PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

ZOOLOGICAL SOCIETY

OF LONDON

FOR THE YEAR

1896.

PRINTED FOR THE SOCIETY,
AND SOLD AT THEIR HOUSE IN HANOVER-SQUARE

LONDON:
MESSRS. LONGMANS, GREEN, AND CO.,
PATERNOSTER ROW.

6. On the Development and the Species of the Crustaceans of the Genus *Sergestes*. By Dr. H. J. Hansen (Copenhagen)[1].

[Received October 15, 1896.]

Contents.

i. *Introductory Remarks.*

Three years ago the Rev. T. R. R. Stebbing, in his most useful book "A History of Crustacea. Recent Malacostraca" (The Intern. Scient. Ser. vol. lxxiv.), writes on the genus *Sergestes* :—"The species known as adults are very numerous, of very various sizes . . . . . The account of the genus occupies eighty-eight quarto pages and seventeen plates of Spence Bate's 'Report on the *Challenger* Macrura.' It was the subject of a monograph by Kröyer in 1856, and the interest of the subject seems still very far from being exhausted." That the supposition in the last line of this quotation is correct will be proved by this little treatise. Besides the large section of Bate's 'Challenger Macrura' and Kröyer's monograph, almost a score of papers contain contributions to the knowledge of this interesting genus; but for all that no other group or extensive genus of Decapoda has been up to this time so incompletely studied. This will be plainly recognized when the chief results of this paper are stated—*these are that of the 59 (or 60) hitherto described species only about 20, or one-third of the total number, have been established on adult animals, such as have almost or entirely arrived at sexual maturity; and that almost all the other species are true larvæ, and even of these a considerable portion are larval stages of species already established on adult specimens, while of the 20 species founded on adult specimens 2 with good reason will be excluded and at least 4 must be cancelled as synonyms!* The authors, who have established new species and have avoided describing or at least acknowledging larvæ as real adult species, only make mention of large or very large specimens and, in all probability, have not studied smaller forms.

To throw some light upon the older larval stages of the species, distinguishing between the larvæ and the adults, referring a series of the larvæ to the adult forms, examining the value and variation of different characters, &c., will be the aim of this short treatise.

[1] Communicated by the Rev. T. R. R. Stebbing.

Several years ago, when trying to determine the very rich material of pelagic forms (among them also the type specimens of the 15 species described by Kröyer) preserved in the Zoological Museum of the University in Copenhagen, I discovered the value of numerous species, but I had no mind to write any preliminary note on the question. Since then I have not had the time necessary for working out a monograph (requiring some hundred figures); but seeing now that at least during some years I shall be very much engaged with other work, while authors continue to describe larvæ as well-established new species, I have thought it convenient to write this communication. A monograph will, nevertheless, be extremely desirable, for of most species and larval stages new full, and accurate descriptions and new figures, much better than the existing ones, must be worked out. Many of the described forms it is impossible to recognize with certainty without a re-examination of the type specimens. A monograph must also be based upon the investigation of the collections in the few museums which possess rich material of pelagic Crustacea; it will be rather toilsome, but very remunerative, as at the present time it is scarcely possible within any other group of Decapoda to elucidate a large portion of the development of almost two-thirds of the species.

The genus *Sergestes* is now generally referred to a separate family, the *Sergestidæ*. To this also the following genera have been transferred: *Sciacaris*, Bate; *Petalidium*, Bate; *Acetes*, H. M.-Edw.; and *Leucifer*, Vaugh. Thomps. On *Sciacaris* and *Petalidium* some remarks will be communicated in the following pages; the two other genera I must omit on this occasion, though much addition to our knowledge could be given. *Leucifer* has been treated at great length by Bate, who admits only 2 species, but 4 species are preserved in our museums. Of *Acetes* 2 species are known (one of which has not been examined since 1837), but we possess 6 species, the distinctive characters of which are very curious; it is, however, impossible to give a good idea of the species of these two genera without a considerable number of figures.

Before concluding these few remarks I desire to offer my sincere thanks to Prof. Dr. K. Brandt (Kiel) and Geheimrath Prof. Dr. R. Leuckart (Leipzig), who lent me two type specimens, and especially to Geheimrath Prof. Dr. V. Hensen (Kiel), who lent me examples of 4 Plankton species, and Prof. Dr. C. Chun (Breslau), who, on my request for the loan of type specimens of two species, favoured me with his whole finely preserved material collected by himself, chiefly with a closure-net, "Schliessnetz," at the Canary Islands and at Ragusa and Lesina in the Adriatic.

ii. *The History of the Genus.*

As C. Spence Bate and A. Ortmann, the last two authors who have given an apparently but not really complete enumeration of the known species, have overlooked several publications, and as other contributions have been published during the last few years, it will be convenient to give a short account of all the papers containing descriptions of new species, and, moreover, to make some few remarks on the most important contributions treating of the development. Papers which contain no descriptions of new species, and generally are but of little interest for our knowledge of the genus, are omitted.

The genus *Sergestes* was established by H. Milne-Edwards in 1830 ("Descr. d. genres Glaucothoë, Sicyonie, Sergeste et Acète," Ann. d. Sc. Natur. t. xix.) with one new species, and in his Hist. Natur. d. Crust. t. ii. 1837, he does not know more species.—In 1850 G. de Natale (Descriz. zool. d'una nuova specie di Plojaria et di alcune Crostacei del porto di Messina) described and figured one new species.—In 1855 H. Kröyer published preliminary descriptions ("Bidrag til Kundskab om Kræbsdyrslægten *Sergestes*, Edw.," Overs. K. D. Vidensk. Selsk. Forbandl. i 1855) of 15 new species, and in 1859 his well-known monograph ("Forsög til en monographisk Fremstilling af Kræbsdyrslægten *Sergestes*, Med. Bemærkninger om Decapodernes Höreorganer," K. D. Vidensk. Selsk. Skrifter, 5 Raekke, Nat. Math. Afd. iv. 2) containing full descriptions and numerous figures of the same 15 species. The descriptions are worked out with his usual care, and both these and the plates surpass almost all subsequent contributions; but his scanty material of most species and complete ignorance of the development have given rise to the error, at that time very excusable, of treating larvæ as adult species. Of corrections I shall only here mention that 3 of his species do not belong to the genus (see later on); and that when he states that the examples of *S. serrulatus*, *S. caudatus*, and *S. laciniatus* were captured in the Kattegat off Denmark, this is absolutely a mistake, all 3 species originating in the subtropical or tropical seas.—In 1861 W. Stimpson published ("Prodrom. descr. animal. evertebr., quae in Exped. ad Ocean. Pacific. Septentrion. . . .," Proceed. Acad. Nat. Sc. Philadelphia, 1860) shorter descriptions of 5 new species, one of which he transferred to a new genus, *Sergia*, which must be cancelled as being of no value at all.—In 1875 A. Metzger ("Crustaceen aus d. Ordnungen Edriophthalmata und Podophthalmata," Jahresber. der Commission zur wiss. Unters. der deutschen Meere in Kiel für die Jahre 1872, 1873: Berlin, 1875) established one new species.—In 1881 C. Spence Bate published ("On the Penæidea," Ann. & Mag. Nat. Hist. ser. 5, vol. viii.) preliminary descriptions of 4 new species (and of the new genus *Petalidium*), all from the 'Challenger'; the paper is of some importance for the priority of at least one of the names. In 1888 Bate's above-mentioned large contribution in the 'Challenger' Report, vol. xxiv., was issued. Together with the species in the preliminary paper he describes in all 24 new species of *Sergestes*, but figures only 18 of them; next he gives an extract of the Kröyerian descriptions and a new representation of 7 of Kröyer's species examined by himself. He indicates "Greenland" as the locality for all the animals described by Kröyer, though only one of Kröyer's species was taken in that neighbourhood—a curious mistake which has already been corrected by Ortmann. He cancels 2 of Kröyer's species, but one of the two, *S. arcticus*, is a valid species. Bate also employs numerous pages and several plates in the representation of larval stages (see later on). This large contribution is of course of great importance, but unfortunately neither the descriptions nor the figures are so good as could be wished, and in numerous instances (see later on) a re-examination of the type specimens is absolutely necessary—the greater part of the new species are but larvæ. Besides the genus *Petalidium* he also establishes the genus *Sciacaris*, each of these containing one species. The latter genus is of no value, it is but a *Sergestes*-larva.—For some small but classical contributions we are indebted to S. I. Smith. In 1882 he gives ("Report on the Results of Dredging, und. the supervis. of Al. Agassiz . . .," Bull. of the Mus. of Compar. Zool. vol. x.) the correct branchial formula of *S. arcticus*, Kr., and an excellent description with good figures of a new species; in 1884 ("Rep. on the Decap. Crust. of the Albatross Dredgings . . . in 1883," U. S. Comm. of Fish and Fisheries, pt. x.; Rep. f. 1882) he describes a new species and gives figures of *S. arcticus*, Kr., and *S. robustus*, Smith; in 1886 ("Rep. on the Decap. Crust. . . . in 1884," U. S. Comm. of Fish and Fisheries, pt. xiii.; Rep. f. 1885) he communicates a plate with figures of earlier described species.—In 1888 C. Chun ("Die pelag. Thierwelt in gröss. Meerestiefen . . .," Bibliotheca Zoologica, B. 1) describes and figures one new species, captured with a "Schliessnetz," and in 1889 ("Bericht üb. eine nach d. Canarischen Inseln im Winter 1887–88 ausgef. Reise," Sitzungber. d. k. Preuss. Akad. d. Wissensch. zu Berlin, Jahrg. 1889) another and very curious new species.—In 1891 J. Wood-Mason ("Nat. Hist. Not. from H.M. Indian Marine Survey Steamer 'Investigator,'" Ann. & Mag. Nat. Hist. 6th ser. vol. vii. 1891 and vol. viii. 1891) establishes two new species; and, as a continuation of the same publication, A. Alcock and A. R. Anderson in 1894 (Journ. Asiat. Soc. of Bengal, vol. lxiii. 1894) describe a third new species, of which a figure was published later on, in 1895 (Illustrations of the Zool. of the R. Ind. Mar. Surv. Steamer 'Investigator': Calcutta 1895).—In 1893 A. Ortmann ("Decapoden und Schizopoden," Ergebnisse d. Plankton-Exped. d. Humboldt-Stiftung, B. ii. G. b.) gives a more important contribution, containing descriptions and figures of 2 new species, additional notes and corrections on several earlier known species, and the cancelling of 3 names as synonyms; he also tries to make up an analytical key of most of the known species, distributing them into the genera *Sergestes* and *Sergia*, but as the greater part are larval forms with several of the characters changing from stage to stage, the keys are of no value.—Finally W. Faxon in 1893 ("Prel. Descr. of new Spec. of Crust.—Rep. on the Dredg. Operat. off the West Coast of Centr. America . . .," Bull. of the Mus. of Compar. Zool. vol. xxiv.) describes 3 new species. In the full treatment ("The Stalk-eyed Crustacea.—Rep. on an Explor. off the West Coast of Mexico . . .," Mem. of the Mus. of Compar. Zool. vol. xviii. 1895) he communicates extensive descriptions and a series of figures of the same 3 species, but he withdraws 2 of them as synonyms to earlier known forms; one of these, *S. halia*, must, however, be re-established.

The result is that of *Sergestes* and *Sergia*, taken together, 59 species have been established, of *Sciacaris* 1—in all 60 species, of which 7 have been withdrawn by various authors, but only 5 with good reason; so that we have the preliminary result: 55 species.

The development of *Sergestes* was first and most fully elucidated by C. Claus. In 1863 ("Ueber einige Schizop. und niedere Malacostraken Messina's," Zeitschr. f. wiss. Zool. B. xiii. 1863) Claus describes a larva which he names *Acanthosoma*, without, however, being able to indicate its relations; but he (pp. 437–439) correctly refers *Mastigopus*, Leuckart (1853), to a larva of *Sergestes*. In 1876 (Untersuch. zur Erforschung der Geneal. Grundlage des Crustaceen-Systems) he shows all the principal features of the metamorphosis: he has found a *Protozoëa*-stage, and states the zoëa described by Dohrn as *Elaphocaris*, *Acanthosoma*, and *Mastigopus* to be successive stages of the development. One point is of special interest, viz. his statement that the two posterior pairs of trunk-legs, which are well developed with [illegible] exopods in the *Acanthosoma*, are thrown off by the moulting to the *Mastigopus*-stage, and then grow out again; they become "sichtbar als kurze Schlauche, die wir an grösseren und älteren Larven in verschiedenen Uebergangsstufen zu kleinen Füssen sich entwickeln sehen" (Zeitschr. w. Zool. p. 438).—Some months before the "Untersuchungen" of Claus appeared v. Willemoës-Suhm published ("Prelim. Remarks on the Development of some Pelagic Crust.," Proc. Roy. Soc. Lond. vol. xxiv. 1876, and Ann. & Mag. Nat. Hist. ser. 4, vol. xvii.) a short paper, in which he states that *Elaphocaris*, Dohrn, is the zoëa of *Sergestes*, and that the development passes through an *Amphion*-stage &c.; but on the *Mastigopus*-stage and its want of the two posterior pair of trunk-legs he says nothing.—In Bate's 'Challenger' Report 30 pages and several plates are occupied by the representation of a series of *Elaphocaris*, *Acanthosoma*, *Mastigopus*, and considerations about the development. On p. 383 he says: "By tracing the several stages, we may safely conclude, from the direct structural affinities, that *Mastigopus* is a young *Sergestes*." This is correct, but when he really tries to establish any limit between *Mastigopus* and *Sergestes* he is not fortunate, nay, in the description of *Serg. longispinus*, Bate (pp. 417–18), he even writes: "The fourth and fifth pairs are entirely absent," and later on he is "inclined to think that their absence is owing to the early stage of development"; thus his *Serg. longispinus* is a young *Mastigopus* with the legs referred to still less developed than in the form he in the earlier part (pp. 376–77) describes as *Mastig. acutiformis*, Bate. Thus the differences

between *Mastigopus* and *Sergestes* have not been apprehended by Bate.—In 1893 A. Ortmann (in his above mentioned paper) gives a general view of the development of *Sergestes*; on p. 68 he says that the reduction of the two posterior pairs of trunk-legs in *Mastigopus* "ist der hauptsächliche Unterschied von der erwachsenen *Sergestes*-Form," which in this draught is rather obscure, and this author has also accepted the larvæ described by his predecessors as adults, as being valid species of *Sergestes*.

iii. *The adult* Sergestes *and* Mastigopus.

No author has put or answered the question how to decide whether a specimen of a *Sergestes* is really adult. At first sight this does not seem to be the case. Long ago Milne-Edwards discovered an organ only found in the adult (or subadult) male, viz. a large and very complicated appendix on the first pair of pleopods, the so-called "petasma," and Kröyer added the peculiar development of the exterior flagellum of the antennulæ. Later on Bate, Smith, Wood-Mason, and Faxon have found similar structures in some species. But it is interesting to observe that all the species in which these structures have been found, or, in other words, the species of which the male sex has been determined, are comparatively large, at least 15–25 mm. in length and sometimes much longer, that they all possess short eye-stalks with rather small or very small and *totally black eyes*, and that they have the fifth pair of trunk-legs tolerably developed and the fourth pair rather long and fringed with numerous long cilia; while in most of the described species no petasma and no transformation of the exterior flagellum of the antennulæ have been found, and all these species are rather small, rarely more than 4–15 mm. long, almost all with rather long or long eye-stalks, rather large or large eyes, all with the eyes *either totally yellowish* (or whitish) *or at most with a blackish spot in the interior*, and the fourth and especially the fifth pair of trunk-legs rather short or even rudimentary. When Kröyer published his monograph the development was quite unknown, and not being able to find any male specimen of numerous species he believed that his specimens were females. Bate and Ortmann, who later on studied collections many times richer than that examined by Kröyer, do not mention having met with any male of any of the numerous smaller species! These results suggest that the smaller species must offer some peculiarity.

The collection of *Sergestes* in the Zoological Museum of the University in Copenhagen is very large, 300 bottles and tubes (each containing all the specimens of a species from the same locality): all the animals, with extremely few exceptions, have been collected with surface-nets. Trying to discriminate and determine the forms, I soon took notice of the fact that among an enormous material (98 tubes) of *S. atlanticus*, M. Edw., with black eyes, not rarely were found somewhat smaller specimens with pale or yellowish eyes, which possessed a shape recalling somewhat the very curious, ovate, and obliquely implanted, but much larger eyes in *S. ancylops*, Kr. The result of further comparison was that *every conceivable intermediate stage between the small* S. ancylops, *Kr.* (with its abnormal eyes, its rudimentary last pair of trunk-legs, and its dorsal spines on some of the abdominal segments, &c.), *and large, mature specimens of* S. atlanticus, *M.-Edw.* (S. frisii, *Kr.*), *was found.* We possess *S. ancylops* from 17 localities, and in 10 of these it was taken in company with larger transition-stages to, or completely developed specimens of, *S. atlanticus*. That typical specimens of *S. ancylops* and transition-stages to the black-eyed form do not possess any petasma, scarcely needs mention, but neither was it found in the smallest of the black-eyed specimens. The result was that *S. ancylops*, Kr., must be considered as the *Mastigopus*-stage of *S. atlanticus*, M.-Edw., and that the idea of *Mastigopus* must be extended to embrace such stages as only differ from the *Mastigopus* of Claus, Bate, and Ortmann in having the fourth and fifth pairs of trunk-legs somewhat longer, while their eyes in shape and colour have still preserved the essential characters of the *Mastigopus*. And with that I had gained a result rendering it easy to study the alterations in shape and armature of all the various parts of the animal during its development, and a starting-point for the consideration of other species. Soon afterwards I made out that *S. rinkii*, Kr., is the *Mastigopus* of *S. arcticus*, Kr., &c. And now let us look at the characters of the larvæ in contradistinction to those of the adult animals.

When a species is mature the male sex always possess a large petasma and—so far as we know—a peculiar development of the exterior flagellum of the antennulæ. For the females I have not found any character of discriminative value. But while the well-developed petasma is necessary to decide the real maturity of the male, and the female must have reached the same length as the adult male before it can be admitted as being mature, *such comparison is not necessary for the decision of the question whether a specimen without a petasma has arrived at the adult stage—viz. that its different parts, such as shield with rostrum, eyes, external maxillipeds and legs, uropods, telson, &c. have almost or totally assumed the shape to be found in the mature and sometimes unknown form—or whether it must be considered as a larva.* As declared in the introductory remarks, about two-thirds of the established species are but larvæ; in reality they present several characters immediately stamping them as such, and, furthermore, they show peculiarities which indicate very different stages of metamorphosis. In a multitude of "species" dorsal spines on some or almost all the abdominal segments are present, and such spines only exist in the larval stages, but in many older larvæ the abdomen is quite smooth. In the adults the rostrum is rather short or very short, but, especially in the younger *Mastigopus*-forms, it is most frequently long or even very long. In the larvæ the fourth and fifth pair of

legs are at least shorter, more slender, and with fewer hairs than in the adults. But the best distinction between the larvæ and the adults is, as hinted above, the shape and especially the colour of the eyes: in the larvæ the eye-stalks are almost always long, the eyes are rather large, or even very large, and have an oblique and more or less fungiform shape; while in the adults the eye-stalks are rather short, and the eyes smaller, more regularly globular, and sometimes but slightly thicker than the distal end of the stalk; *in all larvæ the eyes are yellowish (or whitish), and black pigment, when present, is only found in the interior and very remote from the cornea, while in the adults the eyes are totally black.* But it must be emphasized that even when the black eyes are acquired and all other larval characters have been lost, the animals are still immature, as the petasma is developed somewhat later, and the petasma itself does not become completely developed at once to its final shape.

For the rest, more or less conspicuous alterations in all parts of the body and the limbs take place during the development from the youngest *Mastigopus*-stage to the adult *Sergestes*, but it is impossible to give a full elucidation without numerous figures. Besides, the species show considerable differences in development: thus, for instance, the dorsal abdominal spines are in some species lost when the *Mastigopus* is not half-grown, while in other species they are preserved till the *Mastigopus* is almost full-grown and the colour of the eyes alters, &c. Therefore I do not attempt to give a general picture of the metamorphosis, but I will refer the reader to the following more special, but short treatment of the species.

Next we arrive at three fresh considerations: (1) the separation of the adult species from each other; (2) the discrimination of the larvæ, so that the different stages of the same *Mastigopus* may be referred to each other and separated from other larvæ; and (3) the reference of any given *Mastigopus* to its species of *Sergestes*. In the literature of the subject numerous characters have been used, but some of them are only applicable to the adults, others to the larval forms, and several good characters proposed by Krö er and S. I. Smith have been overlooked, or at least not used with sufficient accuracy, by most authors. The whole question of the characters must be re-examined.

For the characterization of the adult species must be used differences in the following structures:—the shape of the rostrum, absence or presence of supra-ocular spine, hepatic spine, and gastro-hepatic groove on the carapace, shape and size of the eyes, the relative length of the 3 joints of the antenn. ped.[1], their size, and the shape of the basal one, the shape of the apical part of the squama, the length and structure of mxp.^{3} (whether the 4 proximal joints are similar to those in trl.^{3} or are obviously incrassated, the arming

[1] In order to abridge the descriptions, I in the following pages make use of some abbreviations:—antenn. ped. = peduncle of the antennulæ, mxp.^{3} = the third pair of maxillipeds, trl.^{1}–trl.^{5} = the first to the fifth pair of trunk-legs, ext. br. of urp. = external branch of the uropods.

or furnishing with setæ or spines of the two distal joints, and the division of the sixth joint into 4, 5, 6, or 8 subjoints, &c.), the number and size of the branchiæ or lamellæ above $trl.^3$ and $trl.^4$, the difference in shape and the furnishing with cilia along the exterior margin of ext. br. of urp., finally sometimes the coarseness or slenderness of the body. *Especially $mxp.^3$ offers most valuable and very neglected differences.* (Of course it will also be possible to detect good characters in other parts, f. inst., in the structure of the 5 pairs of trunk-legs, and one difference is used in the following discussion; the petasma also exhibits characters, but this curious organ it is impossible to describe and make use of without figures.) It will, for the rest, be necessary to examine the animals much more scrupulously than has hitherto been done by most authors, for some described species are not recognizable, and at least *S. edwardsi*, Kr., is collective to such a degree, that between the limits adopted by W. Faxon it includes at least 4 species.

For the discrimination and description of the *Mastigopus*-forms, characters from all the structural features mentioned to be used in the adults can be derived, and moreover the armature of the abdominal segments and the shape of the telson frequently offer good characters. But it must be remembered that alterations in almost all parts take place during the development from the youngest to the oldest larval stage, some of the alterations being very great, others rather small. To succeed in the double aim—the reference of the *Mastigopus* to the adult *Sergestes* and the collocation of all the different stages of the same *Mastigopus*-species, distinguishing them from the stages of other species—we have but one way to go, which, in reality, is rather troublesome. (The development in aquaria of the various stages may be possible, but almost all species being tropical or subtropical, and besides belonging to the open sea, very little help from this method can be expected for many years.) The student must work with copious material, and having isolated and examined and determined all the specimens with black eyes, he must subdivide the species into groups, *making use of characters which alter very little during the older* Mastigopus-*stages and the development to the adult shape*; then he must search in the collection for the oldest *Mastigopus*-specimens which coincide with the adults in the characters mentioned, and try to refer them to the adults; at last he, being especially assisted by most of the same characters, must try to proceed backwards from the older to the younger and then to the youngest stages of every species, wherein he will in numerous instances be much assisted by the circumstance that different stages of the same *Mastigopus* are frequently taken together in the same haul. (Some authors not infrequently write in the descriptions of the small "species" that the specimens vary in several particulars, f. inst. in the development of the dorsal abdominal spines, and this is often derived from the fact that their degree of development has been somewhat unequal.) Applying this principle it will in many instances be possible to determine the youngest forms, which by Bate and Ortmann are

considered as the real *Mastigopus*, and even sometimes to determine the *Acanthosoma*, consequently to elucidate at least one-half of the total metamorphosis. As a rule the differences between the same older stage of any two species whatsoever are more conspicuous than the differences between the species of *Sergestes* to which they belong. During a long-continued study of a rich collection it will gradually be possible to arrive at complete certainty in the collocation of the series of stages of all species well represented, but in too numerous instances it is impossible to refer the forms to the representations of authors without examining their type-specimens.

The characters which undergo very little or almost no change during the metamorphosis from the older *Mastigopus* to the adult, and for that reason offer good marks for identification, are the following:—(1) the structure of $mxp.^3$, viz., whether they are scarcely longer than $trl.^3$ with the 4 proximal joints of the same aspect (the fourth joint flattened) as in $trl.^3$ and the two distal joints equally setaceous on both margins—or whether they are considerably or much longer than $trl.^3$, with the 4 proximal joints considerably thickened and much more robust than in $trl.^3$, and the 2 distal joints almost or totally naked along the one margin, while at least the sixth joint is armed with several long and a number of shorter spines on the other margin (but only the presence of spines, not their number, can here be taken into consideration; (2) the proportion between the naked and the hairy part of the external margin of ext. br. of urp.; (3) the relative length of the 3 joints (especially the first and the third) of the antenn. ped.; (4) the number of subjoints in the sixth joint of $mxp.^3$—Other characters of more secondary value will be pointed out in dealing with the species.

The character derived from the length of $mxp.^3$, and especially from the aspect of their 4 proximal joints in contradistinction to the legs and especially to $trl.^3$, *can also be used in every* Mastigopus-*stage*; it will even almost always be possible to refer a larva with $mxp.^3$ broken off to one of the two groups by comparing the basal joint, which always persists, with the basal joints of the 3 following pairs of trunk-legs.—The character from the uropods is in most cases more or less subject to alteration during the development, and as a general rule it may be stated, that when only $\frac{1}{3}$–$\frac{1}{4}$ of the exterior margin is hairy in the adult, then this part approximates more and more towards occupying $\frac{1}{2}$ of the margin according to the youth of the specimens; but when the margin is hairy in the total or in c. $\frac{6}{7}$ of its length in the adult, then the hairy part is a little shorter in the younger, and still somewhat shorter in the youngest *Mastigopus*.—The character from the length of the joints in antenn. ped. also alters in the younger stages, with the result that the first joint is proportionally longer (and distally much narrower) in the younger than in the older *Mastigopus*-stages.—Several instances proving these rules will be found in the following descriptions of the species.

iv. *Synonymical and other Remarks.*

Before proceeding to a systematic arrangement, founded upon the characters mentioned, it will perhaps be convenient to undertake some reduction of the species, especially of the adult forms, with a view to freeing the next chapter, containing notes on the structure of the species and their larvæ, from these disturbing investigations.

The single species established by de Natale, *S. arachnipodus* (p. 19, Tav. ii. fig. 1), is quite unrecognizable to me, and will, in my opinion, never be interpreted with certainty; therefore I have omitted it from the systematic arrangement.

Of the 15 species described by Kröyer, only 4 (*S. frisii*, Kr., *S. arcticus*, Kr., *S. cornutus*, Kr., *S. edwardsi*, Kr.) have been established upon adult animals. Bate, Chun, and Ortmann have already considered *S. frisii*, Kr., to be identical with *S. atlanticus*, M.-Edw., but when Bate (*op. cit.*[1] p. 389) furthermore withdraws *S. arcticus*, Kr., this is, as pointed out by Ortmann, quite wrong. Of the remaining 11 species 8 are true *Sergestes*-larvæ, while the 3 others, viz. *S. obesus*, Kr., *S. caudatus*, Kr., and *S. serrulatus*, Kr., must be removed from the genus. *S. obesus*, Kr. (p. 257, tab. iv. fig. 10, *a–f*) is a very curious form; the single Kröyerian specimen had been dissected and most of the pieces are preserved, but an investigation of the type specimens of *S. sanguineus*, Chun (1889), proved that this form is identical and that both species have been established upon larvæ which differ so much from the *Mastigopus* of *Sergestes* that the species must be removed from this genus, and it will be discussed later on under *Petalidium*, Bate. *S. caudatus*, Kr. (p. 270, tab. v. fig. 14, *a–d*), is a very young *Penæus* that has just passed the *Mysis*-stage (Kröyer's representation of the trunk-legs is not correct, as his type specimen possesses a well-developed chela on trl.[1], behind which pair are found the basal joints of 4 pairs). *S. serrulatus*, Kr. (p. 268, tab. iv. fig. 12, *a–g*) is a very young *Acetes*, M.-Edw. Finally, *S. laciniatus*, Kr. (p. 274, tab. v. fig. 15, *a–e*), is, as already pointed out by Ortmann, identical with *S. corniculum*, Kr.

Of the species described by Stimpson only one is adult, viz. *S. pacificus*, Stimps. (p. 45), and it is, in my opinion, identical with *S. atlanticus*, M.-Edw., as the differences which the author states to exist between his species and Kröyer's description of *S. frisii*, Kr., are of no value. The fact is that the hepatic spine is placed a little more behind than in Kröyer's figure, in which also the trunk-legs are delineated a little shorter than they are in the animals. Of the other species, *S. longicaudatus*, Stimps., and *Sergia remipes*, Stimps. (p. 46), can, in my opinion, scarcely be recognized without examination of the type specimens.

Of *Serg. meyeri*, Metzger (p. 302, tab. vi. fig. 7), I have examined the type specimen and must declare it to be a large female of *S. arcticus*, Kr. Sp. Bate has in all established 24 new species of *Sergestes*, of which but 3, *S. prehensilis*, Bate, *S. japonicus*, Bate, and *S. kröyeri*, Bate (all briefly characterized in 1881), are decidedly adults. Of the other species, *S. longicollus*, Bate (p. 421, pl. lxxvii. fig. 1), at least has almost arrived at the shape of the adult, but it is, as pointed out by Ortmann, synonymous with *S. tenuiremis*, Kr. It is impossible to me to form any idea of *S. profundus*, Bate (p. 428); Bate's specimens were very much mutilated. The other 19 species and *Sciacaris telsonis*, Bate (p. 438, pl. lxxviii. fig. 1), are all *Mastigopus*-forms in very different stages of development.—When Bate (p. 393, pl. lxviii.) describes and figures trl.[4] and trl.[5] in *S. atlanticus*, M.-Edw., as very short, this must, in my opinion, arise from an anomaly or from some other reason of no value, if the described and figured specimen really belongs to this species, for I am not convinced that all the specimens from the localities enumerated (p. 390) belong to *S. atlanticus*. He states that a specimen, 50 mm. in length, was taken "off Japan; depth 345 fathoms," and that 3 specimens, 43 mm. long, were trawled "south of Australia; depth 2150 fathoms." These 4 specimens at least must be re-examined, as among some hundred specimens I have not found one exceeding 30 mm., and the localities also make the determination somewhat doubtful. The specimens of *S. edwardsi*, Kr. (Bate, p. 403), must also be re-examined with the aid of my descriptions of hitherto not recognized allied species.

S. mollis, Smith, established by that author in 1884 (Rep. Comm. Fish and Fisheries, pt. x. p. 419), I consider to be identical with *S. japonicus*, Bate (described 1881), with which it agrees in the smallness of the eyes, the relative length and thickness of the joints in the antenn. ped., the shape of the squama, the soft and membranous integuments, and the number and the feeble development of the posterior branchiæ.

S. magnificus, Chun, established in 1888 (p. 33, Taf. iv. fig. 4 u. 5), is, according to my examination of one of the type specimens, identical with *S. arcticus*, Kr. Kröyer also has stated that the flagellum of the antennæ surpasses the total length of the animal about 3 times.—*S. sanguineus*, Chun, established in 1889 (p. 538, Taf. iii. fig. 1), is, as stated above, identical with *S. obesus*, Kr., and will be discussed later on under *Petalidium*.

In 1891 Wood-Mason (Ann. & Mag. Nat. Hist. 6th ser. vol. viii. p. 354) established *S. rubroguttatus*, W.-M., a species closely allied to *S. arcticus*, Kr., but the differences in the ext. br. of urp. pointed out by the author are certainly valid specific characters. For the rest, I believe that it may be possible to detect more characters. Perhaps the species is identical with *S. kröyeri*, Bate, established 1881, but both species being insufficiently described, I cannot settle the question, and therefore must support both species.

Of the species established by W. Faxon in 1893, *S. halia*, Fax.

[1] I always quote the 'Challenger' Report, not his preliminary paper; as to Kröyer, I refer to his monograph, omitting his earlier descriptions without figures.

(p. 217), must be mentioned; for in the final report, 1895, he withdraws it "as large and mature individuals of *S. edwardsii*," redescribing and figuring one of the three type specimens as this species (p. 212, pl. li. figs. 1–1 *e*). But his representation shows that *S. halia*, Fax., must be maintained as valid, as the exterior margin of the ext. br. of urp. is naked in almost $\frac{1}{3}$ of its length, while in *S. edwardsi*, Kr., it is hairy in the total length; furthermore, the rostrum, besides being somewhat differently shaped, is considerably shorter in the last-named species than in *S. halia*, Fax., a feature also observed by Faxon (p. 214). When he writes (p. 214):—"Kröyer notes a 'rare variety' of *S. edwardsi*, distinguished by a larger rostrum," I may remark that a preserved specimen of this variety belongs to another species, *S. penerinki*, Bate, H. J. H.

As to this last name and some other names in the following chapter I must say a few words. When an author in the same work has described an adult species and ..s *Mastigopus* as two species, the species, of course, retains the name of the adult. But in some instances only the *Mastigopus* has been described, while I also possess and briefly describe the black-eyed or even the mature form. In order to avoid new names I, in these cases, have used the name of the *Mastigopus* for the adult *Sergestes*, thinking that a double series of names, one for one of the not few *Mastigopus*-stages, and another for the adult species itself, cannot be maintained, as the *Mastigopus* and the *Sergestes*—in strong contradistinction to the relation between the *Squillidæ* and their larvæ—are connected with even transition. To avoid misapprehension I, in these cases, have placed my own name (H. J. H.) after the name of the author who has established the *Mastigopus*. It will, I fear, in the future also be necessary to adopt the oldest name for a species when its *Mastigopus* has been described before the adult.

v. *Conspectus of the Species.*

In the following tabular view (and added notes) all established species are enumerated, and besides two new species are named and later on described. The tabular view is worked out with reference to the adults and the *Mastigopus*-stages, with the exception of the youngest *Mastigopus*-stage (in several instances = *Mastigopus*, auct.), which sometimes differs very much from the somewhat older stages.

When the black-eyed form of a species has been described elsewhere or will be mentioned in my later notes, the name in the tabular view is printed with interspaced letters; if the really mature form is known I further mark the name with an asterisk. When the same stage, in most instances the adult one, has been described under various names, they are given as synonyms following the oldest name, but the different stages of a species are connected with a {.

By this, perhaps somewhat artificial, mode of proceeding it will, I hope, be easy to form a notion of the species.

Group I.

Mxp.[3] *at most but little longer, sometimes shorter than trl.*[3], its first joint rarely, *the second–fourth joints never obviously incrassated in proportion to the joints in trl.*[3], its two distal joints with numerous bristles along both margins. (In the *Mastigopus*, *S. longispinus*, Bate, the first joint is somewhat incrassated, the fifth joint with but few bristles, the sixth only with setæ along the one margin.)

A. On the ext. br. of urp. the ciliated part never occupies the half of the exterior margin.

a. The body very long and slender; the distance between the eye-stalks and the mandibles very long.

{ *S. t e n u i r e m i s*, Kr., H. J. H.
S. junceus, Bate.
S. longicollus, Bate.

b. The body shorter and less slender; the distance between the eye-stalks and the mandibles not very long.

α. The first joint in the antenn. ped. about as long as or shorter than the third.

{ **S. a t l a n t i c u s*, M.-Edw. (*S. frisii*, Kr., *S. pacificus*, Stimps.).
S. ancylops, Kr.
S. ovatoculus, Bate.

{ **S. c o r n u t u s*, Kr.
S. longispinus, Bate.

**S. i n o u s*, Faxon.[1]

β. The first joint in the antenn. ped. considerably or much longer than the third.

1. The second and third joints in the antenn. ped. stout.

**S. r o b u s t u s*, Smith.

**S. j a p o n i c u s*, Bate (*S. mollis*, Smith).

**S. b i s u l c a t u s*, Wood-Mas. (*S. phorcus*, Faxon, olim).

2. The second and especially the third joint in the antenn. ped. slender. (The *arcticus*-group.)

{ **S. a r c t i c u s*, Kr. (*S. meyeri*, Metzger, *S. magnificus*, Chun).
S. rinkii, Kr., vix Bate. S. similis H.J.H.
{ *S. dissimilis*, Bate.
S. mediterraneus, n. sp.

**S. p r e h e n s i l i s*, Bate.

**S. k r ö y e r i*, Bate.

{ *S. dorsospinalis*, Bate.
S. laterodentatus, Bate.

S. nasidentatus, Bate.

(*S. rinkii*, Bate, vix Kr.)

S. læviventralis, Bate.

**S. r u b r o g u t t a t u s*, Wood-Mas.

[1] According to the description this species must belong to this subdivision, but it does not agree with the figure (*op. cit.* pl. li. fig. 2), which shows the first joint a little longer than the third.

B. On the ext. br. of urp. the ciliated part occupies more than the half of the exterior margin.

S. corniculum, Kr., H. J. H. (*S. laciniatus*, Kr.)
S. utrinquedens, Bate.
S. longirostris, Bate.

To this group further belong the following species: *S. præcollus*, Bate, *S. semiarmis*, Bate, *S. longicaudatus*, Stimps., *S. remipes* (Stimps.), and *S.* (*Sciacaris*) *telsonis*, Bate. All are but larvæ.

Group II.

Mxp.^{3} *considerably or much longer than trl.*^{3}, *its 4 proximal joints considerably or (generally) very much incrassated or partially almost inflated in proportion to the joints in trl.*^{3}, its two distal joints with very short bristles or totally naked along the one margin, the sixth joint with a number of spines very different in length along the other margin, and a feebler armature may also be found on the fifth joint.

A. The adult and the older larvæ with two branchiæ above trl^3., and the sixth joint of mxp.^{3} divided into 5 subjoints. The adult with a comb of very numerous short spines along the one margin of the sixth joint and of the distal part of the fifth of mxp.^{3} The larvæ with short eye-stalks.

{ **S. henseni* (Ortm.).
{ *S. sargassi*, Ortm.

B. The adult and the older larvæ with one branchia and a lamella above trl^3., and the sixth joint of mxp.^{3} divided into 4 or 6 subjoints. The adult without any comb on mxp.^{3} The larvæ with moderately long or very long eye-stalks. (The *edwardsii*-group.)

a. On the ext. br. of urp. the exterior margin is ciliated in the whole length or (in the larvæ) at least in c. $\frac{11}{12}$ of the length.[1]

{ **S. edwardsi*, Kr.
{ *S. oculatus*, Kr.

b. On the ext. br. of urp. the exterior margin is ciliated at most in $\frac{7}{8}$ of the length.

α. The same exterior margin is in the larvæ ciliated at least in $\frac{3}{4}$, in the adults in more than $\frac{4}{5}$ of the length.

{ **S. vigilax*, Stimps., H. J. H.
{ *S. parvidens*, Bate.
**S. penerinki*, Bate, H. J. H.

β. The same exterior margin is ciliated in less than $\frac{3}{4}$ of the length.

**S. incertus*, n. sp.
**S. halia*, Faxon.
S. armatus, Kr.

[1] Here and in the following part of the tabular view I cannot include larvæ shorter than 9–10 mm. in length, as the character employed alters in the youngest stages (see later on).

To this group further belong **S. hamifer*, Alc. & And., which I am not able to recognize, and the following larvæ: *S. intermedius*, Bate, *S. diapontius*, Bate, *S. fermerinkii*, Bate, *S. spiniventralis*, Bate, and *S. ventridentatus*, Bate, several of which certainly belong to some of the species in the tabular view, but I cannot recognize them; *S. macrophthalmus*, Stimps., in all probability being a younger *S. vigilax*, Stimps.; finally *S. brachyorrhos*, Kr., which is a very young larva of *S. edwardsii*, Kr. (see later on).

S. arachnipodus, de Nat., and *S. profundus*, Bate, I have not been able to refer to any one of the groups; to *Petalidium* is transferred *S. obesus*, Kr. (*S. sanguineus*, Chun), and excluded as not belonging to the genus are *S. serrulatus*, Kr., and *S. caudatus*, Kr.

vi. *Notes on the Species of Group* I.

A. *a*. *S. tenuiremis*, Kr. The specimen described by Kröyer (p. 255, tab. iv. fig. 11, *a*–*b*) is a hardly half-grown *Mastigopus*; *S. longicollus*, Bate (p. 421, pl. lxxvii. fig. 1), is almost (or perhaps fully) adult; *S. junceus*, Bate (p. 416, pl. lxxvi. fig. 1), is the young *Mastigopus*, 6 mm. long, with dorsal spines on the 4th–6th abdominal segments. I have examined a specimen 23 mm. in length, which had just obtained the black eyes; the species grows at least somewhat longer before maturity, but the mature form is unknown. The obtaining of black eyes does not always take place at the same length of the animal, as a specimen with the larger, oblique, yellowish eyes is even 26 mm. long. The species is easily separated from all other known forms by the combination of two characters: the very long and slender body with the long distance between the eye-stalks and the mouth-organs, and the ciliated parts on the ext. br. of urp. occupying, in the older forms scarcely $\frac{1}{3}$, in the younger a little more than $\frac{1}{3}$ of the exterior margin. The quoted figure of *S. longicollus*, Bate (pl. lxxvii.), gives a tolerably correct notion of the species.

It may further be added that of the two branchiæ above trl.^{3} the first is long and the second a little more than half the length of the first and but a little shorter than the first branchia to trl.^{4}, while the second above trl.^{4} is somewhat smaller, but still very well developed. I have seen specimens of this species from numerous localities in the Atlantic, northward to lat. 32° 16′ N., in the Indian Ocean, and in the Pacific as far as the Matelota Islands and lat. 16° 8′ S., long. 111° 50′ E.

A. *b*. *a*. *S. atlanticus*, M.-Edw. As to the synonymy etc., see above. The best representation of this very common species is given by Kröyer (*S. frisii*, Kr., p. 235, tab. i. fig. 1, *a*–*v*). The sixth joint of mxp.^{3} consists of 6 subjoints, the 4 distal of equal length and each of the 2 proximal as long as 2 of the distal subjoints together. The branchial formula as in *S. japonicus*, Bate (*S. mollis*, Smith), viz. a podobranchia and a lamella to mxp.^{2}, a pleurobranchia and a lamella to mxp.^{3} and trl.^{1}–trl.^{3}, finally 2 pleurobranchiæ to trl.^{4}, but the branchiæ are longer than in *S. mollis*, Smith (Rep. Comm. Fish and Fisheries f. 1885, pl. xx. fig. 5), and the 2 branchiæ above trl.[4] are well developed; the statements of earlier authors on the branchiæ of this species are rather deficient.

As stated above, *S. ancylops*, Kr. (p. 262, tab. iii. fig. 8, *a–e*), is the *Mastigopus* of *S. atlanticus*, and I have seen every stage of transition between the larva and the adult. *S. ovatoculus*, Bate (p. 408, pl. lxxiv. fig. 2), is a stage a little older than that described as *S. ancylops* by Kröyer and Bate.

The stages from 7 mm. in length and more are easily distinguished from all other known larvæ by the shape of the eyes, of which Kröyer has given two good figures, and also in the still younger stages mentioned below the eyes have a rather similar shape; in the older stages the sixth joint of mxp.[3] shows the same subdivision into 6 joints as is found in the adult.

A small specimen examined by me is scarcely 6·5 mm. long, trl.[4] is even shorter than the two proximal joints of trl.[3] together; the eyes and the eye-stalks are longer than in the stage figured by Kröyer, reaching a little beyond the basis of the third joint of the antenn. ped.: the first joint of this peduncle is about $\frac{1}{10}$ longer than the third; the very long and slender rostrum occupies $\frac{2}{3}$ of the length of the eye-stalks and carries a small dorsal spine over its basis; the inferior side of the abdominal segments is without spines, while a rudiment of a spine is present on the dorsal side of the third segment, and the spines on the fourth and fifth segments are a little longer than in the following stage; the ciliated part of the ext. br. of urp. occupies a little more than $\frac{2}{5}$, but not $\frac{1}{2}$ of the exterior margin.

The smallest specimen examined by me is but 3·5 mm. long, without the rostrum; the eye-stalks are extremely long, together with the eyes almost as long as the carapace in the median line; the rostrum reaches almost to the tip of the eyes and is adorned with a shorter dorsal spine at the basis and with some short setæ on the distal part; the supra-orbital and the hepatic spines are considerably elongated. The dorsal spine on the third abdominal segment is rather long, the spines on the fourth and fifth segments very long; the epimera of the 5 anterior segments are each produced into a fine spine bent somewhat outwards; the spine on the ext. br. of urp. is placed almost before the middle of the exterior margin, and the branch itself is extremely slender, 13 or 14 times longer than broad. This stage, thus rather diverging from the older ones, is, in my opinion, the youngest *Mastigopus*, and was taken by Prof. Chun at the Canary Islands.

Of *S. atlanticus* I have seen specimens from the Atlantic, northward to lat. 42° N., from the Indian Ocean and from the Pacific lat. 15° S., long. 109° 20′ E., and the China Sea.

S. cornutus, Kr. (p. 249, tab. ii. fig. 2, *a–l*). This species is easily distinguished from *S. atlanticus*, M.-Edw., by the following characters:—The rostrum is much longer, directed obliquely forwards and slenderly acuminated, the eyes are smaller, the third joint of the antenn. ped. is distinctly longer than the first, which, from the spina on the outer margin, is strongly tapering towards the apex, the outer margin even being slightly concave in outline; the sixth joint of mxp.[3] is distinctly 4-jointed, the relative length of these subjoints as in the larva (see below). Above trl.[3] a well-developed pleurobranchia and a lamella, above trl.[4] a well-developed pleurobranchia and a lamella with 2–5 branches at the tip, thus a branchia very little developed and more feeble than in any other adult species known to me.

S. longispinus, Bate (p. 417, pl. lxxvi. fig. 2), is most decidedly the larva of *S. cornutus*, Kr. It attains a length astonishing as compared with that of the adult. The specimen which I am about to describe is 13 mm. long, while the adult male is but 16 mm. The rostrum is somewhat longer than in the adult, without dorsal spine, the supra-ocular and the hepatic spines and the gastro-hepatic groove are well developed. The eye-stalks are very long, the large, somewhat oblique eyes lie above the basis of the third joint of the antenn. ped., the relative length of which is almost as in the adult. Mxp.[3] is but little longer than trl.[3] and constitutes in several respects a transition-form to *S. edwardsi*, Kr., and allied species; the first joint is considerably incrassated, second–fourth joints but little coarser than in trl.[3], the fourth joint with very few and short bristles, the fifth with few setæ more developed on the one than on the other margin, the sixth joint as long as the fifth (a character also found in *S. atlanticus*, etc., while in the *edwardsi*-group the fifth joint is much longer than the sixth), divided into 4 subjoints, of which the first is $\frac{3}{2}$ times longer than the second, and this is as long as the last 2 subjoints together, which are about equal in length, or the third somewhat longer than the fourth; the 3 proximal subjoints each with very few short setæ, and at the end with 2 very long stiff setæ or slender spines, the fourth subjoint with one short and 3 very long apical spines, which, however, are scarcely more robust than those on trl.[2] or trl.[3], trl.[4] reaching a little beyond $\frac{2}{3}$ of the fourth joint of trl.[3] Above trl.[4] a well-developed branchia and a lamella with 3 short apical branches. The 3 anterior abdominal segments each with a rather short dorsal spine, which, at least on the 2 anterior segments, is directed obliquely forward, the fourth segment without any spine and the fifth and sixth each with a short spine; the 4 anterior segments having on the middle of each epimeron a spine directed outwards, the spine being short on the three segments and somewhat longer on the fourth, the fifth segment with a very long spine directed downwards and bending somewhat forwards, and issuing from the inferior margin at a short distance from its posterior end; the sixth segment with a small spine turned downwards from the posterior edge. As in the mature form, the ciliated part occupies between $\frac{1}{3}$ and $\frac{1}{4}$ of the exterior margin of the ext. br. of urp.

The specimen described differs considerably from the figure given by Bate, but the form described by him is somewhat younger. My determination is decidedly correct, as two similar specimens, the one determined by Chun, the other by Ortmann, are referred by these authors to the same species.

S. cornutus, Kr., and especially *S. longispinus*, Bate, present some affinity to *S. edwardsi*, Kr., and allied species, which becomes very evident by the fact that a short process is found on the outer side of the third joint of trl.[1] and trl.[2]

Of *S. inous*, Fax., I have seen no specimens.

A. *b.* β. 1. Of *S. robustus*, Smith, *S. japonicus*, Bate (*S. mollis*, Smith), and *S. bisulcatus*, Wood-Mas., I have seen no specimens. Of *S. robustus* we possess several stages of the *Mastigopus*, but having found none of them described I will omit discussing them in this paper.

A. *b.* β. 2. This rich section of adults and larvæ I have called the *arcticus*-group, as they are very nearly related to each other, and *S. arcticus*, Kr., is the only one well described of the mature forms and the sole species of which I am able to trace the whole development from the *Acanthosoma* (incl.) to the adult. I will begin with some remarks on the adults and on a subadult species.

S. arcticus, Kr., is well represented by Kröyer (p. 240, tab. iii. fig. 7, *a–g*; tab. v. fig. 16); later on S. I. Smith, in the various papers (see above), communicates some additional notes and good figures. The species has been captured in the Atlantic, northward to Greenland, and southward to lat. 38° S., long. 12° E. (Mus. Copenh.); further, in the Mediterranean near Ischia (*S. magnificus*, Chun), and some older larvæ in the Adriatic at Ragusa and Lesina (Chun's collection). But, together with these last larvæ, I found in Chun's collection some young specimens and older larvæ of a new and unfortunately closely related species, *S. mediterraneus*, n. sp., which makes it necessary to present some remarks on the two species, so that it will be possible to distinguish them from each other. Previously no valid species allied to *S. arcticus*, Kr., was known from the Atlantic or the Mediterranean.

The largest specimen of *S. mediterraneus*, m., is 19·5 mm. long, and has almost assumed the adult shape, but the eyes are still not black and therefore their final magnitude cannot be determined. Of characters between this subadult stage and the subadult and adult *S. arcticus*, Kr., I have found the following:—*S. mediterraneus* is destitute of the hepatic spines and the gastro-hepatic groove; the supra-ocular spines are quite rudimentary; the basal joint of the antenn. peduncle is obviously somewhat shorter than the two following taken together, which are a little more coarse than in *S. arcticus*, while the basal joint from the spine near the basis of the exterior margin is somewhat more narrow, with the exterior margin less convex in outline than in *S. arcticus*; the ext. br. of urp. is but 4 times longer than broad, with the outer margin beyond the spine strikingly concave. In *S. arcticus*, Kr., the supra-ocular and hepatic spines and the gastro-hepatic groove are well developed; the basal joint of the antenn. ped. is (measured with accuracy) almost or quite as long as the two following taken together; the ext. br. of urp. is exactly 5 times longer than broad—thus conspicuously more narrow than in *S. mediterraneus*, m.; and the outer margin beyond the spine but slightly concave. The branchiæ (comp. the notes of S. I. Smith in Bull. Mus. Comp. Zool. vol. x. p. 96) do not seem to present any character fit for use. *S. arcticus*, Kr., is smaller than the other species when the eyes obtain the black colour.

Above I have mentioned that *S. rubroguttatus*, Wood-Mas., from the Indian Ocean is, in my opinion, a valid species, as the exter. br. of urp. is described and figured (Ann. & Mag. Nat. Hist. ser. 6, vol. viii. p. 354) to be much more narrow than in *S. arcticus*, Kr., and without the spine on the outer margin. *S. kröyeri*, Bate, and *S. prehensilis*, Bate, are unknown to me; they have the same branchial formula as *S. arcticus*, but a new investigation of both species is much needed; perhaps *S. rubroguttatus*, Wood-Mas., is synonymous with *S. kröyeri*, Bate.

Of *S. arcticus*, Kr., our museum possesses a series of all stages from the *Acanthosoma* (incl.) to the mature form. One of these stages is *S. rinkii*, Kr. Kröyer's representation (p. 265, tab. ii. fig. 3, *a–g*) corresponds well with specimens of 8 mm. in length, rostrum not included, and is rather good; thus he describes and figures the eyes with their long stalks, the very characteristic antenn. ped., the shape of the squama, the dorsal spines on the abdomen, the long pleopods, the uropods with their exterior branch being very characteristic for the young *Mastigopus*, viz. 6·5 times longer than broad and the ciliated part of the exterior margin considerably longer than in the adult, finally the telson, which has a shape very different from that found in the adult—but the representation of the carapace is deficient (see later on) and misleading in one particular. Thus he describes the rostrum as being short, but it must already then have been broken off in one or two of his specimens; in reality it is about as long as the eye-stalks (without the eyes), and adorned at the basis with a dorsal spine almost as long as the diameter of the eye.

The largest specimen of *Acanthosoma*, which, however, I shall not try to describe, is, the rostrum not included, 5·3 mm. in length, and with the rostrum (which reaches somewhat in advance of the eyes) c. 6·6 mm. long. Among the type specimens of Kröyer I find two specimens, which must be the stage immediately succeeding the *Acanthosoma*; one specimen is with the rostrum 6·9 mm. long, but from another locality I have seen a specimen in the same stage measuring even 8 mm. This stage differs considerably from that described by Kröyer, and therefore a short account of it shall be given. The rostrum is exceedingly long, reaching a little in advance of the eyes, on the distal part adorned with some short and fine setæ, and at the basis originates a setaceous dorsal spine, which is adorned with some short and fine setæ and is longer than the diameter of an eye. The supraocular spine is well developed, and the hepatic spine exceedingly long, considerably longer than the diameter of an eye; just in front of the gastro-hepatic groove is observed a short protuberance in the median line. The eyes reach to the middle of the second joint of the antenn. ped.; the basal joint of this peduncle is to the two following together as 11 to 8; trl.[4] and trl.[5] are only buds. The first and second abdominal segments each with a short dorsal spine, the third to sixth segments each with a long spine; the first segment a little above the middle of each side with a rather short spine directed outwards, and besides the epimera of the five anterior segments each produced into a rather long spine, which is directed outwards and on the two anterior segments even bent somewhat upwards and forwards; the sixth segment below on the posterior edge with a shorter spine. The ext. br. of urp. is about 8 times longer than broad, and the spine a little beyond the middle of its exterior margin. Telson with a long process from each of its posterior edges.

The following stage is that described by Kröyer: the rostrum is as already mentioned, the hepatic spine has become somewhat shorter than in the preceding stage; on the abdomen the dorsal spines are somewhat reduced and the epimeral spines are lost, but the spine on the side of the first segment is still visible.

During the subsequent stages a series of alterations take place. The rostrum becomes shortened, but is, however, still during a longer period more than half as long as the eye-stalks, its dorsal spine and the hepatic spines are considerably shortened, the eye-stalks become somewhat shorter; the median protuberance is preserved during some time; the abdominal spines soon completely disappear. In the antenn. ped. the two distal joints together successively are approaching the length of the basal joint, which from being distally slender with the lateral margins slightly converging obtains a considerable breadth with the external margin somewhat convex in outline. The ext. br. of urp. becomes proportionally broader and the spine more remote from the middle of the exterior margin; the process from the edge of the telson becomes shorter and finally disappears. One of these stages is *S. dissimilis*, Bate, described by Bate (p. 437), and later on described and figured by Ortmann (p. 35, Taf. iii. fig. 2).

The sub-adult stage of *S. mediterraneus*, m., is shortly described above. The smallest larva of this species known to me is about 9·5 mm. long, and this and a specimen a little longer are easily distinguished from the similar stage of *S. arcticus*, Kr. The eye-stalks are somewhat shorter; the rostrum is rather short, not half the length or about one-third of the length of the eye-stalks, with a trace of a spine on its superior margin, the hepatic spine is rudimentary or wanting; in the antenn. ped. the two distal joints together are shorter than the basal one, and this presents a shape other than in *S. arcticus*, as in its distal half the lateral margins are parallel with each other; and this part is scarcely broader than the two distal joints, which are obviously coarser than in *S. arcticus*; a very short dorsal spine is present on the fourth to sixth abdominal segments; the ext. br. of urp. is proportionally broader than in *S. arcticus*, between 4 and 5, but not 5 times longer than broad.

As stated above, *S. arcticus*, Kr., has not been captured outside the Atlantic (incl. the Mediterranean and the Arctic sea at Greenland). This is of importance for the reference of larval stages, as Bate has established the species:—*S. dorsospinalis*, Bate (p. 394, pl. lxxii. fig. 1) and *S. laterodentatus*, Bate (p. 395), captured "associated with" another "South of Australia"; *S. nasidentatus*, Bate (p. 398, pl. lxxii. fig. 2), "between Valparaiso and Juan Fernandez"; *S. rinkii*, Bate, vix Kröyer (p. 404, pl. lxxiii. fig. 3), "New Hebrides" and "South Pacific"; and *S. læviventralis*, Bate (p. 425, pl. lxvii. fig. 3), "North of New Guinea"—which 5 reputed species are all larvæ and all belong to two or three species closely related to *S. arcticus*, Kr., or perhaps partially belong to that species. But Bate's representations are not sufficiently good for the decision of such questions: thus, f. inst., the chances are that he has overlooked the hepatic spine in some of the "species," while *S. laterodentatus*, Bate, has obviously been established on a specimen with a long hepatic spine, which has given rise to the name. His description of *S. rinkii* either involves the fault that the rostrum, which is described and figured as short, has been broken off, or the form must decidedly be different from *S. rinkii*, Kr., as a short rostrum and dorsal abdominal spines are not coexistent in this latter species.—In all probability Bate's 5 species belong to two or three of the other known species of the *arcticus*-group, and none of them to *S. arcticus*, Kr., itself.

Further elucidation of the adults and the larvæ of the *arcticus*-group I am not able to derive from existing literature. Yet the result has been that 2 adult and 2 larval species have been cancelled as belonging to *S. arcticus*, Kr., and the other related forms; 3 adult species and 4–5 larvæ have been collocated into the group; finally one new species has been established.

B. *S. corniculum*, Kr.—The stage described and figured by Kröyer (p. 252, tab. iii. fig. 4, *a–e*) and Bate (p. 410, pl. lxxv. fig. 1) is a half-grown larva. The mature form is unknown. The adult with black eyes, 20–22 mm. long, is rather remarkable, as the body is extraordinarily slender, with a considerable distance between the mouth and the eyes, thus in that respect approaching to *S. tenuiremis*, Kr., and being intermediate between this species and f. inst. *S. arcticus*, Kr. Its rostrum is a little lower than in *S. arcticus*, Kr., the supraocular spine rudimentary or lacking, the hepatic spine short, the gastro-hepatic groove distinct. The eyes are but a little broader than the end of the stalk; in the long antenn. ped. the first joint is considerably longer than the third and this considerably longer than the second. An interesting character is that the sixth joint of mxp.[3] is divided into 4 sub-joints, the distal three of equal length and the first somewhat longer, and each of these 4 joints is more or less distinctly divided into 2 joints: thus we obtain 8 sub-joints, of which 7 possess a long seta or slender spine on each side near the apex, but the two spines are not placed opposite to each other, and the last sub-joint has a pair of slender apical spines. The branchiæ recall those in *S. arcticus*, Kr.: above trl.[3] two branchiæ, the first long, the second several times shorter and very narrow; the first branchia above trl.[4] is but half as large as the corresponding one above trl.[3], the second half as large as the first but a little larger than the second above trl.[3]. (In somewhat younger specimens with yellowish eyes all 4 branchiæ are very distinct; the animals are, for the rest, relatively shorter and stouter.) The ext. br. of urp. without any spine on the exterior margin, of which the ciliated part occupies from a little more than the half to about three-fifths of the length.

As to the half-grown larvæ, the representations of Kröyer and Bate will be sufficient.—A younger larva, 6·4 mm. long, coincides fairly well with *S. utrinquedens*, Bate (p. 433), in most respects, but yet differs in several particulars from Bate's description. The supraocular and hepatic spines are well developed; the rostrum is almost as long as the eye-stalks (the eyes not included), with a short and fine dorsal spine at the base; the eyes are much larger and the eye-stalks longer than in the stage described by Kröyer and Bate. The third joint of the antenn. ped. is but a little longer than the second, and the first one as long as the two others taken together. The fourth to sixth abdominal segments each with a very short and fine dorsal spine, the epimera of the first to fourth segments each produced into a short spine, while this spine is considerably longer on the epimera of the fifth segment; the first segment besides on the side having a spine arising from the anterior margin and directed forwards and outwards. On the ext. br. of urp., which is almost seven times longer than broad, the ciliated part occupies a little more than the half of the exterior margin, which—as in almost all young larvæ—is furnished with a well-developed spine.

Of *S. corniculum*, Kr., I have seen numerous specimens from the Atlantic northward to lat. 42° N., from the Indian Ocean and ranging into the Pacific to the Matelota Island and to lat. 16° 10′ N., long. 132° E.

Whether the above-quoted *S. utrinquedens*, Bate, may be a young larva of *S. corniculum*, Kr., or of another species I am not able to decide.

S. longirostris, Bate (p. 415, pl. lxxv. fig. 3).—Prof. C. Chun has determined the small stage of *S. corniculum*, Kr., just described as *S. longirostris*, Bate, which is stated to be 6 mm. long and captured in "Mid Atlantic," and it is very possible that this determination may be correct; but Bate's figure represents the eye-stalks and the rostrum a little too long, and especially a different proportion between the joints of the antenn. ped. &c. I believe that it is impossible to decide whether this identification is correct.

Above I have further enumerated 5 species belonging to Group I. Of these species *S. prœcollus*, Bate (p. 423, pl. lxxvii. fig. 2), is at least rather nearly related to *S. corniculum*, Kr., from which it seems to differ by a somewhat different shape of the ext. br. of urp. and by having the fifth abdominal segment "dorsally produced to a point." *S. longicaudatus*, Stimps. (p. 46), is a larva perhaps belonging to the *arcticus*-group. On the three other species, all larvæ, I have no opinion.

vii. *Notes on the Species in Group II.*

A. *S. henseni* (Ortm.).—Of this interesting species I have seen only two adult specimens, lent me by Geheimrath Prof. Dr. V. Hensen. As the representation by Ortmann (p. 38, Taf. iii. fig. 3) is rather deficient, I shall add some notes. The rostrum is low and short; the supraorbital and hepatic spines are short. Mxp.[3] is considerably longer than trl.[3] and its 4 proximal joints, though more slender than in the following species, are yet much stouter than in trl.[3]; the 2 distal joints are quite naked along one margin, the fifth almost more than double as long as the sixth, which is divided into 5 subjoints, the last 4 of which are equal in length, while the first of them is as long as the two following together; at the base of the first subjoint and at the apex of the first, third, and fifth subjoints is found a long spine; at the apex of the second, fourth, and fifth subjoints a spine about half as long as the long spines; finally along the same margin a fine comb of very numerous spines about as long as the diameter of the joints; the fifth joint of mxp.[3] has about 10 longer spines along the margin and on its distal two-fifths a comb similar to that on the sixth joint, but its spines become shorter towards the base. By this singular armature the species is easily distinguished from all other species known to me. Above trl.[3] a large and a very small branchia, the latter of which is less than a third as long and but half as broad as the large branchia; above trl.[4] two branchiæ, the anterior somewhat larger, the posterior somewhat smaller than the small branchia above trl.[3]; thus the branchiæ are very different from those in the other species of the group. In the following species we find a well-developed process on the third joint of trl.[1] and a similar one on trl.[2], but in this species the process in trl.[1] is rudimentary and wanting in trl.[2] On the ext. br. of urp. no spine is found on the exterior margin, and in the one specimen the ciliated part occupies three-fifths, in the other specimen almost four-fifths of its length. In no other species have I met with any similar variation in this feature, but it also exists in the larvæ (see below).

S. sargassi, Ortmann (p. 34, Taf. iii. fig. 1), is the *Mastigopus* of *S. henseni*. As the material seen by me is rather incomplete, the larger specimens being not very large and besides defective, I add only a few remarks to Ortmann's description. Mxp.[3] is elongated and incrassated in proportion to the legs as in the adult, the fourth joint at the apex and just above the articulation produced into a large, conical process—a very good character for the species; and in a larva a little more than half-grown the sixth joint was already divided into the 5 subjoints. In the largest well-preserved specimen, 8 mm. long, I found above trl.[3] a large branchia and a lamella, comparatively somewhat larger than usual, which had begun to develop itself into a very small branchia, above trl.[4] a very small branchia and a simple lamella; the normal lamellæ above trl.[1] and trl.[2] are a little larger than usual. As in the adult the ciliated part on the exterior margin of the ext. br. of urp. occupies about three-fifths or four-fifths of its length in specimens between 4·5 mm. and

9·6 mm. in length, and the spine is wanting or very small, rarely of moderate size.

In a specimen 6·2 mm. in length the abdomen has lost its spines, the branchial lamellæ to mxp.[3] and to trl.[1]–trl.[3] are very large in proportion to the branchia, still being small, and above trl.[4] no branchia or lamella is developed. In the older stages the eye-stalks are short and the eyes are very large, but in the younger stages—between 4·5 mm. and 6·5 mm. in length—the eyes are still considerably larger; and in specimens of 4·5–5 mm. in length the rostrum is present as a fine and shorter or longer spine; and there are short or very short spines on the fourth to sixth abdominal segments. Such a larva, 5 mm. long, is briefly mentioned and figured by Bate (p. 428, pl. lxv. fig. 4) as *Mastigopus tenuis*, Bate; the figure shows the characteristic process on the fourth joint of mxp.[3], the rostrum is not delineated slender enough. The smallest specimen seen by me is, rostrum not included, c. 2·5 mm. long; the rostrum is as long as the carapace in the median line and distally furnished with fine spines; the eyes are of enormous size and the eye-stalks shorter than in the older stages; the third abdominal segment has a short dorsal spine, the fourth and fifth segments each a very long, the sixth segment a long dorsal spine.

B. For the following species, all belonging to the *edwardsi*-group, I think it convenient to give some introductory remarks, and next to treat the adult animals and the *Mastigopus*-forms separately.

Of adult animals there have been described only *S. edwardsi*, Kr., and *S. hamifer*, Alc. & And., to which *S. halia*, Fax., established in 1893, and in 1895 unjustly withdrawn by the same author, must be added. But in our museum I have found 4 species of adult forms and 5 species of larvæ, 4 of which most decidedly belong to the 4 adult forms; thus an adult form unknown to me must exist. One of the adult species is *S. edwardsi*, Kr., but I have not been able to refer any of the three other species to *S. halia*, Fax., or *S. hamifer*, Alc. & And.; the reasons will be given later on.

How safely I have been able—though not without a rather protracted investigation—to refer the larvæ to the adults will appear from the following case. The old larvæ are very easy to separate, and I possessed 5 species but only 3 of the adults. By the examination of the characters of the larvæ I was induced to re-examine one of the adult species and then it became apparent that it was composed of 2 very closely allied but valid species. Undoubtedly authors have commingled 2–3–4 species in references to *S. edwardsi*, Kr., and between the limits adopted by Faxon it, as stated above, includes at least 4 species.

The adult species are all closely related and very similar to each other. They are all characterized by the above-mentioned powerful development of mxp.[3], which is much longer than any of the trunk-legs; the 4 proximal joints are much incrassated and especially the thickening of the fourth joint is most conspicuous: the sixth joint is much shorter than the fifth, both strongly compressed and on

the one margin furnished with extremely short spines or almost naked, while the other margin of the sixth joint and at least of the distal half of the fifth joint is armed with rather numerous spines, some of which are very long and rather robust. The differences in the armature, especially of the sixth joint, yield very good characters for the species. (The distal part of the fifth joint is most frequently cut off by a secondary articulation.) The eyes are middle-sized, the supraocular and hepatic spines well developed. In the antenn. ped. the first joint is very little longer to somewhat shorter than the third joint, which is slender and obviously longer than the second. On the third joint of trl.[1] and trl.[2] the processes represented by Kröyer in *S. edwardsi* (tab. iv. fig. 9 *f* and 9 *g*) are well developed. The branchial formula as in *S. atlanticus*, M.-Edw. (see above); the branchiæ above the trunk-legs are very long, above trl.[3] one branchia and a lamella; trl.[4] 2 branchiæ, the first of which is about as long as the preceding, the second somewhat shorter and only half as broad, but yet very well developed. The exterior margin of the ext. br. of urp. without any spine or tooth at the proximal end of the ciliated part.

S. edwardsi, Kr.—Kröyer in his representation (p. 246, tab. iv. fig. 9, *a–k*) mentions a variety with longer rostrum, but this belongs to another species, viz. *S. penerinki*, Bate, H. J. H. The species is easily distinguished from all the other species by the character given in my tabular view: that the ext br. of urp. has the exterior margin ciliated along its whole length—and besides by the following features in the structure of mxp.[3] *The sixth joint of this pair is divided into 4 subjoints about equal in length, and each of the 2 distal subjoints is rather or very distinctly divided into 2 subjoints*, thus in all 6 subjoints; the joint *ends with 2 spines* of equal or different length, but at least the one is very long; next its interior margin is furnished with 35–38 spines of very different lengths (and the apical spine on the first, second, and fourth of the 6 subjoints is exceedingly long); besides *a very long spine is present on the same three subjoints on the one side near the exterior margin.* The fifth joint of mxp.[3] also presents some characters, which, however, are omitted. The rostrum is shorter than in the other species of the group, laterally compressed, and seen from the side more or less plainly forming an oblique triangle.—Length 14–21·5 mm.

I have seen specimens from the Atlantic northward to lat. 20° N. (the larvæ to lat. 23° 31′ N.), from the Indian Ocean, and passing towards the Pacific to Djilolo Isl. (c. lat. 1° N., long. 127° 5′ E.).

The three, or perhaps four, next species are easily separated from *S. edwardsi*, Kr., by several characters. *On the ext. br. of urp. at least c.* $\frac{1}{6}$ *of the exterior margin is naked. In mxp.*[3] *the sixth joint is divided into but 4 subjoints very unequal in length*, the third being but half as long as the second; the *joint ends with but one spine*, which is very long, and the interior margin of the joint is armed with but 15–25 spines, and no spine exists on the side of any of the subjoints near the exterior margin.

S. vigilax, Stimps., H. J. H.—Only the *Mastigopus* has been described (see later on). The adults of this and the next species, *S. penerinki*, Bate, H. J. H., are very closely related to each other and easily separated from *S. incertus*, n. sp., and *S. halia*, Fax., by the character, that on the ext. br. of urp. the ciliated part occupies between $\frac{4}{5}$ and $\frac{7}{8}$ of the exterior margin. The best character between *S. vigilax* and *S. penerinki* is that in *S. vigilax* the interior margin of the sixth joint of mxp.³ is armed with 22–25 spines, of which 4 are implanted on the third subjoint, which is but a little or scarcely shorter than the fourth; in *S. penerinki* the sixth joint is armed with c. 15 spines (the apical one as usual not included), of which but two on the third subjoint, which is considerably shorter than the fourth. In *S. vigilax* the rostrum is of medium length, strongly laterally compressed, seen from the side rather broad and apically more or less distinctly truncated, with an acute prolongation from the superior edge.—Length 16–27 mm.

This species is as common as *S. edwardsi*, Kr.; I have seen numerous specimens of adults and larvæ from the Atlantic northward to lat. 42° N.; in the Indian Ocean the larvæ are common and distributed eastward to lat. 24° 50′ S., long. 103° E.

S. penerinki, Bate, H. J. H.—Only the *Mastigopus* has been described (see below). The rostrum of the adult is somewhat elongated, seen from the side a little more narrow than in *S. vigilax* and from the middle tapering towards the acute apex. The chief character in the structure of mxp.³ is given under *S. vigilax*.—Length c. 18·5 mm.

I have seen but two adult specimens, the one captured at lat. 17° N., long. 22° W., and this is one of the specimens alluded to by Kröyer as a variety of *S. edwardsi*.

S. incertus, n. sp.—Only one adult specimen, a female, has been seen, but this is a giant in comparison with the other related species, being 47 mm. long. On the ext. br. of urp. the ciliated part occupies between $\frac{1}{3}$ and $\frac{1}{4}$ of the exterior margin. The first joint of the antenn. ped. is scarcely shorter than the third. The rostrum is somewhat elongated, strongly compressed; seen from the side the proximal half is rather broad and then it tapers towards the acute apex. The interior margin of the sixth joint of mxp.³ with but 13 spines, two of them on the third and one on the fourth subjoint, which is but very little longer than the third. The other characters are mentioned above.

The adult specimen was captured (on the surface) in lat. 34° 50′ S., long. 4° 30′ W.; a sub-adult specimen near that locality, and a larva in lat. 40° 4′ S., long. 53° 20′ E.

S. halia, Fax.—The specimens on which this species was established in 1893 are just the large specimens described and figured by Faxon in 1895 as a variety of *S. edwardsi*, Kr. (p. 212, pl. li. figs. 1–1 *e*). This species, of which I have seen no specimen, is closely related to *S. incertus*, m., but disagrees in one character, about which Faxon writes, p. 213: "The first and second segments of the antennule are of about equal length, while the third segment is longer than the first or the second by one-half." Unfortunately Faxon does not describe or figure the sixth joint of mxp.³ I think that the species will prove to be different from *S. incertus*, m. When Faxon states that 6 large pleurobranchiæ and one smaller podobranchia are present on each side on the body, he certainly has overlooked the 5 lamellæ, which I have found in *S. incertus* and the other species of the *edwardsi*-group.

S. hamifer, Alc. & And., I will mention here, though I have not been able to insert it in my tabular view. The description (1894) and the figure (1895) plainly show that it belongs to this group. As in mxp.³ "the propus is four-jointed," the species cannot be identical with *S. edwardsi*, Kr., but it is impossible for me to settle whether it be really valid or synonymous with one of the other species. Only two characters I have been able to detect, viz.: that mxp.³ seems to be still longer than in any other species, and that its fifth joint is curiously arcuated (see the figure); but it is difficult to say whether these two characters are valid, for instance, to decide whether the shape of the mentioned fifth joint may not be due to some artificial cause. The species must be re-examined.

As mentioned above, I have examined five older *Mastigopus*-forms, four of which have been elsewhere described. The older specimens, c. 10–15 mm. in length, are easily recognized from each other, and some few characters shall be pointed out; but the younger stages are more difficult, being more spiny, &c., and besides the materials seen by me are rather insufficient, and the animals difficult to characterize without the aid of figures. The larvæ are easily distinguished from all larvæ in Group I. by the elongated and vigorous mxp.³, and from *S. sargassi*, Ortm., by the longer eye-stalks. In the old larvæ the sixth joint of mxp.³ is divided into 4 subjoints (the oldest larval stage of *S. oculatus*, Kr., is unknown to me, so that I cannot settle whether its two distal subjoints are divided as in *S. edwardsi*, Kr.), but the armature on the end and on the interior margin is very different from that in the adults.

S. oculatus, Kr.—Kröyer has given a good representation (p. 243, tab. iii. figs. 5, *a–f*); Bate has also described and figured it (p. 406, pl. lxxiv. fig. 1). Both Kröyer and Bate figure, in my opinion, the eye-stalks a little too long. The rostrum is short, seen from the side obliquely triangular, acute, and rather broad at the base; the abdominal segments are dorsally smooth—even in a specimen but 6·5 mm. long—and on the ext. br. of urp. the exterior margin is ciliated in the total or almost the total length (in a larva 10 mm. long, c. $\frac{1}{17}$, measured with accuracy, of the length was naked). By the combination of these three characters the older specimens are easily recognized. The species is most decidedly the *Mastigopus* of *S. edwardsi*, Kr.—*S. brachyorrhos*, Kr. (p. 272, tab. v. figs. 13, *a–b*), is the young *Mastigopus* of *S. edwardsi*, Kr. I have examined Kröyer's type specimen, which is about 4 mm. long.

To his description it may be added that each of the four anterior abdominal segments possesses in the median line on the inferior side a protuberance or lobe, the three anterior of these ending in a spine; on the ext. br. of urp. the exterior margin is ciliated in $\frac{6}{7}$ of its length, thus a very short basal part being naked, but no tooth or spine is present.

S. vigilax, Stimps.—The description of Stimpson (p. 45) agrees rather well with the oldest *Mastigopus*, and no other species known to me agrees with it; his animals were captured at the Azores. Specimens c. 9–16 mm. in length are distinguished from the related forms by the following characters:—The rostrum about as in *S. oculatus*, Kr., but perhaps a little larger, directed upwards and forwards; in specimens 9–10 mm. in length the apex is produced into a short spine directed forwards. The eye-stalks are very long, obviously longer than in *S. oculatus*, Kr.; the eyes large. In the antenn. ped. the first and third joints are of about equal length. The abdominal segments are dorsally smooth, yet in specimens 9–10 mm. long with very short spines or traces of spines on the fourth, fifth, and sixth segments. On the ext. br. of urp. the ciliated part occupies from $\frac{3}{4}$ (in the younger specimens) to more than $\frac{4}{5}$ (in the older specimens) of the exterior margin, but the spine is generally obsolete. The adult form is described above, bearing the same name.—As already pointed out by Ortmann, *S. parvidens*, Bate (p. 409, pl. lxxiv. fig. 3), 9 mm. long, is established on younger specimens of *S. vigilax*, with dorsal spines on the fourth to sixth abdominal segments. Bate's figure gives a rather good idea of this stage. *S. macrophthalmus*, Stimps. (p. 46), is, in all probability, identical with the stage *parvidens*, Bate.

The smallest specimen seen by me (captured by Chun at the Canaries) is (the rostrum included) 4 mm. long, and differs considerably in several particulars from the older specimens, but is more similar to *S. brachyorrhos*, Kr. The rostrum is about $\frac{3}{4}$ as long as the eye-stalks, its short basal part broad, and at its end a dorsal spine, beyond which the rostrum is very slender. The supraocular and the hepatic spines are considerably elongated. The antenn. ped. extremely slender, only 2-jointed, as the second joint is not yet separated from the first; the third is not $\frac{1}{4}$ of the entire peduncle. The posterior margin of the carapace in the median line with a slender spine directed obliquely forwards (this spine is still preserved in specimens c. 8 mm. long, but then shorter and almost perpendicular). Each of the 6 abdominal segments with a dorsal spine, which is short and perpendicular on the first two segments, longer on the third, fifth, and sixth, very long on the fourth segment. The epimera of the 5 anterior segments produced into a short spine directed outwards; the same segments besides inferiorly in the median line with a lobe, which at least on the second segment is armed with a spine. The very narrow ext. br. of urp. with the exterior margin ciliated in scarcely more than $\frac{2}{3}$ of its length, and the spine is well developed. The telson very short as in *S. brachyorrhos*, Kr.

S. penerinki, Bate.—The specimen represented by Bate (p. 418, pl. lxxvi. fig. 3) is rather young, 8 mm. long. I have examined a number of specimens, between 6·4 and 14 mm. in length, partly from the Plankton expedition and partly from our museum. Specimens from c. 7·5 mm. to 14 mm. in length are easily distinguished from those of the same length of *S. vigilax*, Stimps., by having the third, fourth, and fifth abdominal segments—in the younger specimens also the sixth segment—dorsally armed with spines, which in larger specimens are shorter than in the stage figured by Bate, but yet well developed; the spine on the third segment is almost perpendicular. In older specimens the eye-stalks are somewhat shorter than in *S. vigilax*, Stimps., but yet long. In the older stages the rostrum is much shorter than in Bate's figure, but yet longer than in *S. vigilax*, and its distal part is slender and directed horizontally forwards; in the younger stages it is towards $\frac{1}{3}$ or more of the length of the eye-stalks and recalls somewhat that in *S. incertus*, m. (see below), but in specimens that have attained the length of 8 mm. it is destitute of a dorsal spine. In specimens c. 6·4 mm. long the rostrum is about half as long as the eye-stalks, with a very short dorsal spine a little way from its base. In the antenn. ped. the third joint is scarcely longer than the first. (In the young specimens the anterior abdominal segments are ventrally armed as described by Bate.) On the ext. br. of urp. the length of the ciliated part varies, as in *S. vigilax*, in accordance with the length of the specimens, occupying from $\frac{3}{4}$ to $\frac{6}{7}$ of the exterior margin; a tooth is present in the younger, not in the old specimens. The adult form is described above, bearing the same name.

S. incertus, m., is the *Mastigopus* of the adult described above. I have seen rather numerous specimens from 6·2 to 13 mm. in length. They are more slender than the corresponding stages of *S. penerinki*, Bate, which they closely agree with in the antenn. ped., the length of the eye-stalks, and the dorsal armature on the abdominal segments. But they are easily distinguished from this species by the ext. br. of urp., on which the ciliated part in all specimens occupies scarcely $\frac{2}{3}$ of the exterior margin, and the spine is rather long. Moreover, the rostrum, which in proportion to the length of the animal is from more than the half to scarcely $\frac{1}{3}$ of the length of the eye-stalks, is rather characteristic: seen from the side the basal part is rather short and directed obliquely forwards and upwards, and then it suddenly becomes produced into a slender and distally very fine spine much longer than the basal part and quite horizontal; at the distal end of the basal part *the upper margin is armed with a fine spine*, which is very short in the older specimens, *and just beyond which the margin is somewhat concave in outline.* In the young specimens the first two abdominal segments are ventrally in the median line armed with a lobe produced to a spine, and in these and even in specimens c. 10 mm. long the posterior margin of the carapace is armed with an erect spine.

That the referring of this *Mastigopus* to the above-described adult *S. incertus*, n. sp., is correct is proved by a specimen c. 17 mm. long, which constitutes an excellent transition. The rostrum has still essentially the larval shape, with a sharp angle as the trace of the dorsal spine between the oblique basal and the horizontal distal part, but the distal part is shorter than the basal and its upper margin concave as in the true *Mastigopus*. The eyes about as in the adult, but still brown, not black, the eye-stalks as in the adult. The sixth joint of mxp.^{3} essentially as in the adult, with 13 spines on the interior margin. The abdominal segments are dorsally smooth. On the ext. br. of urp. the ciliated part occupies scarcely more than $\frac{2}{3}$ of the exterior margin, and the spine is short.

S. armatus, Kr.—Kröyer's representation (p. 260, tab. iii. fig. 6, *a–e*) gives a good notion of this curious larva. Here I shall but mention some few essential characters. The rostrum is about as long as or a little shorter than the first joint in the antenn. ped., without any dorsal spine or angle. The eye-stalks are of medium length, considerably shorter than in the larvæ of *S. incertus*, m., and *S. penerinki*, Bate. In the antenn. ped. the first joint is *in the older specimens obviously somewhat shorter than the third.* Of the abdominal segments the second is dorsally armed with a shorter perpendicular spine, the third to fifth with very long oblique spines, much longer than in other species of the group, and, besides, the spines on the fourth and fifth segments are much curved. Sometimes a very short spine is present on the first segment, and finally in the younger specimens a short spine on the sixth. On the ext. br. of urp. the ciliated part occupies a little less than $\frac{2}{3}$ of the exterior margin, and the spine is well developed. The largest specimen is 15·5 mm. long.

That this *Mastigopus* does not belong to *S. incertus*, m., with which it agrees in the ext. br. of urp., is decided by the shortness of the first joint in the antenn. ped. in proportion to the third. Thus the adult form is unknown to me. Unfortunately all the specimens seen by me were captured in the Atlantic between lat. 42° 5′ N. and lat. 4° 5′ N., but Bate describes and figures (p. 401, pl. lxxiii. fig. 1) a specimen, 8 mm. long, which seems to be the same species, and the specimens seen by him were captured at "Port Jackson (Australia)," "north of the Sandwich Islands," and "between Japan and Honolulu:" thus it may be possible that it belongs to *S. halia*, Fax., captured in lat. 7° 6′ N., long. 79° 48′ W.

Of the 8 species enumerated at the end of the tabular view as belonging to Group II., *S. hamifer*, Alc. & And., *S. macrophthalmus*, Stimps., and *S. brachyorrhos*, Kr., are mentioned in the notes. The other 5 species are all larvæ. *S. diapontius*, Bate (p. 399, pl. lxxii. fig. 3), is very interesting, being 18 mm. long and easily distinguished from all other species of the group by having the second joint of the antenn. ped. "twice as long as the first;" this large larva, captured in the Atlantic, must belong to an unknown adult form—thus we obtain at least 7 valid species (*S. hamifer*, And. & Alc., not included) of Group II. The 4 other larval species, all described by Bate, are established on very young specimens, between 3·5 and 7 mm. long, and are probably all or almost all but young stages of some of the species described above, but I have not been able to refer them with certainty.

viii. *Remarks on* SCIACARIS *and* PETALIDIUM *of Bate.*

To the genus *Sciacaris*, Bate, only one species, *S. telsonis*, Bate (p. 438, pl. lxxviii. fig. 1), has been referred, and this is a *Mastigopus*-stage, which agrees so closely with *Sergestes* that I must consider it as being the larva to a *Sergestes*-species, and in the tabular view given above I have referred it to Group I.

The genus *Petalidium*, Bate, was established on one species, *P. foliaceum*, Bate (p. 349, pl. lx.), which is very deficiently known as the specimens were extremely mutilated, without legs and with the uropods broken off. But the branchiæ are very interesting. Bate ascribes its arthrobranchiæ to mxp.^{3} and trl.^{1}–trl.^{3}, but according to his analytical figure I believe them rather to be pleurobranchiæ as in *Sergestes*; besides, he mentions and figures large foliaceous plates to trl.^{1}, trl.^{2}, and trl.^{3}, answering to the lamellæ in *Sergestes*. I should not have mentioned this interesting but very imperfectly known form if I had not met with rather similar pleurobranchial lamellæ in *S. sanguineus*, Chun (Sitz. d. k. Preuss. Akad. d. Wiss. zu Berlin, 1889, p. 538, Taf. iii. fig. 1).

According to a careful comparison between the largest type specimen of *S. sanguineus*, Chun. 9·5 mm. long, and Kröyer's representation of his *S. obesus*, Kr. (p. 257, tab. iv. figs. 10, *a–f*), and the fragments of his single type specimen, the two species are identical, and the name given by Kröyer must be adopted. The largest specimen seen by me is a *Mastigopus*, perhaps not more than half-grown. For the recognition of the species it may at once be mentioned that several very characteristic particulars have been figured: thus Kröyer figures the eye, the antennular peduncle, and the uropods, and mxp.^{3} and the trunk-legs are represented by Chun. Next I shall give a short description of the largest specimen. The rostrum is rather short, considerably shorter than the diameter of an eye, almost horizontal, slender, with a dorsal spine at the basis. No supra-ocular spines, but the hepatic spine and the gastro-hepatic groove are well developed. The eye-stalks rather short, but the eyes nevertheless reaching beyond the second joint of the antenn. ped., the eye-stalk with the eye, seen from the side, inverted conical, and the distal part of the cornea forming almost a hemisphere at the end of the cone—a shape very different from that in the *Mastigopus* of *Sergestes*. The antenn. ped. is short, the first joint much longer than the other two taken together, thus longer than in any above-described *Mastigopus* of the same length. Mxp.^{3} very short, somewhat longer than trl.^{1} and very little longer than trl.^{2}; *trl.^{3} is almost* 3 *times longer* and its proximal half considerably more incrassated, near and on the apex with some long setæ and without the trace of any chela; on trl.[2] a feeble beginning to a chela is found. The relative length and the structure of mxp.[3] and trl.[1]-trl.[3] differ very much from that found in *Sergestes*. The branchiæ are very interesting. A rudiment belonging to mxp.[2] I do not dare to interpret: above mxp.[3] and trl.[1]-trl.[3] a small pleurobranchia and a plate are present; the plate above mxp.[3] is a little larger than the branchia, and the plates are much increasing in size from before backwards, so that the plate above trl.[3] is 3–4 times larger than the branchia; above trl.[4] a rudimentary branchia. The abdomen is rather clumsy, dorsally smooth; the ext. br. of urp. with the exterior margin naked in c. $\frac{1}{1\frac{1}{2}}$ of the whole length, as the well-developed spine is situated near the distal end.

The smallest specimen examined is 4·9 mm. long, and differs from the described stage in several particulars of not much importance—a somewhat different shape of the rather short rostrum, a well-developed supra-ocular spine, trl.[4] and trl.[5] only buds, the branchiæ not yet developed, a short dorsal spine on the fifth and sixth abdominal segments, the spine on the ext. br. of urp. still nearer to the apex, &c.

It is easily seen that this species cannot remain in the genus *Sergestes*, but whether it should be referred to *Petalidium*, Bate, or a new genus should be established for its reception is impossible to decide with certainty. The branchial plates recall the plates found in *Petalidium*, and therefore I provisionally transfer it to that genus; but we must call to our remembrance that the branchial plates or lamellæ may be much altered during the further growth, for instance they may be proportionally much reduced in size (*cfr.* the curious reduction of the branchial lamellæ in *S. henseni* (Ortm.) during its development from a *Mastigopus* 6·2 mm. in length to the adult form). Unfortunately the legs and the uropods in *Petalidium* are quite unknown. The species, which must receive the name of *P. obesum* (Kr.), is decidedly distinct from *P. foliaceum*, Bate.

ix. *Geographical and Bathymetrical Distribution.*

With one single exception all the species of *Sergestes* are only found in the tropical and subtropical seas, in the Atlantic reaching northward about to lat. 42°–43° N. The exception is *S. arcticus*, Kr., which ranges to the seas at the southern part of Greenland; but being distributed to the Mediterranean, and even to lat. 38° S., it is in reality no arctic species but a deep-sea form, with the centre of distribution in all probability towards the northern tropic or the Equator, and notwithstanding going c. 20° more northward than the other allied species.

The limits of the geographical range of the species are still very imperfectly known. Above I have mentioned that some of Bate's localities for *S. atlanticus*, M.-Edw., were uncertain, and that Bate's, Ortmann's, and Faxon's specimens of *S. edwardsi*, Kr., must be re-examined, as the species is collective; thus some of the localities given in the literature of the subject are untrustworthy and several others are, in my opinion, not quite certain. But the statements given above as results of my own studies of the animals prove with absolute certainty that at least a series of the species have a very wide distribution: the Atlantic northward to lat. 23°–30° N. and mostly to lat. 42° N., the Indian Ocean, and at least the most western part of the Pacific. From the other parts of the Pacific I have seen no material.

Bate writes on p. 352: "The species of this genus [*Sergestes*] are chiefly oceanic"; and this is, I think, generally admitted. But partly according to the foregoing investigation this statement must be rather altered, for we must distinguish between the larvæ and the really mature forms. *Almost all known larvæ have been taken at the surface.* Yet it must be remarked that at least in short distance from the shore some *Mastigopus*-species generally are met with in considerable depths. This is proved by Prof. Chun, who in 1889 (p. 538) writes on his "*S. longirostris*, Bate": "Er war der häufigste aller Sergestiden [at the Canary Islands] und fand sich regelmässig in dem Inhalt der Tiefennetze. . . . . . Seltener erschien er an der Oberfläche." Later on he captured different larger *Mastigopus*-stages of *S. mediterraneus*, m., and *S. arcticus*, Kr., with intermediate-net ("Schliessnetz"), near Lesina and Ragusa at 80, 100, 400, 500, and 500–600 metres, but all the *Mastigopus*-stages of *S. arcticus*, Kr., are not uncommon near the surface in the northern area of the Atlantic.

While all the larvæ, according to our present knowledge, are essentially oceanic near the surface, the adult forms give another result. I have accepted at most 14 earlier described mature forms as valid species, and of these 8 species—*S. inous*, Fax., *S. robustus*, Smith, *S. japonicus*, Bate (=*S. mollis*, Smith), *S. bisulcatus*, Wood-Mason, *S. prehensilis*, Bate, *S. kröyeri*, Bate, *S. rubroguttatus*, Wood-Mason, and *S. hamifer*, And. & Alc.—have *only* been captured with trawl or dredge between 345 and 2574 fathoms. The other 6 species must be treated separately. *S. arcticus*, Kr., is typically (see Metzger, Chun, and especially the long lists given by Smith) an inhabitant of the deep sea, and only some younger specimens with black eyes have been secured at the surface, and one single really mature specimen (the type of Kröyer) in all probability near the shore. Of *S. henseni* (Ortm.) 2 smaller specimens (not 3, as written by Ortmann), the largest specimen about 24 mm. in length, were captured with the vertical net between 400 and 0 m., while a much larger specimen (35 mm. long) was taken with the trawl from 4000 m. The depth of *S. halia*, Fax., is not recorded, as the specimens were taken with a submarine tow-net; and if *S. armatus*, Kr., is the *Mastigopus* to it, it is certainly no surface species, as *S. armatus* is not very rare in the northern part of the Atlantic, where no adult form which can belong to it has been secured. *S. atlanticus*, M.-Edw., is very common at the surface, but Ortmann communicates that it has been captured in the intermediate net from 700–500 m.; and if some of the specimens recorded by Bate (p. 390) as 38, 43, and 50 mm. long, and coming respectively from 600, 2150, and 345 fathoms, really belong to this species, it grows considerably larger in the deep sea, as no specimen from the surface exceeds 30 mm. Finally, *S. cornutus*, Kr., and *S. edwardsi*, Kr., are the only instances of the 14 species which only have been captured at the surface (and in vertical nets drawn up from 500 m. to the surface). In this paper I have described the mature forms of *S. vigilax*, Stimps., H. J. H., *S. penerinki*, Bate, H. J. H., and *S. incertus*, n. sp., which have all been captured at the surface. *S. tenuiremis*, Kr., H. J. H., and *S. corniculum*, Kr., H. J. H., are common at the surface in the *Mastigopus*-stages; above I have described the younger black-eyed forms of both species, also captured at the surface, but the adult stages are quite unknown and must, in my opinion, be true deep-sea forms. Of *S. diapontius*, Bate, and *S. mediterraneus*, m., only the *Mastigopus*-forms are known, and the adults are certainly inhabitants of the depths. (*S. profundus*, Bate, from 1375 and 2550 fathoms, I omit, as the species is too uncertain.)

Though we still know too little of the bathymetrical distribution, it must, I think, be taken as proved *that at least two-thirds of the species inhabit the depths of the sea when the animals have quite arrived at maturity* (or at least at their full length, cfr. *S. atlanticus*). I can say that with two exceptions—my single adult specimen of *S. incertus*, m., and Kröyer's specimen of *S. arcticus*, Kr.,—no specimen exceeding 30 mm. in length recorded in the existing literature or seen by me has been captured near the surface, but all large specimens, from 30 mm. to 113 mm. (*S. inous*, Fax.) in length, have been secured with trawl or dredge coming from a considerable to a very great depth (345–2574 fath.). Faxon writes on p. 249: "There can be no doubt that the deep-sea Crustacea occasionally come to, or very near to, the surface," and he communicates several instances; I think that, for instance, my single and large specimen of *S. incertus*, m., 47 mm. long, has been secured on such a visit. It is evident that the animals as true swimming forms do not live on the bottom itself, but, I presume, in the water-stratum just above it.

As will be seen from this paper, our knowledge of this rich and curious genus is still rather imperfect. A good monograph, based on the study of the collections in the seven or eight museums which possess materials of importance, would be extremely valuable and elicit numerous new facts; and future deep-sea expeditions, making use of the trawl, intermediate net, vertical net, and surface net, would be sure to discover new species and especially enlarge our knowledge of the metamorphosis and distribution.

7. On the General Results of a Zoological Expedition to Madagascar in 1894–96. By C. I. Forsyth Major.[1]

[Received December 1, 1896.]

I arrived at Mananjary, on the east coast of Madagascar, at the end of August 1894, and embarked at the same place almost two years later, on July 11th, 1896. My original intention had been to hurry on at once, by the most direct route, to Sirabé, situated on the central plateau, at about 12 days' journey to the N.W., in order to profit of what remained of the dry season for the intended excavations in the marshes. The impossibility of finding bearers for the little-known and difficult direct route obliged me, however, to travel first to Fianarantsoa, the capital of the Betsileo, situated in a S.S.W. direction, at 7 days' distant from Mananjary. At Fianarantsoa I had to wait 22 days for the bulk of my luggage, which, according to previous arrangements, ought to have arrived before myself. I employed the time in doing such collecting work as the circumstances would allow. In the meantime, the news arrived of sudden complications in the political situation, and all the Frenchmen residing in the interior left for the coast, with the exception of my young assistant, whom, a little too late in the day, I tried to give out as a British subject.

As there was still some hope left that the Hovas would yield to the French ultimatum, I decided to leave for what I thought would prove a quiet corner in the forest of the Tanala, N.E. of Fianarantsoa, and there to await the events, and eventually the end of the war, which it was supposed would be of very short duration. My subsequent difficulties with the Tanala Governor were of a somewhat more serious nature than I wished to describe in my letters; I have to mention it here, as it considerably interfered with my work. The collecting work in the forest extended from October 1894 to the beginning of February 1895, interrupted in December by a journey to the Betsileo town of Ambositra, in order to communicate with the few Englishmen residing there, and by their help with the British Vice-Consul in Antananarivo.

The first six weeks of my stay in this district we were encamped in the midst of the forest, near Ivohimanitra, at from 1000 to 1100 metres above the sea. The second stay was at Ambohimitombo, a short day's journey N.W. from the latter place and some 400 metres higher up. As I then supposed that later on I would have no more opportunity to visit the forest-region, I determined to collect everything that would come in my way. From this system I had completely to depart in the sequel. Being much dependent on the cooperation of the natives, I soon found out that it was very difficult to train them for a manifold collecting work. Besides, I had after a while to convince myself that I was only able to do fruitful work in what I was best acquainted with. In my subsequent stays in the forest therefore, without leaving

[1] Communicated by the President.