RICHARDSON) no measurements were given or only immature specimens were at hand; these instances have been omitted in the table.

Concerning the geographical factor it is obvious that three of the four antarctic species (*sculptus*, *spectabilis*, and *hermaphroditicus*) are among the largest of all species of *Apseudes* and larger or much larger than all other species (except *nipponicus*) from correspondingly shallow water. However, the fourth antarctic species, *antarcticus*, is only 4 mm long; this is probably the correct length of the adults since both BEDDARD (1886) and VANHÖFFEN (1914) record this size.

It is evident from table 6 that larger size seems to be correlated with greater depth, i.e. changed environment. The average lengths of the tanaids from the various groups of localities (depths) are:

	Fres	h- or	brackish <sup>·</sup>	water:	7.1	mm
Tidal	zone	(excl.	antarctic	spp.):	2.7	-
	_	(incl.		- ):	4.8	
c. 10-20	)0 m	(excl.		- ):	8.6	-
	-	(incl.	-	- ):	8.8	
			25-14	00 m:	10.6	
			1400-44	00 m:	12.0	
			4400-68	:00 m	20.9	

The rather large size of the fresh- and brackish water species may seem strange but is a general feature within many oligohaline representatives of mainly marine animal groups (e.g. Palaemonidae).

Apart from the remarkably large species *nipponicus*<sup>1</sup> from shallow water (13 m) round Japan all species beyond a length of 10 mm are either antarctic, truly abyssal, or have a sublittoral-bathyal distribution in the temperate zones only.

Neither in *Apseudes* nor in the pronouncedly abysso-hadal isopod genera *Ischnomesus, Ilyarachna* and *Storthyngura* (WOLFF 1956a, p. 153) do we find large shallow water representatives in arctic seas. Moreover, such representatives seem to be rare in the two orders on the whole *(Mesidothea being a notable exception, perhaps owing to its euryhaline nature).* 

Neotanaidae. In the Ingolf Report HANSEN (1913, p. 6) recorded the size of *N. giganteus* as "about twice as long as any male or female hitherto known of this family from any sea". With "this family" he meant the Tanaidae of that time, corresponding to the present Tanaidae, Paratanaidae, and Neotanaidae. As far as I know there has been no record since 1913 of a representative of any of these three families which attained a size corresponding to that of giganteus.

Table 7 shows that the lengths of the Galathea species of Neotanaidae are remarkably great, in some cases even greater than HANSEN'S giant; in fact, *H. kirkegaardi* is by far the largest of all known tanaids and *N. robustus* the largest but one.

Table 7. Maximum lengths and depth records of the species of Neotanaidae.

	Species	Length in mm	Depth in meters
Neotanais	serr. serratispinosus	8.5	680-3470
	edwardsi	9	1960
	americanus	6	2270-3480
	barfoedi	16.5	2470-2640
_	longimanus	19.2	2690
	giganteus	20	2700
_	hastiger	5	3200
	pfaffi	20.7	3590
_	armiger	10.2	3590-3670
_	affinis	9.9	3680
_	robustus	22.1	4390-4570
_	serr. hadalis	15.7	7150-8210
Herpotand	ais kirkegaardi	25.0	7150

1. The measurement given in fig. 1 (SHIINO 1937) also indicates a length of 16 mm.

Not only is *Neotanais* the most pronounced (polytypic) deep-sea genus known within the tanaids (see p. 232), but it is also (apart from the monotypic genus *Herpotanais* of the same family) *the genus of Tanaidacea with by far the largest species*. The average maximum size is 13.5 mm which is almost 1.5 times longer than of any representative of the families Tanaidae and Paratanaidae. The average maximum size of the family is 14.4 mm.

It will be seen from the table that although the genus *Neotanais* is very homogeneous morphologically, the size of the species varies to a considerable degree (from 5 to 22 mm). It is also obvious that within this genus there is evidently no special correlation between very large size and very great depth.

#### b. Other features

It is not astonishing that all the three hadal tanaids are blind. In *Apseudes* many other species are also blind or have unpigmented visual elements; even a few of the shallow-water species (e.g. *spectabilis* Studer and *australis* Haswell) are totally blind. All the other, abyssal species of Neotanaidae are likewise blind.

The calcification of *A. galatheae* is not quite so strong as in *A. spinosus*, but stronger than in for instance *A. gracillimus*. Both *N. serr. hadalis* and *H. kirkegaardi* are very strongly calcified, the integument being thick and apparently more robust than in any of the abyssal Neotanaidae.

As in the hadal isopods the colour of all three tanaids is milky white both when freshly caught and in alcohol, but it has never the shining tinge found in a few of the isopods. The previously largest recorded tanaid (excl. Apseudidae), *Neotanais giganteus*, was according to HANSEN (1913, p. 21) "quite white when hauled up from the sea"; during the sixty years since the capture its body has become somewhat yellowish.

On the whole, the three hadal tanaids are very

similar to their abyssal and bathyal relatives, thus resembling also in this respect the isopods from the greatest depths.

### 5. Biology

It is regrettable that none of the females of this material had eggs in the marsupium. The fact that neither any of the 40 females of hadal isopods nor any of the 30 females of hadal tanaids, so far collected, have been egg-bearing might indicate that the egg-bearing period is either very short or confined to a special season.

Both explanations appear, however, unlikely. Concerning the length of the egg-bearing period it is a well known fact that arctic-antarctic and temperate shallow-water invertebrates with an unpelagic development have a far longer egg-bearing period than species with pelagic larvae. It is probable that the egg-bearing period of the deep-sea isopods and tanaids lasts several months.

The confinement of the reproduction in the deepsea to a special season is not likely in case of an environment as stable as that of the deep-sea, and is also contradicted by the mode of reproduction found in high latitudes under similar stable conditions.

It is of course possible that egg-bearing females are not so easily caught as other females and the males. Perhaps they prefer a more fossorial life during that period, and thus succeed in avoiding the not very deep-digging trawls used during the Galathea Expedition.

Finally, the lack of egg-bearing females may be due to the fact that these hadal crustaceans grow very old. Although it was shown above for *A. galatheae* and *H. kirkegaardi* that each female must pass through several egg-bearing periods lasting probably at least three months) these periods may occur only once every second or third year, provided that the female reaches an age of, say 15-20 years. In this case the chance of collecting egg-bearing females is of course much smaller.

# **E. SUMMARY**

1. A special chapter discusses the terminology of body segments, appendages etc. It is proposed to name the seven free thoracic segments in Isopoda and Amphipoda peraeonites 1-7 and to use the same appellation in Tanaidacea (which have always peraeonite 1 forming part of the carapax). Accordingly, the legs are called peraeopods II-VII (peraeopod I = cheliped). The pleon segments should be named pleonites 1-5 (followed by the pleotelson), and the pleopods likewise numbered 1-5 (followed by the uropods). It is suggested always to use "joint" for subdivision of appendages and "segment" for subdivision of the body.

2. During the Galathea Expedition three species of tanaids were collected in the Kermadec Trench at depths greater than 6000 m. One is a new species of *Apseudes*, the second belongs to a new genus of Neotanaidae, and the third is described as a new subspecies of *Neotanais serratispinosus*. Moreover, a few closely related species are redescribed for comparison.

3. The postmarsupial development of Apseudes spinosus, M. Sars, A. galatheae n. sp., A. gracillimus Hansen, and Herpotanais kirkegaardi n. gen., n. sp. is discussed.

4. It is suggested that hermaphroditism occurs in four species. In Apseudes gracillimus and A. galatheae the hermaphroditism seems to be protandric, since (1) all males (from the same locality) are larger than all preadult stages and smaller than any adult female, (2) the material of gracillimus comprises two distinct intermediate forms which combine several male and female characters, (3) a late preadult specimen of galatheae shows transition to a male phase. In Neotanais serratispinosus hadalis n. subsp. the material comprises one pure male and one transitional male with several female characters. It seems most likely that in this case simultaneous hermaphroditism (previously known in Apseudes hermaphroditicus) occurs together with gonochoristic reproduction. Two females of N. longimanus Wolff exhibit one rudimentary male character (males of longimanus are unknown), and this probably also indicates hermaphroditism in this species. A common feature in all five tanaid species in which hermaphroditism seems to occur is that they are confined to cold water and all (except A. hermaphroditicus) are abyssal or hadal.

5. Apseudes is preferably a shallow-water genus with only six abyssal species and one species (galatheae) penetrating into the hadal zone. The regional distribution of the genus is cosmopolitan.

6. The vertical distribution of Neotanaidae is given in table 5. One male of the otherwise abyssal subspecies N. serr. serratispinosus is bathyal (collected at a depth of 680 m and about  $10^{\circ}$  C). Apart from this single record all the remaining representatives of the family are from depths greater than some 2000 m and live at temperatures below 3.3°C. Thus, Neotanaidae is undoubtedly one of the most pronounced abysso-hadal families or major taxons of invertebrates to be found. The average of the total of 22 depth records is 3600 m. As in the abyssal and hadal species of five genera of Isopoda Asellota (Wolff 1956 a) the vertical distribution is considerably more restricted and the stenothermy much greater than in other characteristic invertebrate groups in the deep-sea, such as Pycnogonida, Holothurioidea and especially Polychaeta. - The regional distribution of Neotanaidae is cosmopolitan except for the fact that they seem to be missing in the North Polar Sea and in antarctic areas.

7. The hadal tanaids agree with the hadal isopods (l. c.) in the following respects: (1) One of them is distinctly different from any other known species (even being a representative of a new genus), and thus probably belonging to the special fauna restricted to the hadal zone; (2) one is extremely close to a species from the North Atlantic (as three of the species of isopods occurring in the hadal zone as well as abyssally in areas far from the trench in which they were collected); (3) of the five deep-sea trenches investigated by the Galathea tanaids were recorded only from the Kermadec Trench (both isopods and amphipods show a similar preponderance in this trench).

8. The abysso-hadal *Apseudes galatheae* is most closely related to the bathyal and abyssal members of that genus and probably descended from the same ancestor as those. The very archaic family Neotanaidae which cannot be derived from any known shallow-water forms is a striking example of a higher taxon of invertebrates which units high age with an almost purely abyssal occurrence, even including hadal representatives. The relict nature of the family is also emphasized by its absence in arctic and antarctic waters which include several species of the most pronounced deep-sea genera of isopods of a much later origin.

9. The size of the abyssal and hadal Tanaidacea is remarkably large. Table 6 shows that in *Apseudes* there seems to be a correlation between larger size and increasing depth as well as southern distribution (as in many isopods). The average maximum size of the preferably abyssal Neotanaidae is no less than 14.4 mm which is much more than in the other four families of Tanaidacea and even 1.5 times more than in *any* representative of Tanaidae and Paratanaidae. Seven of the ten largest species of tanaids belong to Neotanaidae. Table 7 shows that in this deep-sea family there is no special correlation between large size and increasing depth.

10. Apart from the size the general appearance of the hadal tanaids is very similar to that of their abyssal and bathyal relatives. The colour is always milky white, the calcification is comparatively strong or very strong, and they are all blind.

11. The fact that none of the hadal female tanaids or isopods, so far collected, had eggs in their marsupium probably indicates either that such females are not easily caught by trawls or that they reach a considerable age.

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