first upwards, then it turns downwards in a long arch and ends by running horizontally. The dorsal line starts running horizontally, then it turns downwards and ends in another, lower horizontal line. The supra-orbital spine is curved as an open S, and the rather robust antennal spine forms a semilunear curve with its concavity dorsally. The post-antennal spine is pointing in a more anterior direction in *S. membranacea* than in subspecies *capensis* where it is shorter and points more dorsally. The postero-branchial groove spine is longer and more curved in *capensis* than in the North Atlantic species.

The wings of the carapace are covered with a thick layer of soft, spine-shaped hairs. This coating is also found in the North Atlantic species, but with much fewer hairs and therefore with more open space between the hairs. The subspecies *capensis* has usually a group of plumose hairs in the middle area on the carapace between the dorsal spine and the posterior dorsal organ. These hairs may start even in front of the dorsal spine behind the prehepatic spines, but a certain individual variation in number and placement of the hairs seems to occur. Of the branchio-lateral teeth a little is left posteriorly as in the North Atlantic species.

Abdomen.

Formula, segments I–V: 1. 2. 3. 5., segment VI: 1. 2. 4. 5.

The abdomen has made no greater change from the preceding stage. The first five segments are furnished with a dorsal spine, a ventral spine and pairs of lateral and dorso-lateral spines. The last segment has no ventral spine but a pair of ventro-lateral spines. The plumose hairs of the abdomen are the same in number as on the first Mysis, but the single hairs have grown very long and flexible.

Telson.

The telson has narrowed, being more slim, as was the case also in the North Atlantic species. Further the lateral spines on the telson plate have moved further towards the root of the telson so that now only the distal spine is placed on the branch of the furca, while the second spine in the middle of the row now is placed clearly above the bottom of the cleft and the third spine midway on the uncleaved part of the telson as in the preceding stage, but still a little closer to the basis of the telson plate than in the first Mysis. The telson spines are now clearly parallel to the dorsal spines on the abdominal segments sticking up from the telson plate, whereas they are more in a lateral plane with the telson or forming an angle, always less than 90°, with the telson plate in the North Atlantic species of *S. membranacea.*

Dimensions:

Total length 12 mm, length of carapace without rostrum 3.4 mm, width of same 2.5 mm, rostrum 2.2 mm, abdomen 5.6 mm.

Approximate dimensions of stages in mm.

	Protozoea III	Mysis I	Mysis II
Total length.....	4.5	7.5	12
Carapace.....	1.8 × 2.0	2.5 × 2.0	3.4 × 2.5
Rostrum	0.6	1.6	2.2
Abdomen	1.3	2.7	5.6

Distribution and Remarks.

The subspecies *capensis* has received its name because it was taken by the "Discovery" in the waters round the Cape of Good Hope, South Africa. Most of the catches of the larvae are from the surface, a few from depths down to 150 m (Fig. 23). Two more catches of this subspecies were made further north along the west African coast, one of them off Loanda where a plankton haul 150 m below the surface gave 17 specimens all of Mysis II, another haul a little further north off Cape Lopez, yielded two specimens in the first Mysis stage. This leaves an open space from Cape Lopez until the most southern locality of *S. membranacea* around the Azore Islands. Further it can be noted that the larvae have been taken relatively close to the coast, which seems

to support the author's opinion, that *Solenocera* spawns at the bottom in waters of 100–800 m depth. All records of larvae are from close to the shelf of a continent or an oceanic island and never farther away from this than the current may have brought the larvae through their short span of larval life.

The literature and the larval material and its distribution seem to indicate as the most likely, that the type of *Solenocera membranacea* in time has been divided into three or maybe four groups if counting *S. af-*

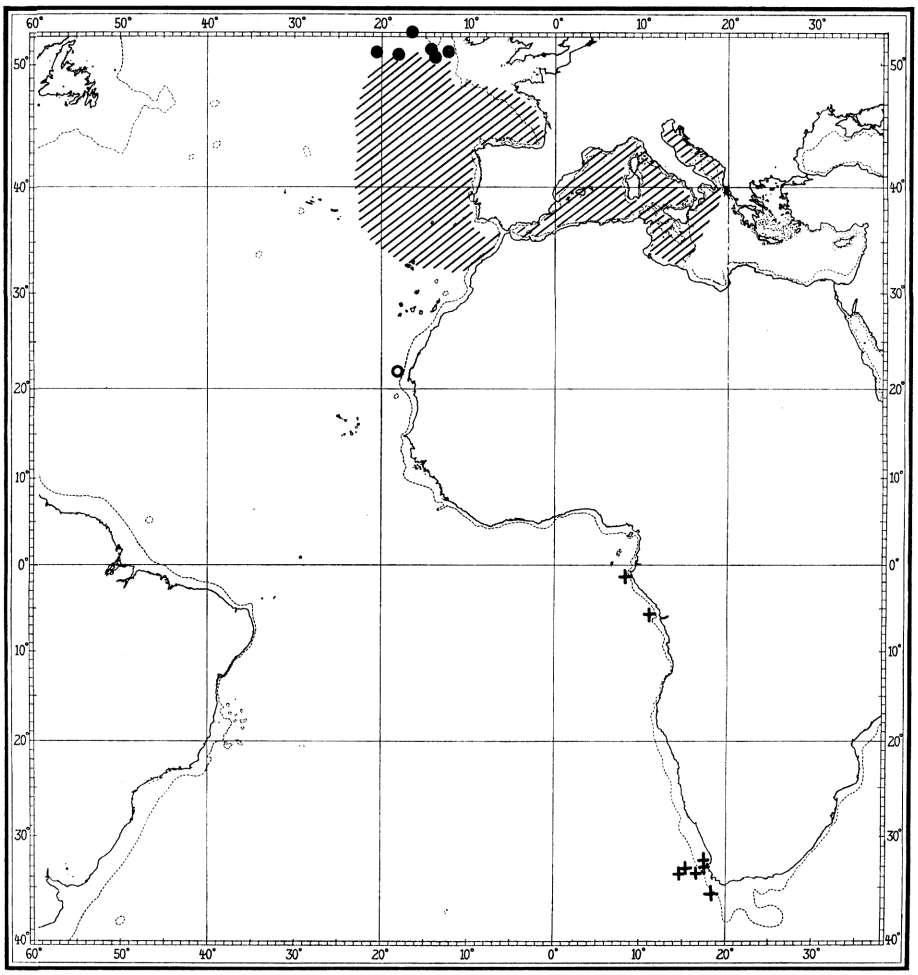


Fig. 23. Map of distribution.

ricanum as a separate one. The groups are the Mediterranean and North Atlantic *Solenocera membranacea*, the South-East Atlantic *S. capensis* from around South Africa reaching north along the west side of Africa to Cape Lopez, and may be *S. africanum* along the Eastern coast of South Africa in the Indian Ocean, and finally *S. muelleri* as the name must be, if it is the larva to the adult described by BURKENROAD as *S. vioscai* which may be the adult to MÜLLER's and ORTMANN's larva *Opisthocaris muelleri* which will be discussed later in this paper. The *S. vioscai* is known from the coast of Venezuela and described by SMITH in 1885 as *S. membranacea*, but BURKENROAD (1934) has established it as a separate species *S. vioscai* on the above

mentioned three females taken by SMITH at Venezuela and two more taken near Pass à la Loutre in Louisiana. If as suggested in this paper *S. muelleri* is the larva of this form, its known distribution will be much enlarged, as the larva has been taken in the Florida current by the HUMBOLT Expedition and further along the whole coast of Brazil down to Desterro where MÜLLER's larvae are from.

Whether these four types are to be regarded as independent species or three of them are to be considered as subspecies of *S. membranacea* must more or less be a question of personal opinion. It can at least only be settled by examining the adults, which have not been at disposal for the present author, and furthermore the question is partly outside the scope of this paper. However, it is clear that we have at least three distinct separate stocks, perhaps four, because the border lines in the distribution between *S. capensis* and *S. africanum* are not clear. Each of these three or four stocks has its own special morphological characters, although all of them are closely related to one another. Judging only from the larvae it can be said that *capensis* is so close to *membranacea* that it is reasonable to place *capensis* as a subspecies under *membranacea*. The larva of *S. africanum* is not known, or at any rate only one larval species is known from the South African area. The larva of *S. muelleri* is so far removed morphologically from the ones on the Eastern hemisphere that it is reasonable to establish it in its own species *Solenocera muelleri* to which BURKENROAD's *S. vioscai* then probably is a synonym.

Solenocera muelleri (ORTM.)

Figs. 24–50.

"Eine dritte Art." FRITZ MÜLLER, 1863, p. 22, Figs. 18–22.
Opisthocaris muelleri ORTMANN, 1893, pp. 77–78, pl. 4, Fig. 5.

Localities.

Protozoea III:

FRITZ MÜLLER's larva from Desterro, Brazil, 1863. several spec.

Mysis I:

Discovery St. 709, 14°01,4′ S–36°30,7′ W, 216–0 m, 24.10.31. B.M. 2 spec.
Unknown locality B.M.

Mysis II:

Coast of Brazil (*Opisthocaris muelleri*) ORTMANN, 1893, several species.
Discovery St. 708, 10°20,6′ S–34°54,7′ W, 208–0 m, 23.10.31 B.M. 1 spec.
— — 709, 14°01,4′ S–36°30,7′ W, 216–0 m, 24.10.31. B.M. 4 spec.
Unknown locality, B.M.

Description.

Mysis I.

Figs. 24–38.

Carapace.

Formula: 1. 2. 3. 4. 5. 7. 8. 9. 10. 11. 12. 13. 14. 16. 18. (19). 22. 23. 24. 27. 28. 29. 30.

This small larva is very characteristic in many points and is therefore easy to recognize. In the first Mysis the surface of the carapace is very uneven with many longitudinal ridges and furrows. From MÜLLER's figure of the third Protozoea (1863, Pl. II, Fig. 18) the most characteristic is a larva with branchiostegal spines as well as branchio-lateral spines, the presence of these types of spines is hitherto only known in the larval *Solenocera* sp. larva. *barbata*. MÜLLER has further shown in his figure a most unusual swelling on the side of the carapace furnished with two spines on its dorsal part, it looks mostly as a deformity and is not observed in any other *Solenocera* larva. It was therefore highly interesting that the material for examination included one sample, with two specimens of Mysis I also from the coast of Brazil and in which these characters

of MÜLLER's larva still could be recognized although in a one stage older larva than MÜLLER figured. The swelling is the beginning of a convoluted surface where the branchiostegal lobe is about to develop, because this lobe is not found in third Protozoea, but begins to develop in the first Mysis. MÜLLER's bulb inside the carapace margin is longer than the one I found in the following stage, which was the youngest stage I had at hand. Here the bulb was partly transformed into a beginning lobe. MÜLLER further found two spines attached to this bulb, whereas I in the first Mysis found several spines of which two were larger than the rest. The paired prehepatic spines are by MÜLLER drawn as a single spine in the medial line, a mistake which very easily can be made, especially when not having made a diagram over the possible spines as the one presented in this paper, Fig. 1.

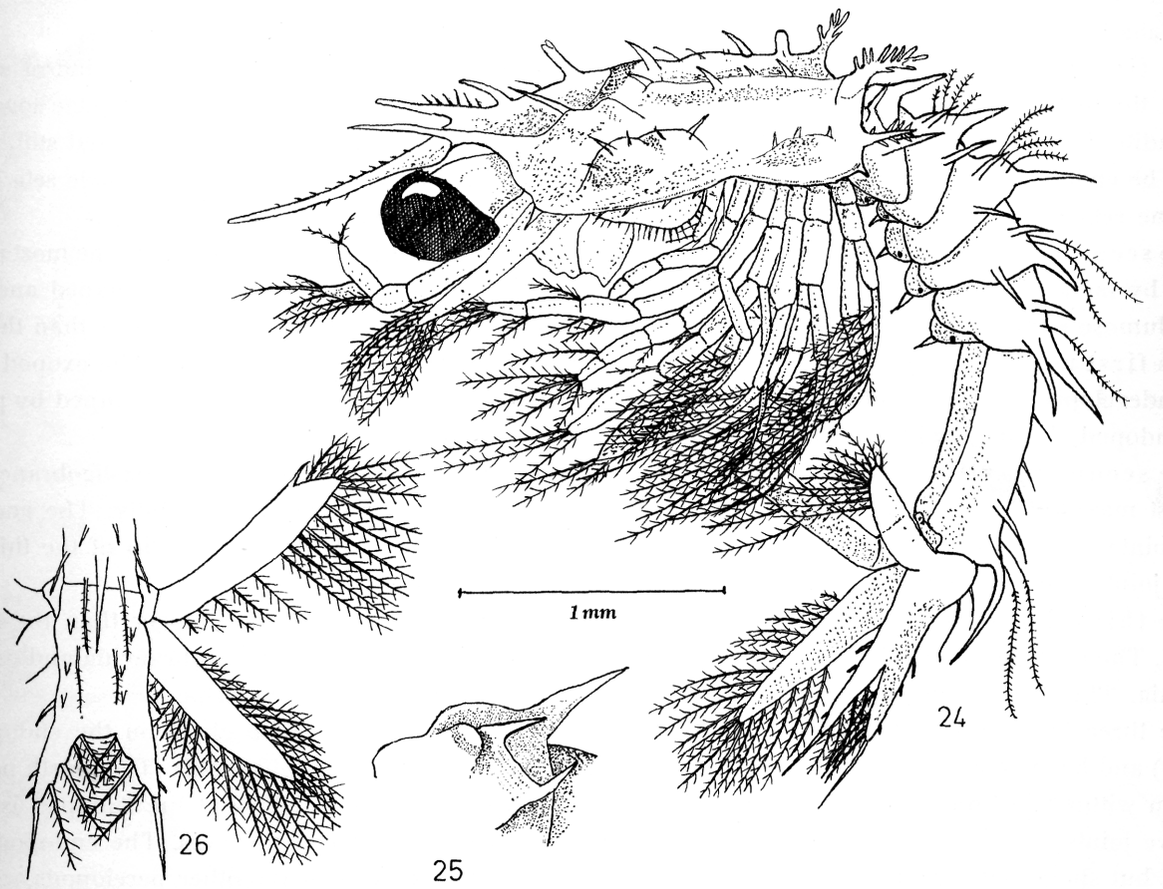
The carapace of the first Mysis has a large and well-developed rostral plate. The rostrum itself is long and a little curved, and covered with fine, anteriorly pointing, spines mostly on its dorsal side. There are both a rostral and an epigastric rostral tooth, of which the rostral tooth is the largest and has many stiff surface hairs. Still in the middle line behind the rostrum is the anterior dorsal organ which is rather long and at its tip divided into two small bulbs. The posterior dorsal organ is much smaller, though above average size. The cervical groove is very distinct and extends forwards into the concavity between rostrum and the ridge on which the supra-orbital and postorbital spines are placed. The supra-orbital spines are as usual the largest spines except for the rostrum, but also the post-orbital spines are large. Here it may be mentioned that in all the other larval species there has never been observed a post-orbital spine, but instead of this a post-antennal spine. This seems to be the same spine which normally is placed posteriorly to the supra-orbital and the antennal spine in a longitudinal line between these two first spines, but closest to the antennal spine, and therefore I have called it the post-antennal spine. Further when the carapace has a cervico-branchial groove debouching between the supra-orbital spine and the antennal spine, the spine called the post-antennal spine has always been found laterally of this groove, but in *S. muelleri* the spine is placed on top of the ridge running backwards from the supra-orbital spine, and can therefore most naturally be mentioned the post-orbital spine. Of longitudinal grooves or ridges we have further the branchio-cardiac groove which in this species is very long running anteriorly in line with the pre-hepatic spines which also are present. In the following stage, the second Mysis stage, this spine extends farther forward so as to connect with the ridge from the supra-orbital spine. Thus here a longitudinal ridge connects the supra-orbital spine with the postero-branchial groove spine, whereas the first Mysis still has an open stretch between these two spines. Following the carapace margin from the rostrum backwards we find first the already mentioned supra-orbital spines, after them follow a short, conical, antennal spine, and then, most extraordinarily, four branchio-stegal spines. In all the other species known the maximum is three, and in *Solenocera muelleri* it is only in the first Mysis that we find four such spines. In the following stage the most posterior of them has disappeared, reducing the number to the normal maximum of three. Further back on the margin are placed also four branchio-lateral spines plus one on the posterior corner itself, this latter is not the often found latero-posterior marginal spine, because this is also present, only it has moved a tiny stretch away from the corner. This last spine is large and covered with filamental teeth. Also the number of the branchio-lateral spines is reduced in the following stage to three + one, but here the number is not unusual, the third Protozoea of *Solenocera* sp. larva *barbata* has 7–8 of them. From the posterior margin extends posteriorly the latero-posterior marginal spines, above them is the postero-branchial groove spines and above them again, close to the middle line, a pair of medio-posterior marginal spines, all three pairs are covered with filamental teeth.

Inside the margin the following spines are placed: the unpaired dorsal or epi-cardiac spine in the median line between the two dorsal organs but closest to the posterior dorsal organ; in front of this the pre-hepatic spines; farther anteriorly and more laterally the post-orbital spine, which both have been mentioned; and along the branchio-cardiac groove four spines. The most anterior one of these four spines is in line with the prehepatic spine, which therefore also can be looked upon as the latero-hepatic spine up to which the branchio-cardiac groove or ridge has reached. At the side of the spines a few soft hairs have started to develop on the carapace. In the following stage these hairs increase considerably in both size and numbers.

Abdomen.

Formula, segments I–V: 1. 2. 3. 5., segment VI: 1. 3.

On the abdomen all six segments have both a dorsal and a dorso-lateral spine. The first five segments are further furnished with a pair of lateral spines and a ventral spine. These three spines are missing on the sixth segment, but on the dorsal ridge of this segment is a double row of short spines. Further several long, flexible and partly plumose hairs are found on all the segments beginning from the dorsal ridge where they are longest and continuing along the pleura towards the ventral side of the segment. These are more developed and better seen in the following larval stage and are best developed on the three first abdominal



Figs. 24–26. *Solenocera muelleri.* First Mysis. Fig. 24, total view of larva, from lateral. — Fig. 25, part of first abdominal segment showing the lateral process and the three spines on the dorsal half of the segment. — Fig. 26, telson and right uropod.

segments. On the first abdominal segment we further have the lateral process which is first a membrane between the lateral spine and the dorso-lateral one, then a cutinous bulb, later a muscular bulb, anteriorly of the membrane, but fitting closely into it as shown in Fig. 25. The two spines here, one at each end of the membrane, are soft and vestigial in this stage and in the following second Mysis stage, where the lateral spine is free of the membrane while the dorso-lateral one is lost.

Telson.

The telson has nearly parallel sides. The cleft of the furca is shaped as an angle of about 50°. The two lateral spines are only small and placed near the tip of the furca, the third spine is somewhat larger and placed about midway on the lateral margin of the telson. The double row of spines on the dorsal ridge of the sixth abdominal segment is extending on the telson with three pairs of small spines, three in each row. Also the two long hairs from the sixth segment hanging down above the telson have a counterpart of two long hairs, but these are a little shorter than those on the sixth segment. On each side of the furcal cleft are the usual four plumose setae.

Appendages.

The first antenna has the usual three-jointed peduncle of which the first joint is extremely long, about twice the length of the two following joints together and shows a beginning development of the statocyst hollow. The two following joints have many stiff setae on their medial margins, and the two flagella are short and unjointed.

The second antenna has not yet developed the spine on the distolateral corner, but only stiff plumose setae.

The mandible has a clear distinction between molar- and incisor part, the latter is furnished with a characteristic series of thin, spine-like teeth. The palp is short, unjointed and fleshy. The labium or lower lip is small and split nearly to its base.

The first maxilla has developed a stout basi-endite with strong, cutting teeth and a line of stiff setae behind the teeth on the lateral side of the lobe. The coxa-endite is smaller, with shorter setae towards the basi-endite, longer setae on the proximal half of the end of the lobe; all setae are of the usual stiff, plumose type. The endopod is three-jointed and the exopod has remained as a small bulb with a single seta left; that only one seta is present may be caused by the poor state of preservation of the material.

The second maxilla is of the usual kind with four protopodial lobes or endites of which the most proximal one is by far the largest. The endopod is five-jointed and the exopod is narrow, moon-shaped and fringed with plumose setae of which the most proximal one is very large, three to four times longer than the others.

The first maxillipede has a wide protopod with a mastigobranchia on the coxa. The exopod is small and undeveloped, the endopod is four-jointed and the whole medial margin of the limb, shaped by protopod and endopod, is lined with many stiff and plumose setae.

The second maxillipede has a shorter, also two-jointed, protopod and a smaller mastigobranchia than the first maxillipede. The exopod is better developed with some swimming setae distally. The endopod is three-jointed with a very large basal joint and with a brush of four stiff setae at the tip of the third, most distal, joint; other setae are placed along the medial margin of the limb.

The third maxillipede is developed as an ambulatory limb, and is much longer than the first and second. The protopod is two-jointed with two small gill-buds on coxa for one mastigobranchia and one podobranchia. The endopod is five-jointed; the exopod has distally long swimming setae.

The three first pairs of thoracopods show a beginning development of a chela on the endopod (see Fig. 36) and have on coxa two gill-buds for one mastigobranchia and one podobranchia. The fourth pereiopod is again without beginning chela, the coxa has only a single bud for one gill, and the endopod is divided into five joints. The fifth pereiopod is shorter than the others and without gill-buds. The endopod is five-jointed but short, only the exopod is of full length equal to the exopods of the other pereiopods.

The pleopods are hardly visible, small limb-buds on the first five abdominal segments. The uropods have an unjointed protopod and long lancet-shaped exopods and endopods. They are about as long as the telson, but they have not yet got their full armament of setae.

Dimensions:

Total length 5 mm. Length of carapace 1.5 mm, width of same 1 mm, length of free rostrum 1 mm, length of abdomen 2 mm. This is the smallest of the known larvae. The third Protozoea described by MÜLLER was after his measurement only 1.2 mm. He does not mention how the measurements were taken, but it must be without including the rostrum.

Mysis II.

Figs. 39–49.

Carapace.

Formula: 1. 2. 3. 4. 5. 7. 8. 9. 10. 11. 12. 13. 14. 16. 18. (19). (22). 23. 24. 27. (29). (30).

The whole carapace is in this stage covered with longer and shorter hairs besides the actual spines. The longest of these hairs are even plumose with some short side-hairs on the shaft. The rostrum has enlarged