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THE R. INSTITUTE OF HIGHER PRACTICAL AND SPECIALIZATION STUDIES  
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PLANKTONIC COLLECTIONS

OBTAINED BY THE R. SHIP "LIGURIA"  
DURING THE CIRCUMNAVIGATION OF 1903 - 05  
UNDER THE COMMAND OF H. R. H. LUIGI DI SAVOIA  
DUKE OF THE ABRUZZI

VOLUME I - NUMBER V

ANNELIDS - PART I. TOMOPTERIDS

BY

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DIRECTOR OF THE R. MUSEUM OF ZOOLOGY (INVERTEBRATES) IN FLORENCE  
(WITH A TABLE)

FLORENCE

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1908

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ANNELIDS - I. TOMOPTERIDS  
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MATERIAL

Due to a set of favourable circumstances, this work, which originally had the very modest aim of describing the Tomopterids of the "Liguria", turned into a complete "Review of the Family Tomopteridae" giving the characters of all the twenty-four known species, sixteen of which (including six new species) are described de visu (the others are, for the most part, ancient unrecognizable species).

The sources of the material which I was able to study are the following:

I. Tomopterids collected by the R. Ship "Liguria".

These were represented by no less than 80 specimens, of which those which were easily determined, being adults in a good state of preservation, belonged to eight different species, three of which were new species. Since only 12 species were considered valid in the Review of APSTEIN 1900 (after which no other species from the Family tomopteridae have been described), the collection from the R. Ship "Liguria" is considered to be very valuable.

This collection is also very interesting because, up to now, the species for which modern descriptions exist all came from the Atlantic and European waters, while the tomopterids from the "Liguria" were taken mainly in the Pacific and the Indian Oceans.

The following is the List of Stations from which the "Liguria" Tomopterids originate, with an indication of the species collected at each station. (For more detailed information on the individual stations, see number 1 of these "Planktonic collections" SENNA: Preliminary report and list of the stations).

Station II. 29° 12' N. Lat., 24° 58' W. Gr. Long. (Atlantic,  
West of the Canary Islands).

Tomopteris (Johnstonella) nationalis? APSTEIN.

Station III. 26° 08' N. Lat., 32° 22' W. Gr. Long. (slightly  
South - West of the preceding station).

Tomopteris (Johnstonella) mariana GREEFF.

Station IV. 20° 41' N. Lat., Long. 44° 22' W. Gr. Long. (East of the  
Antilles).

Tomopteris (Tomopteris) elegans CHUN.

Station V. 13° 55' N. Lat., 77° 43' W. Gr. Long. (Caribbean Sea).

Enapteris euchaeta (CHUN).

Station VI. 17° 12' N. Lat., 81° 21' W. Gr. Long. (ibidem).

Enapteris euchaeta (CHUN).

Tomopteris (Tomopteris) elegans CHUN.

Station X. 28° 38' S. Lat., 47° 31' 30" W. Gr. Long. (between  
Bahia and Buenos Aires).

Tomopteris (Tomopteris) Cavallii ROSA.

- Station XIII. 35° 06' 30" S. Lat., 73° 38' W. Gr. Long.  
(Pacific Ocean, near Valparaiso).  
Tomopteris (Tomopteris) Cavallii ROSA  
Tomopteris (Tomopteris) septentrionalis QATR. ex  
STEENSTR.
- Station XIV. 3° 15' N. Lat., 89° 52' 30" W. Gr. Long. (Pacific  
Ocean near the Galapagos Islands).  
Tomopteris (Tomopteris) elegans CHUN.
- Station XV. 13° 24' N. Lat., 97° 22' W. Gr. Long. (Pacific Ocean  
near Acapulco).  
Tomopteris (Johnstonella) Aloysii Sabaudiae ROSA.  
Tomopteris (Johnstonella) Duccii ROSA.  
Tomopteris (Johnstonella) n. sp.? juv. indet.
- Station XVII. 2° 28' S. Lat., 152° 45' W. Gr. Long. (Polynesia,  
between Honolulu and Tahiti).  
Tomopteris species indeterminable.
- Station XX. 28° 20' S. Lat., 170° 05' E. Gr. Long (Between  
New Caledonia and New Zealand).  
Tomopteris (Tomopteris) elegans CHUN.  
Tomopteris (Tomopteris) Cavallii ROSA.
- Station XXII. 10° 35' 08" Lat., 142° 13' 14" E. Gr. Long.  
(Torres Strait).  
Tomopteris species juv indeterminable.

Station XIII. 8° 6' S. Lat., 135° E. Gr. Long. (Arafura Sea).

Tomopteris, species indeterminable.

Station XXIV. 4° 02' S. Lat., 128° 21' E. Gr. Long. (Banda Sea).

Tomopteris (Johnstonella) species juv.

indeterminable.

Station XXV. 3° 40' S. Lat., 127° 45' E. Gr. Long. (Buru Strait).

Tomopteris species indeterminable.

Station XXXIII. 13° 35' N. Lat., 83° 47' E. Gr. Long.

(Bay of Bengal).

Tomopteris, species indeterminable.

Station XXXIV. 9° 39' N. Lat., 81° 26' 30" E. Gr. Long.

(near Ceylon).

Tomopteris (Tomopteris) elegans CHUNS.

" " Cavallii ROSA.

## II. Tomopterids collected by the R. Ship

"Vettor Pisani" during the circumnavigation of 1882 - 84 (under the command of Lieutenant, now Rear - Admiral, Gaetano CHIERCHIA).

These tomopterids had been sent to professor R. GREEFF for study. After his death they were passed on, unstudied, to the Hamburg Museum of Natural History from where they were sent to me last year (1).

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(1) With the approval of the Directorate of the National Museum of Hamburg, these tomopterids (which did not belong to Prof. Greeff) were subsequently sent, by me, to the Zoological Museum of Naples to which the collection of the "Vettor Pisani" was sent from the Zoological Station of Naples.

This collection which I received (I do not know whether it was actually complete) consisted of five tubes which bore only the numbers which I am indicating below and a date from which (by consulting the Report of the Voyage published by CHIERCHIA in the "Maritime Review", 1885) I was able to assume the location which I have added in brackets. 250

No. I 494. May 9, 1882 (Gibraltar).

Tomopteris (Johnstonella) Catharina (GOSSE).

No. II 259. February 17, 1883 (the Pacific Ocean; between Valparaiso and Iquique, near Caldera).

Tomopteris (Tomopteris) septentrionalis QUATR.  
ex STEENS.

No. II 264. February 19, 1883 (Pacific Ocean; between Valparaiso and Iquique, near Antofagasta).

Tomopteris species indeterminable.

- March 19, 1883. Pelagic Haul. (Pacific at Callao).

Tomopteris (Tomopteris) Cavallii ROSA.

" " Eschscholtzi GREEFF.

No. IV 414. May 31, 1884. 1800<sup>m</sup> depth (Pacific, west of the Galapagos Islands).

Tomopteris species indeterminable.

Therefore, the small collection made by CHIERCHIA contained four species, including one (T. Cavallii) which was new at that time, while T. septentrionalis had been found for the first time in the southern hemisphere.

III. Tomopteridae from Hamburg Museum of Natural History.

Dr. W. Michaelsen was kind enough to send me all the tomopterids (most of them undetermined) found in this Museum so that I could study them.

This material (23 tubes) contained tomopterids from 22 different locations representing all of the seas: ten species were represented, three of which were new (identified here with an \*). These species are:

*Enapteris euchaeta* (CHUN).

*Tomopteris* (*Johnstonella*) *Catharina* (GOSSE).

|   |                       |  |
|---|-----------------------|--|
| " | "                     | <i>Rolasi</i> GREEFF.                      |
| " | "                     | <i>Dunckeri</i> ROSA.*                     |
| " | ( <i>Tomopteris</i> ) | <i>septentrionalis</i> QUATR. ex STEENSTR. |
| " | "                     | <i>elegans</i> CHUN.                       |
| " | "                     | <i>Eschscholtzi</i> GREEFF.                |
| " | ( <i>Tomopteris</i> ) | <i>ligulata</i> ROSA.*                     |
| " | "                     | <i>Nisseni</i> ROSA.*                      |
| " | "                     | <i>Apsteini</i> ROSA.                      |

A precise indication of the locations with the names of their collectors can be found at the end of the description for each of the species listed above.

Therefore, this material from the Hamgurg Museum of Natural History is also very valuable and in many respects, very interesting.

IV. Other Material. In addition to the above-mentioned collections, I was able to study specimens of Tomopteris (T.) septentrionalis typical of the coast of Greenland and which were kindly sent to me by Dr. G.M.R. Levinsen of the Royal Museum of Copenhagen, and a number of tomopterids (3 species) which were among the material requested from Messina by my late predecessor Prof. Pio Mingazzini and which I subsequently requested myself.

Never before me had any expert been able to view 16 species of tomopterids; APSTEIN himself had only been able to study 8. Therefore, I felt that I should take advantage of this fortunate situation and prepare a new review of the group.

#### Characters Used in the Systematics of Tomopterids

The internal structure of tomopterids is simple and very uniform. However, one rarely has the opportunity to examine a large number of live specimens. Therefore the systematics of these polychaetes is essentially based on the external characters and on the few internal ones which can be seen against the light, even in the case of preserved specimens.

Nevertheless, the external parts of this group contribute more numerous and specific characters to the systematics than one would expect. Apstein made great advances in this area, but one can go well beyond these, as we will see presently with respect to the pinnal glands.

I will now briefly mention the various characters while offering a few comments on their relative value.



EXTERNAL CHARACTERS: DIMENSIONS. - Generally - speaking, the size of individual adults of a given species does not vary greatly and this is worthy of note, especially since the size can vary considerably from one species to another. Thus, the smallest species are 5 - 6mm long in the adult stage whereas others usually reach 15 - 20 mm. However, on rare occasions, one may find specimens of an uncommon size among these. I was able to examine a Tomopteris (Tomopteris) Apsteini ROSA which was 4 cm in length; APSTEIN examined a T. (Johnstonella) Catharina (GOSSE) 9 cm in length, while Briarea scolopendra, described by Q. and G. (which perhaps is the same species) was approximately 10 centimeters long. 252

When dealing with tailed species, it is useful to separately indicate the length of the body and that of the tail, as the latter is more variable.

It is also advisable to give the maximum diameter (between the extremities of the major parapodia) indicating at what point on the total length (or of the length of the trunk) they are situated.

General appearance - This is determined by a number of factors and is difficult to describe. However, there are two species in this group which are easily recognized and distinguished from one another at a glance despite their apparent uniformity.

Colouring - Anyone having the opportunity to examine live tomopterids should note whether there are any coloured spots on their yellowish and, on the whole, colourless, body. Up until now, this has been observed in only Tomopteris (Johnstonella) Catharina, vitrina, mariana and Rolasi.

Number of segments - In the tailless species, the number of segments is equal to the number of pairs of parapodia, plus one for the pygidial segment, which is generally imperceptible, and two (for tailed species, three) for the region anterior to the first pair of parapodia. The difficulty is often greater in tailed species because the caudal parapodia are often very rudimentary and sometimes even missing and consequently, the limits of the segments are not well defined. Therefore, whenever possible, the number of segments of the trunk should be indicated separately.

I was able to note that in tomopterids, unlike what I observed in earthworms, the number of segments continues to increase even after sexual maturity. However, at a given moment, this growth stops and there are only very small variations from one individual to another.

In the tailless species, it is relatively easy to ascertain whether the posterior extremity is still growing; in this case it appears as an opaque button, which stains very well, with one or two pairs of stump-like parapodia, whereas when the growth is complete, the posterior extremity does not show these characters and even the last pair of parapodia, although small, are well-formed. We will deal with the tailed species when discussing this appendage.

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Cephalic region - For the sake of simplicity, I have called the part of the body anterior to the first real parapodia, the "cephalic region". Therefore, this also includes the segment with the large setigerous cirri.

In the lower part of this region, between the bases of the large setigerous cirri, is the mouth, below which, a smaller, ventral pair of setigerous cirri can sometimes be found. Also to be considered in this region are: the characteristic prostomium with its horns, the ciliated epaulettes, a cephalic groove and, among the internal parts which we will deal with later, the brain, the eyes and

possibly the "statocysts?"

Nomenclature of the cephalic appendages - The prostomial horns, the small setigerous cirri or the anterior cirri (not always present) and the large setigerous cirri together form two or three pairs of "cephalic appendages" the nomenclature of which has caused a great deal of confusion as shown in the following table:

|                          |      | <i>Corna del prostomio.</i>  | <i>1.<sup>a</sup> Cirri setigeri.</i> | <i>2.<sup>a</sup> Cirri setigeri.</i> |
|--------------------------|------|------------------------------|---------------------------------------|---------------------------------------|
| Eschscholtz              | 1825 | —                            | Fühler.                               | Stacheln.                             |
| Quoy et Gaymard          | 1827 | Premiers tentacules.         | o                                     | Seconds tentacules.                   |
| Bush                     | 1847 | Kopffortsätze.               | 1. <sup>r</sup> Tentakel.             | 2. <sup>r</sup> Tentakel.             |
| Grube                    | 1848 | Stirnfühler.                 | o                                     | Hintere Fühler.<br>(Fühlercirren).    |
| Leuckart u. Pagenstecher | 1858 | Hornförmige Stirnlappen.     | Vorderste Cirren.                     | Hintere Cirren.                       |
| Carpenter                | 1859 | First pair of frontal horns. | Second pair of frontal horns.         | Styliform processes                   |
| Keferstein               | 1861 | Kopflappen.                  | Retraktile Fühler.                    | Starre Fühler.                        |
| Carpenter u. Claparède   | 1862 | Frontal horns.               | First antennae                        | Second antennae.                      |
| Quatrefages              | 1865 | Premieres antennes.          | Deuxieme antenne.                     | Tentacules.                           |
|                          |      | (Antennae anteriores)        | (Antennae posteriores)                | (Tentacula)                           |

For the 1st pair of appendages, I have used the term prostomial horns so as not to prejudice the matter of their homology. However, it seems to me that they are not antennae or tentacles but rather, simple prostomial lobes. As for the other two pairs of appendages, I am well aware that the term "cirri" is used for polychaetes for certain appendages of parapodia, but the addition of "setigerous" prevents any confusion. However, in the text, I have also used "cirri" alone, for the sake of brevity. The expression "tentacular cirri" used by Germans implies very questionable homologies.

Prostomium and its horns - Morphologically speaking, the posterior limits of the prostomium are difficult to determine. Anatomically speaking, I have also included the "neck", that is, the narrow part between the horns and the rest of the cephalic region.

The part of the prostomial horns which is curved posteriorly is hollow for a distance which varies according to their length, and the cavity communicates freely with that of the prostomium and with the body in general. The anterior margin of the horn is blade-like and where the two blades intersect on the median line there can sometimes be an incision. Often, before intersecting, the inserted base of two blades extends farther back along the dorsal side so that the true anterior extremity of the prostomium extends slightly forward in the form of a blunt protuberance.

I would like to point out here that, although APSTEIN never mentions the shape and size of the prostomium and its horns in his description, this character should not be overlooked. For example, four species of tomopterids are found in Messina, two of which are caudates (Enapteris enchaeta (CHUN) and Tomopteris Apsteini (ROSA))

and two of which are tailless species (T. planktonis (APSTEIN and T. elegans (CHUN))). By simply studying the shape of the prostomium, one can easily distinguish the first species from the second and the third from the fourth.

Ciliated epaulettes. - (According to CARPENTER and CLAP, Wimperepauletten according to CHUN). These sense organs (see, for example, in figures 4, 7, 10, the two longitudinal bands with their borders in relief at the sides of the cerebral region) are not too difficult to detect even in the preserved specimens and, although APSTEIN rarely mentions them, they constitute useful and fairly constant characters (see the descriptions) in one species. Particularly distinctive are the completely precerberal ones of Enapteris euchaeta (CHUN) (see figure no. 1 CHUN table III).

However, it should be noted that in young individuals, these epaulettes may be different in shape and extension than those of the adult and in the very young specimens they may even be absent.

Mouth. - Situated ventrally between the bases of the large setigerous cirri, therefore very far back (less so however than in other polychaetes), it shows no noteworthy characteristics except that, quite often, the proboscis or the muscular pharynx is everted. When it is semi-everted, it appears as an oval body through which a longitudinal groove passes ventrally. However, when it is completely everted, it appears as a large tube whose edge may extend as far as the anterior extremity of the head. When invaginated, the posterior limit of the proboscis reaches, on the average, the first pair of parapodia with some variations in length according to the species. In the species Enapteris, it is exceptionally slender and short.

Anterior setigerous cirri. - They are not present in all species of tomopterids. They are anterior to the mouth, in a ventral - lateral position at the base of the prostomial neck. They are in the form of tentacles with a pointed extremity and, in adults, their length rarely equals that of the frontal horns. In young individuals, they are always much longer. Each cirrus contains an extremely slender seta (two? in the T. Rolasi?), which only occupies the distal part of the cirrus.

There has been a great deal of discussion on the systematic value of these cirri. QUATREFAGES based his division of tomopterids into two species on the absence or presence of these cirri. CARPENTER, CLAPAREDE and VEJDOVSKY gave no value to this character, whereas GREEFF and APSTEIN gave it more consideration.

Actually there are species in which this first pair of cirri is always absent, others in which it always occurs and others where it can be present or absent.

Among the species in which the first cirrus is always absent are Enapteris euchaeta (CHUN), Tomopteris septentrionalis QUATR. and STEENSTR. and T. Cavallii (ROSA). In fact, in the first and third species, it was noted that the first cirrus was also absent in very young specimens, 2 mm. long.

However, the first cirrus is always found in the Tomopteris elegans (CHUN) for example. CHUN, APSTEIN, SCHWARTZ and I have examined a large number of specimens of this species.

However, there are certainly species in which the first cirrus is sometimes absent and, at other times, in fact more frequently, it is present. Its absence is observed mainly in older individuals.

With respect to this third case, I have provided greater detail on Tomopteris Catharina (GOSSE), vitrina VEID, Aloysii Sabaudiae ROSA,

and Eschscholtzi GREEFF. See also under T. Apsteini ROSA.

In any case, when describing a species, one should look carefully for this cirrus, which is not always easy to see, and determine if even traces of it exist.

I will not dwell here on the morphological significance of these "anterior setigerous cirri". I will only express the opinion that they do not (as VIGUIER claims, for example) represent a pair of parapodia. I believe that this is true of the large setigerous cirri (see 2nd pair) but not of the first ones which, as previously stated by CLAPAREDE, are most probably persistent larval cirri.

These would be setigerous larval cirri, such as are known in other polychaetes, and which are present in some species and not in others. (They are, almost without exception, present in the subgenus Johnstonella). I consider this proven by the fact that these cirri are always more developed in young individuals than in adults [See CARPENTER and CLAPAREDE (1) for figures of very young individuals, pl. 7, fig. 14; VEIDOVSKY (1) tab. VI, fig. 5; APSTEIN (2) Tab. X, fig. 6, 7, 8; SCHWARTZ (1) fig. 12], are simple right from the start, that they are initially completely anterior and are innervated by the brain (see, in particular, SCHWARTZ (1) page 524). Furthermore, their seta does not have the characters of an acicula, like that of the second cirri: it is located only at the distal part of the cirrus and does not have any basal musculature.

Second setigerous cirri - It is now a widely accepted fact that this pair is definitely a first pair of parapodia which was altered, but which kept its acicula while the subsequent parapodia lost all of their setae.

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From the systematic standpoint, in the second pair of cirri, it is important to note the shape and size of the large basal cone and the

relative length of the setae which can range from 1/3 of the body length up to four times the body length, as in certain specimens of Enapteris euchaeta (CHUN).

The relative length of the second cirrus is a valid character. However, one should keep in mind that this cirrus is, relatively speaking, slightly longer in young individuals. This applies in particular to tailed species. In such species, a more constant number is obtained when comparing the length of the cirrus (or, of its seta, which gives the same results) and that of the body.

The seta of this cirrus may bear regular incisions (which only LANGERHANS has mentioned) on the external side, and particularly on the distal half. These incisions are more or less marked according to the species.

Trunk and tail. - Approximately half of the species of tomopterids (that is to say, among the known species, the only species of the genus Enapteris: E. euchaeta, almost all, with the exception of two, of the tomopteris of the subgenus Johnstonella and two species of the subgenus Tomopteris) have a tail.

Even the caudate species do not have a tail when they are young. However it is difficult to mistake an anurous adult for a young individual of a caudate species because, even in the young, there is already a trace of the tail, unless the specimen is so young that a systematic study is not possible.

The tail is characterized by a smaller diameter, a reduction of the celomic cavity, often by a different appearance of the intestine, by parapodia different from those of the trunk or more or less rudimentary or even, (at least at the end) lacking altogether.



Nevertheless, it is not always easy to accurately determine where this tail begins.

SCHWARTZ (1, page 508) divides caudate tomopterids into those with a distinct tail such as, for example, E. Euchaeta (CHUN), and those with a gradual tail, like the T. (T.) Catharina (GOSSE). However, I have noted that there may be a certain sexual dimorphism with respect to this character: for example, in T. Apsteini (ROSA), the tail is distinct in the female and more gradual in the male.

We will deal later on with the data which can be obtained from the parapodia to determine where exactly the tail begins. Here I would merely like to point out that the characters of the tail are very important in systematics but that it is also important to take into account the considerable differences in these characters depending on age (even in individuals who are already sexually mature) and to also take into account a possible sexual dimorphism.

Parapodia - The number of parapodia is equal to the number of the segments posterior to the segment where the large cirri are located, excluding, in caudate species, sometimes a certain number of terminal segments and always a pygidial segment.

Therefore, in the case of anurous specimens, what we said earlier about the number of segments applies to this number as well: the number varies very little in adults of the same species but varies considerably from one species to another. In caudate species, often the number of parapodia is almost impossible to determine and can vary considerably when the caudal parapodia are rudimentary or absent. In these cases, it is necessary to at least determine the number of parapodia in the trunk, and it is interesting to note that, at least in

some cases, this number is entirely constant in the same species.

I am referring to T. Apsteini ROSA (T. scolopendra APSTEIN) in which all of the specimens examined by APSTEIN and all those examined by me had 17 pairs of parapodia on the trunk (it should be pointed out that I include the peculiarly modified parapodia 18, 19, 20 with the tail, whereas APSTEIN includes them with the trunk). However, this applies only to females.

In addition to the number of parapodia, valid characters can be obtained from their shape, their normal direction with respect to the axis of the body, their relative dimensions, etc. (See the descriptions of the species).

The parts of the normal parapodia, that is, the parapodia of the anurous forms and the trunk parapodia of caudate specimens (we will deal with abnormal parapodia further on) are the following: each parapodium consists of a trunk which branches off at the tip into two rami (1) each of which, along with the bordering membrane, forms a palette or pinnule.

Pinnules or palettes. - Therefore, when examining a pinnule, one should consider: 1. the ramus which forms its axis, 2. the pinnal membrane. Like the pinnules, one of the two rami is dorsal and the other is ventral. The length of the rami varies only slightly, however, their shape varies considerably. The shape is usually conical however, in the genus Enapteris for example, it is

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(1) I have used the term "trunk of the parapodium" where for example, APSTEIN uses Ruder (or ramus) and I have used "ramus" where he has used Ruderast (or branch of the ramus). I do not feel that I have caused any serious inconvenience by using this clearer terminology in Italian particularly since the homologies of the parts of the parapodium of tomopteris are still unclear to us.

rectangular; in Tomopteris Carpenteri QUATR., the two rami are very disproportionate; in T. Dunckeri the ventral ramus in particular is slightly digitate, etc..

The pinnal membranes are inserted in the rami such that the two pinnules lie on a plane which is vertical and perpendicular to the longitudinal axis of the body assuming the parapodium is transversal and not inclined forward with respect to this axis, which is normally the case for the anterior parapodia, or inclined backwards as in the posterior parapodia. Normally however, the two pinnules of a parapodium partially rest against each other.

The pinnal membranes, which especially determine the appearance of the pinnule, can show specific or even general characters which are quite important. Particularly special are those found in Enapteris euchaeta (CHUN), which do not border the two sides of the internal angle between the rami, the low and puckered membranes of the T. Nisseni (ROSA) and those of the T. ligulata (ROSA), which extend along the entire length of the trunk of the parapodium.

In some species, the ventral pinnule has a spur gland situated inferiorly which we will deal with when discussing the glands.

When describing the pinnules the term "external blade" refers to the pinnal half of the membrane which is located at the top in the dorsal pinnule, and at the base in the ventral pinnule. The term "internal blade" refers to the other half. Each pinnule can also be divided into a proximal half and a distal half. A pinnal gland is called "upper or superior" if it is located at half the length of the upper blade, "lower or inferior" if it is found at half the length of the lower blade and "apical" if it is located on the extension of the

axis or the ramus.

Rosettes. - The rosettes can be found on the trunks of the parapodia (in one case on their ventral ramus) and on the pinnules. They are clearly phosphorescent organs, as claimed GREEFF (1881), and not eyes as VEJDOVSKY (1878) believed. These rosettes are only found in one group of Tomopteris which I have placed in the subgenus Johnstonella and which, with the exception of one, are mainly found in warm seas.

Older authors did not make a clear distinction between the rosettes and the pinnal glands and GREEFF himself continuously confuses these terms in his work of 1879. However, in his work of 1885 he makes a clear distinction between the rosettes (rosettenformige Organe) and the pinnal glands (Flossendrusen).

The rosettes on the trunk of the parapodia (there is one per pair of parapodium and generally only on the first two pairs) have been well described by GREEFF (1885) who used fresh specimens and therefore, I will refer to his description. In the preserved specimens, they appear as a mass of yellow or brown globules, sometimes compressed to form a "melon-shaped" body surrounded by a ring of glandular cells, and on the whole, they actually resemble a "rosette" which can be small but sometimes even very large. They are not superficial, but rather formed as a result of globular sinking of the skin.

The rosettes found on the pinnules have basically the same structure but are generally small. Sometimes they can be mistaken for pinnal glands (which we will call hyaline glands) and APSTEIN himself made this mistake once. Any possible doubts as to their identity

can be dispelled by treating them with osmic acid which deeply stains the central adipose globules.

Furthermore, the location of the rosettes on the pinnules seems to be constant (the only exception, which I find very questionable, is Tomopteris Vitrina VEJD). They are located on the interior margin of the pinnule, with the center directly against the ramus which forms its axis, near the apex.

APSTEIN has taught us to note the exact parapodium in which these pinnal rosettes begin to appear (usually around the 3rd) and whether, on the first of these parapodia, they begin to appear on one pinnule only or if they appear simultaneously, as they usually do, on two pinnules.

Pinnal glands. - If this work contributes, even slightly, to furthering progress in the systematics of tomopterids, it will be above all because, for the first time, it mentions the fact that the common term "pinnal glands" or Flossendrusen includes two completely different types of glands. Thus, based on the different distributions and combinations of these two types of glands, a new and very reliable criterion can be established to distinguish species.

APSTEIN (2) correctly used the term pinnal glands. In some cases, he even observed that, in addition to the large glands, there were also small glands; however he did not make a clear distinction between the two categories of glands. He attributed the property of staining well with haematoxylin to both, while it is a property of only one of them. Therefore, I will divide the pinnal glands of tomopterids into two categories: chromophile glands and hyaline glands.

Chromophile glands. - These glands are found (without any proven exceptions) in all the species of tomopterids and always only on the ventral pinnule. There is only one of these glands on each pinnule.

The gland may begin to appear on the first parapodium, but this is rare. They are most commonly present in the third, fourth or even fifth parapodia. The first is generally smaller than the subsequent ones. In a pinnule, the gland may be apical, apico-inferior or inferior.

The chromophile glands stain well with haematoxylin (better with haematin) before the rest of the pinnule is stained, or at least their glandular tubules stain well.

The shape of these glands varies, but they are generally cupolar, with the apex inclined towards the blade of the pinnule or actually facing it.

Each gland consists of bunches of tubes (similar to others, which also stain well, found scattered on the pinnal margin) converging towards a common opening. The base of the gland (often even the internal part) forms a granulose mass which does not stain as well. All of this forms a body which is sometimes flat, sometimes very prominent, which varies in size and which can also take up the entire space between the axis (ramus) of the pinnule and the edge of the pinnule. (See figures: cr).

The tubules contain a granulose, or more often filamentose substance.

Hyaline glands. - These glands are no longer found in all species of tomopterids (they are present in the only species of the

genus Enapteris, they are lacking in almost all the Tomopteris of the subgenus Johnstonella and they are present in almost all the species of subgenus Tomopteris). They are usually found on the ventral pinnule but can also be found on both pinnules or even only on the dorsal pinnule. In this case, too, there is always only one hyaline gland per pinnule.

The position of the hyaline glands on a pinnule can be apico-inferior, apical or even apico-superior, however the fact remains that when the two types of glands co-exist, the hyaline gland is always distal to the chromophile gland, if this gland is inferior (or apico-inferior), and proximal, if it is apical. In other words, the hyaline gland is always superior with respect to the chromophile gland, that is, it is always found on the side of it which, following the pinnal margin, leads to the upper part of the pinnule.

The hyaline glands can be found beginning at the first parapodium, in fact this is usually the case. When a same species has both chromophile and hyaline glands, these latter glands can be found first alone, and then, in successive parapodia in conjunction with the chromophile glands.

These glands (hyaline) do not stain at all with haematoxylin (unless, of course, the stain is too intense) nor do they darken with osmic acid, as do the centers of the rosettes.

These glands can be in the shape of a cone, or a wide truncated cone but more often, they are globulose or lemon-shaped. They do not protrude but rather, are depressed, with the apex inclined towards the point closest to the pinnal margin.

Each gland is made up of meridian tubules which curve into a common

opening at the apex. Often these tubules are yellow or brown at the free end, and often a regular mass or ring of yellow, brown or blackish globules which seem to be their excretion is also often found at the opening. The tubules themselves appear sometimes clear and sometimes full of yellowish granules. When the tubules making up the hyaline gland are few and large as in T. septentrionalis, the gland, if viewed from above, appears as a true rosette.

I have observed that the hyaline glands are often difficult to detect, even though they can sometimes be quite large and consequently, great care must be taken in seeking them out.

Therefore, the characters distinguishing the two types of glands are very clear (see my figures where the hyaline gland is marked j and the chromophile gland is marked cr).

The tables on pages 267 - 68 show the importance of this new character. It can be said that almost all species of the subgenus Tomopteris can be clearly distinguished from one another based on this one character. I can assure the reader that I found this character to be extraordinarily constant.

Spur glands of the pinnules. - Until now, they had never been observed and are found only in a few species (see figures 1, 2, 5, 6, 8, 11, 12). In species having chromophile and hyaline glands, they are closely attached to the hyaline gland and lie on the proximal part of this gland. In species with only a chromophile gland, they are also closely attached to said gland and slightly distal to it. However, they can also be found in the anterior parapodia even if there are no longer any glands.

It appears that these spur glands (probably) protect the glands,



at least this seems to be the case for the hyaline glands. In T. Apsteini, I found the secretion of the gland which had coagulated along the spur gland and at its extremity (figures 11, 12).

Caudal parapodia. - The caudal parapodia have the same fundamental composition as those of the trunk. In the caudal parapodia, the first part which diminishes is the trunk of the parapodium so that the pinnules tend to appear almost sessile. The pinnules tend to thicken, to reduce their membranes and to take on a lanceolate or conical shape. Rosettes and glands tend to disappear.

Often the caudal pinnules can be seen protruding from the sides of the tail, not from the center of the segment but from its posterior extremity, so that the trunks of the parapodia appear placed longitudinally against the sides of the segment with a complete fusion between the internal side (normally posterior) of the trunk of the parapodium and the sides of the tail.

Caudal parapodia are not necessarily rudimentary and may show only the special character of the fusion of the lanceolate pinnules and the trunk with the sides of the tail. This is the case, for example, in T. Dunckeri (fig. 8) where these parapodia begin with a rather abrupt detachment from those of the trunk and continue up to the extremity of the tail. Parapodia of this form, although not rudimentary, should be considered caudal and therefore, (contrary to APSTEIN) I have considered as such, the three pairs of similar parapodia which are also found, in females, in T. Apsteini. Caudal parapodia completely detached from those of the trunk seem to be characteristic of females.

Genital ducts. - When dealing with the external characters we should also consider the genital ducts which are characteristic only of the female and clearly serve for the laying of eggs. They are present sometimes in one and sometimes in two pairs, generally in the form of transverse fissures, between the third and fourth and the fourth and fifth segments on the ventral part of the body at a certain distance from the median line. They are often very difficult to detect.

INTERNAL CHARACTERS. - In the systematics of tomopterids only a few internal characters which are visible against the light are used. These include the characters provided by the brain, the eyes (possibly from the doubtful statocysts), from the digestive tract and from the gonads.

Brain. - It has a particular form in the genus Enapteris (see under heading). In Tomopteris it varies slightly from one species to another but is generally oval in shape, more or less elongated transversely, more or less bigangular, situated a little more forward or a little more rearward, but always anterior to the mouth.

The shape of the brain can vary slightly within one species and even appears marginally different depending on the amount of compression.

Sometimes it is difficult to clearly distinguish the brain from the gangliar mass which is situated ventrally in front of the mouth and which originate from the union the two halves of the gangliar chain which bifurcate to permit backward migration of the mouth. In Enapteris euchaeta (CHUN), this distinction between the brain and the prebuccal mass is not possible.

Eyes. - They are closely attached to the brain. They are very small and close - set in E. euchaeta and more or less large and far - set in Tomopteris.

Depending on the species, their pigment can be brown, blackish or reddish, but it is important to remember that this changes in preserved specimens so that eyes which were originally almost black can appear reddish or even yellowish, as I found in old specimens of T. septentrionalis.

Statocysts. - In describing some tomopterids, two otocysts, which were most probably statocysts, were mentioned. This was the case in T. Catharina as described by CARPENTER and CLAP and others. I found two vesicules which seemed to be statocysts in the T. Ligulata (see heading).

Digestive tract. - When referring to the mouth we also mentioned the proboscis. The following portion of the digestive tract seems to be large in certain species and more slender in others. The caudal portion of this tract sometimes has a special appearance with curves which make it appear contorted.

Gonads. - All tomopterids are unisexual. In certain species, the gonads are found on the dorsal ramus, in others on the dorsal and ventral ramus of the parapodia, but never on the ventral ramus only. Following APSTEIN I have always taken this character into consideration. Released eggs can penetrate everywhere, even the cephalic cavity and therefore it is sometimes difficult to determine the actual position of the gonads.

CHUN pointed out that in Tomopteris elegans, the gonads are localized in a few specific parapodia, whereas in E. euchaeta, they are found in almost all parapodia of the trunk, with the exception of the 1st parapodium. Following the example of CHUN, I have always endeavored to determine in the various species, which parapodia contain gonads because this character, which APSTEIN did not take into account, is also important.

### Classification of Tomopterids

The various species of Tomopterids are generally included in one genus Tomopteris ESCHSCHOLTZ 1825 = Briarea Q. and G. 1827; = Johnstonella GOSSE 1851; = Tomopteris + Escholtzia QUATREF. 1865.

Therefore, as can be seen, only QUATREFAGES tried to divide the tomopterids into two genera distinguishing a new genus Escholtzia (sic) from the old genus Tomopteris.

QUATREFAGES called Tomopterids with 4 antennae Escholtzia and Tomopterids with 2 antennae were placed in the genus Tomopteris.

He considered the prostomial horns to be the first pair of antennae and the small setigerous cirri (anterior cirri) to be the second pair. Therefore, according to him, Escholtzia were tomopterids with the first pair of setigerous cirri and Tomopteris were those lacking these cirri.

The two generic names are used here in the opposite sense because actually the typical species of the genus Tomopteris, the true T. onisciformis, has one pair of cirri (as can be seen particularly in the figures of ESCHSCHOLTZ) and has therefore 4 antennae as understood by QUATREFAGES. However, QUATREFAGES regarded these cirri in T. onisciformis as belonging to the proboscis and not as homologous with

what he calls the second pair of antennae in Escholtzia.

No one accepted the division proposed by QUATREFAGES because, as we have seen, the presence or absence of the first pair of setigerous cirri is a character which is too misleading.

I felt it would be more appropriate to continue classifying all the Tomopteris into one sole genus, with the exception of Tomopteris euchaeta of CHUN for which I established a new genus, Enapteris.

In fact, the particular configuration of the brain, the smallness of the eyes, the slenderness of the proboscis (see CHUN (1), table III, fig. 2), the particular shape of the pinnules (see APSTEIN (2), table XI, figs. 19 and 20), the length of the second cirrus and other minor characters clearly separate this tomopterid from all other known genera.

As for the genus Tomopteris, sensu stricto, for now, I have only divided this genus into two subgenera: Johnstonella (Tomopterids with rosettes) Tomopteris (without rosettes).

APSTEIN (2), in his table on page 38, had already divided Tomopterids into forms with rosettes and forms without rosettes. However, in this latter group, he also included T. euchaeta, which he perhaps would also have separated generically if he had not believed (incorrectly, as we will see) that the same particular brain shape occurring in this species was also found in T. Apsteini ROSA (T. scolopendra APSTEIN) which in all the other characters is similar to other Tomopteris without rosettes.

Therefore let us divide tomopterids into the following primary groups:

A. Genus ENAPTERIS ROSA.

Brain pointed anteriorly extending into an azygous frontal nerve; eyes very small, proboscis slender and very short; parapodia with rectangular rami of which the pinnal margin does not border the internal side; second setigerous cirrus much longer than the body (2 to 4 times longer). Tail and hyaline glands present, the 1st cirrus is missing.

This genus contains only one species - E. euchaeta (No. 1).

B. Genus TOMOPTERIS ESCHSCHOLTZ, sensu stricto.

Brain ovoid (generally transversely oval), not pointed anteriorly; eyes large; proboscis sturdy and long (usually up to the first parapodium); rami more or less conical, completely bordered by the pinnal margin; second cirrus long, at most, as long as the body.

a. Subgenus JOHNSTONELLA.

Rosettes present: the tail and the anterior cirrus are almost always present and the hyaline glands are almost always absent.

b. Subgenus TOMOPTERIS.

Rosettes absent. The tail and the anterior cirrus are almost always absent. The hyaline glands are almost always present.

(The name Johnstonella was taken from GOSSE who used the name Johnstonella Catharina for the species more commonly known by the name T. helgolandica GREEFF, a species which in fact has rosettes and which constitutes the type of this subgenus).

(The type species of the subgenus Tomopteris should be the true T. onisciformis which, is still a doubtful species. However, ESCHSCHOLTZ does not speak of rosettes, and no forms are known in the Pacific (homeland of the T. onisciformis) which are tailless, like this species and which have rosettes. It is very likely that the species of ESCHSCHOLTZ actually lacked rosettes and that it is therefore a Tomopteris (T. elegans CHUN)).

The following tables can be used for an initial orientation on the species of the genus Tomopteris (sensu stricto):

1). Subgenus JOHNSTONELLA

- A. Rosettes only on the trunk of the  
parapodia; tail present .....T. (J) Jevipes (No.2).
- B. Rosettes on the trunk of the 1st  
and 2nd parapodia and on the  
pinnules.
  - 1. With tail.
    - a. With chromophile and  
hyaline glands; ventral  
pinnules with spur gland...T. (J) Duccii (No.3).
    - b. With only chromophile  
glands; ventral pinnules  
(with the exception of  
Nationalis?) with  
spur gland.....T. (J.) Moysii Sab. (No.4).  
T. (J.) Dunckeri (No.5).  
T. (J.) Nationalis (No.6).

2. Tailless; with only  
 chromophile glands; pinnules  
 without spur gland.....T. (J.) mariana (No.7).  
 T. (J.) Rolasi (No.8).
- C. Rosette on the ventral ramus of  
 the 1st and 2nd parapodia and  
 on the pinnules; with tail;  
 only chromophile glands; spur  
 gland absent (1) .....T. (J.) Catharina (No.9).
- D. Rosettes only on the pinnules;  
 with tail; glands absent?;  
 spur glands absent.....T. (J.) vitrina (No.10).

## 2.) Subgenus TOMOPTERIS

- A. With tail
1. Chromophile and hyaline  
 glands only on the  
 ventral pinnules.....T. (T.) Apsteini (No.11).
  2. Hyaline glands on the dorsal  
 pinnules, hyaline and chromophile  
 glands on the ventral pinnules..T. (T.) Nisseni (No.12).

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(1) This group was made purely for convenience: the T. (J.) Catharina should fall into group B because evidently it is not important whether the rosette is found on the trunk of the parapodium or further down, on one of its rami.



## B. Tailless.

## 1. Presence of hyaline and

chromophile glands

## a. Hyaline glands only on

the dorsal pinnules of the

3rd and 4th parapodium...T. (T.) elegans (No. 13).

## b. Hyaline glands only on

the ventral pinnules.

## a. Hyaline and chromophile

glands, apical.....T. (T.) septentrionalis (No.14).

## b. Hyaline glands apical,

chromophile glands,

inferior.....T. (T.) planktonis (No.15).

T. (T.) ligulata (No.16).

## 2. Hyaline glands absent

## a. Chromophile glands

inferior.....T. (T.) Cavallii (No.17).

## b. Chromophile apical ..T. (T.) Eschscholtzi (No.18).

In these two tables I have sometimes included two or even three species in one group (without analyzing them separately) and therefore, for purposes of differentiating, it would be well to refer to the detailed description.

3.) TOMOPTERIDS OF UNCERTAIN SUBGENERANo. 19 T. onisciformis (perhaps = T. elegans). Pacific.No. 20 T. scolopendra (perhaps = T. Catharina). Gibraltar.No. 21 T. Huxleyi (tailed, with anterior cirrus). Torres Strait.No. 22 T. Danae (tailless, without anterior cirrus few parapodia).

Sulu Sea.

No. 23 T. Carpenteri (tailed ?, anterior cirrus absent, rami disproportionate). Antarctic Seas.

No. 24 T. Kefersteini (tail absent; rosettes or hyaline glands in all the dorsal and ventral pinnules). Canary Islands.

Some instructions for the use of the preceding tables are necessary: it should be remembered that:

The tail of very young individuals is always absent  
(see page 257).

The rosettes of the pinnules rarely begin at the first parapodium; generally they begin to appear towards the 3rd.

The chromophile glands rarely begin at the 1st parapodium and sometimes will not begin to appear until the 5th.

The hyaline glands usually appear beginning at the 1st parapodium, but they can also be absent on the first 2 pairs.

The chromophile glands are always found only on the ventral pinnule, whereas the hyaline gland can sometimes be present, even exclusively, on the dorsal pinnule. To distinguish between these two types of glands see page 261 and compare the figures.

#### Genus ENAPTERIS ROSA (see page 266)

##### No. 1 Enapteris euchaeta (CHUN).

- 1818 (Tomopteris onisciformis part.) Grube (1) page 456-468. tab. XVI  
1861 (Tomopteris scolopendra part.) Keferstein (1) page 360-368 tab. IX.  
1865 (Escholtzia Leuckartii part.) Quatrefages (1) page 225.  
1887 (Tomopteris euchaeta) CHUN (1) page 19-21. tab. III fig. 1-3, 6-9.  
1900 (Tomopteris euchaeta) Apstein (2) page 37, 38, 41 et passim,

tab. IX, fig. 19,20.

1901 (Tomopteris euchaeta) Lo Bianco (1) page 453.

1904 (Tomopteris euchaeta) Lo Bianco (2) page 51, tab. XXX, fig. 117 (CHUN).

Not Tomopteris onisciformis Eschscholtz 1825.

Not? Briarea scolopendra Q. and G. 1827.

Not Tomopteris scolopendra Gosse 1855.

The R. Ship "Liguria" collected many samples of this species in the Atlantic (stations V and VI). The following description is mainly based on the specimens from Messina. This description adds very little to the data of CHUN and APSTEIN.

Dimensions. - CHUN had specimens up to 30 mm long; mine reached 20 mm.

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Appearance. - Body ovate - lanceolate, fairly wide (at the 4th parapodium) with tail almost bare and which in adult individuals can measure over 1/3 of the body length, (in a young individual 7 mm. long, it only reached 1 mm.). (1)

Parapodia. - Relatively thick and stubby, very dense only on the trunk of adults (at least in females). They usually go up to and rarely exceed 15 in number. On the tail they are very small (almost imperceptible with a simple magnifying glass) and can also number up to 15, appearing disproportionate over the entire length of the tail. The 13th, 14th and 15th parapodia rapidly diminish and have slightly modified pinnules (at least, this is the case in females, where they are the last parapodia of the trunk). An individual only 7 mm. long

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(1) The tail is well characterized by the fact that its intestine has special folds which make it appear as if twisted into a coil.

already had all 15 trunk parapodia, the last three of which were very short but evident, whereas those on the short tail were imperceptible.

Prostomium with the neck in the shape of a short, narrow peduncle and slender horns, generally curved backwards. In samples preserved in alcohol, the prostomium and its horns usually hang downwards and the anterior extremity of the animal seems to be at an acute angle with the slightly convex sides which begin from the base of the large setae.

Brain - in the form of a triangle with the base (posterior) markedly bipartite and the acute apex extending anteriorly into a nerve which subdivides at the base of a cephalic groove. (See figure in CHUN l. c.).

Eyes - Very small reddish-brown, situated at the apex of the brain.

Ciliated epaulettes. - In the young they are rounded, in adult specimens they are oval and slightly elongated so that they do not reach the shoulder and posteriorly they do not surpass the level of the eyes.

Proboscis. - very short in the form of a calyx; it only occupies 1/5 of the space between the mouth and the first parapodium.

Anterior cirrus - Always absent. CHUN also noted this absence in a young individual which was 2 mm long and had only six pairs of parapodia.

Second cirrus - Always much longer than the body; in small specimens (5 mm) I found (like APSTEIN), that it could even reach a length four times that of the body. The seta is completely smooth.

Pinnules - With rami, not conical, but rectangular, more or less rounded at the outer edge, with the margin bordering only the external and apical sides. In the females at least, the pinnules of the three last parapodia of the trunk (13, 14, 15), are thicker and more rounded and have a particular alveolate appearance.

Rosettes - Absent.

Pinnal glands - There are two types: chromophile and hyaline. both are absent in the first two pairs of parapodia and are found only on the ventral pinnule on the subsequent pairs. The chromophile glands are in a apico-inferior position, that is, they are situated at the lower (or outer) edge of the pinnule; they begin to appear on the 4th parapodium and continue ~~up~~ to the 12th or 13th. The hyaline glands are situated in an apico-superior position, that is, they are located at the upper (or inner) edge of the pinnule. They begin to appear in the 3rd parapodium where they are found alone, whereas, in the subsequent parapodia, they are found together with the chromophile gland.

The chromophile glands are fairly large, mammillary with tubes containing a filamentose substance resting on a granulose mass which in turn rests on the ramus. At the apex, the pinnule often has a slight incision. The hyaline glands are smaller, dolioform and contain a granulose substance.

I tend to disagree slightly with APSTEIN with respect to the distribution of the glands. He maintains (p. 44) that in the third

parapodium, only the large rather inferior gland (that is, the chromophile gland) is present, whereas the smaller, more apical gland (the hyaline gland) does not begin to appear until the 4th parapodium. Actually, the opposite is true. Furthermore, I did not find those discontinuities in the presence of the smaller (or hyaline) glands that APSTEIN found in two out of three individuals.

Gonads - Present only on the dorsal ramus of the parapodia beginning at the second pair. CHUN states that, with the exception of the first parapodium, they are only absent on the rudimentary parapodia of the tail. However, I have always seen them terminate after the 11th parapodium. In other words, I have always observed 10 pairs of them. I, too, like CHUN, have only found female specimens. So far, the male of this species is unknown.

Genital ducts - APSTEIN found them in the form of oval, longitudinal fissures at the base of the 4th and 5th pair of parapodia. However, I, like CHUN have never been able to see them.

Habitat - This species was recognized as a distinct species for the first time by CHUN, who described it using specimens from Naples (where it was subsequently found by LO BIANCO). APSTEIN found this species in Messina where it had already been discovered by KEFERSTEIN and by KROHN who, like GRUBE, mistook it for the species which we have called T. Apsteini. I received many specimens of this species from Messina and also studied many specimens collected by KROHN and classified, under the common name of T. scolopendroides Q. and G., together with specimens of T. Apsteini. This species has not been reported in any other parts of the Mediterranean.

It does not seem to be rare in the Atlantic and, according to APSTEIN, it was found from 30°-40°N. lat. (Sargasso Sea, the Azores) up to the mouth of the Amazon and at Ascencion, that is, at approximately 8°S. lat.

The R. ship "Liguria" collected this species in the Atlantic at stations V and VI, that is, in the Caribbean Sea, where no tomopoterids had ever been discovered before. These samples are generally small, 2-5 mm, with extremely long second cirri, but as for the rest, they have no special characteristics.

This species has not yet been found in other seas.

### Genus TOMOPTERIS Escholtz

Subgenus JOHNSTONELLA GOSSE (See p. 267)

#### No. 2 Tomopteris (Johnstonella) levipes GREEFF

- |      |                                      |   |
|------|--------------------------------------|---|
| 1879 | ( <u>Tomopteris</u> <u>levipes</u> ) | Greeff (2) page 276, tab. XV, fig. 44-45. |
| 1886 | " "                                  | Viguier (1) 414 tab. XXVII, fig. 26.      |
| 1900 | " "                                  | Apstein (2) page 37, 38, 40.              |

Description based on the data of GREEFF.

Dimensions - 5-6 mm in length.

General appearance - Body extremely reduced posteriorly, ending in a short tail.

Parapodia - 15-20 pairs, increasingly smaller posteriorly and absent on the last 4-5 segments (tail).

Prostomium - Has large horns protruding markedly outwards.

Brain - Transversely oval, bilobate.

Eyes - reddish-brown with two lenses.

Anterior cirrus - Short.

Second cirrus - Almost  $\frac{2}{3}$  the length of the body.

Pinnules - Relatively narrow, spoon-shaped with continuous edges, markedly curved towards the concavity of the pinnule.

Rosettes - Present only on the trunk of the parapodia (all of them?); thick with orange or reddish-brown pigment.

Pinnal glands - Seem to be absent (?).

Habitat - GREEFF found this species in Arrecife (Canary Islands).

VIGUIER attributes specimens from Algiers to this species, with some doubt, but does not provide a description and the only figure given does not clarify the matter. It has not been found by others.

The presence of rosettes only on the trunk of the parapodia and not on the pinnules would distinguish this from all other known species, but it would be advisable to confirm the pertinent data since one could wonder whether GREEFF failed to see small rosettes on the pinnules. I feel that the absence of glands is highly improbable.

No. 3. Tomotperis (Johnstonella) Duccii ROSA

1907 (Tomopteris Duccii) Rosa (1)

The "Liguria" collected two specimens of this species at station XV. The following description refers to the larger and better preserved specimen.

Dimensions - 20 mm in length, 5 of which constitute the tail; maximum width between the extremities of the 5th pair of parapodia - 5 mm.

General appearance - Body long and lanceolate tapering into a tail 1/5 the length of the body.

Parapodia - 19 pairs, fairly thick, with the exception of the last pairs, becoming larger up to the 4th and becoming regularly smaller up to the last which, except for the shorter length of the trunk of the parapodium, still resembles the preceding pairs and is not too small. The tail is completely bare.

Prostomium - Convex anterior margin without a frontal incision.



Brain - Very elongated transversely and enlarged at the two sides corresponding to the location of the eyes; the anterior side is concave.

Eyes - large, brown, far-set.

Ciliated epaulettes - Linguiform, narrow with the pointed posterior extremity extending far beyond the posterior margin of the brain.

Proboscis - Little developed; does not reach the first parapodium.

Anterior cirrus - Well-developed, approximately  $2/3$  the length of the frontal horns.

Second cirrus - Approximately  $2/5$  the length of the body, seta marked with incisions.

Pinnules - Oval, slightly elongated with conical rami; at the lower margin, all of the ventral pinnules have a triangular spur gland (not very developed in the 1st and 2nd parapodia) which protrudes from a slight marginal slit of the pinnules but whose base is further back.

Rosettes - One medium-sized rosette on the trunk of the first two pairs of parapodia, situated at the bifurcation in one specimen (the smaller one) and more proximally in the other sample. A smaller rosette on the two pinnules of the 3rd and subsequent parapodia, on the inner side. They <sup>consist</sup> ~~are made up~~ of a small brown spot with a ring of small yellowish piriform cells.

Pinnal glands - Two types. A larger gland (chromophile gland) is present on the ventral pinnules beginning only at the 5th parapodium. It is large, cone-shaped with its base against the lower side of the ramus, behind the base of the spine, but situated rather proximally. A smaller, dolioform gland (hyaline gland) is found on the ventral pinnule of all the parapodia, alone in the first 4 pairs and together with the chromophile gland in the subsequent pairs; at the base of the spine it overlaps with the distal side.

Gonads - Only on the dorsal ramus of the parapodia, from the 2nd up to at least the 14th pair.

Genital ducts - Not visible (in the male species).

Habitat - Along with the T. aloysii Sabaudiae in the Pacific along the coast of Mexico.

No. 4. Tomopteris (Johnstonella) Aloysii Sabaudiae ROSA

1907 (Tomopteris Aloysii Sabaudiae) Rosa (1).

Original description based on two very well preserved specimens collected by the R. ship "Liguria" at station XV.

Dimensions - Length 15 mm, 3 of which constitute the tail. Maximum width of 4 mm between the extremities of the 4th-5th pair of parapodia.

General appearance - Body narrow and elongate with lateral margins, for the most part, almost parallel, tapering rapidly to a tail 1/5 the length of the body.

Parapodia - Ranging in number from 21-23 pairs; 15-18 pairs are attributable to the trunk, of which the last 3-4 pairs are reduced rapidly, gradually leading to 5-7 very short pairs which are part of the tail. The first of these short pairs are still bilobate, the others completely rudimentary and the last segment of the tail (1-2 mm) is completely bare.

Prostomium - Short, in the shape of an inverted cone with a slightly depressed anterior margin and normal horns.

Brain - Transversely oval, slightly concave anteriorly.

Eyes - Large and black.

Vibratile areas - Long and narrow on the back, slightly enlarged at the posterior extremity, which extends to the posterior margin of the

brain and wider in the short segment which extends to the ventral side.

Proboscis - Invaginated and extending to the beginning of the 1st parapodium.

Anterior cirrus - Absent; however, in the younger specimen, under the ventral extremity of the ciliated epaulettes, a circular scar can be clearly seen, which seems to be the base of a cirrus which has fallen out.

Second cirrus -  $2/3$  the length of the body, bearing slight notches.

Pinnules - Medium-sized, oval; the inferior edge of all of the parapodia is marked by a depression from which a flat aculeiform process protrudes and near the base of this (in the 3rd and successive parapodia) there is a gland. On the ventral pinnules with glands, the ramus of the parapodium is blunt at the apex and depressed on both sides at the level of the gland.

Rosettes - There is a large rosette on the trunk of the first two pairs of parapodia (in one sample it was missing on the 1st left parapodium) situated near the bifurcation. It is medium-sized (much smaller than in the T. mariana), and made up of a brown mass surrounded by minute globules. There is a smaller rosette on the two pinnules of the 3rd and successive parapodia situated not very far from the apex of the ramus against its inner side.

Pinnal glands - Only one type (chromophile gland) on the ventral pinnule of all the parapodia from the 3rd pair onward. The gland is large, compact, sometimes in the shape of a truncated cone, sometimes more cupolar and situated on the ventral edge of the pinnule, behind the base of the aculeiform process but more to the proximal side (towards the body).

Gonads - From the second parapodium up to at least the 15th, only on the dorsal ramus.

Genital ducts - Not found (my specimens were males).

Habitat - The specimens from the "Liguria" (station XV) came from the Eastern Pacific, along the coast of Mexico.

This species seems to be related to T. Nationalis, an Atlantic species. It is distinguished from this species by the absence of the anterior cirrus, (which is perhaps not constant), by the greater length of the second cirrus, the black eyes, the absence of a rosette on the dorsal pinnule of the second parapodium, perhaps also by the presence of the aculeiform process on the pinnules, (which was not mentioned in the brief description made by APSTEIN) and finally by the presence of gonads only on the dorsal ramus of the parapodia.

No. 5. Tomopteris (Johnstonella) Dunckeri ROSA

1908 (Tomotperis Dunckeri) ROSA (2)

Description based on a specimen (female) belonging to the Hamburg Museum of Natural History.

Dimensions - Length 17 mm, 8 of which constitute the tail; maximum width of 4 mm between the extremities of the parapodia.

General appearance - Almost scorpioid due to the clear delimitation between the trunk and the long cylindrical tail.

Parapodia. - 26 pairs, 16 on the trunk and 10 on the tail. Those on the trunk are quite thick and increase in length up to the 3rd pair, then remain subequal, and subsequently diminish rapidly in size from the 3rd or 4th last pairs. Those belonging to the tail are widely separated and diminish gradually up to the last pair which protrudes from behind the posterior extremity of the body. Even the caudal appendages are all

bipinnate but these pinnules appear almost sessile on the posterior margin of the segments so that the trunks of the parapodia are short and almost fused with the segments from the inner side.

Prostomium - With a frontal incision and slender pointed horns.

Brain - Transversely oval, once again slightly enlarged at the sides corresponding to the location of the eyes.

Eyes - large, brownish-black.

Ciliated epaulettes - Forming, on each side, a narrow and sinuous strip extending far behind the posterior margin of the brain. They do not extend to the ventral side, however they rise and widen on the shoulder so that in a ventral view, they appear like a scroll with open and sinuous edges.

Proboscis - Well developed. In the sample studied it was everted.

Anterior cirrus - Not present (at first glance, the ciliated epaulette seen in ventral view can be mistaken for an anterior cirrus).

Second cirrus - Almost 1/2 the length of the body.

Pinnules - Those belonging to the body are quite different (at least in the female) from those on the tail. In the parapodia of the body (16 pairs) the ramus is thick and short and its extremity (particularly in the ventral pinnule) is divided into two lobules one of which is longer and digitiform. The pinnal membrane is not very developed and in general it is oval-quadrate. A sturdy, triangular spur gland with its base against the ramus protrudes from the inferior margin of all the ventral pinnules of the trunk. The pinnules of the caudal parapodia (which are striking because of their brown colour) have a conical ramus which is extremely elongated and undivided and which is bordered by a narrow strip, without spines. In general, it is lanceolate in shape. Only the first pair of caudal parapodia is more cylindrical and has a trace of a spine at the extremity. Most probably, these differences do not exist in male specimens.

Rosettes - There is a small rosette on the trunk of the 1st and 2nd parapodia, not very far from the bifurcation. A very small rosette (a round spot with a trace of glandular rings) is found on the two pinnules of the 3rd parapodium and on the successive parapodia of the trunk, on the inner side of the pinnules. There are no rosettes on the caudal pinnules.

Pinnal glands - Only one type is present (chromophile glands). A large conical gland is situated on the ventral pinnule of all the trunk parapodia from the 3rd pair onward. It has its base in a depression of the inferior side of the ramus and is adjacent to the proximal side of the above-mentioned spur gland. The gland though smaller is also found, on the first pair of caudal parapodia.

Gonads - Only found on the dorsal ramus of all the trunk parapodia (however, in the first pair they were only visible from one side).

Genital ducts (female) - In the shape of two pairs of small eyelets not far from the ventral chain, on the lines between the 3rd-4th and the 4th-5th parapodium, included in a brown transversal line.

Habitat - The Indian Ocean between Ceylon and the Strait of Dampier (New Guinea). A sample collected by Dr. G. DUNCKER and belonging to the Hamburg Museum of Natural History.

Observations - This species has the same basic characters as the T. (J.) Aloysii Sabaudiae. However, it is clearly distinguished from this species by many accessory characters such as the particular shape of the ciliated epaulettes, the distinct delineation between the trunk and the tail, the shape of the rami of the trunk pinnules and the presence of caudal pinnules, different from those of the trunk but not rudimentary, on the entire tail so that the last pair protrudes freely beyond its extremity.

No. 6. Tomopteris (Johnstonella) nationalis APSTEIN  
1900 (Tomopteris nationalis) Apstein (2) p. 37, 38, 41.

The following description is based on the limited data provided by APSTEIN. The "Liguria" collected a sample from station II which, because of its poor state of preservation, we cannot attribute to this species with any degree of certainty. The data obtained from this sample have been listed in the appendix.

Dimensions - 13 mm in length.

General appearance - Body tapering into a long tail which is  $1/6-1/7$  the length of the body and has rudimentary parapodia.

Brain - Oval.

Eyes - Reddish-brown.

Anterior cirrus - As long as the frontal horns.

Second cirrus -  $1/2$  the length of the body.

Rosettes - A large rosette on the trunk of the 1st and 2nd parapodia; a small rosette on the ventral pinnule of the second parapodium and on the pinnules of the successive pairs.

Pinnal glands - A gland on the ventral pinnule on the 3rd and subsequent pair of parapodia.

Gonads - On the two rami of the parapodia.

Habitat - The Plankton Expedition found two samples of this species, one near the Azores and the other in the North-equatorial current between the mouth of the Amazon and the Cabo Verde Islands.

Appendix - A sample collected by the R. Ship "Liguria" near the Canary Islands (station II) is referrable with some doubt, to this species. The following characters may be identified: Length 5 mm including the tail; Anterior cirrus slightly longer than the horns of the prostomium; Second cirrus slightly longer than  $1/2$  the length of the

body, with setae showing only traces of notches; Parapodia - 12 developed pairs and 4-5 rudimentary pairs. A large rosette on the trunk of the 1st and 2nd parapodia approximately half way down. A small rosette on two pinnules of the parapodia (seen only from the 4th); it is on the inner margin of the pinnule near the extremity of the ramus. A pinnal gland at the inferior margin at the ventral pinnules clearly present on the 3rd and subsequent parapodia but perhaps already present on the second pair. Protruding from the inferior margin of the ventral pinnules is an aculeiform process which is not mentioned in the description of T. nationalis by APSTEIN.

If this sample does not belong to T. nationalis, it must belong to a new species.

No. 7. Tomopteris (Johnstonella) mariana GREEFF

1882 (Tomopteris mariana) Greeff (1) page 384.  
 1885 " " " (3) " 440, tab. XII, fig. 3, 4,  
 12-16, 19, 20.  
 1900 (2) " 37, 38, 40 et passim, tab. X,  
 fig. 9-14.

The "Liguria" collected a specimen of this species at station III. The following description is based on this specimen and on the original description by GREEFF and APSTEIN.

Dimensions - Our specimen is 6 mm long (maximum length found also by APSTEIN) with a maximum width of 3 mm between the extremities of the 5th pair of parapodia.

Appearance - Oval shape; no tail. In our sample, a small, pale yellow spot could still be seen on the extremity of each pinnule. In fig. 9 by GREEFF (3) this species in fact bears a small orange spot, amoeboid in appearance, at the extremity of each pinnule, in addition to the other spots scattered over the entire body.



Parapodia - 12 pairs (GREEFF says 12-13 pairs, in spite of the fact that his specimens were only 2-2.5 mm long., APSTEIN does not specify any number). They are slender and rather widely separated. They increase in length up to the 5th pair, and then diminish gradually up to the last pair which is still well developed and which, because it is folded backwards, extends considerably beyond the posterior extremity of the body. This, according to GREEFF, bears two short cirriform appendages which, in our specimen, were represented by small protuberances.

Prostomium - Slender; the horns are divided by a deep frontal incision.

Brain - Briefly transversely oval, slightly notched halfway down the transversal margin.

Eyes - Large, blackish.

Ciliated epaulettes - Narrow, linguiform, with very prominent borders, with the pointed extremity extending dorsally up to the posterior margin of the brain.

Proboscis - Extending to half the length of the 1st parapodium.

Anterior cirrus - Robust, as long as the frontal horns.

Second cirrus - Very wide at the base; approximately  $\frac{2}{3}$  the length of the body; there are small notches on the outer side of the seta.

Pinnules - Oval, elongate, with a continuous edge and slender conical rami (in the figures of APSTEIN, the rami appear much more stumpy, perhaps due to the compression caused by the slides).

Rosettes - A very large rosette on the trunk of the first two pairs of parapodia halfway down (see the more detailed description and the figures by GREEFF). A much smaller rosette on the two pinnules of each parapodium, beginning at the 3rd pair. They are leaning against the inner side of the rami, not far from the apex and appear as a brown spherule, surrounded by piriform granular cells.



To date, this species has only been described by GREEFF and the following description is based in his data (text and figures).

In the appendix, I have added new data which I obtained from GREEFF's material.

Dimensions - 6 mm long (in GREEFF 2, however in GREEFF 1, the length given as 3 mm).

General appearance - Oval, elongate shape; no tail, posterior extremity ending in two rudimentary cirri; body covered with small orange or violet stellate spots.

Parapodia - 12-14 pairs, rather widely separated and long; after the 3rd pair they diminish gradually up to the last pair, which is still well-developed.

Prostomium and horns normal.

Brain - Rounded or slightly transversely oval, quite bilobate.

Eyes - Large, brownish-black, with double lens.

Ciliated epaulettes - Narrow, extending to the posterior margin of the brain.

Anterior cirrus - As long as the frontal horn and containing two setae back to back.

Second cirrus - Half the length of the body.

Pinnules - (According to the figures) average-sized, oval, with a continuous edge.

Rosettes - There is a large yellow rosette approximately halfway down the trunk of the 1st and 2nd parapodia. There is a yellow, smaller rosette on the dorsal and ventral pinnule of all the parapodia against the inner side of the rami.

Pinnal glands - From the 3rd parapodium onward, the ventral pinnule bears a cupolar gland approximately halfway down the inferior edge, (this is based on the text and fig. 2, however fig. 5 shows the same gland on the ventral pinnule of a parapodium which, since it has a large rosette on the trunk, must be from the 1st or 2nd pair).

Gonads - In his table on p. 32, APSTEIN shows this species as having two gonads per parapodium whereas GREEFF, whose data were used by APSTEIN, does not mention anything in this regard. However, in fig. 5, GREEFF has drawn a gonad on the ventral ramus of a parapodium, and wherever there is a ventral gonad, there is always a dorsal one.

Genital ducts - Females - 2 ventral pairs between the 3-4 and the 4-5 parapodia.

Habitat - Rolas Canal and the South-West coast of São Thomé (Guinea). According to MALAQUIN and DEHORNE it is also found in Amboina.

Appendix - Among the material of the Hamburg Museum of Natural History, I found a small tube bearing the following information:  
Sao Thomé, I. das Rolas, R. GREEFF. It contained some tailless Tomopteris (J.) which could only belong to T. (J.) mariana or T. (J.) Rolasi, as they are the only two species which GREEFF claims to have found in Rolas.

An examination of these specimens told me that they did not belong to T. (J.) mariana but rather to T. (J.) Rolasi.

They were not very well preserved but I was able to recognize most of the characters attributed to T. (J.) Rolasi by GREEFF. The specimens had a maximum length of 5 mm with a narrow elongate shape, immediately distinguishing them from T. mariana, which is more oval in shape. I was not able to resolve the matter of the gonads since both of the rami were too full of mature eggs, nor was I able to verify the double setae on the anterior cirrus.

The rosettes on the trunk of the first two pairs of parapodia were still slightly visible, however, this was not the case with those of the pinnules. Nevertheless, I noted something interesting with respect to the pinnal glands. GREEFF states that these glands (which are chromophile glands) begin to appear at the 3rd parapodium, as in T. mariana. They do however, become larger beginning at the 3rd parapodium but, they are already present on the two first pairs of parapodia, although they are limited to a small, high, conical and enlarged mass of a few tubes with a common opening. From the 3rd parapodium onward, the glands are larger, mammillary and occupy almost all of the space between the ramus and the inferior margin of the pinnule.

Therefore T. (J.) Rolasi is distinguished from T. (J.) mariana not only by the rosettes on the pinnules of the two first pairs of parapodia, as stated by GREEFF, but also by the fact that it has a small chromophile gland on the ventral pinnule of these pairs.

No. 9. Tomopteris (Johnstonella) Catharina (GOSSE).

- Non Tomopteris onisciformis Eschscholtz 1825  
 ? Briarea scolopendra Quoy et Gaymard 1826.  
 1847 (Tomopteris onisciformis) Bush (1) page 180-186, tab. VII, Fig. 5).  
 1851 (Johnstonella Catharina) Gosse (1) page 356, fig.  
 1855 (Tomopteris scolopendra) Gosse (2) volume 1, pag. 106, fig.  
 1858 ( " onisciformis) Leuck. u. Pagenst. (1) page 558-613, tab. XX, fig. 1-8.  
 1858 " quadricornis) " " (1) ibid.  
 1858 (? Nereis phasma) Dalyell (1) vol. II, page 260, tab. 36, fig. 16, 17  
 1859 (Tomopteris onisciformis part.) Carpenter (1) page 353-357, tab. LXII, fig. 1-7.  
 1862 " " Carpenter et Clapar. (1) page 59-68, tab. VII.  
 1865 (Escholtzia quadricornis) Quatref. (1) page 225.  
 1865 " Leuckartii part.) Quatref. (1) page 225.  
 1865 (Tomopteris Pagenstecheri) Quatref. (1) page 227.  
 1875 " onisciformis) Möbius (1).  
 1878 " " Vejdovsky (1) passim.

|      |   |                     |   |
|------|---|---------------------|---|
| 1879 | " | <u>helgolandica</u> | Greeff (2) page 261.                                |
| 1892 | " | "                   | Apstein (1)   |
| 1897 | " | "                   | Michaelsen (1) page 35.                             |
| 1900 | " | "                   | Apstein (2) page 35-39 et passim, tab. X, fig. 1-6. |
| 1905 | " | "                   | Schwartz (1) page 521, tab. XVIII, fig. 12.         |
| 1905 | " | "                   | Reibisch (1).                                       |
| 1906 | " | <u>onisciformis</u> | Herdman (1) page 100-101, fig. text, XII.           |
| 1907 | " | <u>helgolandica</u> | Malaq. et Dehorne (1) p. 156.                       |

I was able to study several specimens of this species which were collected by W. MICHAELSEN near Helgoland and a specimen collected by the R. Ship Vettor Pisani in Gibraltar.

The following description is based on these specimens and on the data of the authors, particularly BUSH, LEUCKART and PAGENSTECHER, CARPENTER and CHAPAREDE and APSTEIN.

Dimensions - The average length for mature adults with a well-developed tail is 16 mm and 1/4 of this length constitutes the tail. The largest specimen that I have ever examined (from Helgoland) was 17 mm long (maximum length given by BUSH as well) almost 5 mm of which represented the tail, whereas specimens 12 mm long did not yet have a well-developed tail.

Individuals with uncommon dimensions can sometimes be found. In fact, APSTEIN refers to one 87 mm in total length, which is slightly shorter than the length found by QUOY and GAYMARD for their Briarea scolopendra which perhaps belongs to this same species.

In adults, the maximum width (between the extremities of the 4th or 5th pair of parapodia) is approximately 1/4 the total length.

General appearance - A tail is present, except in young individuals with six or fewer pairs of parapodia. Its overall shape is rather narrow and elongate. After the 4th parapodium, the lateral margins run almost parallel for a long stretch and then converge rapidly, but gradually, behind, at the point where the trunk and the tail meet. This tail is

short with rudimentary parapodia and bare over a short terminal stretch. Young individuals, without a tail or with an imperfect tail are, in general shorter and more oval in shape.

Authors who have studied live individuals speak of a series of red dots along the second cirrus and in other areas, particularly along the ventral gangliar chain.

Parapodia - Not very thick and numbering up to 21 pairs; it is not rare to see specimens with 18 and 20 pairs, particularly in mature adults. Approximately 1/4 of these parapodia are usually caudal and rudimentary.

An clear demarcation between the parapodia of the trunk and the caudal parapodia, and also between the trunk and the tail, is generally impossible. Perhaps there is a slight sexual dimorphism in this case since, in the female specimens, there is a more clearly marked boundary between the parapodia of the trunk and the caudal parapodia.

Prostomium - Slender neck region with short but very high horns with a deep frontal incision.

Brain - Briefly transversely oval, generally slightly bilobate.

Eyes - Black and large with two lenses. Two otocysts (?) in the anterior region of the brain have also been noted, for example, by CARPENTER and CLAPAREDE, tab. 7, fig. 12.

Ciliated epaulettes - Wide, linguiform, converging posteriorly and extending beyond the posterior margin of the brain, sometimes covering its sides slightly. (According to CARPENTER and CLAPAREDE, they are absent in young individuals).

Proboscis - Rather short and does not reach the first parapodium; usually found to be semi-everted.

Anterior cirrus - Generally present but sometimes completely lacking. This absence, which is only noted in rather large specimens, was observed by LEUCKART and PAGENSTECHER, by CARPENTER and CLAPAREDE and by APSTEIN (2, page 35) himself, in specimens from Trieste. I also found the anterior cirrus to be absent in a specimen from Helgoland, 13 mm long, whereas it was present in other specimens from the same location and in one from Gibraltar. However, in the two specimens from Helgoland, I found the anterior cirri to be reduced to basal stumps. (See CARPENTER and CLAPAREDE).

In adults, the length of the anterior cirrus is normally less than that of the frontal horns.

Second cirrus - Usually (in adults) approximately  $2/3$  the length of the body. The data given by authors in this regard are contradictory. For example, BUSH states that it is as long as the body but in his figures, it appears to be only half the length; LEUCKART and CLAPAREDE maintain that it is  $1/3$  the length of the body; APSTEIN claims that it is just slightly shorter than the body but in his figure of an adult sample he shows it to be  $1/3$  the length of the body (and  $2/3$  the length in his figure of a very young specimen). Naturally it is relatively shorter in adult individuals with well-developed tails.

Pinnules - They vary in shape and can be rounded (particularly the first one) or more or less elongate (sometimes, in the caudal parapodia, they are narrow and lanceolate). Their rami are conical and simple. Sometimes, in mature females, the pinnules, particularly the posterior ones, become brown and sponge-like.

Rosettes - There is a rosette on the ventral ramus of the first two pairs of parapodia (sometimes on the trunk of the parapodium near the bifurcation) made up of a group or a ring of yellowish globules,



surrounded by a large rosette of piriform glandular cells. I found the position of these rosettes to vary slightly, sometimes 1/3 of the way down the length of the ramus, sometimes 2/3, sometimes almost in contact with those of the pinnules. Due to this variability, it would not be impossible to sometimes find these rosettes even on the trunk of the parapodium before its bifurcation, as shown in the figures (at least in young individuals) of LEUCKART and PAGENSTECHER, table XX, fig. 8 a. b.

A rosette subequal to the preceding one is found on the dorsal and ventral pinnules of all the parapodia of the inner edge with its center against the ramus, not far from its tip. According to the authors, the rosettes are yellow in live specimens.

Pinnal glands - Only one type (chromophile). One of these glands is found on the ventral pinnule of all parapodia halfway down the inferior margin. The gland is conical or mitriform but average in size and not very conspicuous.

Gonads - On the dorsal and ventral pinnules of the parapodia; they already begin to appear on the first pair and I have sometimes seen them up to the 13th pair.

Habitat - APSTEIN obtained specimens of this species from Trieste. I obtained one from Gibraltar (collected by G. CHIERCHIA). This species was not found in any other part of the Mediterranean. It is common in the North Sea and on the coasts of Great Britain. It is found on the banks of Newfoundland, south of the Azores, down to the mouth of the Para (see APSTEIN 2, page 45 et seq. and tab. XII). Therefore it is not found in the Arctic circumpolar subregion of Ortman and is found in the boreal and tropical subregion of the Atlantic (including the Mediterranean). MALAQUIN and DEHORNE cite a specimen from Amboina.

Synonymic note - This species is generally called Tomopteris onisciformis or T. helgolandica. Both of these names are unacceptable. T. onisciformis ESCHSCHOLTZ 1825 is a Pacific species which is very different from our species due to the absence of a tail. Therefore, in 1879, GREEFF gave our species the name of T. helgolandica. This latter name cannot be used because previous authors had already distinguished this species from T. onisciformis (see synonyms) by using other names.

Therefore, all that remains to be clarified is whether this species should be called T. scolopendra (Q. and G. 1825, GOSSE 1855) or T. Catharina (GOSSE 1851). It is probable (as I will mention under the subgenus T. Scolopendra) that our species is actually that of Q. and G. and it is certain that it is the T. scolopendra of GOSSE. I felt that it would be more accurate to adopt the name of T. Catharina which it had been given by GOSSE in 1851 before identifying it with the T. scolopendra of Q. and G. This would avoid any confusion because this name was then ascribed (by KEFERSTEIN and APSTEIN) to completely different Mediterranean species, that is, to our T. Apsteini.

Genus TOMOPTERIS subgenus TOMOPTERIS Eschscholtz

No. 10. Tomopteris (Johnstonella) vitrina VEJD.

1878 (Tomopteris vitrina) Vejdovsky (1) page 81 et seq., tab. VI, VII.  
1900 " " Apstein (2) page 37-39.

Until now, this species had only been found by VEJDOVSKY and the following description is based on his findings.

Dimensions - Not indicated.

General appearance - Body tapering into a tail where medium-sized parapodia are still present. Purple pigment marks are found along the ventral gangliar chain.

Parapodia - Up to 22 pairs.

Prostomium - With a long neck and straight, medium-sized horns.

Brain - In the shape of an inverted triangle, with rounded edges.

Eyes - Large, black, with only one lens.

Ciliated epaulettes - (According to fig. 1) very small with their posterior tip reaching only the anterior margin of the brain.

Anterior cirrus - Can be present or absent. VEJD. found it to be present in a young individual and in a male adult, but absent in two females. (Does it not have any setae?).

Second cirrus - The length is not indicated.

Pinnules - Oval, with a continuous edge.

Rosettes - Only on the pinnules, that is, each parapodium (in young individuals only the first two pairs) has a large rosette on both of the pinnules, near the apex of the ramus but more or less on its outer (?) side.

Pinnal glands - Appear to be absent.

Gonads - On the two rami of the parapodia, from the first pair onward.

Habitat - Trieste.

A great deal of the data on this species should be confirmed, such as the absence of pinnal glands and the position of the rosettes on the outer edge, rather than on the inner side of the pinnules. If these characters did not exist, the species would be very close to

T. Catharina (GOSSE) from which it would be distinguished by the shape of its brain and the presence of rosettes only on the pinnules, a character which has been indicated only for T. Kefersteini.

It is strange that VEJDOVSKY found this species only in Trieste (four specimens) whereas the numerous specimens obtained from that

location by APSTEIN were all T. Catharina (= helgolandica). It would be worthwhile to conduct further research on tomopterids from this location.

No. 11. Tomopteris (Tomopteris) Apsteini new name

- 1818 (Tomopteris onisciformis part.) Grube (1) page 456-468, tab. XVII.  
 1861 (T. scolopendra part.) Keferstein (1) page 360-368, tab. IX.  
 1865 (Escholtzia Leuckartii part.) Quatrefages (1) page 225.  
 1879 (? Tomopteris scolopendra part.) Greeff (2) page 261 et passim.  
 1885 (T. " " ) Carus (1) volume 1, page 246.  
 1900 (T. " " ) Apstein (2) page 37, 38, 42 et passim.

No Tomopteris onisciformis Eschscholtz 1825.

No? Briarea scolopendra Q. et G. 1827.

No Tomopteris scolopendra Gosse 1855.

I was able to study seven specimens of this species from Messina sent to me by the Hamburg Museum of Natural History.

Dimensions - The average length is approximately 20 mm; one of my specimens was 40 mm long with a diameter of 9 mm between the extremities of the larger parapodia.

General appearance - Elongate with margins which, after the 3rd or 4th parapodium, are almost parallel for a long stretch and then converge slightly backward. The last segment of the tail is very slender and bare.

Parapodia and appendages - The appendages of the trunk and the tail can total up to 40; the trunk of adult females seems to always have 20 appendages, that of males between 18 and 22. The tail appendages, which are at first long and then become shorter with indistinct edges, can total up to 15.

The parapodia (with the exception of the rudimentary ones on the tail) are quite thick; they increase up to the 3rd or 4th pair and then are gradually diminish up to the end of the trunk where they are nevertheless well developed.

In females, the first three caudal parapodia (18, 19, 20), though not shorter than the last parapodia of the trunk, are almost sessile with lanceolate pinnules (see pinnules); the remaining caudal parapodia are barely visible or absent.

In males, the parapodia of the trunk continue onto the caudal parapodia, diminishing abruptly but without changing their essential nature. In my larger specimen, the parapodia become gradually smaller up to the 22nd pair, then, suddenly (tail) they become very small and gradually more rudimentary; up to the 30th pair they are still bilobate, and subsequently appear only as slightly perceptible protuberances or are completely absent. A smaller specimen had 18 pairs of normal parapodia, followed by a 19th pair which was unexpectedly very small, then a bare tail with a mere trace of a lateral intumescence on the annular reliefs which divide the first long caudal appendages.

Prostomium - With a wide and very short neck and low horns curving backwards. Before meeting on the median line, they run almost parallel towards the back of the head for a short stretch. Their point of intersection appears almost turriculate and often protrudes from the anterior profile between the two horns.

Brain - Transversely oval, slightly trapezoid, fairly depressed anteriorly and posteriorly (particularly in non-compressed specimens in which it appears bigangliar); contrary to APSTEIN's observations, it is completely different from that of Enapteris euchaeta (CHUN).

In front, and in part above the anterior margin of the brain, there is a clear roundish vesicle (cephalic groove) which opens outward dorsally through an orifice which, in the example drawn by me (see fig. 10), appears as a duct with three radiating branches.

Eyes - Very large and far from the anterior lateral ends of the brain; dark brown in my samples which had been in alcohol for many years; perhaps in fresher examples they would be black like those of APSTEIN. These eyes are very different from the very small eyes of the E. euchaeta; they have a very convex, almost conical lens.

Ciliated epaulettes - Forming two strips pointed posteriorly which run from the shoulder and converge behind, with their posterior extremities extending far behind the posterior margin of the brain.

Proboscis - Well-developed (is not everted in any of my specimens).

Anterior cirrus - Always present; in my average-sized specimens (approximately 20 mm long) it is almost half the length of the frontal horns; however in the larger specimen (40 mm long), it is reduced to a slender little horn no longer than half a millimeter and very difficult to detect.

Second cirrus -  $3/4$  the length of the entire body.

Pinnules - On the trunk, oval with a continuous edge, except for the ventral pinnules where a small spine protrudes slightly from the inferior margin near the hyaline gland (see pertinent section). They vary on the tail according to sex. In females, the pinnules of the three first pair of caudal parapodia (18, 19, 20), which are almost sessile, have longer, conical rami and a narrow edge so that they appear lanceolate. Furthermore, they are lacking glands, spines and gonads; the subsequent pairs become suddenly rudimentary or are absent altogether. In males, the pinnules of the trunk gradually become those of the tail.

Rosettes - Absent; however, at the point where the rosettes of the pinnules are normally found, there is often a lighter, glandular areola.

Pinnal glands - There are two types (not one as APSTEIN claims).

The chromophile glands, situated halfway down the inferior margin of the ventral pinnules, begin to appear only on the fourth parapodium (here they are very small), and then become very large on the fifth and subsequent parapodium and gradually diminish towards the end. They are very prominently cupolar in shape or even tomato-shaped, with wide edges. In the female, the chromophile glands are present only on the parapodia of the trunk; in males there are also traces of them on the first caudal parapodia.

The hyaline glands are also found only on the ventral pinnules, but right from the first parapodium. They are found alone on the first three pinnules, however, from the 4th onwards, they are back to back, situated slightly distally, together with the chromophile gland. They are formed of a narrow, conical and elongate strip of tubules with an opening from which, in many of my specimens, there was a discharged secretion clotted by the alcohol. Close to the hyaline gland, on the proximal side, that is, between the hyaline and the chromophile gland, runs a narrow, slightly protruding spine. It is also found in the first three pinnules; as for the caudal segments, the same as what was said for the chromophile gland applies with respect to the presence of the hyaline gland and the spine.

Gonads - On the dorsal and ventral ramus of all the parapodia of the trunk beginning from the first pair.

Genital ducts - (Female) small, roundish, situated at the level of the anterior margin of the 4th and 5th parapodium; the two which are found on each pair are joined by a transverse groove.

Habitat - To date, the presence of this species has only been confirmed in the Mediterranean, in Messina; perhaps it can also be found in Naples. It does not seem at all common because it has never been

found among the many Tomopteris that this laboratory has obtained from Messina over several years.

In 1848 GRUBE (1) classified tomopterids of the Petersburg Museum collected by KROHN and coming "warscheinlich" from the Mediterranean, under the name T. onisciformis. His description reveals that part of them belonged to this species and the other part belonged to E. euchaeta. In fact, SCHWARTZ found specimens in the Berlin Museum which were designated as the "GRUBE collection from the Petersburg Museum" and he noted that these specimens, which corresponded well to the figure drawn by GRUBE, belonged to the species with which we are now dealing. However, based on what he says about the length of the second cirrus, it is clear that GRUBE also mistook this species for the E. euchaeta. I received many specimens from the Hamburg Museum designated as "Tomopteris scolopendroides Q.G. Messina, KROHN leg. determ." seven of which belonged to the species described here and the others to E. euchaeta.

In 1861, KEFERSTEIN found this species in Messina and described it as belonging to T. scolopendra. However he too confused it with E. euchaeta as can be seen from his description and figure of the brain and, as APSTEIN already noted, from his observations on the second cirri which can be 3 or 4 times the length of the body.

APSTEIN (2) also found this species in Messina. Although neither CHUN nor LO BIANCO mention to the presence of this species in Naples, GREEFF (2) states that he received this species from the Zoological Station at Naples. However, the description which he gives of the brain (l. c. page 268) does not apply in any way to E. euchaeta, which is the only caudate species which is found, with certainty, in Naples. APSTEIN states that this species is also found in Madera but this information taken from LANGERHANS (1) is extremely doubtful.



Remarks - APSTEIN (2) calls this species Tomopteris scolopendra KEFERSTEIN. This is not acceptable although we do not know for certain what the old T. scholopendra (Q. and G. 1827) was, this name was already used by GOSSE in 1855 to describe T. Catharina (= T. helgolandica GREEFF). Therefore, I must propose the new name T. Apsteini as I found it was not suitable to adopt the name T. Leuckarti under which QUATR. had placed both the T. onisciformis of CARPENTER (= T. Catharina GOSSE) and, with a great deal of doubt, T. onisciformis of GUBE, which, as we have seen, includes this species and also E. euchaeta.

There are two essential differences between my description and that of APSTEIN. At first glance, they could lead one to believe that my T. apsteini is not at all T. scolopendra APSTEIN.

APSTEIN states that this species differs from E. euchaeta in that it has only one gland on each pinnule. However, in actual fact, the hyaline gland here is so close to the chromophile gland that APSTEIN could have mistaken it for only one gland.

A more serious mistake is that he finds the brain of T. scolopendra to be identical to that of E. euchaeta whereas it is completely different. Perhaps APSTEIN did not verify this character himself, but rather, assumed it from the description and the figure of KEFERSTEIN who also confused E. euchaeta with this species and obviously used the brain from E. euchaeta in his figure. In any case, there can be no doubt as to the identity of the two species, because the common characters are numerous and extremely precise.

No. 12. Tomopteris (Tomopteris) Nisseni ROSA1908 (Tomopteris Nisseni) Rosa (2)

I have only seen one specimen of this fine species which resembles Tomopteris Carpenteri QUARTREF in many of its characters. The specimen which I examined was imperfect and belonged to the Hamburg Museum of Natural History. Here are the characters which I was able to recognize.

Dimensions - Length of the trunk 17 mm with a maximum width of 6 mm approximately one quarter of the way down the trunk. It tapers into a tail whose length I was not able to determine because, in our specimen, it was crushed and then broken off at the tip and therefore reduced to a thread 10 mm long, formed (except for a very short initial stretch) almost solely by the cuticle. From this tail hang 8 pair of reduced parapodia, equidistant for the entire length of the tail.

Parapodia - 25 very thick pairs on the trunk. They increase in size up to the 5th pair and then become gradually smaller; however the last pairs do not become rudimentary. On the rest of the tail, there are 8 pairs, at first not much smaller than the last pairs on the trunk but very widely separated right from the start (even on the first segment where the tail is intact).

Prostomium - With almost no neck; slender and very long horns, so much so that the distance between their extremities reaches 7 mm. There is a wide frontal incision.

Brain - Not well visible.

Eyes - Fairly large, reddish-brown, more visible from the ventral side.

Ciliated epaulettes - Not well visible.

Anterior cirrus - Absent.

Second cirrus - 26 mm long, that is, more than one and one half the length of the body.

Pinnules - On the trunk with subequal, conical but thick rami, with an extremely puckered, but very low margin, particularly in the anterior parapodia. These margins do not run along the trunk of the parapodium. The pinnules on the tail are relatively narrow and long.

Rosettes - Absent (at first glance the hyaline glands of the pinnules could be mistaken for rosettes).

Pinnal glands - Two types, chromophile and hyaline. The chromophile glands are found on the ventral pinnule of the parapodia from the 4th (inclusive) onward and are situated on the inner margin of the pinnule. They are very large, particularly on the 5th parapodium, extending on one side to the margin of the pinnule and on the other side, resting on the ramus. They form a very prominent and slightly cupulate mass.

The hyaline glands can only be seen from the third parapodium onwards and are found on the dorsal and ventral pinnules in an apical position. Each gland is a slightly piriform body, formed by very slender tubules which are brown at the opening and therefore form a rosette-type spot.

Gonads - Only on the dorsal ramus; already present on the second parapodium; in the specimen which I examined, the sexual elements were very small.

Genital ducts - Not seen.

Habitat - The Atlantic Ocean 20°S 27°W; a specimen collected by Captain H. NISSEN.

Observations - At one point I believed that this species belonged to Tomopteris Carpenteri described by QUATREFAGES in 1865 and which was never found again.



The "Liguria" collected specimens of this species at stations IV, VI, XIV, XX, XXXIV. I will refer to these specimens at the end. The following description is essentially based on the study of many specimens from Naples and mainly from Messina.

Dimensions - Up to 6 mm in length.

General appearance - No tail. General shape oval due to the fact that the first parapodia are usually directed anteriorly whereas the subsequent ones are transverse and the final ones are directed posteriorly. Sometimes however, the first parapodia are already found to be directed transversely and the general shape seems to be more lanceolate.

Parapodia - 14 pairs, slender and widely separated. Those of the last or the last two pairs protrude beyond the posterior extremity of the body. These final pairs are still perfectly shaped and not very short in adults; only in young individuals do they appear as simple appendages protruding behind like two cirri (last pair), or protruding obliquely (second to last pair). The posterior region of the body on which they are situated then appears (that is before the individual has stopped growing) as an enlarged button which stains well.

Prostomium - The horns are very high at the base (like a whale's tail) separated from each other by a deep incision from which the interior extremity of the prostomium extends a rounded conical protruberance. The cavity of the prostomium extends only  $\frac{1}{3}$  of the length of the horns.

Brain - Slightly variable in shape; usually it simply has a shape which varies between rounded and transversely oval but it sometimes shows traces of a median incision at the anterior or posterior margin or at both.

Eyes - Fairly large, reddish-brown (with four lenses according to CHUN).

Ciliated epaulettes - Run parallel to each other or diverge slightly backward. In adults they appear as two large strips which run a certain distance from the sides of the brain and whose rounded posterior extremity extends slightly beyond the posterior margin of the brain. In young individuals they are slightly oval.

Proboscis - Extending up to the first parapodium.

Anterior cirrus - Well developed; I found it invariably present in all of the many specimens examined.

Second cirrus - Approximately  $2/3$  the length of the body; its seta is marked with lateral notches.

Pinnules - Slightly variable in shape; oval or elongate with the distal extremity wider, almost like an oar paddle.

Rosettes - Always absent.

Pinnal glands - Two types; that is, a chromophile gland on the ventral pinnule beginning at the 4th pair of parapodia (not before) and a hyaline gland present only on the dorsal pinnules of the 3rd and 4th pairs of parapodia. (According to APSTEIN, who did not make a distinction between the two types of glands, the third parapodium is lacking a dorsal gland but it is found on the ventral pinnule. The very careful examination of the numerous specimens from Naples, Messina and the Atlantic permit me to confirm, without a doubt, that APSTEIN's data are inaccurate).

The chromophile gland of the ventral pinnules (which stain well with hematoxylin) has an enlarged conical shape and is situated in an apico-inferior position, that is, its axis (oblique with respect to the axis of the ramus) is directed towards an intermediary point between the

apex and the lower edge of the pinnule. The hyaline gland (which does not stain with hematoxylin) of the 3rd and 4th dorsal pinnule is in an apico-superior position, that is, symmetrical with that of the chromophile glands. It is sometimes as large as these glands and appears as a more or less globoid mass formed by tubules which run like meridians, colourless or more or less yellowish or brown at the upper tip, generally yellowish, sometimes granulose like those of the chromophile glands. Often, a rather regular and sometimes very prominent mass of yellow or brown granules is found at the opening of the hyaline glands.

Gonads - Present only on the dorsal ramus of only six parapodia (3-8); (according to SCHWARTZ, they are also found on the 9th parapodium).

Genital ducts - Two pairs in the female, transversal, at the base (anterior) of the 4th and 5th pair of parapodia.

Habitat - The Mediterranean (Naples-Messina); warm and temperate regions of the Atlantic and Pacific; Indian Ocean. The explorations of the R. Ship "Liguria" showed that the area of distribution of this species is considerably larger than what was believed. Up to now, it had been found in Naples, Messina and that part of the Atlantic Ocean where the Plankton-Expedition collected it throughout the entire southern half of its voyage (between almost 10° lat. S. and approximately 43° lat. N.) (1).

In the Atlantic, the R. Ship "Liguria" collected specimens which are fully typical of this species at station IV, that is to say, in the area already known, and subsequently VI, that is to say, in the Caribbean Sea, which had not been explored by the Plankton-Expedition.

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(1) See APSTEIN (2) table XIII: T. Kefersteinii (= elegans). The locations of Algiers and the Canary Islands are excluded as they are based on data by VIGUERE and GREEFF, respectively, and which refers to the real T. Kefersteinii GREEFF.

However, what is particularly interesting is the fact that the "Liguria" also found specimens of this species in other seas. They were found at station XIV, which is in the Pacific approximately 170 miles north of the Galapagos; subsequently at station XX, south of New Caledonia and finally at station XXXIV in the Gulf of Bengala. Specimens taken from these various stations did not differ in any way from the typical specimens collected from Naples and Messina.

No. 14. *Tomopteris* (*Tomopteris*) *septentrionalis* QUATR. ex STEENSTR.

- |      |                                       |  |
|------|---------------------------------------|--|
| 1849 | ( <u>Tomopteris septentrionalis</u> ) | Steenstrup (2) p. IV, <u>Nomen nudum</u> .                   |
| 1865 | (T. " )                               | Quatrefages (1) p. 229.                                      |
| 1883 | (T. " )                               | Levinsen (1) p. 248.   |
| 1900 | (T. " )                               | Apstein (2) p. 37, 38, 41, et passim,<br>tab. XI, fig. 16-17 |
| 1905 | (T. " )                               | Reibisch (1).  |

Many specimens of this species, which was believed to be found exclusively in the northern Atlantic, were collected by the R. Ship "Liguria" at station XIII, in the Pacific near Valparaiso. In addition to these, I examined many other specimens from locations near the aforementioned one, part of which were collected by the R. Ship "Vettor Pisani", and part of which belong to the Hamburg Museum of Natural History. Finally, thanks to the kindness of Dr. G.M.R. Levinsen of the Copenhagen Museum, I was also able to study many specimens from the coast of Greenland, a typical location for this species.

The specimens from the North Atlantic are identical to those from the southern Pacific. From all of these specimens, I obtained the following description which, on many points, completes and corrects APSTEIN's data.

Dimensions - APSTEIN states that the maximum length is 12 mm. My adult specimens range from 10 to 14 mm.



Appearance - Tail absent; shape ovate-lanceolate, more or less elongate and pointed posteriorly.

Parapodia - Variable in number (in adults) from 20 to 23 pairs, sometimes quite close together, sometimes more widely separated. They diminish very gradually up to the last pair which is still bilobate and extends slightly beyond the posterior extremity of the body.

Prostomium - Neck region wide and short with rather thick horns divided by a slight frontal incision.

Brain - Oval and always very elongate transversely, sometimes clearly biganglionic, sometimes without a trace of median incisions.

Eyes - Brownish-black, large, widely separated.

Ciliated epaulettes - Seen in dorsal view, they appear as narrow, parallel strips whose pointed apex extends far beyond the posterior margin of the brain; anteriorly they widen and their rounded anterior extremity extends a fair distance on the ventral side.

Proboscis - Robust and very long can even extend beyond the first parapodium; it is everted in most specimens.

Anterior cirrus - Always absent.

Second cirrus - Approximately  $2/3$  the length of the body with deep notches in the distal region.

Pinnules - Oval, elongate; the margins are usually puckered and concave posteriorly; their rami are long and conical.

Rosettes - Absent (those which APSTEIN called rosettes and which he claims to have found only in a few individuals, are actually hyaline glands).

Pinnal glands - Two types: chromophile, present from the 4th parapodium onward, and hyaline present alone on the first ventral pinnule of the three first parapodia and thence together with the chromophile glands. They are both apical, but where the hyaline gland is found with

the chromophile gland, the former is situated on the upper or inner side of this latter gland, more or less against its side and with the apex always much farther from the edge of the pinnule.

The chromophile glands are in the shape of an elongate, enlarged cupola or of a minaret cupola in the form of a strip of narrow tubules containing a filamentose substance. The upper, very slender extremities, meet in a nipple-like eminence. (Completely similar isolated tubules are scattered here and there on the pinnule).

The hyaline glands are often difficult to detect; they are yellow, dolioform hyaline bodies, made up of a few, relatively large meridian tubules and when viewed from above they resemble rosettes. They are more easily found due to the fact that in most cases, there is at their apex, a orange or rust-coloured spot in which groups of bright globules can be seen.

[My description of the pinnal gland differs from that of APSTEIN, so much so, that when I knew only the specimens from the Pacific for the species studied here, I did not dare classify them as T. septentrionalis. An examination of the typical specimens from Greenland showed me that, even with respect to the glands, the specimens from the Pacific were identical to those from the North Atlantic and that the description of the glands given by APSTEIN is incorrect. All things considered, it can be seen that the facts observed by APSTEIN and by myself are the same and that the difference lies in the more or less exact interpretation and observation of these facts. APSTEIN speaks of only one gland (apical) on all of the ventral pinnules; he notes however that a brown spot of pigment can sometimes be seen at the opening of this gland. However, this spot is that which is normally found at the opening of the hyaline gland adjacent to the chromophile gland. This hyaline gland was generally

overlooked by APSTEIN due to its transparency. I say "generally" because he saw the hyaline gland when it was alone on the first three parapodia (see his fig. 16), however he did not notice that it was different from the chromophile gland. Furthermore, he sometimes saw the hyaline gland near the chromophile gland and interpreted it as a rosette which was not always present. Specifically, in APSTEIN's fig. 17, representing a parapodium of the 4th pair, the more apical gland is the chromophile, which in this parapodium is usually still small and the so-called rosette which is near this gland is the hyaline gland. Here however there is another inaccuracy because APSTEIN shows this supposed rosette as being situated on the inner side of the gland, whereas it is on the upper side. Evidently, the pinnule observed by APSTEIN was not properly unfurled so that its upper margin was folded underneath, something which easily happens].

Gonads - Present only on the dorsal ramus of the parapodia. They begin to appear only on the 2nd pair and can continue farther back sometimes only up to the 13th pair, sometimes even up to the 16th parapodium. My specimens included males and females.

Genital ducts - Not seen.

Habitat - Up to now, it was believed that this species belonged to the North Atlantic. APSTEIN's (2) table XII shows that it is absent in the Baltic Sea and the North Sea and is abundant between the region north of Scotland and Greenland and in the Labrador Straits down to the banks of Newfoundland, and is also found north-east of the Azores, at approximately 43° Lat N.

The specimens which I obtained from the Copenhagen Museum also originated near Greenland and bore these descriptions: (1) 58°, 29'; 44°, 54'. (2) 58°, 59'; 28°, 24'. (3) 58°, 29'; 44°, 54'. Obviously,

the first number indicates Latitude North and the second the Longitude West.

However, it has now been seen that this species, which, though it had been studied in detail, had never been found in the rest of the Atlantic, can be found in the Pacific Ocean.

In fact, specimens which I studied, originated in the following regions:

1. Specimens collected by the R. Ship "Liguria" at station XLII, at, 35° 06' 3" Lat. S. 73° 38' Long. W. (near Valparaiso).

2. Specimens collected by the R. Ship "Vettor Pisani" on the 17th of February, 1883 (off the coast between Valparaiso and Iquique almost opposite Caldera).

3. Specimens belonging to the Hamburg Museum of Natural History bearing the description: Pacific Ocean, 20° 25' S., 73° W., Kap. H. Nissen leg. (that is, off the coast of Chile, below the tropics).

Therefore, all of these specimens originate off the coast of Chile between 20° and 35° S.

Thus, T. septentrionalis is a new "bipolar" species since the areas of the Pacific where it was found are still included in the "Antarctic region" under the "southern circumpolar" region of ORTMANN (see geographical distribution).

Observation re synonyms - APSTEIN (2, page 41) calls this species: T. septentrionalis n. sp. because STEENSTRUP who used this name to describe the Tomopteris of the North did not provide any description.

Nevertheless, QUATREFAGES (1. c.) who obtained specimens of this species from STEENSTRUP, provides several characters and must therefore be considered the founder of this species. Moreover, LEVINSEN (1. c.) also provides various characters among which he includes the absence of a tail and the anterior cirrus.

No. 15. Tomopteris (Tomopteris) planktonis APST.

1900 (Tomopteris planktonis) Apstein (2) p. 37, 38, 42 et passim,  
tab. 11, fig. 21, 22.  
1905 (T. " ) Reibisch (1).

The following description is based on two specimens which I obtained from Messina. Until now, this species was only known in the Atlantic.

Dimensions - APSTEIN's specimens were 5 mm long, mine were 6 mm with a maximum diameter of 2 mm.

Appearance - Tail absent, oval-lanceolate shape with the maximum diameter at about half the length of the body; posterior extremity very pointed; generally robust appearance.

Parapodia - Brown and very thick, from the 6th or 7th parapodia they are all directed posteriorly, very close together and regularly decreasing in size. APSTEIN counts 13 pairs; of my specimens one (adult female) had 15 pairs, the last being clearly bilobate and extending beyond the extremity of the body. The body was still growing because it appeared as a more opaque button ending in two posterior eminences, a trace of a 16th pair of parapodia. The other specimen (male) had 18 pairs of parapodia.

Prostomium - With a wide and very short neck; the anterior margin of the horns continuous without the least trace of a median incision (in fact, with a small eminence).

Brain - Transversely oval, quite bigangliar.

Eyes - Large, blackish at the lateral extremities of the brain.

Ciliated epaulettes - When seen in dorsal view, they appear as narrow strips with a margin running parallel at a certain distance from the sides of the brain and ending at the level of its posterior margin where it becomes rounded. Anteriorly, they are wider and raised and

are situated obliquely against the base of the neck of the prostomium, and are therefore well visible even when viewed from the ventral side.

Proboscis - Extending up to the first parapodium; the intestine is very large, reaching at least up to the 9th or 10th parapodium.

Anterior cirrus - Absent.

Second cirrus -  $3/4$  the length of the body, with a gobulose base and extraordinarily slender.

Pinnules - With conical rami and a complete oval margin which extends from the outer side slightly beyond the bifurcation. The ventral pinnules have a slight incision at the apex of the chromophile gland.

Rosettes - Absent.

Pinnal glands - Two types. A chromophile gland on the ventral pinnule of the 4th and subsequent parapodia, halfway down the inferior edge, and a hyaline gland in the apico-superior position on the ventral pinnule from the first parapodium onward. The chromophile gland is large and cupolar with loosely-joined tubules and extends to a granulose mass resting on the ramus. The hyaline gland is colioform, with tubules sometimes full of clear globules.

Gonads - Only on the dorsal ramus, present (at least in females) on all of the parapodia. The female's eggs were as large as the base of the parapodia.

Genital ducts - Noted by APSTEIN between the 4th and 5th parapodium, in a strip of brown pigment. I, however, was not able to see them.

Habitat - This species seems to be common in the Atlantic where it was found, according to APSTEIN, from approximately 70°N (west of Greenland) up to almost 10°S (near the Ascension Islands). I was surprised to have two specimens of this species from Messina. It is

easily distinguished from T. elegans by its stout appearance. T. elegans is common in Messina whereas planktonis is probably very rare in that area.

No. 16. Tomopteris (Tomopteris) ligulata ROSA.

1908 (Tomopteris ligulata) Rosa (2)

I received specimens of this new species collected in the Atlantic and the Pacific, and all belonging to the Hamburg Museum of Natural History. It is a curious species and very distinctive because of its pinnal membranes which extend along the entire trunk of the parapodia. However, it is very similar to T. planktonis in all other respects. Therefore, I felt it would be worthwhile to make continuous comparisons between the two species in the description.

Dimensions - My specimens were from 6 to 9 mm long and even up to 12 mm; the maximum diameter was 4 mm. (The maximum length known for T. planktonis is only 6 mm).

General appearance - Tail absent, lanceolate shape (not ovate - lanceolate like T. planktonis, from which this species can be distinguished at first glance); the body already reaches its maximum diameter at the first third of its total length.

Parapodia - Fairly thick, particularly the last ones. They number 20-24 pairs (in T. planktonis, the maximum number of pairs is 18); the last parapodia are still well developed, overlap and extend slightly beyond the posterior extremities.

Prostomium - Identical to that of T. planktonis, that is, with a very short neck and medium-sized horns whose continuous anterior margin rises to form a frontal convexity.

Brain - I was not able to clearly detect its contours and sometimes it seems transversely oval, sometimes subquadrate.

On the ventral part of the brain, or rather at the anterior margin of the gangliar mass which is anterior ventrally to the mouth, I have repeatedly seen large light-coloured vesicles (otocysts?) which I have not observed in T. planktonis.

Eyes - Red or brownish-red, quite large, widely separated (in T. planktonis they are blackish).

Ciliated epaulettes - Similar to those of T. planktonis as they are also narrow parallel strips running along the sides of the brain and ending bluntly somewhat beyond its posterior margin; anteriorly they run along the sides of the neck curving quite markedly towards the ventral surface.

Anterior cirrus - Always absent.

Second cirrus -  $3/4$  or  $4/5$  the length of the body, with an almost globose base which is high rather than long, and very slender setae (as in T. planktonis).

Pinnules - With conical rami and an oval, elongate edge, longer than in T. planktonis. Characteristically, the outer edge of the two pinnules rises in the form of a puckered strip which is quite high and extends over the entire length of the trunk of the parapodium, which therefore remains bordered by two edges, one dorsal and the other ventral. This character was constant and very evident in all the parapodia of all individuals from all locations and makes it possible to immediately distinguish this species from T. planktonis.

Pinnal glands - Two types. The chromophile gland is located on the ventral pinnule of the parapodia from the 4th pair (inclusive) onward, approximately halfway down the inferior margin. It is very large in



the first parapodia and, in general, similar to that of T. planktonis on which it is also situated in the same position. The hyaline gland, which is rather globular with transparent tubules at whose common opening a group of yellow gobules can often be seen, is in a apico-superior position on the ventral pinnules, along with the chromophile gland, beginning at the 4th parapodia. It is found alone on the 3rd, 2nd and 1st pair (it is still very evident in T. planktonis). I did not find this gland but I cannot say for certain that it is completely absent.

Gonads - Only on the dorsal ramus.

Genital ducts - Not seen; my specimens were males.

Habitat - The Pacific and Atlantic Oceans (tropical and northern regions). My specimens bear the following description of the location:

Atlantic 22° N., 35° W. Cap. H. NISSEN legit.

id. 21° N., 21° W. id.

id. 17° N., 30° W. id.

id. 33° S., 30° W. id.

Pacific 31° S., 84° W. id.

I can confirm that the specimens from the Pacific are totally identical to those from the Atlantic.

No. 17. Tomopteris (Tomopteris) Cavallii ROSA

1907 (Tomopteris Cavallii) Rosa (1)

The R. Ship "Liguria" collected specimens of this species in the Atlantic (station X), in the Pacific (XIII and XX) and in the Indian Oceans (XXXIV). The R. Ship "Vettor Pisani" had already collected this species in Callao. The following description is based on specimens from these five locations.

Dimensions - Length up to 6 mm with a maximum diameter at the 4th-5th parapodium of 2.5 mm.

General appearance - Ovate-lanceolate; tail absent.

Parapodia - Up to 15 pairs; not very thick. The last two pairs extend considerably beyond the posterior extremity.

Prostomium - Neck region very thick and short and rather robust horns with a large frontal incision.

Brain - Situated rather anteriorly, mostly at the neck of the prostomium; its shape is transversely ovate and bigangliar.

Eyes - Large, light brown or yellow, situated in the center of the two cerebral gangliar masses.

Ciliated epaulettes - Short, prominent, not extending beyond the posterior margin of the brain and adhering to the sides of the neck which, as a result, appears swollen at the sides, almost auriculate.

Proboscis - Robust, extending to the first parapodium.

Anterior cirrus - Always absent, even in specimens less than 2 mm long.

Second cirrus -  $2/3$  the length of the body; its setae bears rare notches in its distal region.

Pinnules - Very broad beginning at the 4th parapodium. Therefore, although the parapodia are not very close together, under the magnifying glass they touch each other and overlap.

Rosettes - Absent.

Pinnal glands - Only one type (chromophile); one is found on the ventral pinnule from the 4th parapodium (inclusive); they are situated halfway down the inferior margin of the pinnule; they are large, sometimes enormous, and cupolar.

Gonads - Only on the dorsal ramus of the parapodia from the first pair up to at least the 9th or 10th pair.

Genital ducts - Not seen.

Habitat - The specimens which I studied come from the following locations:

Atlantic Ocean, between Bahia and Buenos Aires (R. Ship "Liguria" station X).

Pacific Ocean, opposite Valparaiso (R. Ship "Liguria", station XIII).

Pacific Ocean, Callao (R. Ship "Vettor Pisani", March 19, 1883).

Pacific Ocean, between New Caledonia and New Zealand (R. Ship "Liguria", station XX).

Indian Ocean, Ceylon (R. Ship "Liguria", station XXXIV).

Therefore, the T. Cavallii has a wide area of distribution but seems to be almost completely absent in the Atlantic Region of ORTMANN and is found only at its southern boundaries.

No. 18. Tomopteris (Tomopteris) Eschscholtzi GREEFF

1879 (Tomopteris Eschscholtzi) Greeff (2) page 276, tab. XV, fig. 42, 48, 51.  
1900 (T. " ) Apstein (2) page 37, 38, 42.

I was able to study 19 specimens of this species which no one has ever found after GREEFF. Eighteen of these specimens belong to the Hamburg Museum of Natural History (among them two of GREEFF's original specimens) and one belongs to the Florence Museum of Invertebrates where it has been since 1867 (see also "addition" on page 308).

Dimensions - Length varies from 11 to 17 mm, average 15 mm; maximum diameter between the extremities of the parapodia of the 7th-8th pair, approximately 1/3 the length.

General appearance - Tail absent; general shape ovate - lanceolate with the maximum diameter found at almost half the length of the body and with the posterior apex slightly truncate.

Parapodia - From 21 to 25 pairs, an average of 23-24 pairs; increasing in length up to 7th-8th pair, then gradually decreasing and coming closer together; the last pairs are very short but have two pinnules which are transversal, unlike the preceding ones which (except at the anterior extremity of the body) are directed posteriorly. This accounts for the truncate appearance of the posterior apex of the body.

Prostomium - Neck very short with horns generally curved posteriorly.

Brain - Transversely oval, quite bigangliar.

Eyes - Large, brownish-black.

Ciliated epaulettes - Wide, linguiform, running parallel to the pointed posterior extremity.

Proboscis - Stout; appeared everted in almost all of my specimens.

Anterior cirrus - Present only in some of the specimens which I examined, not even present in the two original GREEFF specimens. This author states that this cirrus is present but can no longer be found in many specimens.

Second cirrus - Almost as long as the body (approximately 3/5) even in the original specimens of GREEFF, who states that it is longer than half the length of the body.

Pinnules - Large, generally slightly wider than they are long, always short, with a continuous edge and with conical, short and simple rami.

Rosettes - Completely absent.

Pinnal gland - Only one type (chromophile); one gland is found on the ventral pinnule beginning at the 4th parapodium (not anteriorly) in an apical position, between the apex of the ramus and the apex of the pinnule. The gland consists of a cupolar strip of filamentose tubules and is average in size on the 4th parapodium, larger on the 5th and diminishes rapidly on the subsequent pairs. GREEFF depicts it as a

cupola with its base resting against the apex of the ramus. In reality, it does not touch the ramus, and that which at first glance seems to be the basal part of the gland is instead a mass of common glands lying on the surface of the pinnule which, at the base of the gland, are thicker and curve towards each other resulting in a cupolar (but not prominent) formation. The actual gland is easily distinguished by the colour it takes on with hematoxylin and, without staining, by the yellowish, opaque colour of the gland when exposed to reflected light.

Gonads - Found from the 2nd up to at least the 18th pair of parapodia, only on the dorsal ramus. GREEFF's figure incorrectly shows them as situated on a ventral ramus.

Genital ducts - Represented by a pair of large, round papillae with a central opening, situated only on one pair, at the base of the 4th pair of parapodia.

Habitat - Southern regions of the Atlantic and the Pacific Ocean. The 17 specimens which I examined came from the following areas:

1. (Original specimens of GREEFF); GREEFF states that he obtained them from the Godeffroy Museum and describes their location as Sud Atlantischer Ozean (South Atlantic) 43° S. B., 21°04, this would indicate that they were collected south of the Cape of Good Hope.

2. (Specimens from the Hamburg Museum collected by SCHNEEHAGEN) location: Atlantischer Ozean (Atlantic Ocean).

3. (Specimens sold to the above-mentioned museum by Mr. PUTZE); they bear the following description of location: 1. Sudatlantischer Ocean (South Atlantic); 2. China; 3. China Sea; 4. Bass Strasse (Bass Strait).

4. Specimens sold to the Florence Museum of Invertebrates by Mr. SCHAUFFUS of Dresda in 1867, location: Atlantic Ocean.

Therefore, the only reliable source is that of SCHNEEHAGEN (Atlantic). All the other specimens come from dealers and therefore their location is less certain. Nevertheless, the coinciding descriptions which refer to the Atlantic, some to the southern Atlantic more specifically, can be considered reliable. However, I have my doubts with respect to the following locations: China, the Sea of China and Bass Strait. It is quite peculiar that the four tubes of Tomopterids sold to the Hamburg Museum by the same dealer with such different indications of locations, should all contain specimens from one and the same species.

ADDENDUM - Among the many specimens of Tomopteris Cavallii collected by the R. Ship "Vettor Pisani" at Callao (March 3, 1883) I also found two which, although young (only 5 mm long), clearly belong to T. Eschscholtzi. This discovery of our species on the South American coast of the Pacific make the descriptions of location that we mentioned earlier more plausible, at least that of the Bass Strait. Therefore, T. Eschscholtzi also has a very wide area of distribution in the southern region.

#### SPECIES OF UNCERTAIN SUBGENERA (19-24)

##### No. 19. Tomopteris (subg.?) onisciformis ESCHSCH.

1825 (Tomopteris onisciformis) Eschscholtz (1) page 735, tab. V, fig. 5.

1865 (T. " ) Quatrefages (1) page 226.

No T. onisciformis Bush, Leuckart u. Pagenst., Carpenter, Carpenter and Claparede, Grube, Möbius et caeterum auct.

The following characters have been taken from the limited data and the few figures provided by ESCHSCHOLTZ.

Length - 5-6 mm.

General appearance - Tail absent; narrow, elongate shape with slightly convex margins.

Parapodia - 12 pairs, all bilobate and subequal; the posterior extremity of the body extends beyond the last pair.

Prostomium - Horns directed outwards.

Brain ?

Eyes - Normal size (as shown in the figure; the author described them as small but he had no basis for comparison).

Proboscis - Everted in the figure.

Anterior cirrus - present ("Am Russel zwey Fühler"<sup>1</sup> see figure also).

Second cirrus - (Stachel) 1/3 the length of the body (in the figure).

Habitat - Sud See (= Pacific Ocean).

ESCHSCHOLTZ's specimen must have been an adult, based on the shape of the posterior extremity. The two last pairs of parapodia in the figures are marked with a dotted line and the author who considered them separately from the first 10 pairs which he calls "Respirationsflossen" draws them as "vier Fortsätze"<sup>2</sup>. QUATREFAGES (l. c.) believed that they were "pieds à spermatozoides". The information given by ESCHSCHOLTZ consisting of "in den Flossen kleine Kügelchen, die auch zuweilen in die Höhle des Mittelleibes gelangen"<sup>3</sup> seems to refer to eggs.

QUATREFAGES incorrectly refers to the data of ESCHSCHOLTZ.

All of the Tomopteris from the northern hemisphere described as T. onisciformis were not related to this species and generally belong to T. (J.) Catharina GOSSE (= T. helgolandica GREEFF).

MAC INTOSH (1, page 532) mentions a T. onisciformis among the specimens collected in the Antarctic seas by the "Knight Errant" and by the "Triton" in 1880-82, but this determination is completely uncertain.

Among all the known species, the only one which is probably identical to T. onisciformis ESCH. is T. (T.) elegans CHUN which is also found in the Pacific Ocean.

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1 Two feelers on the proboscis.

2 Four processes

3 Little balls in the processes, which sometimes also appear in the cavity of the abdomen.

No. 20. Tomopteris (subg?) scolopendra (Q. and G.).

- 1827 (Briarea scolopendra) Quoy et Gaymard (1) page 235, tab. VII,  
fig. 1-6.  
1832 (Br. " ) " " (2) page 281-286, tab. XXI,  
fig. 21, 24.  
1855 (? Tomopteris scolopendra) Gosse (2) page 316 (vide sub T. Catharina)  
1865 (T. briarea) Quatrefages (1) page 226, 227.  
? Non T. scolopendra Keferstein 1861 and Apstein 1900 (vide sub  
T. Apsteini).

The following characters have been taken from the descriptions and figures of QUOY and GAYMARD (1) and (2).

Length - Total length approximately 4 inches (approximately 10 cm); there is a tail which is approximately 1/2 the length of the body. It has rudimentary parapodia on the first half and the second half is bare.

Prostomium - Short horns and a deep frontal incision.

Eyes - Black.

Anterior cirrus - Absent.

Second cirrus - Almost half as long as the body, with a series of brownish-red specks.

Parapodia - 24-25 pairs including the reduced posterior pairs.

Pinnules - Narrow, lobate (?) at the extremity.

Habitat - Gibraltar.

From 1855, GOSSE (2) ascribed this name of T. scolopendra to the species which he had previously described under the name of Johnstonella Catharina (see this species) more commonly known as T. helgolandica. Therefore, this name can no longer be used, as it was used by APSTEIN, following KEFERSTEIN, to describe the Mediterranean form which we call T. Apsteini. It is very possible that the Br. scolopendra of Q. and G. is actually the known T. (J.) Catharina of GOSSE (helgolandica of GREEFF). In fact, we can consider: 1. that none of the data by Q. and G. contradicts this identification; 2. that T. (J.) Catharina is also



found in Gibraltar; 3. that only a specimen of this species was found to be almost the same size as that of Q. and G.; 4. that in this species, the old specimens may be lacking the anterior cirrus; 5. that the series of reddish-brown specks along the second cirrus is also found in T. (J.) Catharina and that, furthermore, up to now, pigmentation has only been described in species of the subgenus Johnstonella. Perhaps it will prove feasible to change the name of T. (J.) Catharina (= helgolandica) to T. (J.) scolopendra. For the time being, it would not be advisable since the tendency to call the Mediterranean form which we call T. Apsteini by the name T. scolopendra is still widespread.

No. 21. Tomopteris (subg.?) Huxleyi QUATREF.

Non Tomopteris onisciformis) Eschscholtz (1) 1825.  
 1859 (T. " ") Huxley in Carpenter (1) page 358, 359, tab. LXII, fig. 8, 9.  
 1865 (T. Huxleyi) Quatrefages (1) page 227.

The following characters are taken from the description and the figures of HUXLEY (in CARPENTER l. c.).

Length - 25 mm.

General appearance - Tail present. General shape very narrow and elongate, the width between the extremities of the longest parapodia only reaches 1/6 or 1/7 of the total length. The tail begins gradually at approximately half the length of the body, that is, at the 14th or 15th pair of parapodia. The animal is transparent and colourless.

Parapodia - 31 pairs, increasing in size up to the 5th-6th pair, then gradually diminishing and finally becoming rudimentary only on the posterior part of the tail.

Brain - Transversely elongate, bilobate.

Eyes - Black.

Ciliated epaulettes - In the corner above the base of the second cirrus, extending ventrally up to the side of the anterior cirrus and dorsally elongate in the guise of a strip.

Anterior cirrus - Present (since, as confirmed also by CARPENTER and CLAPAREDE, the "long, curved, spine-like process" which, according to HUXLEY, is situated ventrally on each side near the anterior extremity of the ciliated epaulettes, is clearly an anterior cirrus).

Second cirrus - One half the length of the body.

Pinnules - (According to the figures) medium-sized, oval, with a continuous edge.

Rosettes and pinnal glands - Absent or at least not plainly visible, otherwise they would have been included in the fairly detailed description and figures of the author.

Habitat - Torres Strait (Voyage of the "Rattlesnake" 1849).

QUATREFAGES, and rightly so, separated this species from the supposed T. onisciformis (= T. Catharina). CARPENTER had confused these two species. However, QUATREFAGES gives a totally incorrect summary of HUXLEY's data in his analyses.

No. 22. Tomopteris (subg.?) Danae W. C. M.

1862 (T. Danae) W. C. M. (1) page 429, figure in the text (\*)

The following description is based on the very limited data and the figures of W. C. M.

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(\*) I must express my sincere thanks to my friend Prof. HENRY B. WARD of the University of Nebraska who kindly sent me an exact transcription (with a copy of the figure) of the article of W. C. M.

Dimensions - Small; maximum width between the extremities of the first pair of parapodia equal to approximately 2/5 the length of the body.

Appearance - Like a T. elegans; tail absent.

Parapodia - 12 pairs, widely separated and perpendicular to the body except for the last pairs which are directed posteriorly. The very last pair is considerably smaller and extends beyond the posterior extremity of the body.

Prostomium - With normal horns.

Brain - According to the figure (which is too small) it is transversely oval.

Eyes - According to the small figure, they seem to be large and far-set.

Anterior cirrus - Absent (according to the text).

Second cirrus - One half the length of the body.

Pinnules - Large, flat.

Genital ducts - According to the figure, there seem to be a pair of ventral genital ducts between the 4th and the 5th parapodium. (The specimens seem to be an adult as the figures show certain points which appear to be eggs).

Habitat - Sulu (Soloo) Sea; collected by DANA in 1842 during the "Wilkes Exploring Expedition".

This species could be the T. (T.) Cavallii ROSA.

No. 23. Tomopteris (subg?) Carpenteri QUATREF.

1865 (Tomopteris Carpenterii) Quatrefages (1) page 227-229, tab. XX (not 16 bis, as mentioned in the text) fig. 1, 2.  
1885 (??T. Carpenteri) Mac Intosh (1) page 531.

The following characters are based on the description and figures of QUATREFAGES.

Length - (In spite of the great shrinking of the specimen) 45 mm; traces of a break would suggest that there was also a tail.

Parapodia - 30-31 pairs, almost in contact with one another, increasing in size up to the 5th pair, decreasing after the 15th up to the final pairs which are completely rudimentary.

Prostomium - With thick, short, curved horns.

Ciliated epaulettes - Dorsal, triangular.

Anterior cirrus - Absent.

Second cirrus - Slender, longish.

Pinnules - Characteristic: the dorsal ramus is short, conical and situated at a right angle on the ventral ramus which is blunt and almost as large as the trunk of the parapodium. The pinnal membranes are low, puckered and extend for a good distance along the trunk of the parapodium.

Rosettes - Are not mentioned.

Pinnal glands - The very large cupulate body that the author describes and draws, indicating that it rests against the inferior margin of the ventral ramus and reaches the edge of the pinnule, is clearly a chromophile pinnal gland.

Genital ducts - Represented by a pair of roundish openings at the level of the 4th pair of parapodia.

Habitat - Southern Ocean (par. 60°, 3' lat. S and 0°, 60' long.). A specimen collected by the Expedition of the "Zelée".

Many characters of this species are similar to that of my T. (T.) Nissenii.

MAC INTOSH (1) states that a considerable number of this species was found in large numbers by the Expedition of the "Challenger" between the Kerguelen and Mac Donald Islands. However, this is very uncertain and they most probably belong to T. Eschscholtzi.

No. 24. Tomopteris (subg?) Kefersteini GREEFF

1879 (Tomopteris Kefersteinii) Greeff (2) page 275, tab. XV, fig. 40, 41, 43, 46, 47.

1886 (T. " ) Viguiet (1) page 412, tab. XXV, fig. 310.

Not T. Kefersteinii Apstein, Lo Bianco, Schwartz.

This species was, mistakenly I feel, identified by APSTEIN as the T. elegans of CHUN. Here I have given the characters based on the text and figures of GREEFF and have added [in brackets] the limited data obtained from Viguiet. At the end, I will offer the reasons why I feel these two species should be kept distinct unless the data of GREEFF and Viguiet are to be considered grossly inaccurate.

Dimensions - Length 4-5 mm.

General appearance - Tail absent. Shape (from figure 40 by GREEFF) rather narrow and elongate. The width between the extremities of the longest parapodia (5th or 6th pair) is approximately 1/4 the total length.

Parapodia - 13-17 pairs (18 in the figure in addition to two terminal cirri).

[Viguiet found 15 pairs at most but his specimens were young]. These parapodia are much shorter and thicker than in T. elegans; the last pairs, which are still well-formed, do not extend beyond the posterior extremity of the body which ends in two short cirri (perhaps juvenile parapodia).

Prostomium - Similar to that of T. elegans with high horns separated at the base by an incision from which (in figure 41 of GREEFF) an eminence protrudes.

Brain - Transversely oval, bilobate (however, these two lobes cannot be seen in the figures of GREEFF). [According to Viguiet, the brain varies in shape and is sometimes round, sometimes oval, more or less

elongate transversely and sometimes more or less bilobate].

Eyes - Reddish-brown with two lenses [according to Viguiet, they can be incompletely subdivided into four].

Ciliated epaulettes - Extremely unusual. GREEFF describes and draws them as two clavate protuberances running in a lateral-ventral direction along the cerebral region of the head and then protruding anteriorly like two clavae. [The same peculiar configuration is drawn by Viguiet in fig. 5 and confirmed in the text].

Proboscis - (In the figures of GREEFF) extending up to the first parapodium.

Anterior cirrus - Shorter than the frontal horns.

Second cirrus - Almost one half the length of the body.

Pinnules - (According to the figures) rounded, with a continuous edge.

Rosettes and pinnal glands - Rosettes absent on the parapodia or on the rami; however, it is uncertain whether the bodies which GREEFF indifferently calls "rosettenformiges Organ" or "Flossendrüse" in the description of fig. 40, should be interpreted as rosettes or rather (as in the case of Apstein) as pinnal glands. They are roundish, yellowish transparent bodies and one is found on the dorsal and ventral pinnule of all the parapodia in an apical position (between the apex of the ramus and the apex of the pinnule). [VIGUIER confirms this data provided by GREEFF]. I believe that they are hyaline glands.

Gonads - According to the figure of GREEFF they are found on the dorsal and ventral ramus of all the parapodia.

Habitat - Arrecife, the Canary Islands (GREEFF), Algiers (VIGUIER).

COMPARISON between T. Kefersteini GREEFF and T. elegans CHUN  
(= T. Kefersteini APSTEIN).

Here I would like to give the reasons why I feel APSTEIN's identification of T. Kefersteini GREEFF with T. elegans, that is, with the form described under the name of T. Kefersteini by APSTEIN, is, in my opinion, unacceptable.

I will disregard the secondary differences (number of parapodia, a few more in the species of GREEFF, a more narrow shape, etc.) and will deal only with two main points.

1. Pinnal glands (or rosettes?). You will recall that the T. elegans of CHUN (T. Kefersteini of APSTEIN) does not have rosettes. In this species, the pinnal glands (hyaline) are found on the dorsal pinnules only on the 3rd and 4th parapodium and the chromophile glands are found on the ventral pinnules beginning only at the 4th parapodium. (As we have seen in the case of T. elegans, APSTEIN's data are slightly inaccurate).

From the text and the figures of GREEFF, it is not clear whether the yellow body which he indifferently calls (in the explanation of fig. 40) "rosettenförmiges Organ" and "Flossendrüse" is a rosette or a gland and this doubt was not even clarified by fig. 7, Plate XXV of VIGUIER in which, however, it seems to be a hyaline gland.

In any case, if they actually are rosettes, GREEFF's species is not related to the T. of CHUN and APSTEIN. If they are glands, the same applies, because GREEFF claims that they are found on the dorsal and ventral pinnule of all the parapodia. GREEFF states this expressly in his text (page 275) and draws the yellow bodies on the two pinnules of all the parapodia in two figures (40 and 41)..

2. Ciliated epaulettes - In the species of CHUN and APSTEIN, the ciliated epaulettes have no particular characteristics. In the T. Kefersteini of GREEFF they are completely different from what is normally found. GREEFF expressly states (page 275): "Auf der unteren Seite des

Kopfsegmentes, etwas hinter und nach innen von dem ersten Fühlercirrenpaar und die äusseren Segmente des Gehirns von unten bedeckend, erheben sich, der Haut dicht anliegend, zwei keulenförmige lebhaft wimpernde Wülste"<sup>1</sup>. [On the underside of the head segment, somewhat posterior to the first pair of cirri, and covering the outer part of the brain, arise two club-shaped, ciliate bulges.]

This description is confirmed by fig. 41 of GREEFF but is also confirmed by fig. 5, table XXV of VIGUIER who, in his text (p. 413), after noting a few small differences between his specimens (from Algiers) and the data presented by GREEFF, states "Neanmoins l'aspect général du ver, la disposition des organes en rosette sur les nageoires, enfin la forme des organes vibratiles de la face inférieure de la tête, sont tellement semblables que etc."<sup>2</sup> [Nevertheless, the general appearance of the worm, the position of the rosette organs on the pinnules, and finally, the shape of the ciliated epaulettes found on the under side of the head, are so similar that, etc.]

Therefore, I believe, as CHUN has already maintained, that the T. elegans of CHUN (which is the T. Kefersteini of APSTEIN, SCHWARTZ and LO BIANCO) can in no way be identified with the T. Kefersteini of GREEFF and VIGUIER.

#### APPENDIX

No. 25. Tomopteris (T.?), sp. TREADWELL (1) page 1160.

Length - Up to 25 mm.

Parapodia - Absent posteriorly for 10 mm (tail) - 17 pairs.

Anterior cirrus - Short.

Second cirrus - As long as the sections with parapodia.

Pinnules - Large.



Rosettes - (Parapodial eyes) absent.

Brain - Bilobate.

Eyes - Dark-brown.

Habitat - Near Tahiti (station 3802-3037 of the "Albatross" 1902).

As there is no information on glands (the author states that the pinnules were in poor condition) the author was very wise not to give a name to his species which is probably new.

### Geographical Distribution of Tomopterids

Until now, detailed information on the geographical distribution of tomopterids existed only for the European seas and in general, for the Atlantic Ocean up to approximately 10° Lat. S. Of particular importance among this data are those collected by the Plankton Expedition (see APSTEIN (2), page 45-55, tab. 12, 13, 14).

Almost nothing was known about the other seas and the information was limited to the following: that south of the Cape of Good Hope (in a location which was very specific but not certain since they were specimens which came from dealers) a Tomopteris Eschscholtzi was collected once; that once (perhaps twice), T. Carpenteri was taken from the Antarctic seas and that in the Pacific T. onisciformis, Dannae, and Huxleyi were collected once, all species (except for the first), that are doubtful and even unrecognizable (1).

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(1) It should be added that in 1907 MALAQUIN and DEHORNE (1) determined the presence in Amboina (expedition of M. BEDOT and C. PICTET) of T. helgolandica (= T. Catharina) and T. Rolasi. However, there is no description of the first species and, for the second, there are only a few characters and figures of young individuals. Therefore, these two determinations cannot be considered well-founded.

Therefore, the new information contained in this work which gives an initial idea of the distribution of tomopterids outside the area studied up until now, will be appreciated. I have based the study which follows on the excellent work of A. E. ORTMANN (1) concerning zoological marine geography and in the following table I have indicated the pelagic regions and subregions accepted by this author while also including, under the same name, the littoral and subregions which limit landwards the various pelagic regions or subregions.

In the pertinent column of each region or subregion, I have indicated the species of tomopterids which are found there, giving careful consideration to all the ancient data found in APSTEIN (2) and the new data contained in this work.

With the assistance of this table we can review the most interesting findings.

Bipolar tomopterids - The truly bipolar <sup>(1)</sup> marine forms are very rare and until now, none of these forms have been known in tomopterids. As we have seen (p. 309) it is difficult to accept the validity of the information provided by MAC INTOSH (1) on the presence of Tomopteris (Johnstonella) Catharina which he calls T. onisciformis, in Antarctic waters.

But a truly bipolar tomopterid is Tomopteris (Tomopteris) septentrionalis QUATREFAGES and STENNSTR. It was known only in the "Arctic Circumpolar" and the "Northern Atlantic" subregions of the "Arctic region" and I was able to study specimens collected by the "Vettor Pisani"

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(1) ORTMANN ARNOLD E.: Grundzüge der marinen Tiergeographie. - Jena (Fischer), 1896).

(2) For more information on this topic see CHUN C., Die Beziehungen zwischen dem arktischen und antarktischen Plankton. - Stuttgart (E. Nägeli) 1897.

Distribution of Tomopterids according to the pelagic regions of Ortmann l. c.

| ARCTIC REGION                      |                                   |                                  | ATLANTIC REG.                  | INDOPACIFIC REG.             | ANTARCTIC REGION                     |  |
|------------------------------------|-----------------------------------|----------------------------------|--------------------------------|------------------------------|--------------------------------------|--|
| SUBREGION<br>Arctic<br>Circumpolar | SUBREGION<br>Northern<br>Atlantic | SUBREGION<br>Northern<br>Pacific |                                |                              | SUBREGION<br>Southern<br>Circumpolar | SUBREGION<br>Antarctica<br>Circumpolar |
| <i>T. (T.) septentrionalis</i>     | <i>T. (T.) septentrionalis</i>    |                                  | <i>T. (T.) planktonis</i> , M. |                              | <i>T. (T.) septentrion.</i> (*)      |  |
| <i>T. (T.) planktonis</i>          | <i>T. (T.) planktonis</i>         |                                  | <i>T. (J.) Catharina</i> , M.  | <i>T. (J.) Catharina?</i>    |                                      |  |
|                                    | <i>T. (J.) Catharina</i>          |                                  | <i>T. (T.) elegans</i> , M.    | <i>T. (T.) elegans</i>       |                                      |  |
|                                    |                                   |                                  | <i>T. (T.) ligulata</i>        | <i>T. (T.) ligulata</i>      |                                      |  |
|                                    |                                   |                                  | <i>T. (T.) Cavallii</i> , (**) | <i>T. (T.) Cavallii</i>      | <i>T. (T.) Cavallii</i>              |  |
|                                    |                                   |                                  | <i>E. euchaeta</i> , M.        |                              |                                      |  |
|                                    |                                   |                                  | <i>T. (J.) mariana</i>         |                              |                                      |  |
|                                    |                                   |                                  | <i>T. (J.) Rolasi</i>          | <i>T. (J.) Rolasi?</i>       |                                      |  |
|                                    |                                   |                                  | <i>T. (J.) levipes</i> , M?    |                              |                                      |  |
|                                    |                                   |                                  | <i>T. (J.) nationalis</i>      |                              |                                      |  |
|                                    |                                   |                                  | <i>T. (J.) vitrina</i> , M.    |                              |                                      |  |
|                                    |                                   |                                  | <i>T. (T.) Apsteini</i> , M.   |                              |                                      |  |
|                                    |                                   |                                  | <i>T. (T.) Nisseni</i>         |                              |                                      |  |
|                                    |                                   |                                  | <i>T. (?) Kefersteini</i> , M? |                              |                                      |  |
|                                    |                                   |                                  | <i>T. (?) scolopendra</i> , M. |                              |                                      |  |
|                                    |                                   |                                  |                                | <i>T. (J.) Aloisii</i> Sab.  |                                      |  |
|                                    |                                   |                                  |                                | <i>T. (J.) Duccii</i>        |                                      |  |
|                                    |                                   |                                  |                                | <i>T. (J.) Duncckeri</i>     |                                      |  |
|                                    |                                   |                                  | <i>T. (T.) Eschscholtzi?</i>   | <i>T. (T.) Eschscholtzi?</i> | <i>T. (T.) Eschscholtzi</i>          |  |
|                                    |                                   |                                  |                                | <i>T. (?) onisciformis</i>   |                                      |  |
|                                    |                                   |                                  |                                | <i>T. (?) Danae</i>          |                                      |  |
|                                    |                                   |                                  |                                | <i>T. (?) Huxleyi</i>        |                                      |  |
|                                    |                                   |                                  |                                |                              | <i>T. (?) Carpenteri??</i>           | <i>T. (?) Carpenteri</i>               |

\* Specie tipiche - \*\* Solo ai margini notali della regione. - M. Specie che si trovano anche nel Mediterraneo. - M. Specie trovate solo nel Mediterraneo.  
 ? Specie il cui genere dubbio più o meno incerto. - ? Dopo il nome, significa che la località non è certa.

by the "Liguria" and by Cap. H. NISSEN, all collected not far from the coast of Chile between 20° and 25° Lat. S. in a region which is therefore geographically subtropical or tropical but still belongs to the "southern circumpolar subregion" of the "Antarctic region" which extends along the west coast of South America almost up to the Equator.

It is absolutely certain that these specimens are identical to those of the North because I was careful to compare them with typical specimens from the coast of Greenland.

Tomopterids common to the "Atlantic region" and "Indopacific region" are Tomopteris (Tomopteris) elegans CHUN, T. (T.) ligulata ROSA, T. (T.) Cavallii ROSA and perhaps ? T. (T.) Eschscholtzi GREEFF (for exact locations, see the descriptions of species and list of stations of the "Liguria").

However, among the above-mentioned species, T. (T.) Cavallii and T. (T.) Eschscholtzi are characteristic of the "southern circumpolar subregion" (Antarctic region) which connects the two aforementioned regions in the south. It is also possible that one may also find T. (T.) Ligulata in this region, which in the "Atlantic" and "Indopacific" regions was found only in the part closest to the southern boundaries of the region.

As for T. (T.) elegans, it is common in the "Atlantic region" particularly in the central region (also in the Mediterranean) and is also not rare in the "Indopacific region" both in the Indian and in the Pacific Oceans. It has never been found in the seas of the "southern circumpolar subregion" and can certainly not be considered a species characteristic of this region which penetrated the two preceding regions. The case is very interesting (1).

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(1) The T. Catharina and the T. rolasi are also common to the Atlantic and Indian Oceans (Amboina) (see p. 317 (73) in the notes).

Brief review of the individual regions or subregions. (Once again, see the documentation and, for the location, the description of the individual species and on p. 248 (4) the list of the stations of the "Liguria").

Arctic Region - I have nothing new to add to the information already known. This region is divided into three subregions: in the first region ("Arctic Circumpolar") the characteristic species is Tomopteris (Tomopteris) septentrionalis QUATR., and also T. (T.) planktonis APST., but this species penetrates the region from the "Atlantic" region. The characteristic species in the second subregion ("Northern Atlantic") is Tomopteris (Johnstonella) Catharina, however the two above-mentioned species are also found in this subregion. Covering the third subregion ("Northern Pacific"), we still do not know anything.

Antarctic region - It is divided into two subregions: for the first of these ("Antarctic Circumpolar") only one species is known, namely T. (T.?) Carpenteri QUATR. and, as we have seen, it is extremely doubtful that it was actually found in the neighbouring region. The characteristic species for the second subregion are T. (T.) Cavallii ROSA and T. (T.) Eschscholtzi GREEFF; also found in this subregion is T. (Johnstonella) septentrionalis (bipolar).

Atlantic region - Of the species found in this region, one T. (J.) Catharina, penetrates it only for a brief section north of the neighbouring region; this is a little strange because all of the other Tomopteris of the subgenus Johnstonella belong to the "Atlantic region" or "Indopacific region" and are not found in neighbouring regions. Another species, however, T. (T.) Cavallii ROSA penetrates the southern part of this region, from the "southern circumpolar subregion." Perhaps the same applies to T. (T.) ligulata.

I would refer the reader to the table for the other species of this region. However, I will only say a few words on the Mediterranean tomopterids. ORTMANN also includes the Mediterranean in the "Atlantic region" although he designates Gibraltar as the limit between the area of the Atlantic belonging to the "Atlantic region" and the area belonging instead to the "Northern Atlantic subregion" of the "Arctic region".

The distribution of the tomopterids, in itself, justified this approach.

In fact, the following species were found in the Mediterranean:

Enapteris euchaeta (CHUN): Messina, Naples

Tomopteris (Johnstonella) Catharina (GOSSE): Trieste, Gibraltar.

Tomopteris (J.) vitrina (VEJD): Trieste.

? Tomopteris (J.) levipes (GREEFF)P Algiers

Tomopteris (Tomopteris) elegans (CHUN): Messina, Naples

Tomopteris (T.) planktonis (APST.): Messina.

Tomopteris (T.) elegans (CHUN): Messina, Naples

Tomopteris (T.) Apsteini (ROSA): Messina, ?? Naples

? Tomopteris (?) Kefersteini (GREEFF): Algiers

? Tomopteris (?) scolopendra (Q. et G.): Gibraltar

Among these species, T. (J.) Catharina GOSSE, which is characteristic of the subregion "Northern Atlantic" of the "Arctic region" was only found in Gibraltar and Trieste and seems to be completely absent in Naples at Messina. The other species are also found in the true "Atlantic region" (T. (T.) elegans CHUN is also found in the "Indopacific region") with the exception of T. (T.) Apsteini ROSA, which up to now has only been found in the Mediterranean, and T. vitrina, Kefersteini and scolopendra which are doubtful species (which is also the case with T. (T.) elegans).

Indopacific region - As can be seen from the table, we can now add six absolutely certain species to the few uncertain ancient species which

were found in this region. We have already mentioned three of them, which are also common to other regions, whereas the other three are, up to now, unique to this region. As there are three species belonging to the subgenus Johstonella which is essentially tropical, it is very unlikely that these species will also be subsequently found in the "Southern circumpolar subregion" (1).

In conclusion, the information that we have up to now on the geographical distribution of tomopterids clearly confirms the validity of the regions established by ORTMANN. In this regard, we anxiously await the results of the study on tomopterids by the "Valdivia", the "Siboga" and other expeditions.

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(1) For the T. Rolasi and T. Catharina (= helgolandica) indicated also by MALAQUIN and DEHORNE for Amboina see the notes on p. 317 (73) and 320 (76).

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(\*) I was able to consider this work, which I became acquainted with only during the correction of the proofs, in the systematic and zoogeographical part of my work but not in the chapter "Characters used in the systematics of tomopterids". On p. 254-55 of this chapter it should be added that the authors (as MALAQUIN (1) and (2) had already done) also consider the first pair of setigerous cirri as a first pair of parapodia, except that the horns of the prostomium are part of this first pair and, in it, represent that cirrus which, during development, is seen inserted dorsally on the base of the second pair of setigerous cirri and which then disappears. This homology seems extremely questionable in my opinion.

## EXPLANATION OF TABLE 12

(The dorsal pinnule is always directed upwards. j = hyaline gland; cr = chromophile gland; r = rosette; g = gonad).

- Fig. 1. Tomopteris (Johnstonella) Duccii ROSA: ventral pinnule of the 2nd parapodium.
2. Id. Pinnules of the 6th parapodium.
  3. T. (J.) Aloysii Sabaudiae ROSA: the whole animal viewed dorsally.
  4. Id. The head - dorsal view.
  5. Id. Pinnules of the 2nd parapodium.
  6. Id. Pinnules of the 5th parapodium.
  7. T. (J.) Dunckeri ROSA: head.
  8. Id. Last parapodia of the trunk and the two first caudal parapodia.
  9. Id. Pinnules of the 5th parapodium.
  10. T. (Tomopteris) Apsteini RUSA (= T. scolopendra APST.): head.
  11. Id. Pinnules of the 2nd parapodium.
  12. Id. Pinnules of the 7th parapodium.
  13. Id. Pinnules of the 2nd caudal parapodium of a female.
  14. T. (T.) Nisseni ROSA: pinnules of the 2nd parapodium.
  15. Id. Pinnules of the 13th parapodium.
  16. T. (T.) elegans CHUN (= T. Kefersteini APST.): pinnules of the 4th parapodium.
  17. T. (T.) septentrionalis QUATREFAGES and STEENSTR.: pinnules of the 5th parapodia.
  18. T. (T.) ligulata ROSA: pinnules of the 3rd parapodium.

19. Id. Pinnules of the 4th parapodium.
20. T. (T.) Cavallii ROSA: pinnules of the 5th parapodium.
21. T. (T.) Eschscholtzi GREEFF: pinnules of the 5th parapodium.
22. Id. Ventral pinnule of the 8th parapodium.