# Deep-Water Crustacea of the Genus *Sergestes* (Decapoda, Natantia) from Cook Strait, New Zealand

*by*

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# Deep-Water Crustacea of the Genus *Sergestes* (Decapoda, Natantia) from Cook Strait, New Zealand

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*Abstract*

FOUR species, namely *Sergestes arcticus, S.* cf. *S. seminudus, S. potens* and *S. japonicus,* are recorded and described. Of these, *S. japonicus* is recorded for the first time from the Southern Hemisphere. *S.* cf. *S. seminudus* and *S. potens* are also new to the New Zealand fauna, whilst *S. arcticus* has previously been recorded in the area only as a larval stage.

*S. potens* and *S. japonicus* are uniform scarlet species without internal luminescent organs (organs of Pesta) and are referred to the subgenus *Sergia,* here formally defined. *Sergestes arcticus* and *S.* cf. *S. seminudus* are particoloured red and transparent species which possess organs of Pesta and are referred to the subgenus *Sergestes* s.s. here formally defined. A synopsis of the 57 species recognized in the genus is given.

*S. arcticus* is abundant at about 100 fathoms during the night in Cook Strait, but probably sinks into deeper water during the day; the partially benthic *S. potens* is recorded from groper and ling stomachs caught in 40 to 60 fathoms. All records of Sergestidae from the New Zealand region are discussed, and a checklist of the recognized species given.

VERY few specimens of the aberrant penaeid genus *Sergestes* have been recorded in the literature from New Zealand waters. This typical bathypelagic group is frequently encountered whenever mid-water collections are made elsewhere in the world, but hitherto little work of this type has been done in this area. The *Challenger* Expedition, though working the deep-waters off our coast in 1874, was using slow-moving bottom trawls, and these are largely ineffective in collecting fast-swimming pelagic crustacea. This expedition, however, took a larval stage on the surface of Cook Strait, near Wellington, but unfortunately the specimen has been lost and its name (*S. parvidens*) is now not recognized. Of the other overseas oceanographical expeditions that worked in the New Zealand area, the *Terra Nova* in 1910 took only larval stages, the *Discovery II* (1932) and the *Galathea* (1951-52) have not had their sergestid material described, while that of the *Dana* (1928-30) has only had preliminary descriptions of some of the more interesting species published. Two of these, *Sergestes disjunctus* Burkenroad and *Sergestes index* Burkenroad, were from

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north-east of the Bay of Plenty, New Zealand, and consequently were the first adult *Sergestes* to be recorded from our waters. However, neither of these has been taken in Cook Strait as yet.

In 1941 Professor L. R. Richardson, of this Department, obtained a sample of 47 large shrimp from the stomachs of groper and ling caught by the Pawley brothers in the course of their commercial long-line fishing in Palliser Bay, Cook Strait. It had long been known that the stomachs of these fish, at least in certain seasons, often contained interesting crustacea, fish and squid never collected by any other method, but specimens had seldom come into the hands of zoologists. Professor Richardson identified the shrimp with a large sergested taken off South Africa and recorded by Barnard (1950) as *Sergestes phorcus* Faxon, a species which must now be known as *Sergestes potens* Burkenroad. Although constantly having this sergestid in mind from the start of the Department's study of the fauna of Cook Strait, it had not been taken by any of the mid-water hauls made between 50 and about 600 fathoms up until February this year. In that month a beam trawl struck bottom at about 550 fathoms a little south of Palliser Bay and took from the mud bottom a specimen of *S. potens* associated with a typical benthic shrimp of the genus *Sclerocrangon*. The segestid was uniform scarlet in colour and possessed a large number of purple lens-less photophores scattered over its body and appendages.

From the beginning of our work in Cook Strait an abundant small, transparent, pink *Sergestes* has been taken, especially at night, in the 50–150 fathom zone associated with larger numbers of *Pasiphaea* of the same colouring. This sergestid is the common North Atlantic species *S. arcticus,* already recorded from the New Zealand area as a larval stage by Gurney and Lebour (1940) and also recorded below from the Bay of Plenty, the Chatham Rise, and off the coast of Otago.

In February of this year a small specimen of the scarlet membranous *S. japonicus* was taken in a mid-water haul at about 500 fathoms, and several larger specimens of this same scarlet species were caught at about 600 fathoms in April. These are the first records for the Southern Hemisphere of *S. japonicus,* a species well known from deep water in the North Atlantic, and recorded from the northern Indopacific only twice. Also in April a single specimen of another transparent, pink species, very similar, if not identical to *S. seminudus* of Indonesian waters, was taken at a similar depth.

In order to identify these species it became necessary to review the systematics of the genus *Sergestes*. It was found that Burkenroad (1937a, 1945) had suggested a subdivision of the genus, on differences in types of luminous organs and pigmentation, into the two subgenera *Sergestes* s.s. and *Sergia;* and that he had used these without formally defining them. The reality of this subdivision was quite clear in the field as the differences in appearance and habit of the two groups could be immediately recognised. Consequently I have reviewed the records of colour and luminous organs in this genus and then formally defined the two subgenera. Following this I have given a synopsis of all the 57 species of *Sergestes* known to me from the literature, though synonyms have, except in a few important cases, been omitted. These species have been arranged in a number of groups as originally used by Hansen in his many publications.

Finally, all Sergestidae recorded in the literature from New Zealand waters are discussed, and a checklist of all species recognized from the area given.

## PREVIOUS RECORDS OF *Sergestes* FROM THE NEW ZEALAND REGION

The *Challenger* Expedition collected a larval *Sergestes* off Wellington in July, 1874. This was described by Bate (1888) with others from the North Pacific and tropical Atlantic as a new species, *S. parvidens*. Hansen (1896), following Ortmann (1893), regarded this as the young mastigopus of *S. vigilax* Stimpson. In 1903, Hansen stated that this New Zealand specimen could not be found in the British

Museum, but one specimen taken by the *Challenger* in the Atlantic and recorded as *S. parvidens* was a larval stage of *S. vigilax*, while other specimens recorded from off Cape York, Australia, and identified as *S. parvidens*, but not published by Bate, were larvae of *S. edwardsi*. However, Sund (1920: 22 footnote) considers that *S. parvidens* Bate could not possibly be a larval stage of *S. vigilax* and cannot relate it to an adult species. Thus it appears that *Sergestes parvidens* must be removed from the New Zealand fauna, as the species is regarded as unrecognizable from the account and the original specimen is lost.

*Sergestes kröyeri* Bate, the type specimen of which was taken at *Challenger* Station 170, off the Kermadec Islands, has always been listed in the New Zealand fauna (see Hamilton, 1896; Hutton, 1904), but will not be considered further here, as at present the Kermadec Province is not accepted as truly belonging to the New Zealand (or Maorian) Sub-region (A. W. B. Powell, R. K. Dell, unpublished views).

The *Terra Nova* Expedition took a number of larval stages of *Sergestes*, but no adults, off the North Auckland Peninsula in shallow plankton tows. Borradaile (1916) identified numerous mastigopi from this material as *S. semiarmis* Bate, the types of which Hansen (1903) had not been able to find in the British Museum and which he consequently regarded as unrecognizable. Borradaile states that this New Zealand material was possibly a larval stage of *S. corniculum*, but he gives no reason for this. In 1924, Gurney recorded five early larval forms of *Sergestes* (understood by Gurney to consist in reality of " groups of species ") from this *Terra Nova* material. These were named as *Elaphocaris dohrni, E. ortmanni, E. hispida, "Acanthosoma* of *hispida* type " and "*Acanthosoma* of *dohrni* type ". The possibility that these early larval forms could be linked up with adults taken in New Zealand waters must not be overlooked, but the whole question of relating larval stages to adults in this genus is very complex and greatly complicated by the uncertainty of much of the adult systematics as well as the aberrant sequence of larval stages. It should be noted that the common *Sergestes arcticus* has larvae of the *E. dohrni* type, and in fact Gurney and Lebour (1940) recorded an *Acanthosoma* larva from a *Terra Nova* station south of New Zealand as *S. arcticus*.

Burkenroad (1940) gave preliminary descriptions of two new species of *Sergestes* taken by the *Dana* Expedition at Station 3630, north-east of the Bay of Plenty. These species, *S.* (*Sergestes*) *disjunctus* and *S.* (*S.*) *index*, were taken in bathypelagic hauls made with " open nets " and are the first adult specimens of the genus recorded from the New Zealand area.

## MATERIAL AND METHODS

Although the majority of the specimens examined were collected by the Department of Zoology, Victoria University, during investigations into the fauna of Cook Strait, specimens of *Sergestes* were also made available by the Dominion Museum, the Marine Department Fisheries Laboratory, the Chatham Islands 1954 Expedition, and the Portobello Marine Biological Station. The Collections of the Auckland Museum, the Canterbury Museum, the Canterbury University Zoology Department, and the Otago Museum were also examined for Sergestidae without success. Through the kindness of Dr. Isabella Gordon, of the British Museum (Natural History) I was able to examine, during 1955, the type of *Sergestes kröyeri* and search the collections under her charge for other sergestid material from the New Zealand area.

The following abbreviations are used in presenting the collection and station data for this material: BT, beam trawl; N2M, 2 metre cone net; N4M, 4 metre cone net; OT, otter trawl; fms., fathoms; hrs., hours (time given in International 24-hour system); mm, millimetre. All drawings have been made with an Abbé camera lucida. The carapace length, measured directly with fine dividers and accurate within 0·5 mm, is used as the standard measurement of the shrimp throughout, and this is the measurement given in the " material available " lists.

Order DECAPODA

Suborder NATANTIA

Section PENAEIDEA

Family SERGESTIDAE

Subfamily SERGESTINAE

Genus SERGESTES M.-Edwards, 1830.

1830. *Sergestes* M.-Edw., *Ann. Sci. Nat. Zool.* XIX: 348.
1896. *Sergestes* Hansen, *Proc. Zool. Soc. London* 1896: 936 (review of genus).
1919. *Sergestes* Hansen, *Siboga Exped.* XXXVIII: 2.
1922. *Sergestes* Hansen, *Rés. Camp. Sci. Monaco* LXIV: 11 (key to Atlantic species).
1950. *Sergestes* Barnard, *Ann. S. Afri. Mus.* XXXVIII: 638.

Sergestidae with first 3 pairs of pereiopods elongate, slender, with stiff outstanding setae; 1st pereiopod without proper chela; 2nd and 3rd pereiopods nearly always with very small chelae; 4th and 5th pereiopods with 6 segments, the dactyli being absent, 5th much shorter than 4th, one or both being natatory. 1st maxilla with palp; 2nd maxilla with 2 lobes; 1st maxilliped with segmented palp. Branchial lamellae as well as arthrobranchs; 2 arthrobranchs on 4th pereiopod, none on 5th. Petasma with processus ventralis not forked. (Adapted here from Barnard, 1950.)

The type species of the genus is *Sergestes atlanticus* M.-Edw., 1830. At least 57 adult species are currently accepted, mostly pelagic in tropical and subtropical seas. Three different types of luminous organs occur in the genus, though no species has more than one type and some have none at all. The larval development is aberrant among the Decapoda and certain specialised names are used. The first stage is the nauplius (see Gordon, 1955), followed by the elaphocaris (protozoea), the acanthosoma (zoea) and the mastigopus (post-larval) stages.

## SUBDIVISION OF THE GENUS *Sergestes*

The subdivision of this rather unwieldy genus has been a constant point of difficulty since Hansen's review in 1896. He divided the species into two groups (I and II) on the relative length and strength of the 3rd maxilliped as compared with the 3rd pereiopod, and further divided each group into several subgroups on other morphological characters. This division he maintained with minor alterations in his later papers (1903, 1919, 1922, etc.).

In 1924, Gurney stated (p. 88) that, because of the several strikingly different types of early larvae (representing " groups of species "), " it is permissible to suggest that the genus *Sergestes* may be a composite of two or more really distinct genera which have reached a great similarity of form by convergence ".

Burkenroad (1937a) drew attention to the great resemblance in critical features between the "*S. corniculum*" group of species in Hansen's Group I and the "*S. sargassi*" group of species in Group II. He finds that they can be distinguished from one another only by " the form of the third maxillipeds, among characters of more than specific significance ". He then called attention to the fact that Pesta (1918, quoted in Hansen, 1922: 21) had described internal pigmented organs within the cephalothorax of *S. corniculum* Kröyer, *S. arcticus* Kröyer and *S. vigilax* Stimpson, and had suggested for them a luminous function. These three species are illustrated in colour by Hansen (1922, Pl. I). This plate shows that they are transparent species with scattered red chromatophores, which tend to be concentrated on the anterior part of the body. The two figures of *S. arcticus* also show clearly the internal organs described by Pesta as a red mass within the transparent cephalothorax. A mature *S. robustus* Smith, figured on the same plate, is an all-red species, while immature specimens of *S. robustus* and *S. tenuiremis* (*non* Kröyer, now regarded as *S. kröyeri* Bate) appear to have orange or pink cuticular pigment rather than chromatophores. Burkenroad demonstrated that the internal pigmented organs were modified areas of the gastrohepatic gland and that in life a bright blue pigment was associated with them, though this was obscured by a dense layer of carmine chromatophores on the surface of the gland itself. However, manipulation of living

specimens of several species with these organs was not effective in producing light. These " organs of Pesta ", as they were termed by Burkenroad, varied in number and position in various species, up to 10 being present in *S. corniculum,* and were present in all members of the genus other than Hansen's groups " *S. challengeri* ", " *S. robustus* ", " *S. mollis* " and " *S. tenuiremus* ". He noted that these groups, containing then about 16 species in all, included all those species with dermal lens-bearing photophores (the " *S. challengeri* " group) and all those with dermal, lens-less organs of possible luminous function (the " *S. robustus* " group). He suggested that the presence or absence of the organs of Pesta might mark " the genus off into natural groups ", the enlargement of the third maxillipeds having possibly occurred " independently in two different stocks ".

In 1940 Burkenroad described 18 new species of *Sergestes,* distributing them between the subgenus *Sergestes* s.s. which he characterises in 1945 as including all those species with organs of Pesta, and the subgenus *Sergia* Stimpson, in which he includes those without these organs.

It has long been realised that two different types of pigmentation were present in the genus. These have been termed by Kemp in unpublished observations (Dennell, 1940: 315; 1955: 399) the " all-red " group and the " half-red " group, the latter having the posterior abdominal segments almost colourless. He found the pigmentation of these two groups to be basically different. In the all-red group, the colour is due to the distribution over the entire body of a red pigment carried in the cuticle, while in the half-red group the colour of the anterior part of the body is not due to cuticular pigment but to red subcuticular chromatophores (though faint cuticular pigments may also be present). All members of the half-red group have organs of Pesta and none have dermal photophores, while no members of the all-red group have organs of Pesta though dermal photophores, either with or without lenses, are present on most. Thus it can be seen that Kemp's half-red species belong to Burkenroad's subgenus *Sergestes* s.s. and the all-red to the subgenus *Sergia,* the pigmentation differences therefore being of subgeneric importance.

Zahl (1953) and Hardy (1956) have published excellent coloured illustrations of examples of these two subgenera. Zahl's colour photographs of specimens from the Straits of Messina show a species of *Sergestes* s.s. (p. 592) with extremely large stellate chromatophores on the carapace, and a species of *Sergia* of the " *S. robustus* " group (pp. 616–617) with the characteristic carmine photophores clearly visible on the scaphocerite and some of the thoracic appendages. Hardy's sketches, made during the *Discovery* Expeditions, illustrate *S. arcticus* and *S. vigilax* (Pl. 17) of the half-red subgenus *Sergestes* s.s. and the all-red *S.* (*Sergia*) *robustus* (Pl. 18) as well as other bathypelagic crustaceans of the same two colour types.

Although Hansen attempted to summarise all the data on this genus in his detailed review (1896) he did not cover the question of colour in any way. Indeed, during the preceding 60 odd years, since the genus was described by Milne-Edwards, only a few brief references to the colour of various species had been made (e.g., Wood-Mason and Alcock, 1891a: 190; 1891b: 353). However, meagre though these references were, the two widely different colorations had been seen: all-red *Sergia* species (" blood-red ", " lurid-red ", " deep crimson ", etc.), and transparent *Sergestes* s.s. with red chromatophores (described as " white " with " red spots ", " pink blotches ", etc.).

The first species recognised as bearing dermal photophores, *S. challengeri,* was described by Hansen in 1903 from the *Challenger* Expedition material examined by Bate (1888). These photophores, over 117 were seen in the damaged, unique specimen, all possessed a prominent, circular, biconvex, chitinous lens and an internal reflecting layer, which in Hansen's preserved material was unpigmented. This discovery was the first definite record of luminous organs, as distinct from luminous secretions, in the Decapoda, though photophores of a highly developed type were well known in the closely allied Euphausiacea.

Apparently the first record of the production of light by decapod photophores was that of Stanley Gardiner (Kemp, 1910b) who described specimens of *S. challengeri* taken in the Indian Ocean as "brilliantly phosphorescent on the occasion of their capture". Kemp, while demonstrating the detailed structure and histology of these photophores, was able to record that the cellular layer immediately beneath the lens contained a deep blue pigment in life (still present in specimens preserved in weak formalin) and also that the number of photophores present increases with size. In 1913 he gave further details of the distribution of photophores in *S. challengeri,* especially those on the ventral surface of the body.

Terao (1917) described in detail the distribution and histology of the lens-bearing photophores in the Japanese *S. lucens* Hansen (recorded as *S. prehensilis* Bate), closely related to *S. challengeri.* These photophores were red in life, numerous, 157 being found on one specimen, and were observed to emit a dim, intermittent, greenish-yellow light. Within the next three years, two more species of the "*S. challengeri*" group, *S. fulgens* Hansen, 1919, and *S. splendens* Hansen, 1920 (*nom. preocc.* now known as *S. talismani* Barnard) were described, each possessing large numbers of lens-bearing photophores on the body and appendages. The distribution of these organs in the latter species is given in detail by Hansen (1922).

In 1935 Gordon re-examined a number of the "*S. challengeri*" group of species and gave comparative illustrations of the photophore patterns on the ventral surface of the body in *S. prehensilis, S. lucens, S. talismani* (as *S. splendens* Hansen) and *S. challengeri.* Thus five species were then recognised in this group. She also recorded that Kemp, who had studied fresh material of *S. prehensilis* during the *Discovery* Expedition, found that the total number of photophores in this species "varied enormously according to the age and size of the specimens" (from 183 to 358). She was thus able to show that it was photophore pattern rather than number which would be of systematic significance. *S. prehensilis* (as *S. gloriosus*) had already been described as possessing lens-bearing photophores by Stebbing (1905), who also recorded this species as "red" in colour. Two further species of this group of the subgenus *Sergia, S. scintillans* and *S. stellatus,* were described by Burkenroad in 1940. Structures inside the coxae of the 5th pereiopods in *S. tenuiremis,* believed to be large lens-bearing photophores by Welsh and Chace (1938) have since been recognised as spermatophores by Burkenroad (in Dennell, 1940: 314).

In contrast to this type of photophore, pigmented "patches" (opaque white in preserved material) seen in some species of *Sergia,* being similarly arranged to the lens-bearing photophores of *S. challengeri,* led Sund (1920) to suggest that they were also luminous organs. Dennell (1940) examined and described histologically these lens-less dermal organs in *S. regalis* Gordon. He found these to be photophores of an entirely new type, consisting of horizontal sheets of interwoven fibres and scattered perpendicular "photogenic bodies". He was later able to observe (1955) luminescence from this type of organ in *S. robustus* and *S. splendens* Sund (recorded as *S. richardi*) and thus demonstrate that they were indeed photophores, though they "have no evolutionary relationship with the lensed organs occurring in *S. challengeri* and its allies". These lens-less photophores had been first recognised by Kemp (1910a) when he described *S. robustus* as an all-red species with "crimson spots" on various parts of the body and appendages. Illig (1914), Hansen (1919: 10; 1922: 21) and Sund (1920: 11, 15, 18) gave further details of these lens-less organs in *S. robustus* and the closely related species, *S. gardineri* Kemp, *S. splendens* Sund and *S. grandis* Sund. Burkenroad (1937a) described from life the lens-less photophores of *S. splendens* (recorded as *S. crassus*) as "transparent structures invested on their inner sides by a layer of vermilion pigment". Dermal organs of the same type were found in preserved specimens of *S. phorcus* Faxon, which also belongs to the "*S. robustus*" group. Within the next two years, Welsh and Chace (1938) figured the distribution of lens-less organs on the body and appendages of *S. grandis*

Sund (167 in a large specimen), and Gordon (1939) had described another species in this group, *S. regalis*, giving Kemp's notes on the distribution of the lens-less " deep purple spots " on this otherwise bright scarlet shrimp.

In 1940 Burkenroad described seven new species of the subgenus *Sergia* as having lens-less dermal photophores and thus belonging to the " *S. robustus* " group. Lens-less photophores were also reported in *S. bisulcatus* Wood-Mason. In addition to observing the luminescence of these photophores in *S. robustus* and *S. splendens*, Dennell (1955) illustrated their pattern in these two species and in *S. grandis*. In all three species these photophores are described as " carmine " in life. Specimens of *S. japonicus* Bate (with which *S. mollis* Smith is synonymous, see Burkenroad, 1940: 53) and *S. kröyeri* (with which *S. tropicus* Sund is synonymous, see Burkenroad, 1940: 50), though uniformly pigmented red in life, were found to lack photophores of any type. *S. laminatus* Burkenroad, 1940, is another species of *Sergia* belonging to the same photophore-less " *S. japonicus* " group, also characterised by having a relatively membraneous integument.

In 1940, Dennell made a thorough histological examination of the organs of Pesta in *S. seminudus* Hansen (recorded as *S. corniculum*), *S. sargassi* Ortmann, *S. diapontius* Bate and *S. edwardsi* Kröyer. He described possible lens and reflector cells and concluded that these organs were, as had been suggested before, almost definitely luminous organs. This opinion he was later able to confirm from his own observations (1955) on living *S. vigilax* and *S. atlanticus* M.-Edw. In addition to observing the organs of Pesta luminescent in the two species mentioned above, he recorded that in these two as well as in *S. cornutus* Kröyer, *S. armatus* Kröyer, *S.* " *hanseni* " (presumably *S. henseni* Ortmann) and " *S. sundi* " (unknown to me), the organs in life were dark blue with a carmine pigment cap.

Thus it is clear that the genus *Sergestes* may be divided into two subgenera on both morphological and physiological grounds. Those species possessing organs of Pesta and lacking cuticular pigmentation are referred to the subgenus *Sergestes* s.s. and those without organs of Pesta, with cuticular pigmentation and often possessing dermal photophores, to the subgenus *Sergia*. This systematic division may not reflect the differences between the two groups adequately and in the future, when we have a more intimate knowledge of the sergestids, it may be necessary for this primary separation to be at the generic level.

## DEFINITION OF SUBGENERA AND SYNOPSIS OF SPECIES

As there are no formal definitions of the subgenera in use, the following are put forward, mainly abstracted from Burkenroad's papers.

### Subgenus SERGESTES s.s. M.-Edwards, 1830

1940. *Sergestes* s.s. Burkenroad, *Ann. Mag. Nat. Hist.* ser. 11, vi: 38.
1945. *Sergestes* s.s. Burkenroad, *Trans. Conn. Acad. Arts Sci.*, 36: 587 footnote 11.
1955. *Sergestes* s.s. Dennell, *Jour. Linn. Soc. London Zool.* XLII: 399.

Species of *Sergestes* s.l. with specialised luminescent modifications of the gastrohepatic gland (organs of Pesta) but without dermal photophores. Supraorbital and hepatic spines may be present or absent in adult. Ovary confined to cephalothorax. Colour in life due to red subcuticular chromatophores mainly concentrated on the anterior part of the body.

The type species of the subgenus is the same as for the genus, *S. atlanticus* M.-Edw., 1830.

### SYNOPSIS OF THE SUBGENUS *Sergestes* s.s.

1 (6) 3rd maxillipeds subequal with 3rd pereiopods.
2 (3) The two distal segments of the 5th pereiopods setose on both margins — The " *S. corniculum* " group. *S. corniculum* Kröyer, 1855; *S. rubroguttatus* Wood-Mason, 1891; *S. seminudus* Hansen, 1919; *S. nipponensis* Yokoya, 1933; *S. erectus*

Burkenroad, 1940; *S. disjunctus* Burkenroad, 1940; and *S. coalitus* Burkenroad, 1940.

3 (2) The two distal segments of the 5th pereiopods setose on only one margin.

4 (5) Third segment of antennular peduncle shorter than first. Petasma with processus uncifer terminally hooked ..... The "*S. arcticus*" group. *S. arcticus* Kröyer, 1855, and *S. similis* Hansen, 1903. (*S. affinis* Hansen, 1919 must be a *lapsus calami* for this species.)

5 (4) Third segment of antennular peduncle subequal or longer than first. Petasma with processus uncifer not terminally hooked ..... The "*S. atlanticus*" group. *S. atlanticus* M.-Edwards, 1830, and *S. cornutus* Kröyer, 1855.

6 (1) Third maxillipeds greatly enlarged, considerably longer than 3rd pereiopods.

7 (8) The two distal segments of the 5th pereiopods setose on both margins. Petasma with processus uncifer well developed and long pars media ..... The "*S. sargassi*" group. *S. sargassi* Ortmann, 1893; *S. henseni* (Ortmann, 1893); *S. nudus* Illig, 1914; *S. pectinatus* Sund, 1920; *S. pestafer* Burkenroad, 1937; *S. verpus* Burkenroad, 1940 and *S. index* Burkenroad, 1940.

8 (7) The two distal segments of the 5th pereiopods setose on only one margin. Petasma with rudimentary processus uncifer and short pars media.

9 (10) Dactyl of 3rd maxilliped with 4 subsegments. Outer margin of uropodal exopodite not setose proximally ..... The "*S. vigilax*" group. *S. armatus* Kröyer, 1855; *S. vigilax* Stimpson, 1860; *S. diapontius* Bate, 1881; *S. halia* Faxon, 1893; *S. incertus* Hansen, 1896, and *S. stimulator* Burkenroad, 1940.

10 (9) Dactyl of 3rd maxilliped with 6 subsegments. Outer margin of uropodal exopodite setose for entire length in adult ..... The "*S. edwardsi*" group. *S. edwardsi* Kröyer, 1855; *S. orientalis* Hansen, 1919; *S. tantillis* Burkenroad, 1940, and *S. semissis* Burkenroad, 1940.

## Subgenus SERGIA Stimpson, 1860

1860. *Sergia* Stimpson, *Proc. Acad. Nat. Sci. Philad.* 1860: 46.
1940. *Sergia* Burkenroad, *Ann. Mag. Nat. Hist.* ser. 11, VI: 43.
1945. *Sergia* Burkenroad, *Trans. Conn. Acad. Arts Sci.* 36: 587 footnote 11.
1955. *Sergia* Dennell, *Jour. Linn. Soc. London Zool.* XLII: 399.

Species of *Sergestes* s.l. without specialised luminescent modifications of the gastrohepatic gland (organs of Pesta). With or without dermal photophores, which when present may or may not have cuticular lenses. Supraorbital and hepatic spines absent in adult (secondary hepatic prominences may sometimes be present). Ovary may extend into the abdomen. Adult with red cuticular pigment distributed over entire body and appendages in life.

The type species of the subgenus is *Sergia remipes* Stimpson, 1860. This is a late mastigopus stage which Burkenroad claims (1945) to have identified with this group of the genus *Sergestes.*

## SYNOPSIS OF THE SUBGENUS *Sergia*

| | | | |
|---|---|---|---|
| 1 | (4) | Dermal photophores (lens-bearing or lens-less) present on body and appendages. | |
| 2 | (3) | Photophores of the lens-bearing type | The "*S. challengeri*" group. *S. prehensilis* Bate, 1881 (syn. *S. gloriosus* Stebbing); *S. challengeri* Hansen, 1903; *S. fulgens* Hansen, 1919; *S. lucens* Hansen, 1922; *S. talismani* Barnard, 1947 (*nov. nom.* for *S. splendens* Hansen); *S. scintillans* Burkenroad, 1940, and *S. stellatus* Burkenroad, 1940. |
| 3 | (2) | Photophores of the lens-less "opaque spot" type ..... ..... ..... | The "*S. robustus*" group. *S. robustus* Smith, 1882; *S. bisulcatus* Wood-Mason, 1891; *S. phorcus* Faxon, 1893; *S. gardineri* Kemp, 1913; *S. splendens* Sund, 1920 (syn. *S. richardi* Hansen, *S. crassus* Hansen); *S. grandis* Sund, 1920; *S. plumeus* Illig, 1927; *S. regalis* Gordon, 1939; *S. creber* Burkenroad, 1940; *S. extenuatus* Burkenroad, 1940; *S. maximus* Burkenroad, 1940; *S. potens* Burkenroad, 1940; *S. bigemmeus* Burkenroad, 1940; *S. inequalis* Burkenroad, 1940, and *S. filictum* Burkenroad, 1940. |
| 4 | (1) | No dermal photophores present on body or appendages. Integument membraneous ..... ..... ..... ..... | The "*S. japonicus*" group. *S. tenuiremis* Kröyer, 1855; *S. japonicus* Bate, 1881 (syn. *S. mollis* Smith); *S. kröyeri* Bate, 1881 (syn. *S. tropicus* Sund); *S. profundus* Bate, 1888; *S. inous* Faxon, 1893 and *S. laminatus* Burkenroad, 1940. |
| *Incertae sedis* | | ..... ..... ..... ..... ..... | *S. colosii* Cecchini, 1933 (description not seen), and *S.* (*Sergestes*) *sundi* Dennell, 1955 (*nomen nudum* apparently an unpublished name supplied by Burkenroad, see p. 393). |

## RECORDS OF *Sergestes* FROM THE COOK STRAIT AREA

Four species of this genus are recorded here from the deep-water of Cook Strait, three of these, *S.* cf. *S. seminudus, S. potens* and *S. japonicus,* being new records for the New Zealand region, while one species, *S. arcticus,* previously recorded from the region as a larval stage, is now shown to occur also in the Bay of Plenty, over the Chatham Rise and off the coast of Otago.

### Sergestes (Sergestes) arcticus Kröyer, 1855

Restricted synonymy:

1859. *Sergestes arcticus* Kröyer, *K. Danske Vidensk. Selsk. Skr.* ser. 5, 4: 240, Pl. 3. fig. 7; Pl. 5, fig. 16.
1886. *Sergestes arcticus* Smith, *Ann. Rept. U.S. Comm. Fish Fisheries,* Pl. XX, figs. 1, 2.
1910. *Sergestes arcticus* Kemp, *Fisheries Ireland Sci. Invest.* 1908, I: 30, Pl. III, figs. 13–19.
1922. *Sergestes arcticus* Hansen, *Rés. Camp. Sci. Monaco* LXIV: 62, Pl. I, figs. 1–2 (coloured); Pl. III, fig. 3.
1940. *Sergestes arcticus* Gurney & Lebour, *Discovery* Rept. XX: 19, fig. 12 (larval stages).
1950. *Sergestes arcticus* Barnard, *Ann. S. Afri. Mus.* XXXVIII: 639, fig. 120.
1952. *Sergestes arcticus* Holthuis, *Lunds Univ. Arssk.* 2, 47 (10): 8, fig. 1.

#### MATERIAL EXAMINED

*Victoria University, Zoology Department, Cook Strait Collections*

Coll. VUZ 24 (Station FOR) 41° 36′ 30″ S., 174° 57′ 30″ E., 14/1/56, 1800–1900 hrs., N2M at about 100 fms. over 540 fms.—1 ♂ 9 mm.

VUZ 25 (Station FOS) 41° 37′ S., 175° 2′ E., 14/1/56, 2140–2300 hrs., N2M at about 100 fms. over at least 300 fms.—6 ♂♂ 8–10 mm, 7 ♀♀ 7–15 mm, 1 unsexed 8 mm.
VUZ 26 (Station FUC) 41° 37′ S., 175° 4′ E., 14/1/56, 2315–0100 (15/1/56) hrs., BT at about 100 fms. over 150–300 fms.—1 ♂ 8 mm.
VUZ 27 (Station FUD) 41° 37′ S., 175° 5′ E., 15/1/56, 0125–0225 hrs., N2M at about 50 fms. over at least 100 fms.—1 ♀ 9 mm.
VUZ 28 (Station SAR) 41° 29′ S., 174° 57′ E., 15/1/56, 0415–0545 hrs. BT at about 130 fms. over at least 200 fms.—1 ♂ 7 mm.
VUZ 51 (Station DOP) 41° 35′ S., 174° 53′ E., 22/2/56, 1730–1830 hrs., N2M struck bottom at about 200–300 fms.—2 ♀♀ 8.5–9 mm.
VUZ 52 (Station DOR) 41° 35′ S., 174° 57′ E., 22/2/56, 2020–2130 hrs., N2M at about 100 fms. over at least 400 fms.—11 ♂♂ 8–14 mm, 9 ♀♀ 7–14 mm.
VUZ 53 (Station HUL) 41° 41′ S., 175° 17′ E., 23/2/56, 0100–0215 hrs., BT on bottom at about 250–350 fms.—1 ♂ 10 mm, 6 ♀♀ 7.5–8.5 mm.
VUZ 54 (Station GUL) 41° 39′ 30″ S., 175° 17′ E., 23/2/56, 0300–0450 hrs., BT on bottom between 50–200 fms.—1 ♀ 11 mm.
VUZ 57 (Station BOOS) 42° 1′ 30″ S., 174° 58′ E., 31/3/56, 0230–0540 hrs., N2M at about 300 fms. over at least 1,200 fms.—4 ♀♀ 8–10 mm.
VUZ 81 (Station KUB) 41° 45′ S., 175° E., 17/2/57, 0920–1100 hrs., BT at about 600 fms. over about 870 fms.—1 ♂ 11.5 mm.
VUZ 82 (Station JUG) 41° 42′ 30″ S., 175° 9′ E., 17/2/57, 1200–1355 hrs., BT at about 500 fms. over 550 fms.—2 ♀♀ 14 mm.
VUZ 83 (Station JUG) as preceding, 1430 hrs., BT struck bottom at about 550 fms.—1 damaged specimen.
VUZ 84 (Station CUK) 41° 47′ S., 175° 02′ E., 19/4/57, 1500–1700 hrs., N2M at about 400 fms. over about 800 fms.—5 ♂♂ 9–14 mm, 8 ♀♀ 9–14.5 mm, 2 damaged 10–15 mm.
VUZ 85 (Station CUK) as preceding, 1915–2400 hrs., N4M at about 600 fms. over about 800 fms.—1 ♂ 12 mm, 1 ♀ 8.5 mm.
VUZ 94 approx. 42° 2′ S., 175° 22′ E., 24–25/8/57, 1845–0115 hrs., N4M at 500–600 fms. over about 1,400 fms.—1 ♀ 14 mm.
VUZ 100 (Station FOJ) 41° 36′ S., 174° 44′ E., 29/8/57, 1315–1430 hrs., BT on bottom at about 380 fms.—1 ♀ 14 mm.

*Chatham Islands 1954 Expedition (D.S.I.R.)*

Station 7, Chatham Rise, 40° 42′ S., 179° 55′ E., 24/1/54, 1880 hrs., BT on bottom at 280 fms.—1 ♀ 9.5 mm.
Station 52, Chatham Rise, 44° 04′ S., 178° 04′ W., 10/2/54, 0632 hrs., BT on bottom at 260 fms.—1 ♂ 8 mm, 1 ♀ 8.5 mm.

*Dominion Museum Collections*

23/1/57, off Taiaroa Head, Otago, 45° 38′ S., 171° 12′ E., about 0200 hrs., trawl at about 150 fms. over 600 fms.—1 ♂ 7 mm, 2 ♀♀ 5–7 mm.
B.S. 204 (net 4), White Island Trench, Bay of Plenty, 37° 29′ S., 177° 17′ E., 25/2/57, N2M on 500 fms. wire, over about 600 fms. M.V. *Alert*—1 damaged, about 8 mm.

*Portobello Marine Biological Station Collection, Dunedin*

Station Alert 54.13A, N.E. of Otago Heads, Canyon A, 2/3/54, BT on bottom at about 300 fms.—4 ♀♀ 8.5–13.5 mm, 1 damaged 14 mm.
Station Alert 54.17 (as for 54.13A)—2 ♀♀ 9–11 mm.

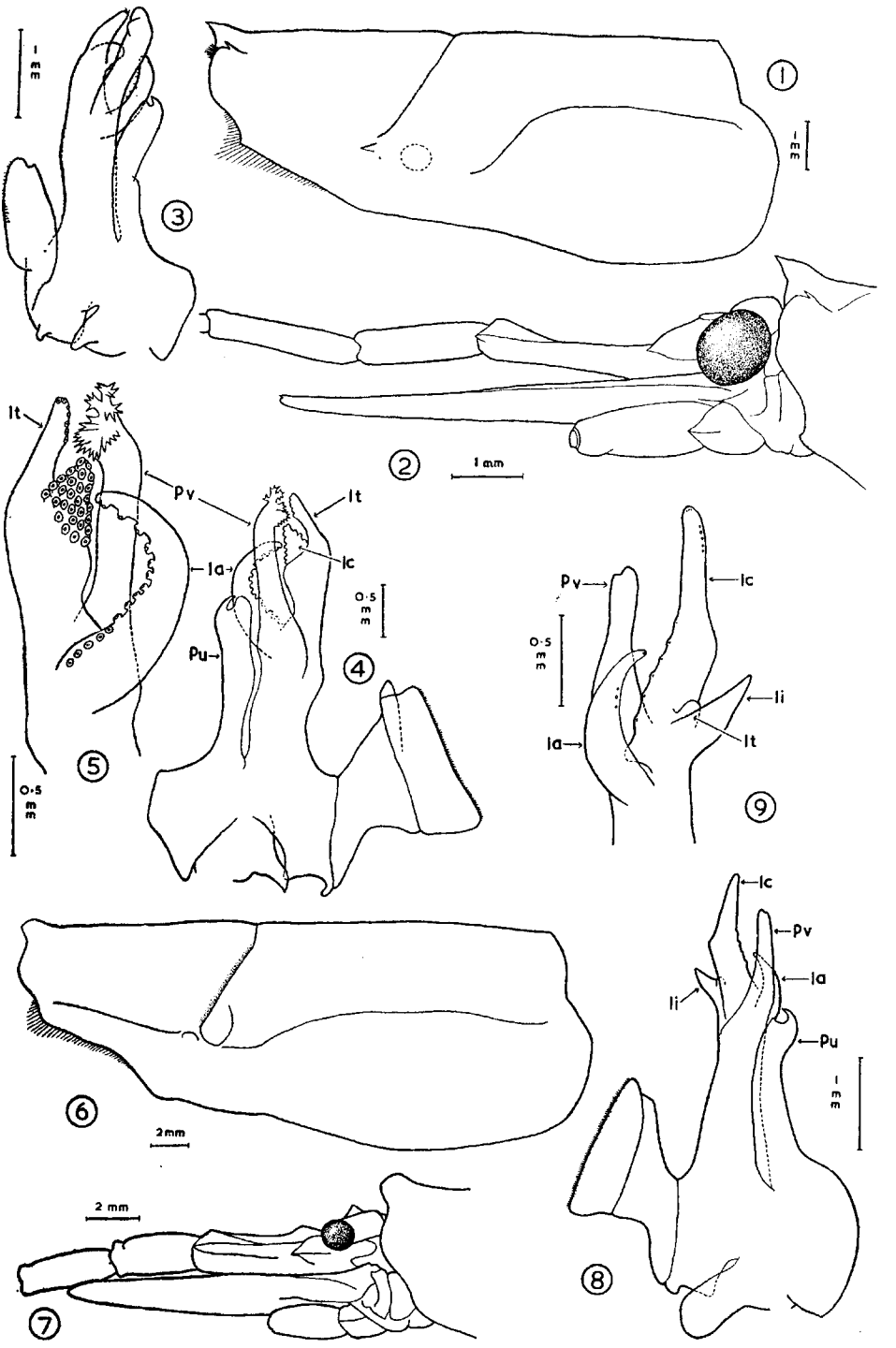
## SPECIFIC DIAGNOSIS

A relatively small, fragile shrimp with long appendages and characteristically prominent laterally-directed eye stalks.

Rostrum short, acute, projecting slightly beyond the anterior margin of the carapace and with the dorsal margin weakly convex. Supraorbital crest armed with spine; cervical groove distinct, terminating near the prominent hepatic spine. Suprabranchial groove and ridge well marked.

Eyes large, black, cornea wider than stalk, no protuberance (ocular tubercle) on the latter. Antennular peduncular segments long and relatively slender, second and third together subequal to proximal, third a little longer than second. Third maxillipeds not greatly enlarged, subequal in length to 3rd pereiopods. Only one margin of the two distal segments of the 5th pereiopods fringed with setae.

Male with petasma as shown (Figs. 4, 5); processus ventralis long and armed distally with several small clumps of spiniform projections; lobus terminalis only a little shorter, with several terminal "crochets" (retractible hooks); lobus connectens short, triangular and with anterior face armed with closely packed crochets; lobus armatus curved, long and reaching to the lobus




FIGS. 1–5. *Sergestes arcticus*.—Fig. 1, carapace, lateral view (anterior organ of Pesta represented by broken circle) ♀. Fig. 2—Anterior part cephalothorax, lateral view (setae omitted) ♀ 10 mm. Fig. 3—immature left petasma, posterior view, ♂ 8 mm. Fig. 4—Right petasma, posterior view, ♂ carapace length 12 mm. Fig. 5—As preceding, anterior view.
FIGS. 6–9. *Sergestes japonicus*.—Fig. 6—Carapace, lateral view, ♀. Fig. 7—Anterior part cephalothorax, lateral view (setae omitted), ♀ 28 mm. Fig. 8—Left petasma, posterior view, ♂ 21 mm. Fig. 9—As preceding, anterior view.

connectens, with single row of crochets along inner margin; processus uncifer long, hooked and reaching to the base of the lobus armatus, no lobus inermis present.

Female with two curved teeth medially on coxa of 3rd pereiopod.

Carapace length of New Zealand specimens up to 15 mm, males tend to be smaller than females.

## BRANCHIAL FORMULA

I have followed Burkenroad (1937b) in regarding the dorsal series of gills in *Sergestes* as arthrobranchs rather than pleurobranchs. Thus the branchial formula of the New Zealand specimens of *S. arcticus* is as follows:

| | Maxillipeds | | | Pereiopods | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 4th | 5th |
| Pleurobranchiae | — | — | — | — | — | — | — | — |
| Arthrobranchiae | — | *l* | 1 + *l* | 1 + *l* | 1 + *l* | 2 | 2 | — |
| Podobranchiae | — | 1 | — | — | — | — | — | — |
| Epipodites | 1 | 1 | — | — | — | — | — | — |
| Exopodites | 1 | — | — | — | — | — | — | — |

*l* represents a branchial lamella (i.e., a rudimentary arthrobranch).

This formula agrees with the records, but not the terminology, for *S. arcticus* given by Smith (1882, 1884) and Hansen (1903, 1922) and also with Calman's (1909: 280) formula for the genus *Sergestes*.

In the New Zealand specimens the anterior arthrobranch of the 3rd pereiopod is nearly twice the length of the anterior branch of the 4th. The posterior arthrobranch of the 3rd pereiopod, clearly not rudimentary, is larger than the posterior branch, and only a little shorter than the anterior branch, of the 4th pereiopod.

## COLOUR IN LIFE

*S. arcticus* in life is transparent with red chromatophores scattered over the body and appendages, these being mainly concentrated on the carapace and mouth parts. Within the carapace itself the black stomach and the bright scarlet organs of Pesta are especially prominent.

In addition to the above general description the following details have been observed from fresh specimens. The chromatophores are especially concentrated dorsally on the carapace and the first two abdominal segments, while the rest of the abdomen is almost colourless except for some patches of chromatophores on the ventral surface of the 6th segment and at the base of the tail fan. The cornea is jet black and the eye stalk bears a few scattered red chromatophores. Of the mouth parts the 2nd maxilliped is the most prominent, many chromatophores occur on all segments especially on the distal two. All the setae of the mouth parts are themselves bright red. The ventral surface of the cephalothorax is also red and there is usually one chromatophore on the coxopodite of each pereiopod. In the male the petasma is sprinkled with small chromatophores at the same concentration as on the pleopods. Of the organs of Pesta only the anterior pair, slightly dorsal and posterior to the base of the mandible, are clearly visible through the carapace. These appear as circular scarlet bodies, becoming opaque yellow after preservation. The more dorsal organs cannot be clearly seen through the musculature of the body, but appear as strongly pigmented scarlet areas within the carapace.

Previous more or less complete descriptions of the colour of this species have been given by Kemp (1910a), Hansen (1922: 63, Pl. I, figs. 1, 2) and Holthuis (1952).

## LENGTH OF ANTENNAL FLAGELLUM

The flagellum is so seldom preserved unbroken that its length is not often recorded. A female specimen of *S. arcticus* with a carapace length of 14 mm had an undamaged flagellum of 170 mm, the characteristic crescentic bend occurred after 54 mm and every segment of the remaining 116 mm was armed with the pair of curved setae so often described in this genus. This example can be compared to Stebbing's (1905) statement that his *S. gloriosus* (*S. prehensilis* Bate), with a carapace length of 15 mm, had an antennal flagellum 163 mm in length.

## SYSTEMATIC POSITION

This New Zealand form shows all the features of the "*S. arcticus* group" of the subgenus *Sergestes* s.s.: 3rd maxillipeds subequal with 3rd pereiopods, the two distal segments of the 5th pereiopods setose on only one margin, 3rd segment of antennular peduncle shorter than 1st, processus uncifer terminally hooked. Within this group it can be fully distinguished by rostral and branchial features from the only other species described, the North Pacific *S. similis*. Though the petasma of *S. similis* is undescribed, that of our New Zealand form agrees in every detail with the highly characteristic organ of *S. arcticus* excellently illustrated by Hansen (1922) and others.

## DISTRIBUTION

This extremely well known and abundant Atlantic species has been recorded in all regions of the North Atlantic from the coasts of Norway and Greenland to the Mediterranean and the Canary Islands, while in the South Atlantic it has been taken off the French Congo, South Africa and Uruguay. However, in the Pacific it has been reported from only two localities, off Chile (Holthuis, 1952) and from *Challenger* Station 159, south of Australia (Hansen, 1903: 59). Though Gurney and Lebour (1940) state that an acanthosoma larva from *Terra Nova* Station 251 (54° 2′ S. 177° 0′ W, south of New Zealand) "seems to be indistinguishable from *S. arcticus*", adults of this species have not been recorded from the New Zealand area until now.

Sund (1920) found *S. arcticus* to be the commonest species of the genus in the North Atlantic and stated that it had virtually the same distribution in that ocean as the genus *Pasiphaea*. Also Ekman (1953) mentions that *S. arcticus* in the Atlantic is one of the few bathypelagic species which are truly cosmopolitan with regard to temperature. By this he means that the species is found in equatorial as well as in both north and south cold-water regions, though it might avoid waters in the highest latitudes.

*S. arcticus* has almost invariably been taken in Cook Strait in association with an abundant bathypelagic *Pasiphaea*, very similar to, but distinct from, the North Atlantic *P. sivado* (Risso).

## BATHYMETRIC DISTRIBUTION

*S. arcticus* has been taken in nearly every bathypelagic haul made in Cook Strait between 50 and 600 fms. However, as all nets used have been of the "open" type, specimens could have been taken at any depth between the surface and that at which the net was being used. Only four collections (V.U.Z. 25, 52, 53, 84) contain sufficient numbers of specimens to warrant individual discussion. The two most interesting were both made shortly before midnight at about 100 fms., a total of 34 specimens being taken for 2½ hours work. A haul made shortly after 1 a.m. at about 300 fms. took 7 specimens, while another made at 400 fms. after 4 p.m. caught 15 specimens.

Thus it can be said that adult *S. arcticus* in Cook Strait can be found during the night from at least 50 fms. to about 300 fms. with an apparent concentration at about 100 fms., while during the day there may be another concentration at about 400 fms. Sund (1920) found that during the *Michael Sars* North Atlantic Expedition adults were not common above about 250 fms. though they had been taken up to 100 fathoms and even less. During work with "closing" nets on the *Atlantis* in the Western North Atlantic, Welsh and Chace (1938) took *S. arcticus* between 100 and 500 fms. and later were able to show (Waterman *et al.*, 1939) that though the centre of average vertical distribution was a little above 300 fms. extensive diurnal vertical migration of at least 100 and as much as 200 fms. takes place, some specimens being in less than 100 fms. between about 8 p.m. and 4 a.m.

### SIZE AT MATURITY AND PARTIAL PARASITIC CASTRATION

Male specimens with a carapace length of less than 9 mm invariably have a petasma with the various lobes and crochets incompletely developed. The immature petasma illustrated (Fig. 4) is from a specimen with a carapace length of 8 mm and represents an even earlier stage than that figured by Holthuis (1952). Those specimens with carapace lengths of 10 mm and more always have, with certain exceptions mentioned below, mature petasma. Thus males, and we must assume, females, usually mature at a carapace length between 9 and 11 mm.

Many specimens have small or large larval nematode worms loosely coiled in the posterodorsal portion of the cephalothorax immediately beneath the carapace. Collection VUZ 25 had one so parasitised out of 14, collection VUZ 52 had 6 parasitised out of 20 and collection VUZ 84 had 5 out of 15, making a total of 12 of these 49 specimens parasitised (approx. 24%). Specimens with such a nematode in the area of the gonads have the dorsal mid-line of the carapace characteristically weakly convex, and males, at least, show partial parasitic castration. Thus no parasitised male seen had a mature petasma, even specimens with carapace lengths of 14 mm had this organ small and still relatively undeveloped.

## Sergestes (Sergestes) cf. S. seminudus Hansen, 1919

? 1919. *Sergestes seminudus* Hansen, *Siboga Exped.* XXXVIII: 18, Pl. I.

### MATERIAL EXAMINED

*Victoria University, Zoology Department, Cook Strait Collections.*

Collection VUZ 84 (Station CUK) as given above—1 ♀ 20 mm.

### EXTENDED DIAGNOSIS

The single female specimen available has the cephalothorax separated from the abdomen and both 3rd maxillipeds and certain pereiopods missing. A short description of the main characters of this damaged specimen is given below.

A relatively large, attenuated, firm-bodied shrimp with long appendages and prominently ridged carapace.

Rostrum relatively small, compressed, very slightly raised above the anterodorsal mid-line of the carapace and hardly projecting beyond the anterolateral margin of the carapace. Anterior margin of the rostrum with an acute tip flanked dorsally and ventrally with short concave portions. Carapace relatively long and attenuated, greatest depth, at posterior margin, a little less than two-fifths the length. Supraorbital crest prominent, but supraorbital spine absent. Hepatic spine small but distinct. Cervical groove well defined dorsally and laterally, almost continuous anteriorly with a well defined lateral ridge running from anterior to the hepatic spine towards the base of the antenna. Suprabranchial groove and ridge prominent with a slightly less prominent horizontal ridge laterally across the branchial region.

Telson weakly grooved dorsally, distally setose with no dorsal spinules present.

Eyes not large, cornea considerably shorter but broader than distal segment of ocular peduncle. Ocular tubercle present, broader than high.

Antennular peduncle relatively narrow and attenuated, proximal segment a little longer than the third, which is itself longer than the second. Antennal scaphocerite, with outer margin distinctly convex, reaches a little beyond the proximal third of the third segment.

Mouth parts as for genus. As both 3rd maxillipeds are missing, it is impossible on this feature to be sure of the group to which this specimen belongs.

The 1st pereiopod reaches a little beyond the distal end of the antennular peduncle and is non-chelate. 2nd and 3rd pereiopods extend well beyond the antennular peduncle, and both bear minute chelae of the type apparently characteristic of the "*S. corniculum*" and the "*S. sargassi*" groups (see Burkenroad, 1937a: 320). Here the fixed finger is shorter than the free finger, both bearing distally a fan of setae, while the fixed finger and a portion of the hand bear a conspicuous longitudinal series of very long plumed setae exactly as shown by Hansen (1922, Pl. VII, figs. g–h). The ischia of 1st and 2nd pereiopods bear a spine distolaterally. The 4th and 5th pereiopods are both of the compressed laminar type usual in the genus, the 4th reaching to the distal end of the antennal peduncle, while the 5th, with both margins of the two distal segments setose, reaches a little beyond the distal half of the merus of the 4th.

Setose portion of external margin of uropodal exopodite half as long again as non-setose portion. No tooth present on this outer margin.

Female with no teeth or lobes medially on coxa of 3rd pereiopod, but with a small spinule posterodistal to the opening of oviduct.

### BRANCHIAL FORMULA

As given for *S. arcticus* above. The anterior arthrobranch of the 3rd pereiopod is nearly twice the length of the anterior branch of the 4th, which is a little longer than the posterior branch of the 4th, the latter being subequal to the posterior branch of the 3rd pereiopod.

### COLOUR IN LIFE

Organs of Pesta present. The coloration of this " half red " species was observed in the fresh state as follows. Red stellate chromatophores were scattered all over body and appendages, but with a greater concentration on the carapace. The posterior half of the dorsal surface of the carapace had a distinct purplish-blue cuticular pigment present, and another small patch of the same pigment occurred laterally on the carapace in the area of the anterior organ of Pesta. The stomach is clearly visible through the carapace as a large greenish-black anterodorsal mass.

### SYSTEMATIC POSITION

As the two distal segments of the 5th pereiopods are setose on both margins and organs of Pesta are present, the specimen belongs to either the "*S. corniculum*" or the "*S. sargassi*" groups of the subgenus *Sergestes* s.s. The absence of both 3rd maxillipeds in the only specimen available, does not allow it to be placed in one of these two groups, as the relative length of this appendage is apparently the only feature distinguishing one group from the other (see Burkenroad, 1937a: 320). However, owing to the great similarity in appearance between this specimen and the illustrations of *S. corniculum,* especially as regards the ridges, grooves and shape of the carapace, I believe it to be closely related to that species. Assuming it to belong to the "*S. corniculum*" group, the absence of a supraorbital spine distinguishes it from *S. corniculum, S. disjunctus* and apparently from the inadequately described *S. nipponensis*; the presence of a transverse groove between the hepatic spine and the lateral ridge anterior to it distinguishes it from *S. rubroguttatus* and *S. coalitus;* while the low ocular tubercle distinguishes it from *S. erectus.* This leaves only *S. seminudus* to be considered. This species described from Indonesian waters by Hansen (1919), is very similar indeed to the New Zealand specimen, differing only to a small extent in the relative lengths of the segments of the antennular peduncle. However, our female specimen cannot be definitely identified with *S. seminudus* (if, indeed, it belongs to the "*S. corniculum*" group) until mature males are taken and the petasma compared to that of Hansen's species.

It should be noted here that Burkenroad (quoted by Gurney and Lebour, 1940: 38) states that there are three species in the Atlantic confused with *S. corniculum* " but he is not at present able to give a final opinion or names for the species which he has distinguished ". In the same year Burkenroad (1940) described five new species belonging to the *S. corniculum* and the *S. sargassi* groups, by comparing them, without illustrations, to one another and to *S. seminudus, S. henseni* and *S. "sargassi* Ortmann" of Hansen. This does not allow us to know what he means by these species. Until his promised revision of the genus (1937a, 1940, 1945) is published, it is very difficult, if not impossible, to identify many species which he has dealt with in a preliminary manner.

**Sergestes (Sergia) potens** Burkenroad, 1940

1905. *Sergestes bisulcatus* (non Wood-Mason) Stebbing, *Mar. Invest. S. Africa* IV: 87, Pl. XXIV A.

1910. *Sergestes bisulcatus* (non Wood-Mason) Stebbing, *Ann. S. Afri. Mus.* VI (IV): 381.

? 1925. *Sergestes grandis* (non Sund) Hansen in Calman, *S. Afri. Fish. Mar. Biol. Surv.* 4 (III): 23.

1940. *Sergestes (Sergia) potens* Burkenroad, *Ann. Mag. Nat. Hist.* 11, VI: 48.

1950. *Sergestes phorcus* (non Faxon) Barnard, *Ann. S. Afri. Mus.* XXXVIII: 641, fig. 120.

### MATERIAL EXAMINED

*Victoria University, Zoology Department, Cook Strait Collections*

—/4/41. East side of Palliser Bay, 30 fms. from stomachs of groper, *Polyprion* sp. and ling, *Genypterus blacodes* (Bloch & Schn.) Coll. Pawley brothers—25 ♂♂ 18–29 mm, 22 ♀♀ 14–32 mm.

Coll. VUZ 83 (Station JUG) as given above—1 ♂ 27 mm.

VUZ 100 (Station FOJ) as given above—1 ♀ 20 mm.

*Dominion Museum Collections*

6/6/42. Cook Strait, Middle Ground, 60 fms. gut contents of single groper *P. oxygeneios* (Bloch & Schn.), Coll. C. Kaberry, Marine Dept. Wellington—23 ♂♂ 21–28 mm, 8 ♀♀ 21–25 mm.

### DESCRIPTION

This description is mainly based on a male specimen, with carapace length 23 mm, collected by the Pawley brothers in 1941.

A large, deep-bodied, heavily-built shrimp with relatively soft integument and prominent eyes.

Rostrum relatively large, compressed, directed obliquely dorsally; anterior margin produced in its centre into a short acute point and with a small acute tooth, sometimes rudimentary, on anterodorsal margin. Carapace deep, greatest depth, across branchial region, just under half greatest length. Supraorbital and hepatic spines absent. Cervical groove weakly defined laterally, not continuous dorsally; posterior cervical groove apparently absent; suprabranchial groove and ridge weak.

The 6th abdominal segment, which is longer than the telson, ends posteriorly with a minute dorsal spinule. The telson is acute distally and dorsally grooved with three pairs of minute spinules on the distal portion of the dorsal surface.

Eye with cornea large, considerably wider and also longer than distal segment of ocular peduncle. No ocular tubercle present.

Antennular peduncle relatively short and stout, proximal segment not as long as second and third together, third a little shorter than second and twice its own depth. Antennal scaphocerite reaches almost to centre of this third peduncular segment.

Mouthparts as for genus. The 3rd maxilliped is relatively long and slender, but shorter than the 2nd or 3rd pereiopods; it extends a little beyond the distal end of the antennular peduncle. The dactylus is divided into six and the propodus into two subsegments.

The 1st pereiopod reaches to about the middle of the propodus of the 3rd maxilliped and is non-chelate. The 2nd and 3rd pereiopods both reach well beyond the antennular peduncle and are both minutely chelate. The 4th and 5th pereiopods are both of the compressed laminar type usual in the genus.

Non-setose portion of external margin of uropodal exopodite twice length of setose portion. Endopodite a little more than two-thirds length of exopodite.

Male with petasma as shown (Figs. 15, 16); processus ventralis wide at base with slender, unarmed tip, relatively short, not reaching as far as lobus armatus or terminalis. Lobus armatus long, subequal or longer than lobus terminalis, armed with 3 to 5 crochets distally and a number along the inner margin; well-defined lobus accessorius at base, armed with several crochets. Lobus terminalis and lobus connectens both armed distally and both produced proximally into an armed protrusion. The unarmed lobus inermis projects beyond the lobus terminalis and is subequal with the lobus connectens.

Female with posterior margin of 5th thoracic sternite convex and bulbous and coxa of 3rd pereiopod produced medially into two blunt lobes.

### BRANCHIAL FORMULA

As given for *S. arcticus* above. The posterior arthrobranch of the 3rd pereiopod is about four-fifths the length of the anterior one, subequal to the anterior arthrobranch of the 4th pereiopod and a little longer than the posterior branch of this limb.

### SIZE

A size frequency graph of the 25 males and 22 females in the Pawley brothers 1941 collection is given in Fig. 19. In it males and females have been treated together, as they both reflect the same trends. This graph shows that the majority of the specimens, 73%, are in the restricted size range of 23 to 26 mm (carapace length). If we can assume that the sample reflects the size composition of the shoals on which

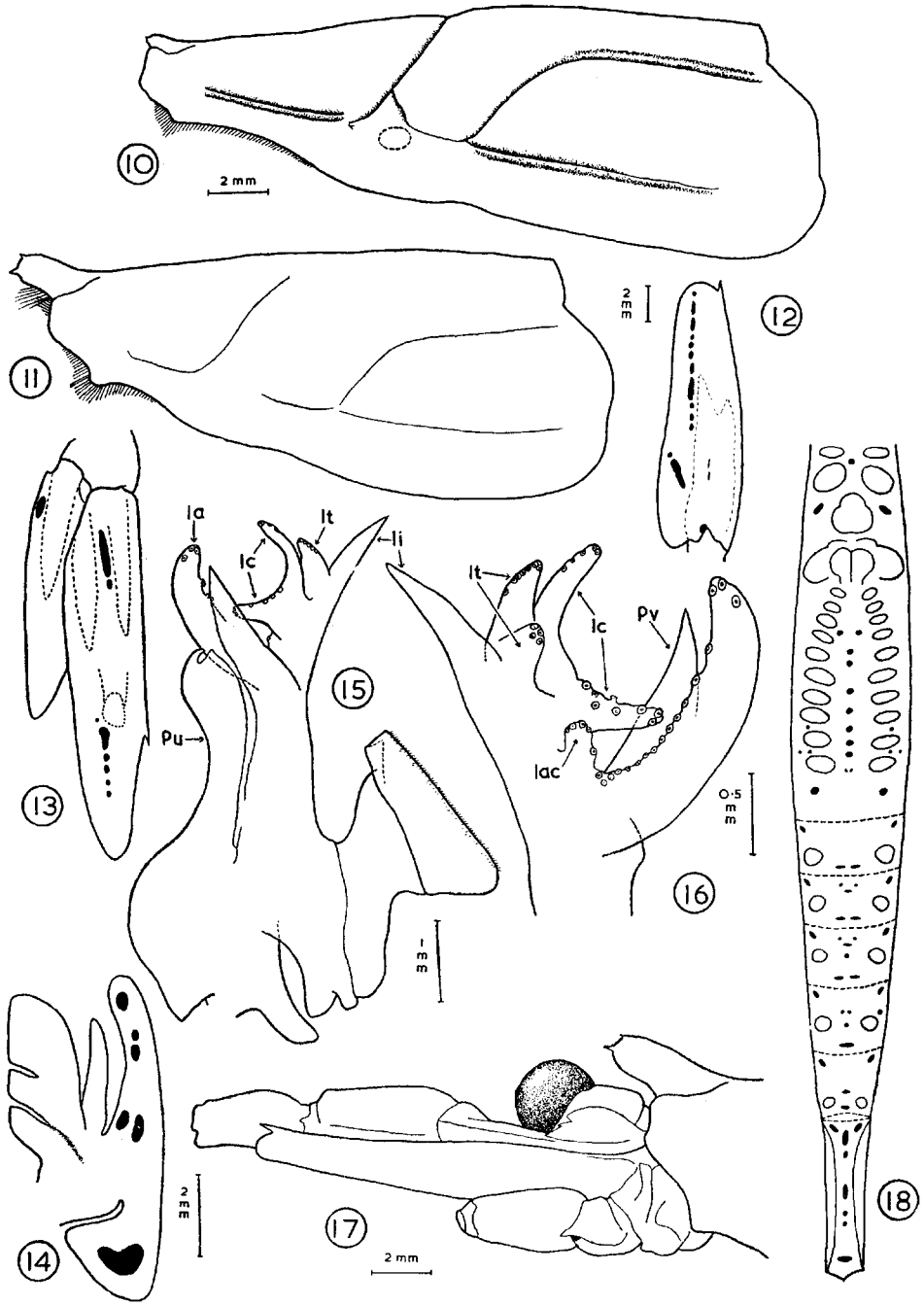



FIG. 10. *Sergestes* cf. *S. seminudus,* carapace, lateral view (anterior organ of Pesta represented by broken circle) ♀.

FIGS. 11–18. *Sergestes potens.* Fig. 11—Carapace, lateral view, ♂. Fig. 12—Left scaphocerite, ventral view (setae omitted), ♀ 27 mm. Fig. 13—Left uropod, ventral view (setae omitted), ♀ 27 mm. (Figs. 11–13 drawn to same scale. Photophores represented in black.) Fig. 15—Right petasma, posterior view, ♂ 24 mm. Fig. 16—as preceding, anterior view. Fig. 17—Anterior part cephalothorax, lateral view (setae omitted), ♂ 23 mm. Fig. 18—Diagrammatic view ventral surface to show photophore distribution. (Bases of appendages open circles, photophores in black.)

the fish were feeding, the uniformity of size range within these shoals should be noted.

The following measurements were taken from mature specimens of both sexes (mm):

| | *Male.* | *Female.* |
|---|---|---|
| Length entire | 87.5 | 113 |
| Length carapace | 24 | 32 |
| Length rostrum | 1.5 | 2 |
| Length abdomen | 51 | 66 |
| Length 3rd somite abdomen | 9 | 11 |
| Length 6th somite abdomen | 12 | 15 |
| Length telson | 11 | 13 |
| Length 3rd maxilliped | 32.5 | 45 |
| Length 1st pereiopod | 24.5 | 34 |
| Length 2nd pereiopod | 35 | 48 |
| Length 3rd pereiopod | 38.5 | 60 |
| Length 4th pereiopod | 28.5 | 37 |
| Length 5th pereiopod | 16.5 | 21 |

The male was chosen from the commonest size range (carapace length 24 mm) while the female is the largest specimen in the collection (length entire about 113 mm). This female is, as far as I can ascertain, only surpassed in size by one other specimen of the genus *Sergestes* recorded in the literature. This is the type male of the closely related *S.* (*Sergia*) *maximus* Burkenroad, 1940, with a length of about 136 mm (carapace length 41.5 mm). The type female of *S.* (*Sergia*) *inous* Faxon, 1893, is also given as 113 mm in length. The length entire is measured from the tip of the rostrum to the posterior tip of the telson and is inaccurate, due to the difficulty in extending the abdomen.

## COLOUR IN LIFE

The only specimens seen in a fresh condition were the damaged female from Collection 83 and the undamaged female from Collection 100. Each was examined within a few hours of capture and the following colour notes combine the observations made on both:

Entire body and appendages uniform scarlet, eyes black, organs of Pesta absent, numerous intense purple lens-less photophores (fading to yellow in preservative) arranged as follows:

CARAPACE: An irregular patch present behind base of antennule and above ventrolateral angle, an irregular row in roof of branchial chamber at level of suprabranchial ridge.

EYESTALK: None.

ANTENNULAR PEDUNCLE: 2 distoventrally on 3rd segment.

ANTENNAL PEDUNCLE: 1 distolaterally on penultimate segment, 1 distoventrally on ultimate segment.

SCAPHOCERITE: 1 ventrally at articulation and a longitudinal row of about 9–11 irregularly spaced in distal two-thirds. One long streak and 1 small spot diagonally in proximal third.

MANDIBLE: 1 at distal end of proximal segment of palp.

1ST MAXILLA: None.

2ND MAXILLA: 5 on anterior half of exopodite and a large kidney-shaped one on posterior half.

1ST MAXILLIPED: 1 on the penultimate segment of the exopodite.

2ND MAXILLIPED: 1 proximally on merus, 1 distally on both carpus and propodus.

3RD MAXILLIPED: 1 distodorsally on both merus and carpus, and 1 distoventrally on propodus.

1ST PEREIOPOD: 1 proximally on ischium, and 2, one larger than the other, proximally on the merus.

2ND PEREIOPOD: 1 proximally and 1 distally on ischium, none on merus.

3RD PEREIOPOD: 2 on ischium as in 2nd pereiopod, row of 8–13 on merus.

4TH PEREIOPOD: 2 on ischium as in 2nd pereiopod, 1 distally on merus, and 2 distally on carpus. 2 internal pigmented patches were visible by reflected light, 1 on ischium and 1 proximally on merus; these were found on dissection to be similar in structure to the externally visible photophores.

5TH PEREIOPOD: 2 on ischium as in 2nd pereiopod, 1 distally on both merus and carpus.

1ST PLEOPOD: 1 proximally on exopodite.

2ND–5TH PLEOPODS: 2 distolaterally on coxopodite, 1 distally on basipodite, and 1 proximally on exopodite.

UROPOD: 1 at proximomedial angle of both endopodite and exopodite, an irregular streak and spot longitudinally on proximal third and an irregularly spaced longitudinal row of about 5 on distal third of exopodite.

THORACIC STERNUM: 1 between bases of antennae. 1 large one each side of labrum. 2 between bases of 1st–2nd maxillipeds. 1 between bases of 2nd–3rd maxillipeds. 1 between bases of 3rd maxillipeds. 1 between bases of 1st–2nd pereiopods. 1 between bases of 2nd–3rd pereiopods. 1 median and 1 pair between bases of 3rd–4th pereiopods. 1 between bases of 4th pereiopods. 1 median and 2 pairs (1 large and 1 small) between bases of 4th and 5th pereiopods. 1 median pair between bases of 5th pereiopods. 1 large one behind base of each 5th pereiopod.

ABDOMINAL STERNUM: Each sternite (1st–6th) with one prominent antero-lateral pair and in addition in the midline: 1st sternite, 1 pair behind bases of pleopods. 2nd sternite, 1 pair and 1 unpaired in front of, and 1 pair behind, bases of pleopods. 3rd sternite, 1 pair and 1 unpaired in front of, 1 unpaired between and 1 pair behind, bases of pleopods. 4th sternite, 1 pair in front of, 1 unpaired between, and 1 unpaired behind, bases of pleopods. 5th sternite, 1 unpaired between and 1 unpaired behind, bases of pleopods. 6th sternite, a median longitudinal row of 4–6 irregularly shaped photophores (the posterior one wider than long).

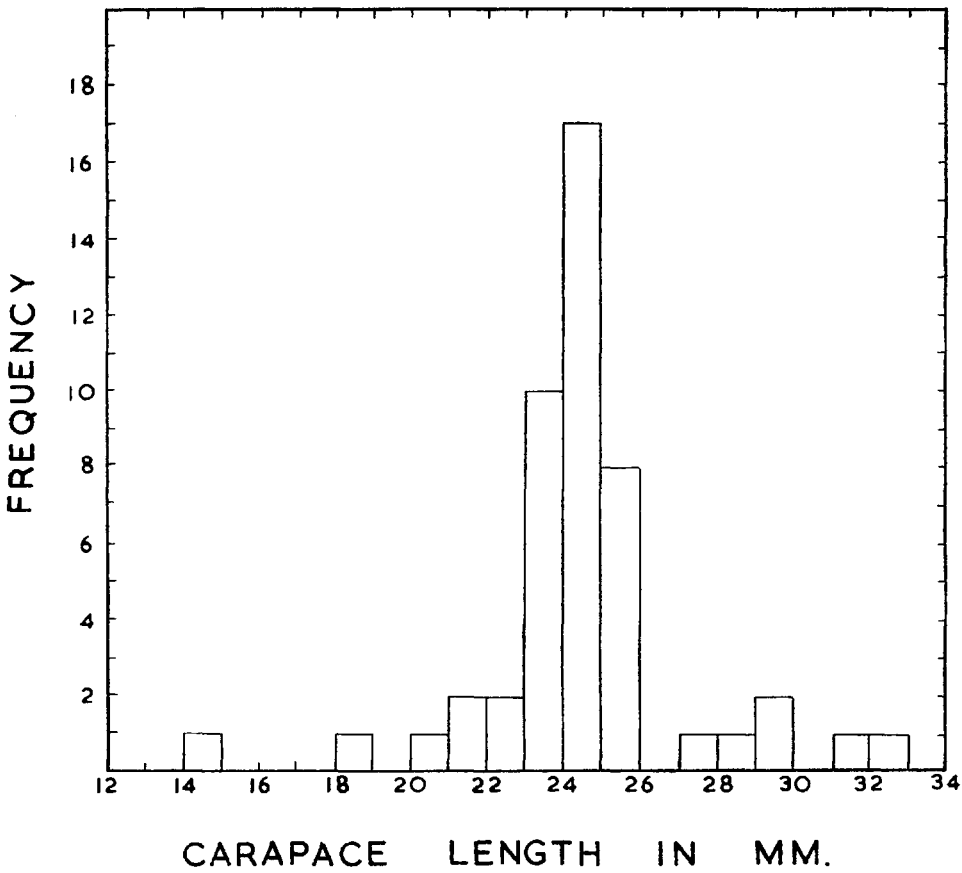



FIG. 19. *Sergestes potens*. Size frequency histogram for the 47 specimens collected by the Pawley brothers in 1941.

ABBREVIATIONS USED IN FIGURES.

la—lobus armatus.
lac—lobus accessorius.
lc—lobus connectens.
li—lobus inermis.
lt—lobus terminalis.
Pu—processus uncifer.
PV—processus ventralis.

## SYSTEMATIC POSITION

The presence of lens-less dermal photophores on the body and appendages indicates that this species belongs to the "*S. robustus*" group of the subgenus *Sergia*. Within this group the characters of the petasma, and photophore distribution where known in any detail, immediately distinguishes it from all species except *S. bisulcatus, S. phorcus, S. grandis* and *S. potens*. Thus it remains to examine the relationships of these species and to compare them with the New Zealand specimens described above.

In 1893, Faxon gave a very short and incomplete "preliminary description" of a new species of *Sergestes, S. phorcus,* taken by the U.S. Fish Commission Steamer *Albatross,* during 1891, from a number of stations between the Galapagos Islands and the Gulf of California. When he published his definitive account of the Stalk-Eyed Crustacea of this Expedition in 1895, he more fully described and illustrated this species, but placed it doubtfully as a synonym of the Indian Ocean *S. bisulcatus* Wood-Mason, 1891, the latter's description being not detailed enough to permit him to be sure of this identification.

Hansen (1896), in his comprehensive summary of the genus *Sergestes,* accepted *S. phorcus* as a synonym of *S. bisulcatus* in his checklist of species. In 1905, Stebbing described and illustrated two females from South African waters, collected from a depth of 250 to 300 fathoms off a bottom of green sand and mud, and identified them with Faxon's species, though he too was not certain of its association with *S. bisulcatus* Wood-Mason. Stebbing's specimens were described as "red, fading to orange".

Hansen (1919) in his review of part of the genus, based on a study of the specimens collected by the *Siboga* Expedition to the Netherlands East Indies, 1899–1900, re-established *S. phorcus* as a species distinct from *S. bisulcatus* Wood-Mason on the shape of the rostrum and petasma. Since Faxon's (1895) paper, a further description of *S. bisulcatus* Wood-Mason had been published by Alcock (1901) and this, with the new illustrations given of the same species by Hansen, made it quite clear that it was distinct from the species illustrated by Faxon (1895) and from that illustrated by Stebbing (1905). In his paper Hansen introduced the special study of the petasma, the male copulatory organs on the first pair of pleopods. He found them of primary systematic importance in the family Sergestidae. On Pl. I he illustrated in detail the left petasma of *S. bisulcatus* W.-Mason. He stated (p. 5) that he has seen several adult specimens of *S. phorcus* in the material collected in the North Atlantic by the Prince of Monaco.

In 1922 Hansen, describing the *Sergestes* collected during the expeditions of the Prince of Monaco, 1885–1915, admitted that the specimens he identified in 1919 as *S. phorcus* belonged to a species since described from the North Atlantic as *S. grandis* Sund, 1920. He further described this species and gave detailed illustrations of the petasma, comparing it with drawings of the petasma of *S. phorcus* supplied to him by Dr. Waldo L. Schmitt, of the U.S. National Museum from one of Faxon's cotypes. He regarded *S. bisulcatus* Stebbing (non Wood-Mason) as *S. grandis,* though only females had been recorded. From the material collected by the S.S. *Pickle* in South African waters during 1920–21, Hansen (in Calman, 1925) also identified three females and four immature specimens, collected from 270 fathoms and deeper, as *S. grandis* Sund.

Burkenroad (1937a), describing Sergestidae from the Templeton Crocker Expedition to the Lower Californian Region, illustrated for the first time the petasma of *S. phorcus* Faxon. This figure shows clearly the long, gently tapering, lobus ventralis, reaching beyond all the other lobes of the distal portion of the pars media; the lobus terminalis with a weakly developed basal protuberance, though clearly not bilobed; and the lack of a lobus accessorius at the base of the long lobus armatus. Burkenroad also gave a partial record of the distribution of lens-less photophores in this species.

In 1940 Burkenroad gave preliminary descriptions of 18 new species of *Sergestes* from the collections of the Danish Oceanographical Expeditions in the *Dana*. *S.* (*Sergia*) *potens* is described from off the coast of South Africa (Station 3975 VII, open N2M on about 300 fms. of wire over about 1,375 fms. off Cape Town), and is stated to be " nearly related to *S. phorcus* Faxon ". This species is described as having a petasma much as in *S. phorcus* and *S. grandis,* however, the processus ventralis is " expanded at base with slender tip; relatively short, not reaching as far as does the lobus terminalis "; both the lobus connectens and the lobus terminalis are prominently bilobed, each sublobe being armed; and the lobus armatus has " a well-defined lobus accessorius at base larger than that in *S. grandis* ". The specimens from Cook Strait described above agree in every detail with the description of *S. potens* given by Burkenroad. A partial account of the distribution of the lens-less photophores on the type specimen of this species also agrees in all major features with the list given above; however, Burkenroad records photophores on the merus of the 2nd pereiopod where none are present in our specimens from Collections 83 and 100. As he does not mention the photophores on the merus of the 1st pereiopod, " 2nd " may be mistake for " 1st ". Until further fresh material from South African waters is examined, it is impossible to tell if this difference is real or not.

In his " Descriptive Catalogue of South African Decapod Crustacea " Barnard (1950) illustrated and described the petasma and rostrum of two males in the South African Museum from the same haul as Stebbing's (1905) females, but not seen by the latter. From the long lobus armatus and other features he believes these, and consequently Stebbing's specimens, to be *S. phorcus* Faxon. However, he does not appear to have seen Burkenroad's illustration of the petasma of *S. phorcus* (1937a) or his description of *S. potens* (1940). Barnard's specimens, showing the basally expanded, relatively short processus ventralis not reaching as far as the bilobed lobi connectens and terminalis*, are clearly conspecific with the New Zealand material and also agree, in all points recorded and illustrated, with *S. potens* already described from South African waters.

Thus is can be seen that the South African records of *S. bisulcatus* (Stebbing, 1905), *S. potens* (Burkenroad, 1940), *S. phorcus* (Barnard, 1950) and probably *S. grandis* (Hansen, in Calman, 1925) all refer to the same species, and that species must be known as *S.* (*Sergia*) *potens* Burkenroad, which can now be recorded also from Cook Strait, New Zealand.

## BATHYMETRIC RANGE

The single specimen from Collection 83 was taken during the day in a beam trawl which struck mud bottom at a depth of about 550 fathoms. This had been intended as a bathypelagic haul, and it only unintentionally collected on the bottom. Associated with this specimen of *Sergestes potens* were one specimen each of the typically bathypelagic natants *Sergestes arcticus, Pasiphaea* sp. and *Acanthephyra* cf. *quadrispinosa,* as well as a specimen of the characteristically benthic genus *Sclerocrangon.* Similarly the single specimen from Collection 100 was taken during the day in a beam trawl working on the bottom in about 380 fathoms. Although this was primarily a bottom haul, both *Sergestes arcticus* and *Pasiphaea* sp. were associated as above. As the three bathypelagic forms, but not *S. potens,* have been taken on numerous occasions by mid-water nets in Cook Strait, it is reasonable to suppose that the latter, like the crangonid, is a benthic species, at least during the day.

However, all Sergestidae, with the single exception of the shallow-water genus *Sicyonella,* have been regarded, from the evidence of their statoliths, as nektonic (Burkenroad, 1937b). In particular all members of the genus *Sergestes* examined,

* The presence of a lobus accessorius cannot be ascertained from Barnard's illustration (Fig. 120f) as the petasma is figured from the posterior view only.

have " autogenous statoliths " (i.e., self-secreted cuticular pellets) rather than exogenous concretions (containing material introduced from outside), such as are found in *Sicyonella* and other benthic penaeids. I have examined the statoliths of specimens of *S. potens* from both 1941 and the 1942 collections, as well as one from the Collection 83 specimen, and in every case they consist of transparent oval cuticular pellets, slightly pointed at one end, with no trace of extraneous matter included. I do not consider that the possession of autogenous statoliths is necessarily indisputable evidence against *S. potens* being at least a partially benthic species as apparently is the case in the Japanese *S.* (*Sergia*) *lucens* as recorded by Nakazawa (1915). This paper is in Japanese, but I have seen, in the British Museum (Natural History), an English abstract, provided by the author himself, and referred to by Gordon (1935: 313). Nakazawa states that *S. lucens* (recorded as *S. prehensilis*) lives on a bottom of mud and fine sand during the day in depths down to about 100 fathoms and rises at night to mid-water in winter or to near the surface in summer for " swarming ", where, on dark nights in May and June, their luminescence makes a wonderful sight. They are fished in great quantities, about two miles off shore in Suruga Bay, with floatless purse seins lowered to between 50 and 100 fathoms on dark nights, or in conditions of high turbidity after flooding, during the daytime. *S. lucens* is of great economic importance in Japan, and although the fishery started accidentally in 1894, the total annual catch in 1915 was about 10 million lbs.

Now if *S. potens* had the same habits as *S. lucens* and rose to mid-water nocturnally, shoals could be swept by tidal currents over shallower water and on sinking with the approach of daylight would be taken in large numbers by groper and ling. These fish are voracious bottom-feeders, being recorded down to at least 150 fathoms. That this commonly and regularly happens in Cook Strait is borne out by the fact that the stomach contents of these two fish seasonally contain bathypelagic fish, squid and shrimp, which normally are taken well below the depth at which the fish were caught. It should be pointed out that the Pawley brothers lifted their lines in the morning and from the fresh appearance of these luminous shrimps they were probably taken only a short time before the fish themselves were actually caught.

### GEOGRAPHICAL DISTRIBUTION

Off South Africa; mid-water or on bottom, 250–1,500 fms. (Stebbing, 1905; Calman, 1925; Barnard, 1950), mid-water (about 100 fms.) over 1,375 fms. (Burkenroad, 1940).

Cook Strait, New Zealand; on bottom 380–550 fms., in fish stomachs 30–60 fms.

## **Sergestes (Sergia) japonicus** Bate, 1881

1881. *Sergestes japonicus* Bate, *Ann. Mag. Nat. Hist.* ser. 5, VIII: 194.
1884. *Sergestes mollis* Smith, *Ann. Rept. U.S. Comm. Fish Fisheries* 1882: 419.
1886. *Sergestes mollis* Smith, *Ann. Rept. U.S. Comm. Fish Fisheries* 1885: 93, Pl. XX, Figs. 3–5.
1888. *Sergestes japonicus* Bate, *Challenger Rept.* XXIV: 387, Pl. LXX, Figs. 1–2.
1896. *Sergestes japonicus* Hansen, *Proc. Zool. Soc. London* 1896: 949.
1903. *Sergestes japonicus* Hansen, *Proc. Zool. Soc. London* 1903 (1): 57.
1919. *Sergestes japonicus* Hansen, *Siboga Exped.* XXXVIII: 6.
1920. *Sergestes mollis* Sund, *Michael Sars Exped.* 3 (2): 20, Fig. 34.
1920. *Sergestes mollis* Hansen, *Bull. Mus. Nat. Hist. Nat.* 1920 (6): 478.
1922. *Sergestes mollis* Hansen, *Rés. Camp. Sci. Monaco* LXIV: 75, Pl. IV, fig. 3.
1938. *Sergestes mollis* Welsh & Chace, *Biol. Bull.* LXXIV (3): 367, Fig. 2.
1940. *Sergestes japonicus* Burkenroad, *Ann. Mag. Nat. Hist.* ser. 11, VI: 53.
1955. *Sergestes japonicus* Dennell, *Jour. Linn. Soc. London Zool.* XLII: 403.

### MATERIAL EXAMINED

*Victoria University, Zoology Department, Cook Strait Collections*

Coll. VUZ 82 (Station JUG) as given above—1 ♂ 10 mm.
VUZ 85 (Station CUK) as given above—3 ♂♂ 16–21 mm, 1 ♀ 28 mm.

VUZ 86 (Station CUK) as preceding—1 ♂ 18 mm.
VUZ 93 approx. 41° 53′ S., 175° 14′ E., 24/8/57, 1515–1815 hrs., N4M at 500–600 fms. over at least 1,000 fms.—1 ♂ 21 mm.
VUZ 94 as given above—1 ♂ 17 mm.
VUZ 95 approx. 42° 10′ S., 175° 35′ E., 25/8/57, 0230–0845 hrs., N4M at 500–600 fms. over at least 1,400 fms.—1 ♀ 22 mm.

### SPECIFIC DIAGNOSIS

A large, fragile shrimp with small eyes and a soft and membraneous integument.

Rostrum relatively small and obtuse, hardly projecting beyond the anterolateral margin of the carapace and little raised above the dorsal surface of the latter. Supraorbital and hepatic spines absent. Cervical groove distinct and continuous over dorsum, weak anterolateral ridge from hepatic region towards base of antenna, suprabranchial ridge present.

Eyes relatively small, cornea barely wider than and about one-third as long as distal segment of ocular peduncle. No ocular tubercle. Segments of antennular peduncle not greatly attenuated, proximal longer than second, which is subequal to third. No distolateral spine on margin of scaphocerite. Third maxillipeds not greatly enlarged, subequal in length to 2nd or 3rd pereiopods.

Male with petasma as shown (Figs. 8, 9); lobus connectens very long, armed on lateral margin and distally on inner margin with crochets; processus ventralis shorter, with distinct distal nick; lobus armatus curved, shorter than processus ventralis, but reaching a little beyond lobus inermis, armed on inner margin with small crochets; lobus terminalis a simple armed projection, smaller than the unarmed lobus inermis, between the latter and the base of the lobus connectens.

Female with single blunt posteromedial projection on coxa of 3rd pereiopod.

### BRANCHIAL FORMULA

The relative branchial size and arrangement of the New Zealand specimens agrees with the records for this species (as *S. mollis*) given by Smith (1884; 1886, Pl. XX, Fig. 5) and Hansen (1922). This differs from the more usual arrangement in the genus, as given for *S. arcticus* above, in having an arthrobranch and a branchial lamella above the 3rd pereiopod instead of two arthrobranchs.

### SIZE AT MATURITY

Of the two largest male specimens, each with a carapace length of 21 mm, one is still slightly immature with the petasma as illustrated here, while the other shows the full development of crochets similar to that illustrated by Hansen (1922, Pl. IV, fig. 3 i–m).

### COLOUR IN LIFE

These specimens were uniform scarlet in life with some of the inner mouth parts tinged with purple. This pigment was mainly carried in the cuticle of the body and appendages, although small chromatophores were also present. No dermal photophores of any type present. Organs of Pesta absent.

### SYSTEMATIC POSITION

The membraneous integument and the lack of dermal photophores place these specimens in the "*S. japonicus*" group of the subgenus *Sergia*. The absence of an ocular tubercle and the fact that the cornea is barely wider than the ocular peduncle distinguishes it from *S. tenuiremis, S. kröyeri* and *S. laminatus;* the distinctive rostral profile distinguishes it from *S. profundus* and the branchial formula from *S. inous.*

The Cook Strait specimens agree in every way with the numerous descriptions and figures of the North Atlantic *S. mollis* Smith, which has been shown to be synonymous

with *S. japonicus* Bate taken by the *Challenger* Expedition off Japan (see Hansen, 1896, 1903; Burkenroad, 1940).

### GEOGRAPHIC AND BATHYMETRIC DISTRIBUTION

*Sergestes japonicus* is a well known deep-water species in the North Atlantic. Specimens were taken by the *Michael Sars* Expedition between about 125 and 1,050 fms. but those with a carapace length of 18 mm and over were never taken above 500 fms. (Sund, 1920). In 1938, Welsh and Chace were able to show from their " closing net " data that it is the only species of *Sergestes* in the North Atlantic which normally occurs below the level to which light penetrates (i.e., below the photic zone), being found usually below 500 fms. and regularly down to at least 1,000 fms.

Outside the North Atlantic, it has been recorded from only two localities in the Indopacific. The *Challenger* Expedition took it from deep water off Japan and the Philippines, these records being checked by Hansen (1903).

Thus it is now possible to record this small-eyed, deep-water species from Cook Strait, New Zealand, apparently the first record from the entire Southern Hemisphere.

### CHECKLIST OF SERGESTIDAE RECORDED FROM NEW ZEALAND WATERS

In addition to the species of *Sergestes* discussed above, a single species of the aberrant, pelagic genus *Lucifer* V. Thompson* and an unknown sergestid, referred to as " Gurney's larva ", have been recorded from the New Zealand area.

*" Leucifer batei "* Borradaile was recorded from a *Terra Nova* Expedition plankton haul off the North Auckland Peninsula by Borradaile (1916). In an extensive review of *Lucifer,* published by Hansen in 1919, this species was placed in the synonymy of the widespread, Atlantic and Indopacific *Lucifer typus* M.-Edwards.

In 1924, Gurney described a series of sergestid larval stages, collected by the *Terra Nova* in the New Zealand area, as *" Petalidium foliaceum* Bate? ", later regarding them (Gurney and Lebour, 1940) as probably belonging to the genus *Sicyonella* Borradaile. Burkenroad (1945: 587), referring to this type of sergestid larvae as " Gurney's larva ", predicted that they will belong to an " as yet undiscovered sergestid genus " related to *Peisos* and looked for as " a natant form . . . a suspension feeder commonly ranging just off the bottom (but spawning closer to the surface) in the cold waters at fairly considerable depths over the outer slopes of the continental shelves off South Africa, Tasmania, New Zealand and perhaps southern South America."

Family SERGESTIDAE

Subfamily SERGESTINAE

**Sergestes** M.-Edwards, 1830

*S.* (*Sergestes*) cf. *S. seminudus* Hansen, 1919.
*S.* (*Sergestes*) *disjunctus* Burkenroad, 1940.
*S.* (*Sergestes*) *arcticus* Kröyer, 1855.
*S.* (*Sergestes*) *index* Burkenroad, 1940.
*S.* (*Sergia*) *potens* Burkenroad, 1940.
*S.* (*Sergia*) *japonicus* Bate, 1881.

INCERTAE SEDIS

Gurney's larva.

Subfamily LUCIFERINAE

**Lucifer** V. Thompson, 1830

*Lucifer typus* M.-Edwards, 1837.

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* The relative claims of the two generic names *Lucifer* Vaughan Thompson, 1830 (? preoccupied by Linné, 1760) and *Leucifer* Milne-Edwards, 1837, is discussed in Barnard (1950: 644).

## SUMMARY

The work of the Victoria University Zoology Department in the deep-waters of Cook Strait has produced four adult species of *Sergestes,* three of these being new to the fauna. *S. arcticus,* recorded from the New Zealand area before as a larval stage, was found to be abundant at about 100 fathoms during the night, but apparently sank to deeper waters during the day. This species, well known in the Atlantic from the coast of Greenland to off South Africa, has been recorded from only two other areas in the Indopacific, south of Australia and off the coast of Chile. Observations on the colour of this species in life confirm that it belongs to *Sergestes* s.s., organs of Pesta being present. A single female of another species with organs of Pesta, the specific identity of which is doubtful, is recorded as *S.* cf. *S. seminudus.*

A large, uniform scarlet, partially benthic species, *S. potens,* with dermal lensless photophores, was taken twice with a beam trawl, but occurs in large numbers in the stomachs of groper and ling caught commercially in the area. This species, of which only a preliminary description had been previously published, is described here and its photophore distribution given in detail. It has hitherto been recorded only from off South Africa.

Another large, uniform scarlet species, *S. japonicus,* was taken bathypelagically between about 500 and 600 fathoms on a few ocasions and though well known in the North Atlantic and recorded from Philippine and Japanese waters, this is its first occurrence in the Southern Hemisphere.

The subgeneric division of *Sergestes,* suggested by Burkenroad but never systematically defined, is discussed in detail and formally established. Those species possessing organs of Pesta and lacking cuticular pigmentation, are referred to the subgenus *Sergestes* s.s., and those without organs of Pesta, with cuticular pigmentation and often possessing dermal photophores, to the subgenus *Sergia* Stimpson.

All previous records of Sergestidae from the New Zealand region are discussed, and finally a checklist of the species, now recognised from New Zealand waters, is given.



## ACKNOWLEDGMENTS

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