SYMPOSIUM ON
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MARINE FISHERIES P.O., MANDAPAM CAMP
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MARINE BIOLOGICAL ASSOCIATION OF INDIA

MARINE FISHERIES P.O., MANDAPAM CAMP

INDIA

ON THE TAXONOMY, BIOLOGY AND FISHERY OF THE SPINY LOBSTER *JASUS LALANDEI FRONTALIS* (H. MILNE-EDWARDS)[1] FROM ST. PAUL AND NEW AMSTERDAM ISLANDS IN THE SOUTHERN INDIAN OCEAN, WITH AN ANNOTATED BIBLIOGRAPHY ON SPECIES OF THE GENUS *JASUS* PARKER*

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ABSTRACT

During his participation in the Fifth Cruise of the U.S. Research Vessel ANTON BRUUN in the Indian Ocean, the author was able to visit the remote island of New Amsterdam in the Southern Indian Ocean in April 1964, and make a collection of the spiny lobster *Jasus lalandei frontalis* (H. Milne Edwards).* Recent work on the taxonomy of the genus *Jasus* Parker indicates the need for a reappraisal of the nomenclature, validity and status of the various nominal species described under the genus from the different geographical areas. In order to facilitate such work, a detailed description of the material collected is given here, along with the description of an early post-puerulus stage of this lobster from New Amsterdam Island. The phyllosoma larvae of *Jasus* collected off the islands of St. Paul and New Amsterdam are also described and illustrated. Comments on the distribution for the genus *Jasus* as well as the probable routes of dispersal of the larvae are also discussed. On the basis of the present study, a revised distributional map of the spiny lobsters of the world (Family Palinuridae) is given.

There is a seasonal fishery for *J. l. frontalis** in St. Paul and New Amsterdam Islands where at present the catch is limited to 200 tonnes of lobsters per year. A brief résumè of this fishery, as well as aspects of the biology of this lobster from these islands, is dealt with here. An annotated bibliography of over 250 papers which deal with the taxonomy, biology and fishery of species of the genus *Jasus* is also included with a subject-wise index. [* = *Jasus paulensis* (Heller)].

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[1] The revised nomenclature according to Holthuis (1963) should be *Jasus paulensis* (Heller, 1863). See remarks in "Addendum". Thus for *Jasus lalandei frontalis* (H. Milne-Edwards) from the Southern Indian Ocean read *Jasus paulensis* (Heller) throughout this paper.

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PART I

INTRODUCTION

IN a recent Conference on "A Discussion on the Biology of the Southern Cold Temperate Zone" held under the leadership of Professor C. F. A. Pantin in December 1959, Professor G. A. Knox drew attention to the many wide gaps in our knowledge of the littoral zone of the southern cold temperate and subantarctic regions. There are practically no accounts of the littoral ecology of any of the isolated antarctic and subantarctic islands and "....*in particular St. Paul and New Amsterdam Islands are almost completely unknown*" (Knox, 1960) (Italics mine). The mere fact that these two islands are the remotest from any land mass in the area of the Indian Ocean highlights the need for a thorough investigation of the faunal and floral elements both marine and terrestrial of these islands which would undoubtedly throw considerable light on problems relating to speciation. St. Paul and New Amsterdam Islands are situated 38° 43′ S.–77° 30′ E., and 37° 51′ S.–77° 32′ E, respectively. During the last 110 years several scientific expeditions have worked in various parts of the Indian Ocean, but as will be seen from the accompanying figure (Fig. 1) only few have ever touched the islands of St. Paul and New Amsterdam. They are "Novara" (1857–1859), "Gazelle" (1874–76), "Valdivia" (1898–99), "Gauss" (1902–03), "Sapmer" (1950) and "Anton Bruun" (1964). Since 1950, "Sapmer" has made regular fishing cruises to these islands. Other than these, even occasional visits to these islands by ships in transit are rare (except taking off and bringing replacement of personal for the meteorological unit at New Amsterdam) on account of their remoteness and the inhospitable weather conditions that prevail in the area for about six months in the year during the southern winter.

An opportunity to visit one of these islands came by during my participation in the V cruise of the United States Research Vessel "Anton Bruun" in the Indian Ocean when she touched St. Paul Island on 7–4–1964 and New Amsterdam Island on 8–4–1964. One of the striking things that was noticeable in the littoral zone of New Amsterdam Island was the 'invasion' at dusk of the intertidal rocky areas by lobsters some of which were collected for study and identified by me as *Jasus*

[1] The nomenclature should according to Holthuis (1963) be *Jasus paulensis* (Heller, 1863).

lalandei frontalis[1] (H. Milne-Edwards), based on a preliminary review of the genus by Holthuis (1946).

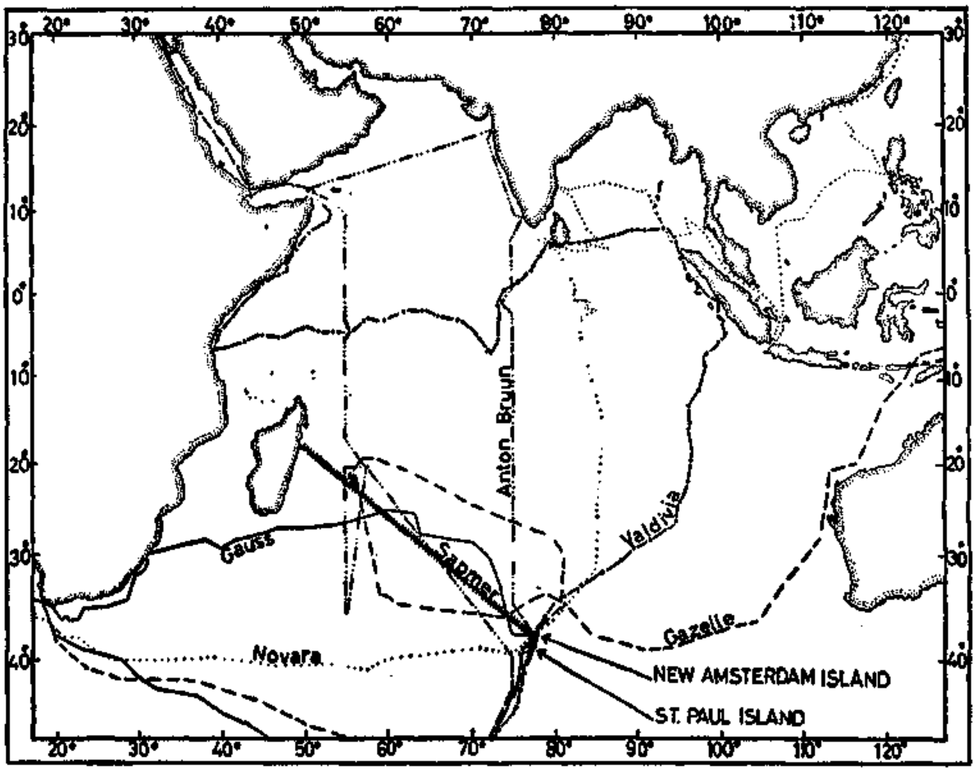

FIG. 1. Map showing the routes in the Indian Ocean of the important scientific expeditions that have also visited St. Paul and New Amsterdam Islands. (Besides these, as part of the IIO Expedition, R.V. *ARGO* stopped at St. Paul for a day in December 1961, and R.V. *ARGO* and R.V. *HORIZON* worked off these islands in November 1962. See Fisher *et al.*, 1964).

A part of the present paper is based on the collections made by me and also collections of phyllosoma larvae obtained from the vicinity of these islands in plankton hauls made at night. Holthuis (1946) in his preliminary review of the genus *Jasus* Parker recognises only two species and one variety (subspecies ?) and remarks that " Comparison of material from the different localities is, however, needed to obtain final certainty" about the valid forms. Remarking about *J. lalandei frontalis* from Juan Fernandez Island, Chace and Dumont (1949) say that "Although very distinct at the limits of its range, from the South African and Australian form *J. lalandei* it is not yet certain that this form is a valid subspecies." Since *J. lalandei frontalis* is the variety or subspecies which occurs in St. Paul and New Amsterdam Islands these statements are of interest. However, Angot (1951 *a*, 1951 *b*), and Grua (1960 *a*, 1960 *b*) denote the lobster here merely as *Jasus lalandii*, while the latter author (Grua, 1963, 1964) treats this under *Jasus paulensis* (Heller), which Holthuis (1946) considers a synonym of *J. l. frontalis*. In the collections that I have with me from New Amsterdam Island, there is a graded series representing sizes from the past-puerulus stage to the adult of this spiny lobster. This has enabled a study of the amount of variability with growth of the

[1] The revised nomenclature according to Holthuis (1963) should be *Jasus paulensis* (Heller, 1863).

diagnostic characters on which the subspecies is based, as well as draw attention to the salient differences between males and females of different sizes, all of which may eventually be utilized for drawing comparisons with the *forma typica*.

The description of the phyllosoma stages of this subspecies given here represents the first report of them to come from the southern Indian Ocean.

As is well known, the species of the genus *Jasus* which are confined to the temperate regions of the southern hemisphere are commercially the most important of all spiny lobsters fished at present as will be evident from the large-scale fisheries they support in South Africa, and South West Africa, Australia, New Zealand, Juan Fernandez Island, and Tristan da Cunha Island. It was possible to obtain some information from the French Meteorologists stationed at New Amsterdam Island at the time of our visit about the fishing conditions for the langouste (*Jasus*), around the two islands. The information obtained corroborates Angot's findings made 14 years earlier during the "Sapmer" expedition from 1 January to 5 April, 1950 sponsored by the Institute of Scientific Research of Madagascar (Angot, 1951 *a*, 1951 *b*), and subsequently by Grua (1960 *a*, 1963). The summary of the observations on fishing is dealt with in a separate section in this account.

The examination of the phyllosoma stages also led to a perusal of the earlier literature on the larvae of *Jasus*, necessitating some comments to be made here on patterns of distribution, transport of larvae by ocean currents, etc. The spatial distribution of *Jasus* is also discussed in the light of known facts about the biogeography of the southern oceans.

In the course of the work, it was possible to index over 250 papers pertaining to the systematics, biology, fishery, and fishery technology relating to species of the genus *Jasus* Parker. Since the coverage is comprehensive and includes almost all important works dealing with this group, an annotated bibliography and a subject-wise index is given at the end to facilitate reference.

I wish to express my sincere thanks to Dr. S. Jones, Director, Central Marine Fisheries Research Institute, Manadapam Camp, for his kind encouragement in the course of this work. A part of this work was supported by the United States National Science Foundation as part of the U.S. Program in Biology, International Indian Ocean Expedition.

In the course of the preparation of this paper I have received valuable assistance in the form of advice and much needed literature from Dr. M. Angot, Institute of Scientific Research, Madagascar; Dr. M. Andre, Paris; Dr. D. R. Fielder, University of Townsville, Australia; Dr. R. W. George, Western Australian Museum, Perth, Australia; Dr. Paul Grua, Station Biologique, Roscoff, France; Professor V. V. Hickman, University of Tasmania, Tasmania; Professor C. F. A. Pantin, F.R.S., University of Cambridge, England; Professor Otto Pesta, Akademie der Wissenschaften, Austria; Dr. R. W. Rand, Union of South Africa; and the late Dr. Keith Sheard, C.S.I.R.O., Australia. My special thanks are due to Dr. Michael M. Mullin, at present at the Scripps Institution of Oceanography, La Jolla, California, who kindly passed on to me for study the phyllosoma larvae from the special plankton collections he made while on the V Cruise of R. V. Anton Bruun, and described in this paper. I am also thankful to Mr. K. N. Prasad for his help in the preparation of the drawings. It also gives me great pleasure to record here my sincere thanks and appreciation to each and every member of the French Government Meteorological Unit stationed at New Amsterdam Island at the time of our visit but for whose help it would not have been possible for me to carry out much of the observations.

TAXONOMICAL NOTES ON THE GENUS *Jasus* PARKER

Holthuis (1960) proposed the addition of the generic name *Jasus* Parker (1883) to the official list of generic names in zoology. A distinct rostrum is wanting or the rostrum is rudimentary in the genera *Jasus, Palinurus*, etc., but the absence of stridulating organs in *Jasus* is characteristic for the genus. Bernard (1950) mentions in a foot note that Von Bonde, W. (1930) claimed that the peduncular joints of the first antenna show a constant ratio in the phyllosoma, puerulus and adults in the three South African genera *Jasus*, *Palinurus*, and *Panulirus*. Barnard confirms this to be the condition in the first two genera, while in *Panulirus* he finds the third peduncular joint of the antenna slightly shorter than the second. He has also experienced difficulty in separating the genera *Palinurus* and *Jasus* on the actual ratios of these segments given by Von Bonde, W., and used instead the presence or absence of the stridulating organ as the chief character to distinguish them. *Jasus* also possesses a rudimentary rostrum clasped by lateral processes. This is shown in Fig. 4 (early post-puerulus stage) and Fig. 2: 2 (adult male) given in this paper.

Jasus is the only genus of Palinuridae known so far to occur around St. Paul and New Amsterdam Islands.

At least seven species described at one time or other under the genera *Homarus*, *Jasus*, *Palinostus* and *Palinurus* are at present referable to the genus *Jasus*. Holthuis (1946) has shown that *Jasus parkeri* Stebbing (1902)should belong to the genus *Puerulus* as can be seen from its original description and figures which also indicated a distinct stridulating organ which as already mentioned is absent in *Jasus*. However, recently George and Grindley (1964) have erected a new genus *Projasus* to accommodate *J. parkeri* and have shown that as in *Jasus*, *Projasus* also lacks the stridulating organ and occupies an intermediate position between *Jasus* and *Palinurellus*, the other two genera of the division "Silantes". The two species and a variety (subspecies ?) of *Jasus* recognised by Holthuis (1946) are as follows:

1. *Jasus lalandei* (H. Milne-Edwards)

   A. *Jasus lalandei lalandei* s. str.

   B. *Jasus lalandei* var. *frontalis* (H. Milne-Edwards)

      Synonyms:

      Jasus paulensis (Heller)

      Jasus edwardsii (Hutton)

2. *Jasus verreauxii* (H. Milne-Edwards)

   Synonyms:

   Jasus hugelii (Heller)

   Jasus tumidus (Kirk)

The diagnostic character distinguishing the typical form *J. l. lalandei* from *J. l. frontalis* is the squamiform sculpturation on the back of the abdominal segments which in the former occupy the entire surface of the segment, while in the latter, a broad and conspicuous smooth band is present along the anterior and posterior margins of each segment, being most marked in the first segment. In this study it has been possible to check the consistency of this character in relation to the size of the specimens and confirm the diagnosis of the variety or subspecies used first by Parker (1887) (to separate *J. edwardsii* from *J. l. lalandei*), and Holthuis (1946).

The New South Wales, Victoria (Australia) and New Zealand (?) species *Jasus verreauxii* (H. Milne-Edwards) can be easily distinguished from *J. l. lalandei* and *J. l. frontalis* by its greenish colour; the upper part of the abdominal segments bearing pimple-like scattered elevations; and the epimeres being serrated posteriorly. In addition, no transverse grooves are present in any of the segments (*see* Gruvel, 1911 *a*; Chace and Dumont, 1949).

Jasus lalandei VAR. *frontalis* (H. Milne-Edwards)[1]

(*Palinurus frontalis* H. Milne-Edwards, 1837: Synonyms: *Palinurus paulensis* Heller, 1862 et 1865; *Palinurus edwardsii* Hutton, 1875 *a*.)

1. *Material*

Phyllosoma stages.—2 specimens from 35° 45′ S., 70° 36′ E. in night 15 minutes surface plankton tow at 21·30 hours on 2–4–1964 (Fig. 5).

Phyllosoma stage.—1 specimen from 33° 22′ S., 74° 56′ E. in night 15 minutes surface plankton tow at 21·30 hours on 10–4–1964 (Fig. 5).

Early post-puerulus stage.—1 specimen from inter-tidal rock pool at New Amsterdam Island collected on 8–4–1964.

Juveniles and adults.—2 females and 4 males collected from between rocks in inter-tidal region at New Amsterdam Island on 8–4–1964.

2. *Description of* Jasus lalandei *var.* frontalis[1] *from New Amsterdam Island*

In view of the fact that a number of drawings are given here, it is not proposed to go into descriptive details unless necessary. The adults and young including the post-puerulus stage in the collection range from 27·5 mm. to 238·0 mm. in total length measured from base of rostrum. The details are given in the accompanying table (Table I).

TABLE I

(Measurements in millimeters)

Characters	Juveniles and adults						Early Post-Puerulus stage
	1	2	3	4	5	6	7
Total length (excluding rostrum) ..	238·0	202·0	150·0	103·0	81·0	58·5	27·5
Length of carapace (excluding rostrum)	95·0	78·0	55·0	39·0	30·5	23·6	10·3
Length of rostrum ..	4·0	4·7	3·5	2·3	2·0	1·5	0·5
Length of 2nd pedunculate joint of antennule ..	15·1	13·0	9·5	5·5	4·2	3·3	0·9
Length of 3rd pedunculate joint of antennule ..	21·1	18·5	11·7	6·5	5·5	4·0	1·5
Shell condition* ..	HOS	HOS	HOS	HOS	HOS	HNS (?)	HS
Sex ..	M	M	F	M	F	M	M

* HOS = Hard old shell; HNS = Hard new shell; HS = Hard shell.

Earlier descriptions of this lobster from St. Paul and New Amsterdam Islands may be found in the works of Heller (1862, 1865), and Angot (1951 *a*, 1951 *b*), while passing references to it are to be found in the works of Veilan (1878), Andre (1932), and others. In none of these is any emphasis placed on the nature of the sculpturation on the abdominal segments. Figure 2: 2 and Fig. 3: 1–12 show the nature of the sculpturation in specimens of sizes 58·8 to 238 mm. in total length. The general pattern is more or less the same and the non-sculptured anterior and posterior parts of each segment are well marked even from the earliest stage. In the post-puerulus stage

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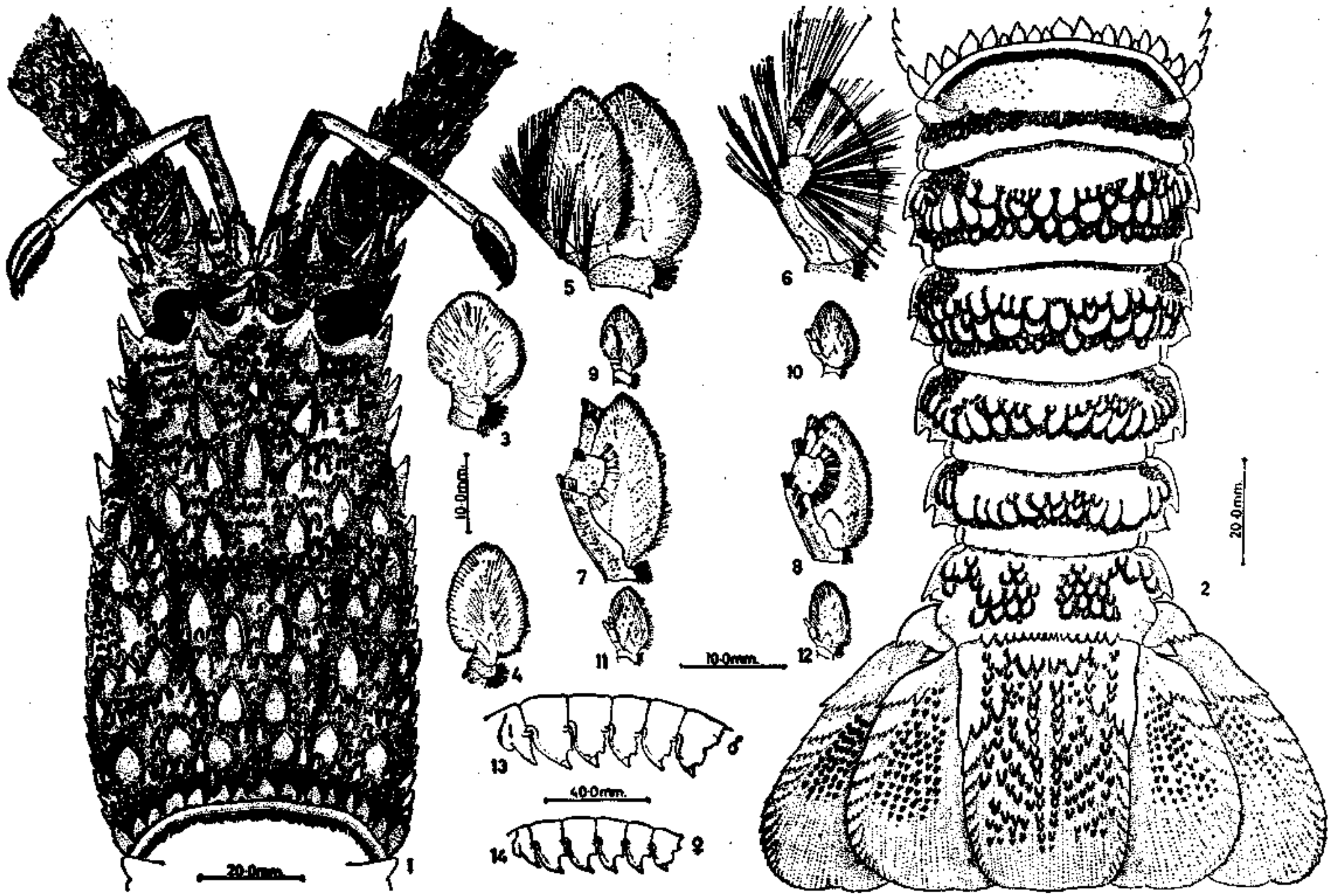


FIG. 2. *Jasus lalandei frontalis* (H. Milne-Edwards).[1] From New Amsterdam Island. (1-2) Dorsal view of carapace and abdomen of male 23·8 cm. in length. (3-4) First and third pleopods of same. (5-8) pleopods one to four respectively of female 15 cm. long (long hairy setae not shown in 3rd and 4th pleopods). (9-12) Pleopods one to four respectively of female 8·1 cm. long. (13-14) Lateral view showing the disposition of epimeres in male 20·2 cm. and female 15·0 cm. long. [1 = *J. paulensis* (Heller)].

(Fig. 4) faint indication of the sculpturation is seen not as uneven surface, but in the colouration of the area by reddish pigments, where the squamiform sculpturation eventually develops. The constancy of this character thus helps to confirm its usefulness as a reliable criteria for separating the representatives of *Jasus* from St. Paul and New Amsterdam Islands from the typical *J. l. lalandei.*

Holthuis (1946), however, remarks that the aforesaid character of squamiform sculpturation [in the case of *J. edwardsii*, and *J. l. lalandei* as given by Parker (1887)] "....is of too little importance to be of specific value." Thus the specimens of *Jasus* from Tristen da Cunha, Juan Fernandez, New Zealand, and St. Paul are considered representatives of one variety of *J. lalandei*, namely *J. l. frontalis* "....differing only in the sculpture of the abdomen." Reference may be made to the section on "Distribution" for further discussion on this point.

3. *Observation on Additional Characters of Juveniles and Adults of* Jasus lalandei frontalis

Carapace.—There appears to be no noticeable difference in the carapace in males and females. However, with age specimens show an enlargement of the spines and spinules. The rostrum is rudimentary and in the male 23·8 cm. figured (Fig. 2: 1) it is abnormal in that it exists as two short-pointed processes instead of one.

Walking legs.—Sexual dimorphism is seen in the nature of walking legs, especially in the fifth pereiopod the propodus which in the male is simple at the distal inner end and the dactylopodite armed along its inner side with spinous hairs (Fig. 3: 18). In the female the fifth pereiopod shows a conspicuous claw-like spine in the distal inner side of the propodus which when juxtaposed with the claw-like dactylopodite gives a subchelate appearance and acts as chelae in berried females helping to keep the eggs clean of foreign matter. After hatching, the egg shells attached to the ovigerous setae of the pleopods are also removed by them.

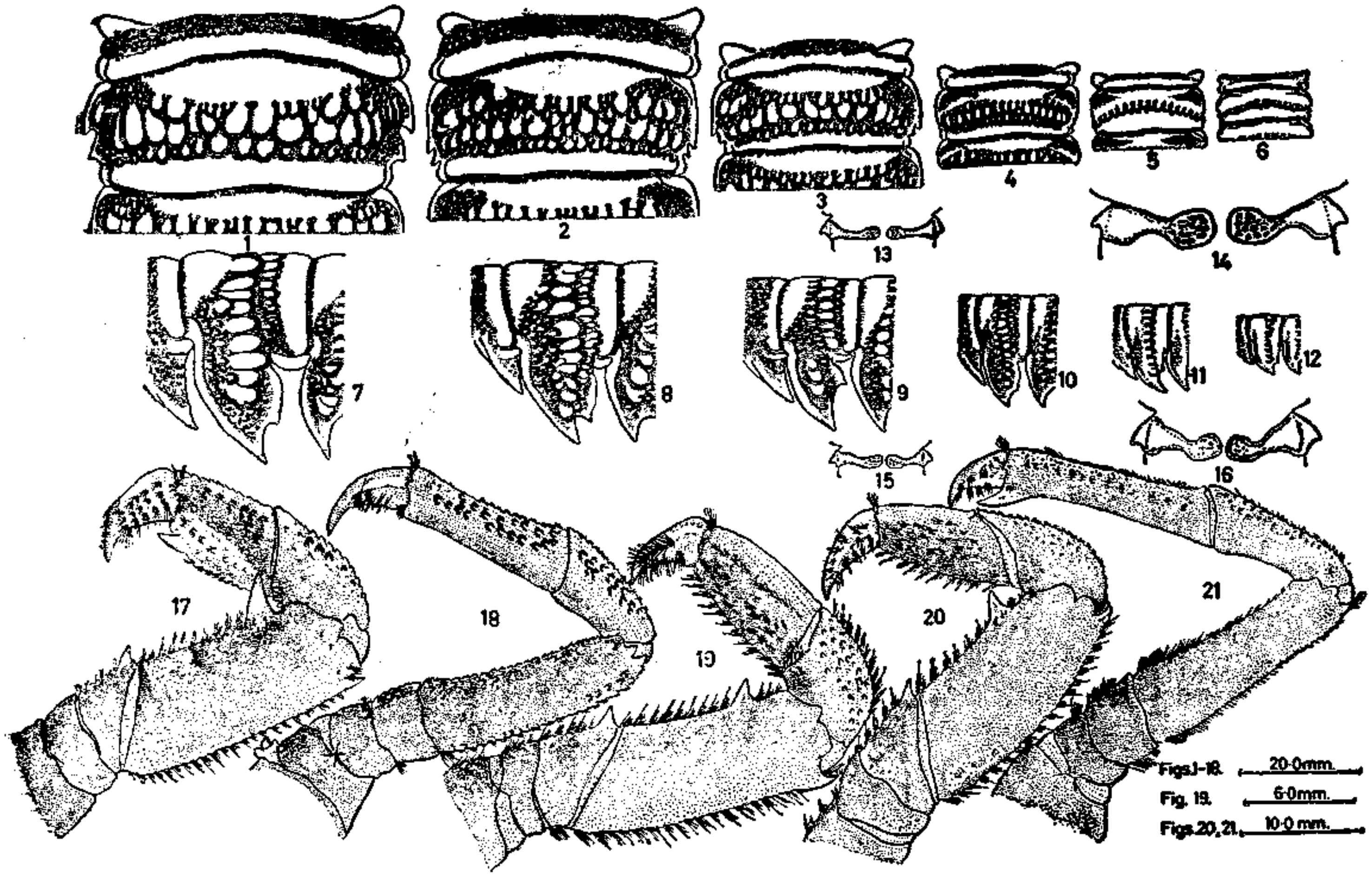
The first pereiopod in the male is robust and short (Fig. 3: 17) and unlike in the female. the propodus is more or less rectangular in outline bearing an enlarged spine at its inner distal end The ischiopodite as well as the meropodite in the male bear a strong claw-like spine each at their distal ends. In the female (Fig. 3: 20–21) the propodite of the first pereiopod is relatively narrower and tapering towards the distal end without any conspicuous spinous process at its distal inner end. The dactylopodite is also relatively smaller, so also the spines on the ischiopodite and meropodite. In a male 103 mm. the propodus of the first pereiopod does not show the strong spine at its distal inner end and as in the female, the propodus slightly tapers distally (Fig. 3: 19).

According to Angot (1951 *a*) the walking legs in the male are relatively longer than in the female.

Abdomen.—The sixth chitinous transverse plate of the tergum of the abdomen immediately preceding the telson in the male carries tufts of short setae at the inner extremities of the two halves. This is evident even in the smallest male in the collection (Text-Fig. 3: 13–14). Angot (1951 *a*) remarks that the tufts of hairs on the chitinous transverse plates are absent in the female. In the present material the large female shows the absence of the tufts of setae (Fig. 3: 16) in the place of which the tergal plates bear a few punctations. The smaller female specimen, however, shows distinct tufts of hairs as in the young and adult males (Fig. 3: 15). It will be interesting to know whether in the female the tufts of setae on the chitinous tergal plates are lost with moulting from young to adult.

The epimeres of abdominal segments of males are directed towards the rear, while in the females (larger specimens especially) they are directed vertically downwards and towards their extremity turned backwards (Fig. 2: 13–14). This difference in the disposition of the epimeres is drawn attention to by Angot (1951 *a*) in larger specimens where the character is still more marked.

The first and third pleopods of the males are figured (Fig. 3: 3–4) in order to show the uniramous condition, the endopodite being absent, The exopodite is broad and leaf-like and the



FIGS. 3. *Jasus lalandei frontalis* (H. Milne-Edwards).[1] From New Amsterdam Island. (1–6) and (7–12) Dorsal and lateral view of abdominal segments showing pattern of squamiform sculpturation in six specimens 23·8 cm. to 5·85 cm. (sequence as given in Table I) in total length. (13–14) Chitinous transverse tergal plates of males 5·85 cm. and 23·8 cm. long showing tufts of hair or setae on expanded symphysial end of plates. (15–16) Same of females 8·1 cm. and 15·0 cm. the former showing the presence and the latter the absence of the setae. (17–18) 1st and 5th pereiopods of male 23·8 cm.. (19) 1st pereiopod of male 10·3 cm. (20–21) 1st and 5th pereiopods of female 15·0 cm. long [1 = *J. paulensis* (Heller)].

inner margin of the protopodite carries elongate setae. In the females the pleopods are biramous, but the pair on the second abdominal segmant have the exopodites and endopodites equally well developed, being broad and leaf-like (Fig. 3: 5). The pleopods of the third, fourth and fifth somites have undeveloped endopodites which are narrower, three segmented, and provided with long ovigerous setae to assist in the attachment of eggs when the lobster is in berry. The pleopods of a very small female measuring 85 mm. shows the endopodite of the second somite to be considerably smaller than the exopodite and devoid of the marginal elongate setae. The endopodites of the second, third, and fourth pleopods are relatively shorter and rod-like breft of the long setae. For the purpose of comparison, drawings made to scale of these along with the pleopods of an adult female are given side by side (Fig. 2: 5–8 and 9–12).

Grua (1964) has drawn attention that at St. Paul and New Amsterdam Islands after egg-laying (May and June) and hatching takes place (August and September), the ovigerous setae become very variable in size on account of damage caused to them by the animal while removing the empty egg shells. Pilosity becomes complete again during the southern summer as a result of a moult distinct from the prebreeding moult.

Other sexual differance that can be noticed externally is the genital opening of the male which is situated on the coxopodites of the fifth pereiopod and the female on the coxopodites of the third pereiopods.

Description of Early Post-Puerulus Stage of *Jasus lalandei frontalis*[1] from New Amsterdam Island

From a rock pool at New Amsterdam Island it was possible to collect a 27·5 mm. specimen, the measurements of which are given in Table I. There is no description of the puerulus stage or early post-puerulus stage of *J. l. frontalis* from St. Paul and New Amsterdam Islands, except a brief mention by Pesta (1915) of the occurrence of such early stages in these islands and hence it is felt that the description given here may be of interest. The specimen (Fig. 4) has a light yellow body colour except the carapace and alternating bands on the antenna which are faintly reddish. Very rudimentary spinulation is seen on the carapace and the groove separating the cephalic and thoracic regions is clearly visible. Tuberculations or timble-shaped processes bearing short setae between the rudimentary spines of the carapace are absent at this stage. The setae on the dactylopodites of the pereiopods are well developed at this stage, but for which the pereiopods are smooth. As already mentioned the squamiform sculpturation on the sterna of the abdominal segments are not developed although their position is indicated by a faintly red-pigmented band along almost the middle of each segment. The sternum of the segments also show minute punctations which are not seen in adults. The telson and uropods are well developed and show the lateral marginal spinous serrations seen in the adults as well as rudimentary spinulations along their dorsal surface. The expodites and the endopodites of the pleopods are large, leaf-like and bear elongate feather-like setae. Each pleopod also possesses an appendix interna with coupling hooks.

In the case of the typical *J. l. lalandei* from South Africa, Von Bonde, C. (1936) mentions that the phyllosoma 35 mm. long changes into a puerulus of 22 mm. At this stage the puerulus resembles the adult in all characteristics except that the pleopods show difference as at this stage swimming in the animal is carried out mainly by the pleopods and not the telson and uropods as in the adults. The coupling hooks of the appendix interna join together the pleopods in pairs to form efficient swimming organs.

Phyllosoma Stages of *Jasus lalandei frontalis*[1] from the Southern Indian Ocean

In the accompanying map (Fig. 5) the locations from where phyllosoma larvae of *J. l. frontalis* were collected in surface plankton hauls at night are shown. These phyllosoma stages are pre-

[1] The nomenclature should according to Holthuis (1963) be *Jasus paulensis* (Heller, 1863).

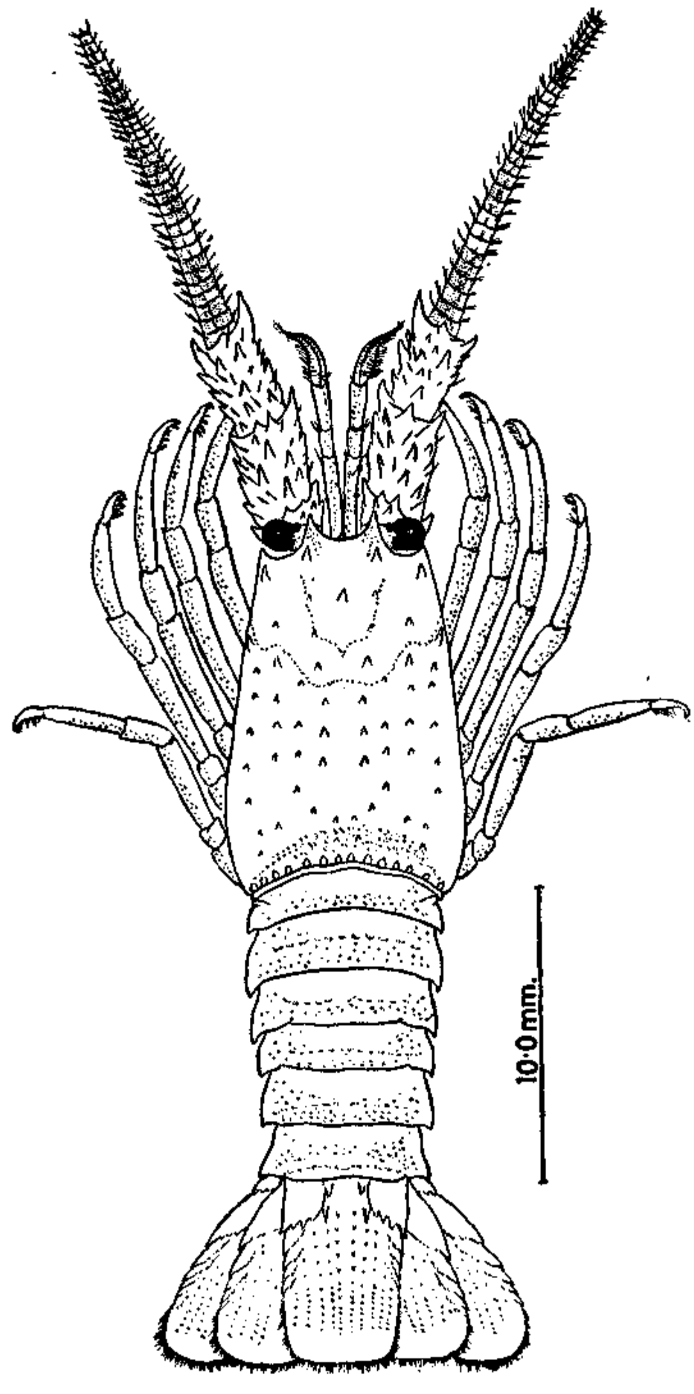


Fig. 4. *Jasus lalandei frontalis* (H. Milne-Edwards).[1] Early post-puerulus stage measuring 27·5 mm. in total length from New Amsterdam Island [1 = *J. paulensis* (Heller)]

sumed to belong to the variety *J. l. frontalis* mainly on account of their being taken in the vicinity of St. Paul and New Amsterdam islands where as already mentioned only this variety of *Jasus* is known to occur at present.[1] The possibility that the larvae could be of the typical form *J. l. lalandei* from South Africa is rather remote as shall be discussed later in the section 'Distribution'.

In Table II the salient measurements of the phyllosoma stages are given with other details, and Fig. 6 gives the drawings of the three stages in the collection. These stages correspond with stages X, XI and XII provisionally recognised by Gurney (1936). These stages are arbitrary as no hard and fast line can be drawn between the successive stages due to the partial overlap in lengths.

TABLE II
(Measurements of phyllosoma larvae in millimetres)

Characters	Southern Indian Ocean (present collection)			Southern Atlantic Ocean (after Gurney, 1936)*					
	1	2	3	1	2	3	4	5	6
Date ..	2-4-1964	2-4-1964	10-4-1964	..	..	..	..	..	..
Stage ..	X?	XI?	XII?	X	X	X	XI	XI	XII
Total length ..	18·6	21·5	25·9	16·85	17·80	19·65	22·75	22·90	28·5
Pre-labral length ..	7·8	9·0	10·5	7·3	7·8	8·7	9·75	9·5	12·0
Post-labral length ..	10·8	12·5	15·4	9·55	10·0	10·9	12·95	13·5	16·5
Antennule peduncular Seg. 1 ..	0·9	1·1	1·25	2·47	2·55	2·65	2·32	3·37	2·29
„ „ Seg. 2 ..	0·3	0·35	0·45	1·0	1·0	1·0	1·0	1·0	1·0
„ „ Seg. 3 ..	0·4	0·5	0·7	1·1	1·24	1·14	1·13	1·12	1·13
Antennule exopod ..	1·4	1·7	2·2	3·85	4·1	4·25	3·75	3·48	3·9
„ endopod ..	0·3	0·55	0·9	1·2	1·43	1·45	1·67	1·4	2·5
Eye ..	2·0	2·4	3·0	2·3	2·4	2·4	2·5	2·65	3·0
Eye stalk ..	3·0	3·7	4·3	3·4	2·8	3·7	3·7	4·2	4·7
Antenna ..	5·2	6·8	9·3	5·6	..	6·2	8·1	8·4	11·0
Width of forebody ..	14·0	15·9	18·3	..	..	..	..	..	..
Width of hind body ..	6·0	7·0	8·7	..	..	..	..	..	..

* Out of the measurements of 9 specimens of *Jasus lalandii* given by Gurney (1936) in his Table VIII, the six taken here correspond to more or less the stages in the present collection. The remaining three specimens given by Gurney belong to stages VIII, IX and XIII, being 10·4, 12·95 and 37·5 mm. long respectively.

The complete developmental stages is not known for *J. lalandei* or *J. verreauxii*. The embryonic development and early post-embryonic stages of *J. l. lalandei* and a few of the phyllosoma stages are known chiefly through the works of Gilchrist (1913, 1916), and Von Bonde, C. (1936). Information on *J. verreauxii* is scanty. In order to facilitate comparison, the phyllosoma stages of *J. lalandei* described by Von Bonde, C. (1936), Gurney (1936), Lebour (1954), and Prasad and Tampi (1959) are given here along with the figure of an early phyllosoma stage of *J. verreauxii* taken from Dakin and Colefax (1940) (Figs. 7, 8 and 9).

When the measurements for the present specimens given in Table II are compared with measurements of phyllosomas of *J. lalandei* given by Gurney (1936) (corresponding stages of which are included in Table II) some disparity is seen in the relative proportions of some of the body characters,

[1] The nomenclature should according to Holthuis (1963) be *Jasus paulensis* (Heller, 1863).

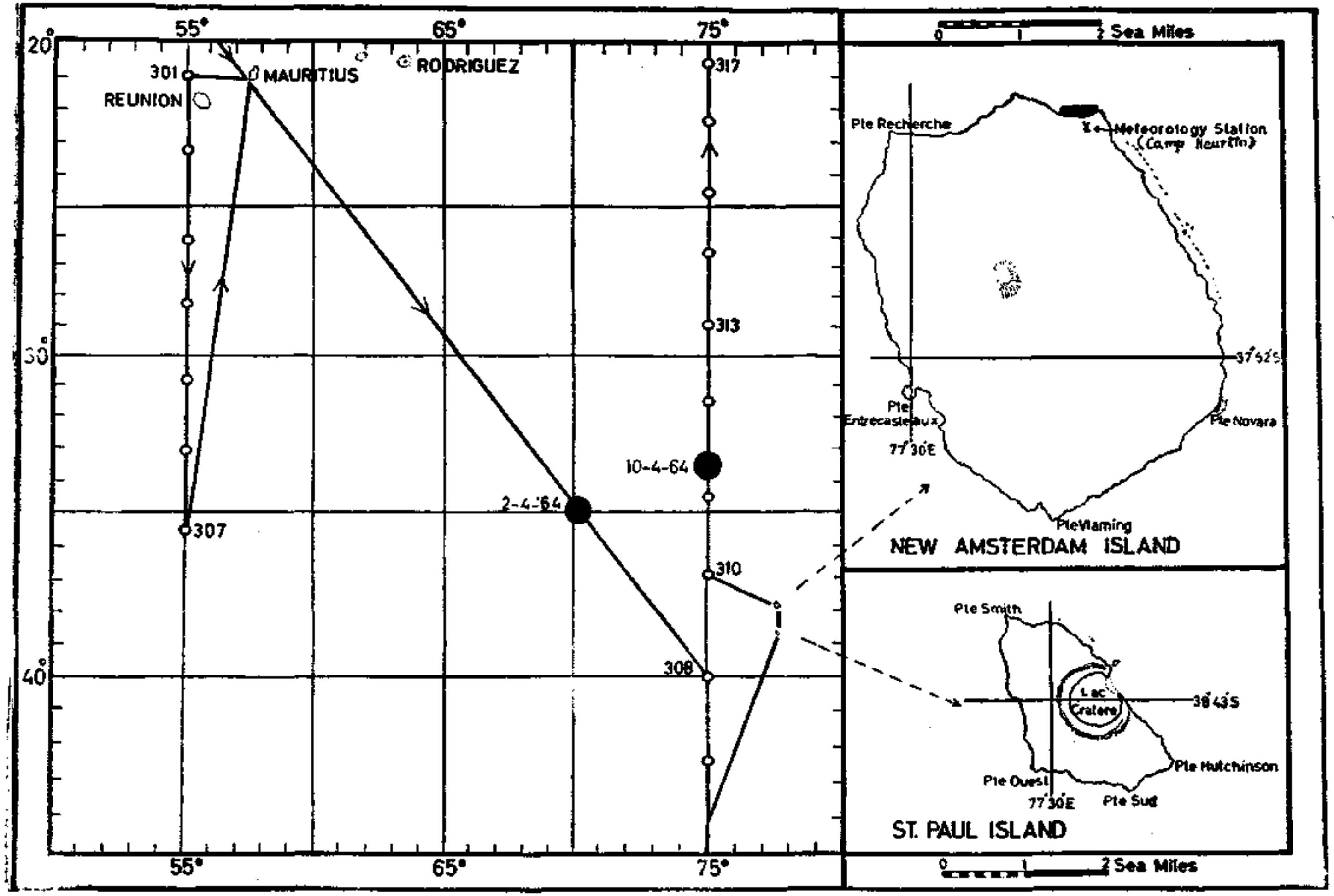


FIG. 5. Map showing a part of the track chart of the V Cruise of the U.S. Research Vessel *Anton Bruun* and the localities with dates (black circles) from where phyllosomas of *J. l. frontalis*[1] were collected. Insert maps show the islands of St. Paul and New Amsterdam, and in the latter island the shaded area indicates the place from where lobsters were collected for the present study [1 = *J. paulensis*].

This is especially pronounced in the antennule, the exopod and endopod being markedly longer in comparable specimens from off Tristan da Cunha. It is difficult to say whether this could be due to the fact the phyllosomas belong to two distinct varieties of *J. lalandei* or due to differences in the mode of taking measurements. I have used a dial calliper measuring to the nearest tenth o a mm. under a binocular microscope. As will be seen from the drawings of the three specimen in the collection (Fig. 6: 2–4) a progressive increase in the segments of the antennule and th endopod and exopod is seen in relation to size.

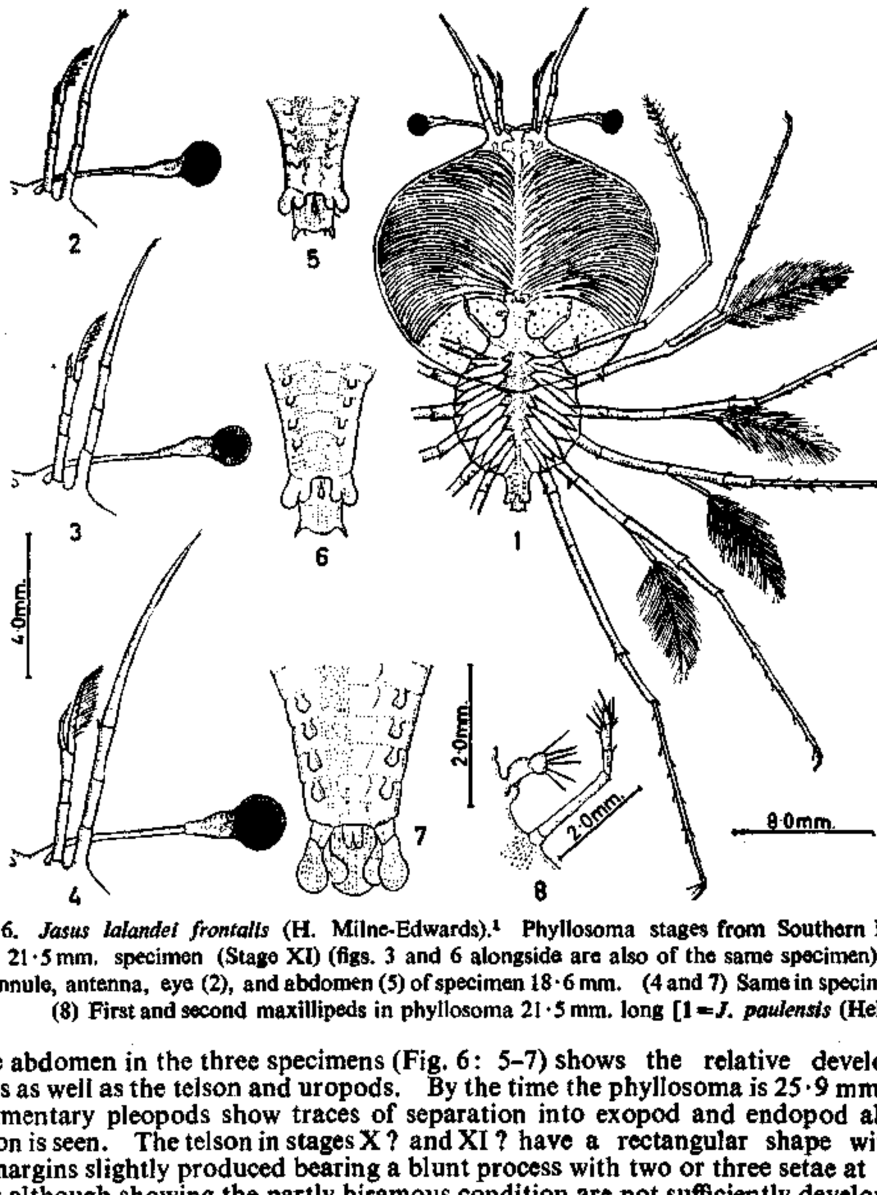


FIG. 6. *Jasus lalandei frontalis* (H. Milne-Edwards).[1] Phyllosoma stages from Southern Indian Ocean. (1) 21·5 mm. specimen (Stage XI) (figs. 3 and 6 alongside are also of the same specimen). (2 and 5) Antennule, antenna, eye (2), and abdomen (5) of specimen 18·6 mm. (4 and 7) Same in specimen 25·9 mm. (8) First and second maxillipeds in phyllosoma 21·5 mm. long [1 = *J. paulensis* (Heller)].

The abdomen in the three specimens (Fig. 6: 5–7) shows the relative development of the pleopods as well as the telson and uropods. By the time the phyllosoma is 25·9 mm. [Stage XII (?)] the rudimentary pleopods show traces of separation into exopod and endopod although no segmentation is seen. The telson in stages X ? and XI ? have a rectangular shape with the postero-lateral margins slightly produced bearing a blunt process with two or three setae at the base. The uropods although showing the partly biramous condition are not sufficiently developed to extend to the level of the posterior margin of the telson. This is seen in stage XII ? where the posterior margin of the telson is rounded. The biramous condition of the uropods is well developed and so also the basal segment.

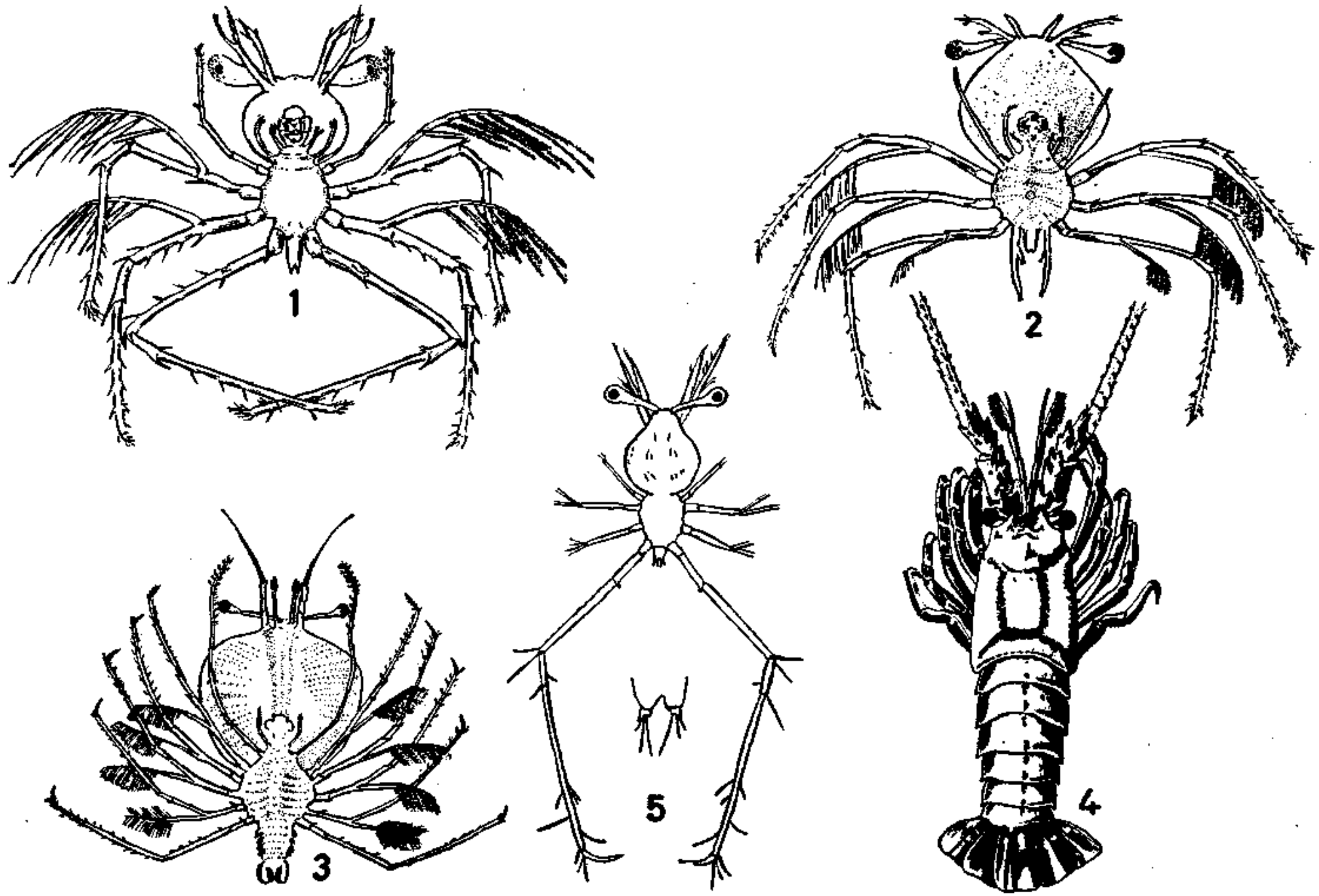


FIG. 7. *Jasus lalandei lalandei* (H. Milne-Edwards). (1–3) Phyllosoma stages (after Von Bonde, C., 1936). (4) Puerulus stage 22 mm. long (after Von Bonde, C., 1936) 1–4 from South African waters. (5) Early phyllosoma stage from Bengula Current (after Lebour, 1954).

Prasad and Tampi (1959) are the first to record *Jasus lalandei* from the tropical waters of the northern hemisphere, namely the Laccadive Sea based on two larvae 1·5 mm. each obtained in plankton haul from *R. V. Kalava* Station No. 448. The figure of the larva reproduced here (Fig. 9) illustrates the point drawn attention to by the authors that the antenna is shorter than the antennule. The antenna is also shorter than the eye which has not yet developed a distinct stalk at this stage. In similar sized (1·5 and 1·7 mm.) larvae of the typical form *J. l. lalandei* from South Africa described by Von Bonde, C. (1936), and Von Bonde, C. and Marchand (1935), the antenna is slightly longer than the antennule and the eye (*see* Figs. 7 and 9).

Distribution of the Genus *Jasus* Parker

The genus *Jasus* Parker has a circumglobular distribution in the southern hemisphere from south of the Tropic of Capricorn to about 46° S. latitude, the only exception being the record of larvae of *J. lalandei* from the Laccadive Sea by Prasad and Tampi (1959). Chace and Dumont (1949) published a map showing the world distribution of spiny lobsters of the family Palinuridae (Fig. 10). However, from the present study of the distribution of *Jasus*, one of the genera of Palinuridae, it is seen that the limits of the distribution of the family given by these authors need modifications. As such a revised distributional map for the family is given here (Fig. 11), along with another showing the distributional limits of the genus *Jasus* (Fig. 12). For the exact distributional limits of the adults reference may also be made to the exhaustive list of localities given under the respective species by Holthuis (1946).

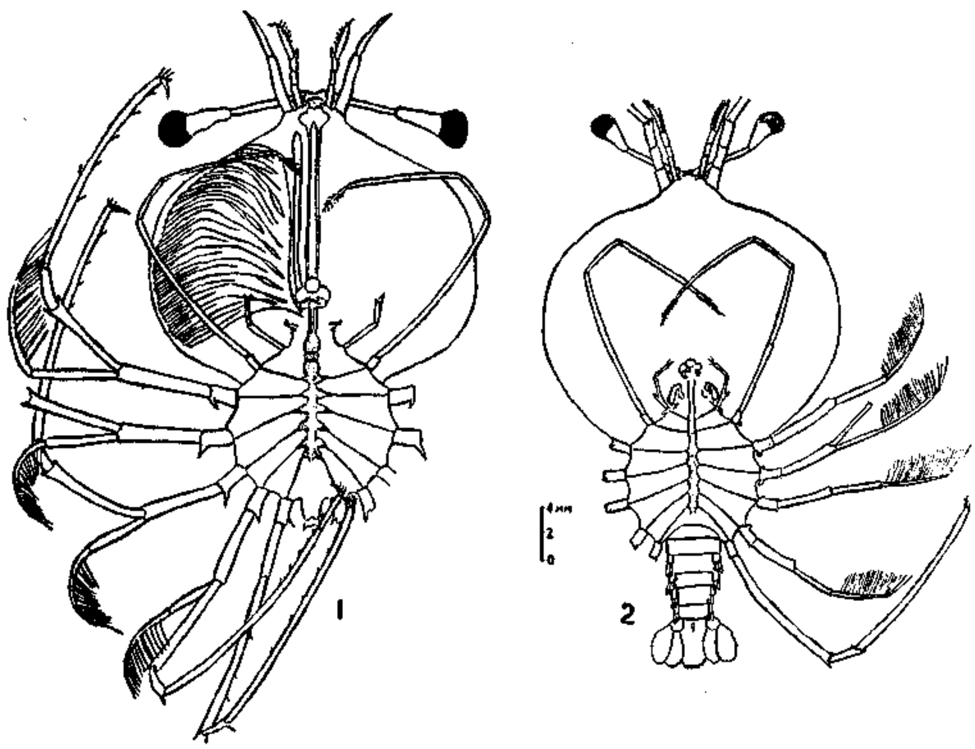


FIG. 8. *Jasus lalandei frontalis* (?). Phyllosoma stages. (1) *Jasus lalandii*, Stage VIII ?, 11 mm. from Discovery Stn. 254 (after Gurney, 1936). (2) Stage XIII ? 37 mm. from Discovery Stn. 100 B. 1-2 from the Southern Atlantic Ocean (after Gurney, 1936).

The distributional pattern of *J. lalandei* when plotted on Lambert's Azimuthal Equal-Area Projection Maps of the antarctic and subantarctic regions (Fig. 13) shows that:

1. St. Paul and New Amsterdam Islands lie almost on the boundary line between the subtropical and subantarctic zones, the mean position of the subtropical convergence on the 77° longitude lying only a few miles south of these islands.

2. A scrutiny of the known distributional limits of the two varieties of *Jasus lalandei*, namely *J. l. lalandei* and *J. l. frontalis* shows an allopatric pattern of distribution. The typical variety is confined to parts of South and South-West Africa, and South-West and South-East Australia, while *J. l. frontalis* is primarily an insular variety, being known from St. Paul and New Amsterdam Islands; New Zealand and Islands in the vicinity such as Stewart Island, and Chatham Island, Juan Fernandez, San Ambrosa and San Felix Islands off Chile, and Tristan da Cunha in the South Atlantic.

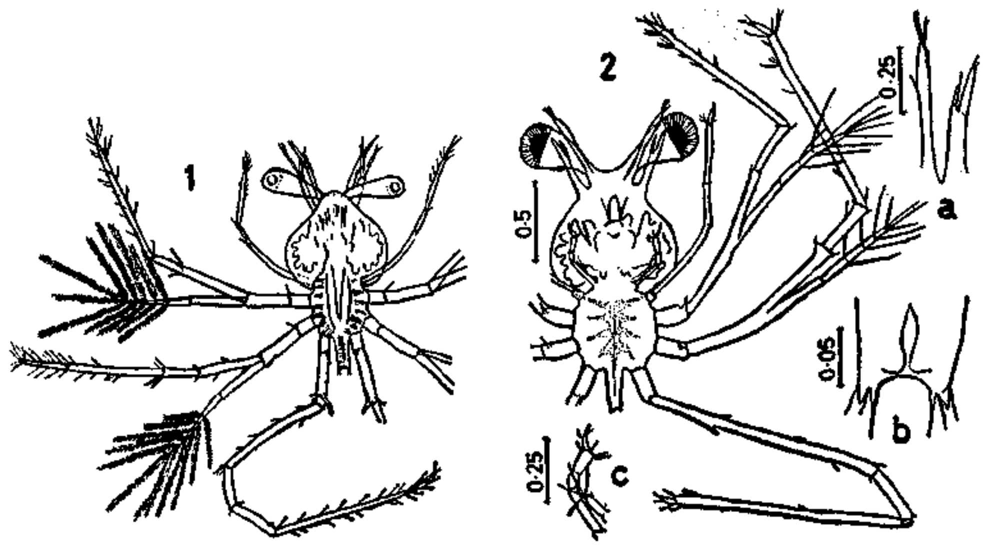


FIG. 9. Phyllosoma stages of *Jasus*. (1) Early phyllosoma stage of *Jasus verreauxii* (H. Milne-Edwards) from Australia (after Dakin and Colefax, 1940). (2 *a–c*). Phyllosoma Stage I of *Jasus lalandii* from the Laccadive Sea (*a*—antennule and antenna, *b*—abdomen, *c*—first and second maxillipeds) (after Prasad and Tampi, 1959).

J. verreauxii on the other hand shows a sympatric distribution occurring along with *J. l. lalandei* along the coasts of New South Wales and Victoria, and is also reported by some to occur in New Zealand. This then is the general pattern of distribution, but several problems need elucidation, such as the status of *J. lalandei* occurring in South-West Australia; whether or not mixed populations of *J. l. lalandei* and *J. l. frontalis* occur in New Zealand; whether the insular populations provisionally treated here under one variety, namely *J. l. frontalis* are in fact endemics in the respective areas and eventually may have to be considered as good varieties or subspecies [*e.g.*, *J. l. paulensis* from St. Paul and New Amsterdam Islands; *J. l. edwardsi* from New Zealand; *J. l. frontalis* from 'Chile' (Juan Fernandez), etc.] or species. Some of these shall be discussed presently.

3. From Fig. 13 it will be seen that the insular areas from where adults of *J. l. frontalis* are known to occur lie almost in the same latitudes within the northern part or outer limits of the subantarctic zone and only exceptionally as in the case of St. Paul and New Amsterdam Islands do they lie just north of the mean line of subtropical convergence. This contrasts with the distribution of the typical form *J. l. lalandei* which in Australia and South Africa lie well above the line of subtropical convergence.

4. Knox (1960) has given the mean winter and summer sea surface isotherms for the southern oceans and when seen in relation to this (Figs. 14 and 15) the distribution of the typical

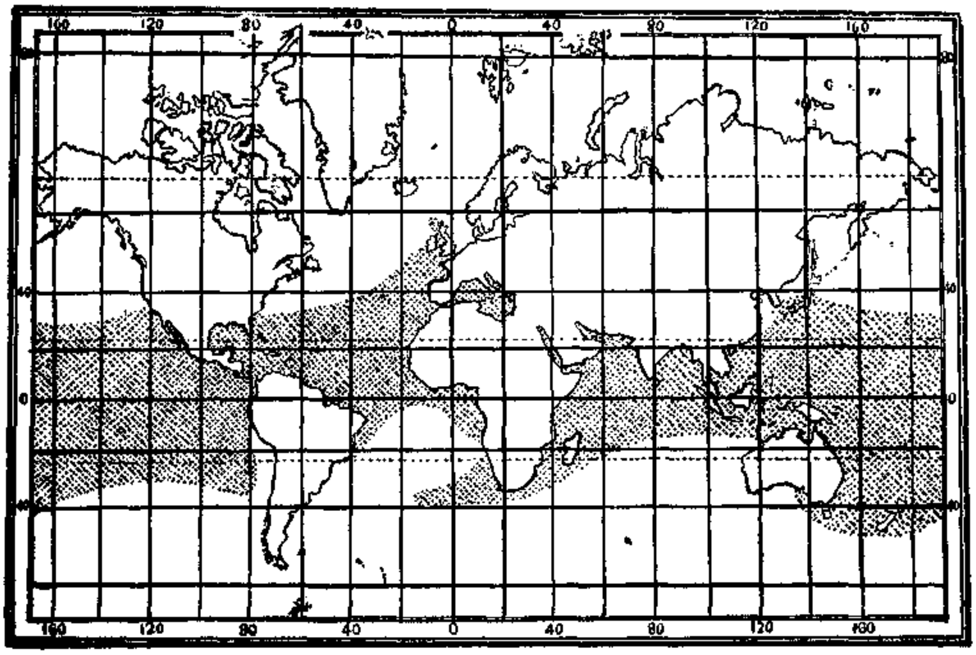


FIG. 10. Map showing the world distribution of spiny lobsters of the family Palinuridae (after Chace and Dumont, 1949).

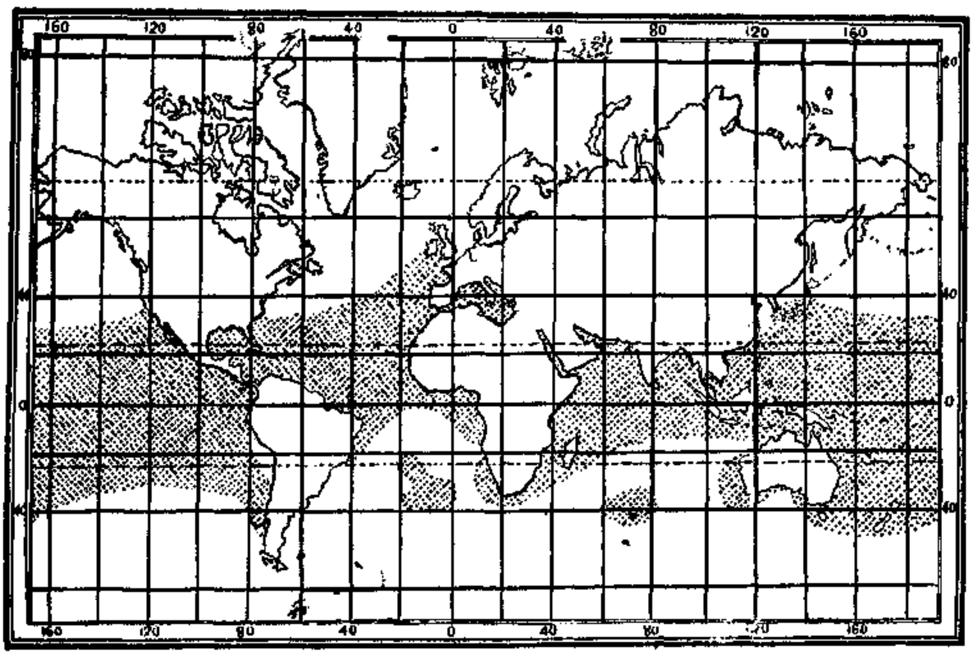


FIG. 11. Revised map showing the world distribution of spiny lobsters of the family Palinuridae.

J. l. lalandei is found to lie within the mean summer and winter sea surface isotherms of 15° and 20° C. during both seasons, except in the area around Southern Tasmania where it is even less than 12° C. during winter. In the case of *J. l. frontalis* the areas fall within the mean sea surface summer isotherms of 15° C. to less than 20° C. and mean sea surface winter isotherms of 10°–15° C. Knox (1960) has also given the coastal water types of the southern temperate and antarctic regions (Fig. 16) from which it will be seen that the distribution of the genus *Jasus* is predominantly restricted to the "Cold temperate mixed water", and rarely infringes into the "Subantarctic cold temperate water type" or into the "Transitional warm temperate water type".

5. On the basis of his studies on the littoral ecology and the biogeography of the southern oceans, Knox (1960) proposed certain biogeographic subdivisions of the southern temperate and antarctic regions mainly based on characteristic temperature and salinity ranges and water masses (Fig. 17) according to which St. Paul and New Amsterdam Islands and the entire distributional areas of the genus *Jasus* come under the "Cold temperate regions" (exceptions being the small area south-east of the Cape of Good Hope, Union of South Africa and along south-west coast of Australia which come under the "Warm temperate transitional regions".

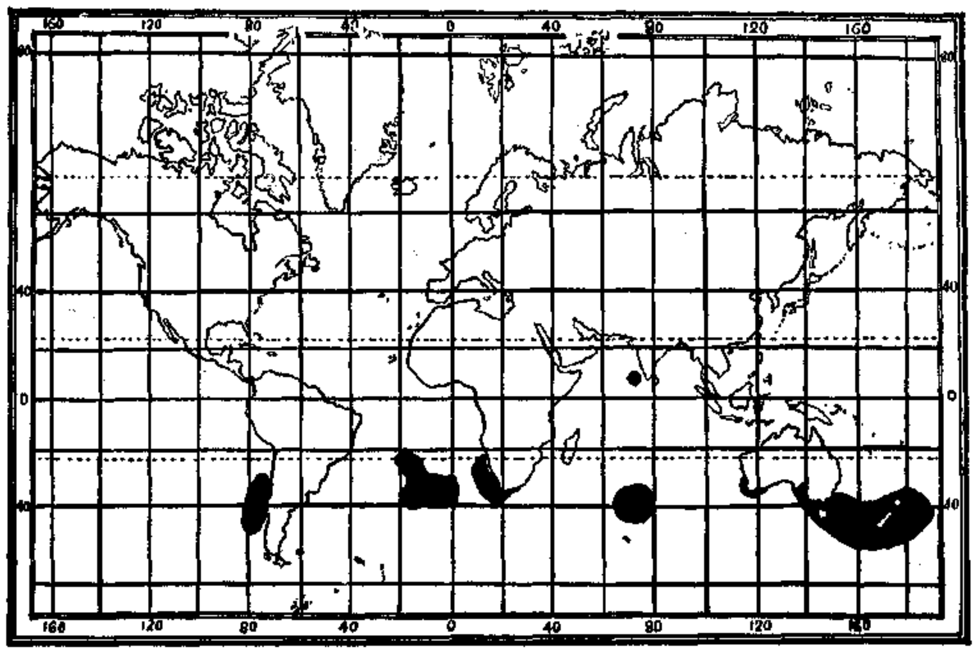


FIG. 12. Map showing the world distribution of spiny lobsters of the genus *Jasus* Parker (Areas from where larvae have been collected are also included).

6. The influence of the 'West Wind Drift' and the connected cold currents adjacant to the land masses in the southern hemisphere on the dispersal and distribution of the subantarctic faunal and floral elements has been repeatedly drawn attention to even recently by several authors at the conference on "A discussion on the biology of the southern cold temperate zone" (Deacon, 1960; Du-Ritez, 1960; Godley, 1960; Holdgate, 1960; Knox, 1960; Mackintosh, 1960; Wace, 1960; and others). A diagrammatic representation of the principle ocean currents as given by Knox (1960) is reproduced here (Text-Fig. 18) to indicate the possible role the 'West Wind Drift' and associated currents could have had or could have on the present-day distribution of *Jasus*. A further discussion is given in the section "Larval Distribution".

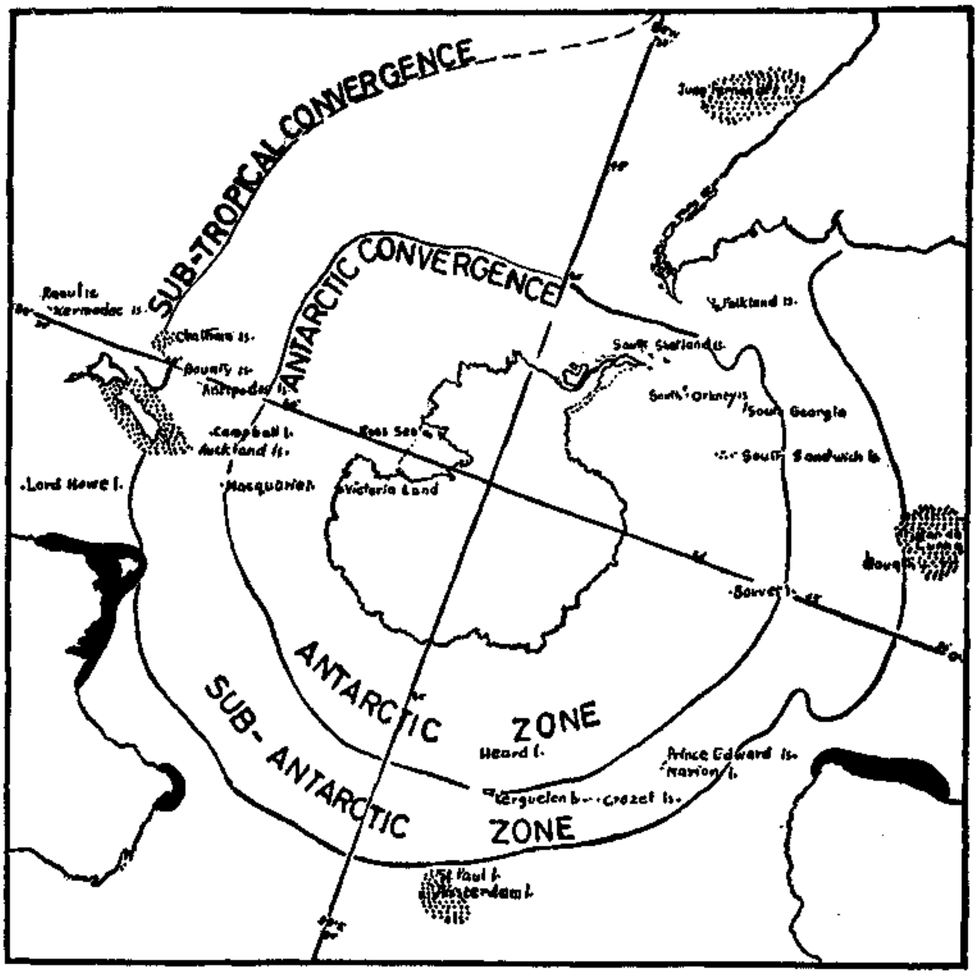


FIG. 13. Map showing the distribution of *Jasus lalandei lalandei* (blackened areas) and *J. l. frontalis* (stippled areas). The insular occurrence of the latter may be noted.

LARVAL DISTRIBUTION OF *Jasus* PARKER

The importance of studying the distribution pattern of phyllosoma larvae of spiny lobsters which could be good indicators of ocean currents and water masses has been stressed in recent years by many workers (Lewis, 1951; Lewis *et al.*, 1952; Thorson, 1960; Ingle *et al.*, 1963; and others). Ingle *et al.* (1963) in a preliminary study of the possible Carribean origin of Florida's spiny lobster (*Palinurus argus*) populations have stressed the significance of water currents on population recruitment and suggested the usefulness of studies in widely separated areas on the availability (or non-availability) of various phyllosoma stages in particular waters, as such studies may help to elucidate or identify current patterns as the long larval life span and the duration of well-differentiated stages may provide a very good natural device for establishing the directions of flow and rate of movement of water masses. In identifying water masses with such planktonic indicators, one point raised by Grice and Hart (1962) needs bearing in mind, namely that some knowledge of the reproductive cycle and longevity of the species is often valuable in deciding whether it is indicating recent or possible old intrusion of water into an area. In the case of the genus *Panulirus*, Thorson (1960) remarks that the phyllosoma of some species have a pelagic life of 150–180 days, for instance, Lewis (1951) found that the larval development in *P. argus* is completed in approximately six months, while in the allied species *P. interruptus* from the California coast Johnson (1951) found that it took slightly less than eight months for the completion of the larval development. Thorson (1960) opined that it is this prolonged planktonic phase of its life-history that has enabled some species of the genus *Panulirus* to show a circumtropical distribution.

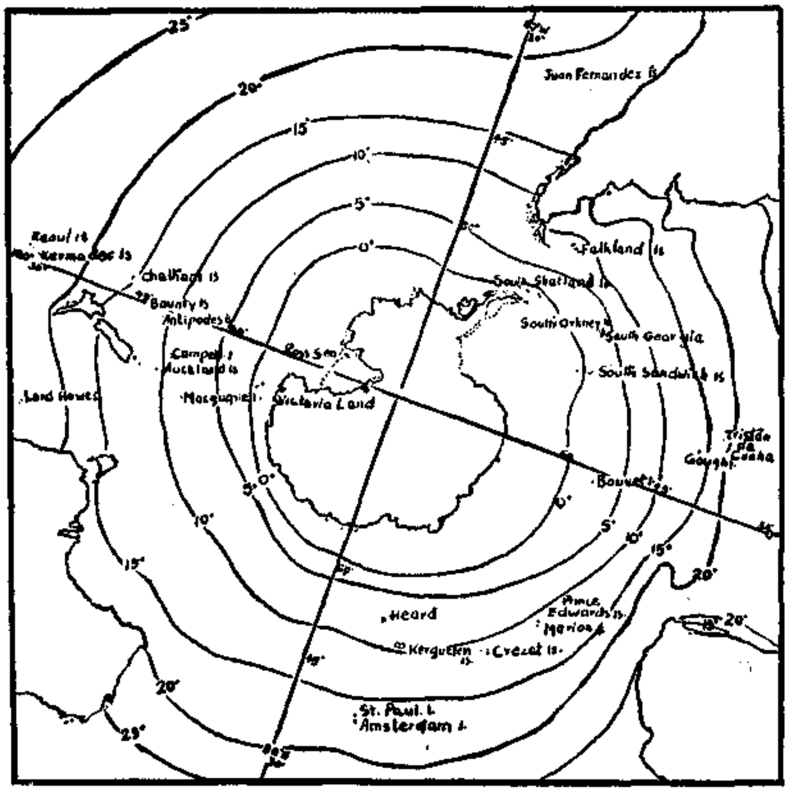


FIG. 14. Mean summer sea surface isotherms for the southern oceans (5° C. intervals) (after Knox, 1960).

Surprisingly enough, although a species of the genus *Jasus* (*J. lalandei*) is the most important commercially exploited species of spiny lobster in the world, the available information regarding the planktonic phase of its life-history is far from complete. First there is still doubt as to the total number of larval stages that may be recognised for *Jasus* though tentatively 13 stages are recognised by Gurney (1936). But for some information about the duration of the prenaupliosoma stage, and naupliosoma stage (Stage II), the actual duration of the various phyllosoma stages in nature is fragmentary and often speculative.

The description of larval stages by Thompson (1907), Anderton (1907), Archey (1916), Gilchrist (1913, 1916), and Von Bonde, C. (1936), refer to collections from coastal waters or a few stages observed in captivity. Von Bonde, C. (1936) mentions that "I have been able to obtain phyllosomata of various sizes betwean 3·8 mm. and 24 mm. and they are to be described in a paper entitled "Experiments in artificial hatching and rearing of the cape crawfish *Jasus lalandei*', *Inv. Rept. No.* 9, *Fish and Mar. Biol. Surv., South Africa* (in preparation)." Probably this report has not yet been published, as I have been unable to find any subsequent reference to it. All this is to show the fragmentary nature of the information available.

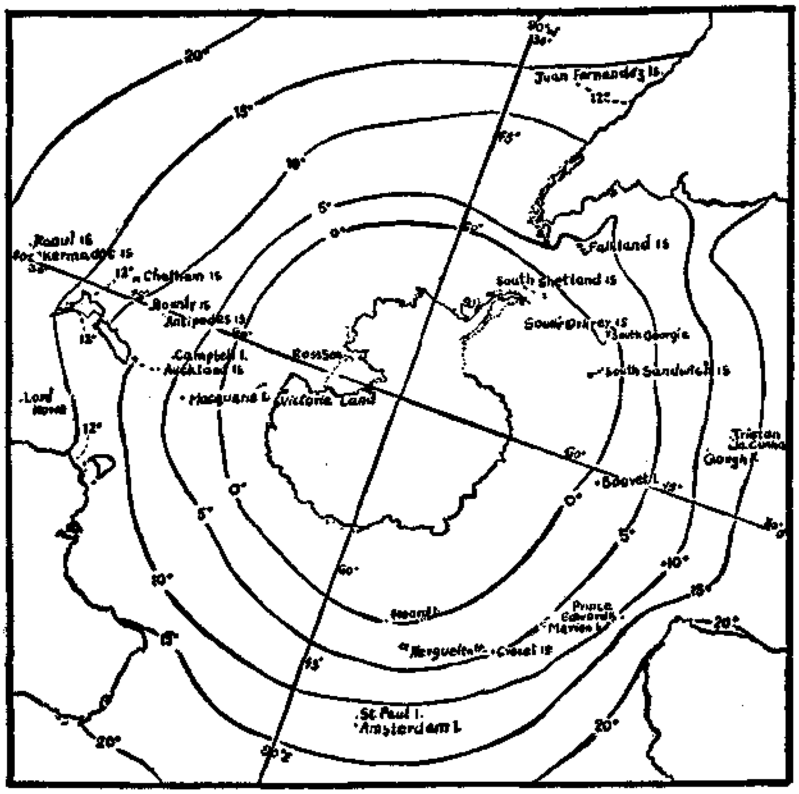


FIG. 15. Mean winter sea surface isotherms for the southern oceans (5° C. intervals) (after Knox, 1960).

Gurney (1936) who found the growth factor in six groups of phyllosoma larvae ranging from 10·4–35 mm. to be 1·3 or less, recorded a small phyllosoma of *Jasus lalandei* (Stage VII ?) about 900 miles North-West of Tristan da Cunha with the remarks that "Unfortunately, as the series of larva is so incomplete, one can only guess at the age as expressed in the number of stage and I am by no means satisfied at the assumption that the larva is in Stage VIII is correct. At all events it cannot be older. We know too little about the age and duration of stages to estimate the age in days, but a guess of six weeks may be fairly near the truth, in any case there is evidence of rapid and extensive travel." He also refers to three specimens of puerulus stage of *J. lalandei* caught at 250 meters depth about 170 miles from land where the ocean depth is over 3,000 metres, and of larvae collected from great depths of 2,480 –2,580 metres which were all found to be in the last stage prior to metamorphosis into the puerulus stage.

In the present instance, the phyllosomas collected on the night of 2–4–1964 from 35° 45′ S. 70° 36′ E. were from about 390 and 435 miles from New Amsterdam and St. Paul Islands respectively. The one takan on 10–4–1964 from 33° 22′ S., 74° 56′ E. is about 270 and 345 miles north of New Amsterdam and St. Paul Islands respectively. The scarcity of the material does not permit an assessment of the probable duration that the larvae had taken to attain the sizes and stages indicated in Table II.

The known occurrence and distribution of the phyllosoma stages of *Jasus* in the Indian Ocean and the Southern Atlantic and Pacific Oceans suggest the following.

1. The general non-occurrence of phyllosoma stages of *Jasus* south of the sub-tropical convergence is interesting and probably points to the transportation of the larvae from the breeding grounds towards the sub-tropics aided by the 'West Wind Drift' and connected currents flowing northwards. Perhaps this also accounts for the non-occurrence of *Jasus* on Gough Island only 352 km. south of Tristan da Cunha; Kerguelen Island south of St. Paul Island; and Macquarie Island, Campbell Island, etc., south of New Zealand. Associated with the currents, temperature may play an important role in limiting the distribution southwards. However, the great depth from which phyllosome of *Jasus* have been collected (Gurney, 1936) indicate that the lower temperatures may be a limiting factor for the earlier stages while later stages may occur in depths where the water temperature is even lower than 10° C.

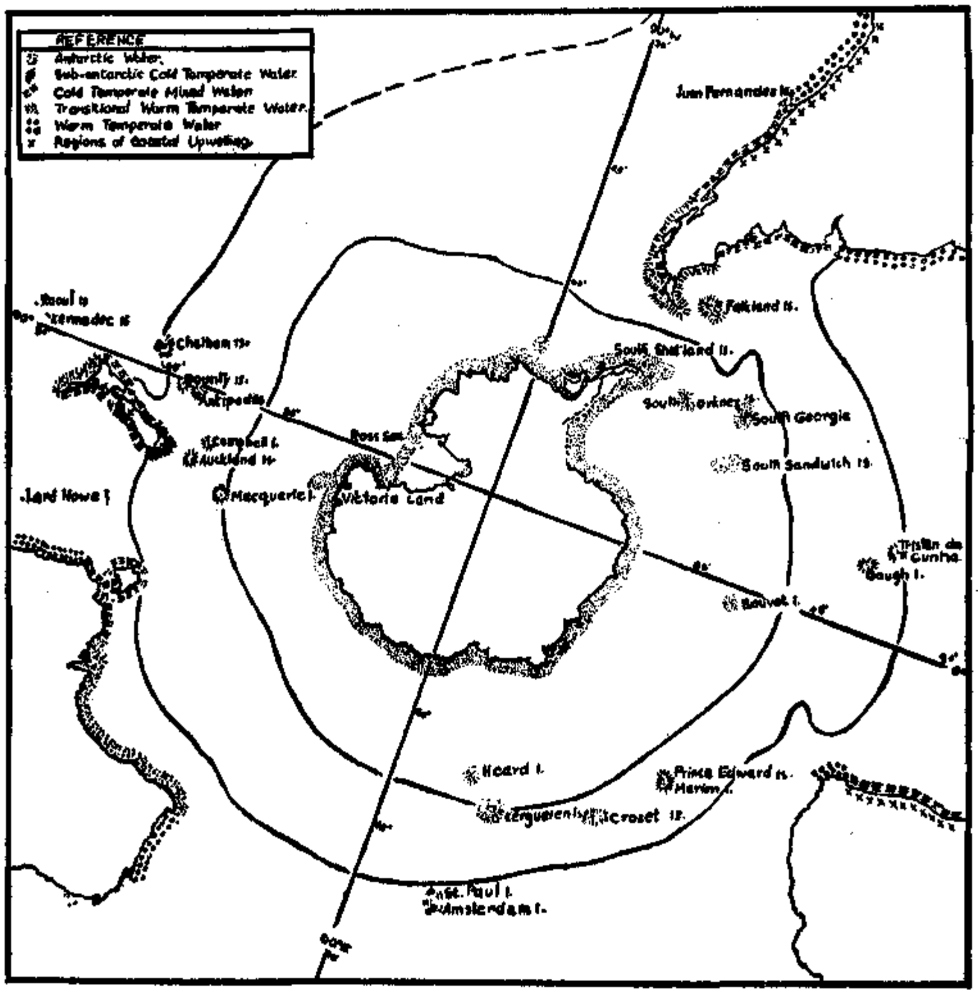


FIG. 16. Coastal water types of the southern temperate and antarctic regions (after Knox, 1960).

2. It appears likely that in the southern Atlantic and southern Indian Oceans, the larvae which are carried away from the islands by the currents are brought back to the islands caught in an "eddy system" during which period development and metamorphosis to the puerulus stage are completed. This could account for the apparently 'endemic' insular distributions of *J. l. frontalis*. The same could also apply to Juan Fernandez Island in the South-Eastern Pacific.

3. That metamorphosis into the actively swimming puerulus stage could take place far out at sea (as much as 170 miles from land over deep water) is clear from Gurney's work (Gurney, 1936). However, the significance of this is not fully understandable as in many other species of allied genera the pueruli first appear in shallow water. In the case of the intensively studied species *Panulirus argus*, Lewis *et al.* (1952) mention of only one instance where a single specimen in the puerulus stage was taken in plankton hauls in the Gulf Stream off Miami and opines that it seems certain that this stage is not normally planktonic.

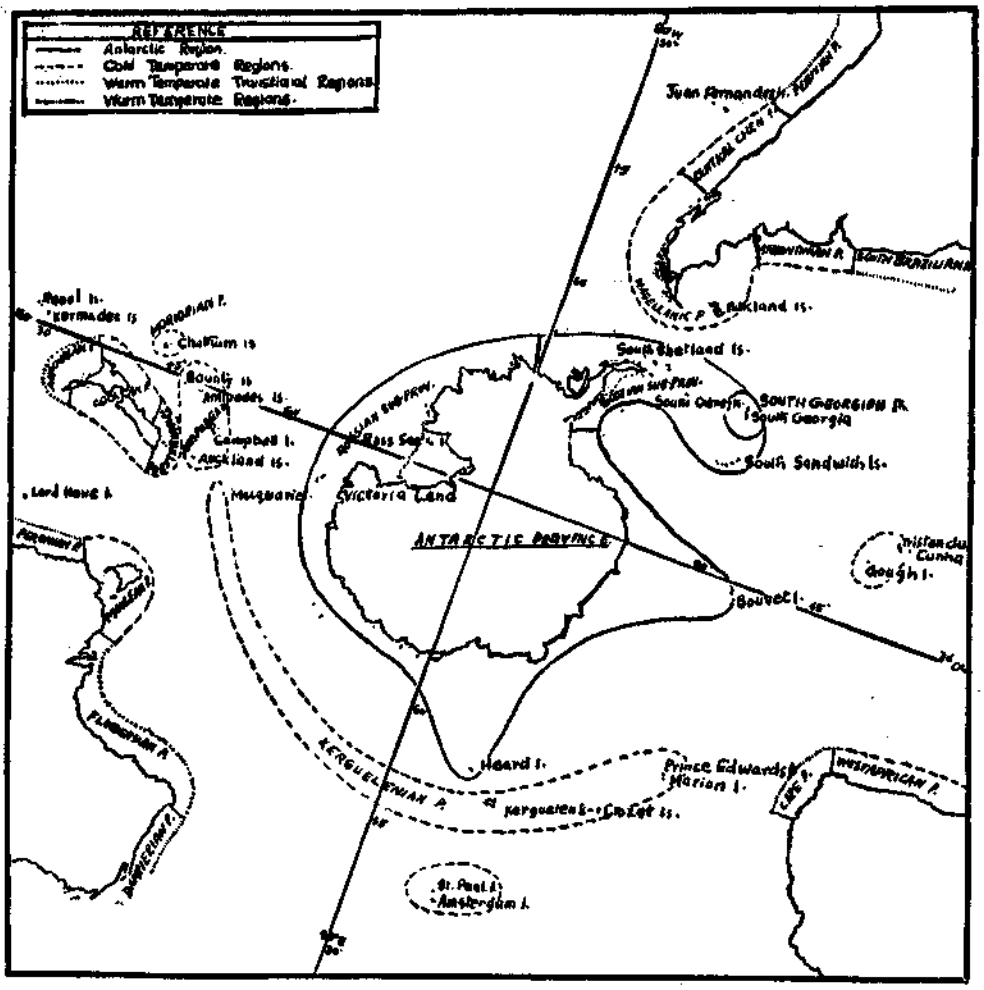


FIG. 17. Biogeographic subdivisions of the southern temperate and antarctic regions proposed by G. A. Knox, 1960.

4. A plausible explanation of the occurrence of very early stage of the larvae of *Jasus* in the tropical waters of the Laccadive Sea is a possible equatorial transgression of the genus at some earlier date and subsequent isolation. The possibility of such an equatorial transgression of the larvae at present from the area of New Amsterdam and St. Paul islands or even South Africa can be ruled out on account of the very early stage (1·5 mm.) of the larvae. Besides, the intervening warm south and north equatorial currents would only act as effective barriers for the distribution of the planktonic larvae. Whether an equatorial transgression of the genus could have taken place during

the late Pleistocene when there had been periodic oscillations in the equatorial Atlantic and Pacific and probably also the Indian Ocean with an amplitude of 6° C. may be considered. The work of Emiliani (1958) based on Radio-Carbon dating of more recent sections of deep-sea cores show that the surface waters were particularly cool about 15,000 years ago whan the tropical surface waters were about 6° C. cooler than at present. Prasad and Tampi (1959) have shown that the cooler waters at depths of about 200 metres in the Laccadive Sea may not rule out the possibility of *Jasus* occurring there. Adults have never been reported from this area, and more information is needed.

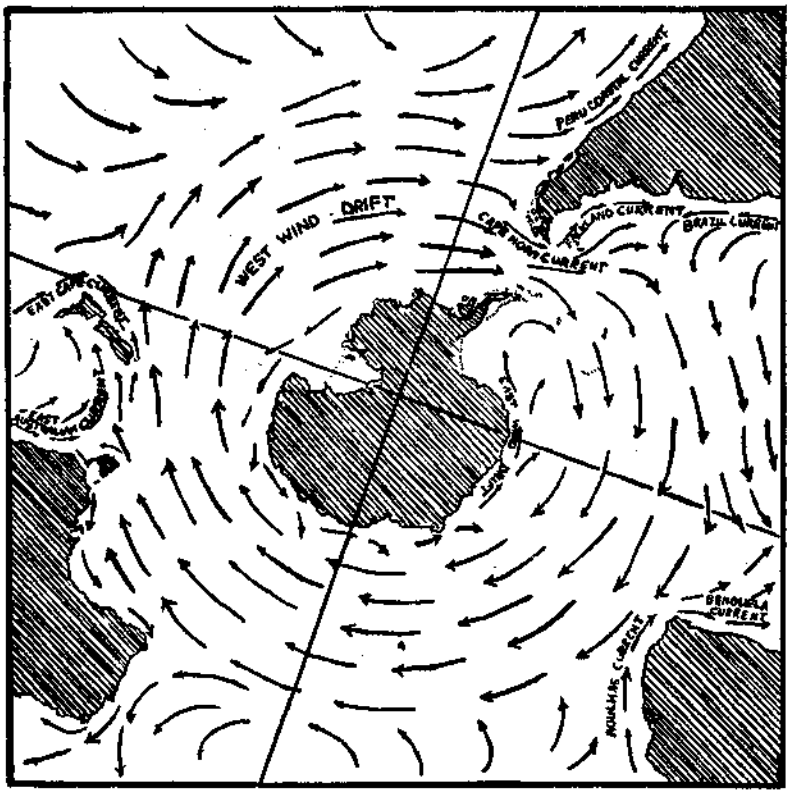


FIG. 18. Diagrammatic representation of the principal ocean current of the southern oceans (after Knox, 1960).

5. Lebour (1954) has recorded the early stages of larvae of *Jasus lalandei* from the Bengula Current and the small size of the larvae indicate that they could have come only from the breeding grounds of the species along the coast of South-West Africa and not represent the *J. l. frontalis* type from Tristan da Cunha. However, the fate of these larvae if they get into the warm South Equatorial current of the South Atlantic is not known. It is likely that an "eddy system" may help to bring back the larvae to the South-West African Coast without being carried out into the warmer current, nor drift as far west as Tristan da Cunha which lies 2,900 km. west of Cape of Good Hope. The current pattern off S. W. Africa as given by Sverdrup, Johnson and Fleming (1949) for the months of February-March which also coincides with the period of occurrence of phyllosoma off this coast indicates this possibility.

6. Stray records of the occurrence of *Jasus lalandei* from the south-western part of Australia are available (Sheard, 1949, 1962), but definite information as to the variety to which it belongs is wanting. The possibility that some larvae could be carried by the currents from the area of New Amsterdam and St. Paul Islands to the S.-W. Coast of Australia cannot be ruled out. Another

possibility is that the once continuous distribution of *J. l. lalandei* along the South-West, South and South-East Coasts of Australia has become disjunct, as along most of the southern coast of Western Australia and part of South Australia, especially in the area of the Great Australian Bight, *Jasus* has not bean reported.

7. This brings up another situation in the case of adult *Jasus* distribution which may be considered here. This is whether effective reproductive isolation in mixed populations (if any are found along mainland areas) of *J. l. lalandei* and *J. l. frontalis* occurring in any one area could take place. Influx of larvae of both varieties into an area could bring about such mixed populations and absence of reproductive isolation will no doubt also be indicated by intergradation in the patterns of squamiform sculpturation on the back of the abdominal segments. On the other hand, if the variability of the sculpturation on the abdominal segment is caused by environmental factors the role played by the duration of the planktonic phase of the developmental stages of the larvae and post-larvae needs study. These points are mentioned here, as at present the two types of abdominal sculpturation noticed in these lobsters are considered to be only of intra-specific importance.

8. A related problem is that some authors have indicated that *J. l. lalandei* and *J. l. frontalis* occur in New Zealand, while others (Parker, 1887; Holthuis, 1946) are of the opinion that the population there is composed of only one type, namely *J. l. frontalis* (=*Jasus edwardsii* of Parker). Careful scrutiny of material will be necessary as it is not unlikely that the larval stages of *J. l. lalandei* found along New South Wales, Victoria and Tasmania coasts could be carried by ocean currents to New Zealand. One point in favour of this is the reported occurrence of *J. verreauxii* in both these areas.

9. Attempts to acclimatise *J. l. frontalis* along the coasts of South Chile have proved unsuccessful, while this variety supports a sizable fishery at Juan Fernandez Island. The temperature, current patterns and the transportation of the larvae may have some bearing on this problem seen here.

10. If the two varieties considered here are eventually found to be allopatric in distribution, or if sympatric, show reproductive isolation, there is no reason why they should not be considered as good species. Elucidation of this can be carried out only by direct observations in nature. In any case, the problem of speciation in *Jasus* would necessitate considering:

(*a*) *The geological history of the genus.*—At present there appears to be no information.

(*b*) *The spatial distribution of the genus.*—Here we find that the variety *J. l. frontalis* has a much wider distribution than the typical form *J. l. lalandei*. Are we to consider that the more widely distributed variety is also the one from which the other has evolved or *vice versa*?

(*c*) This brings up the character of the squamiform sculpturation and whether the variety with the more complete sculpturation is the one from which the second type has evolved or *vice versa*. In the related species *J. verreauxii* the surface of the abdominal segments are studded with only scattered timble-shaped processes.

The wide gaps in our knowledge does not permit any generalizations. It is hoped that the points raised here would stimulate work on these aspects of this interesting group of commercially important lobsters.

Observations on the Biology and Fishery of *Jasus lalandei frontalis* from St. Paul and New Amsterdam Islands[1]

1. *Biology*

Some observations and information gathered during a day's visit is augmented here by the more detailed observations of Angot (1951 *a*) and Grua (1960, 1963). Being partly a review, it is felt that

[1] The nomenclature should according to Holthuis (1963) be *Jasus paulensis* (Heller, 1863).

there is need for drawing attention to some of the important problems connected with the biology of this lobster highlighted by these authors. Chiefly they are:

1. The lobsters around both these islands live amongst rock and sometimes in areas with gravel bottom, but are not found in places with black sandy bottom.

2. Specimens are found at different depths upto 60 m. or more, this being the depth upto which fishing is generally carried out. Actual fishing operations have shown that the depths between 10–35 metres are the most productive and this also corresponds with the areas generally occupied by beds of the giant kelp *Macrocystis*.

3. Better catch is always obtained from rocky rugged bottom areas within the zone just mentioned and fishing is concentrated in such areas.

4. Angot found three colour phases of this lobster and correlation was found between this and the depth from which the lobsters were fished. Near the coast the dominant colour is bright red. This is also the colour group I was able to collect. It is said to become dull red with a tinge of light grey in the zone of the kelp beds and dull red with a dusky tinge at greater depths. Angot found the body of specimens with the last-said colour to be profusely encrusted with the spiral white shells of *Spirorbis*· especially on the carapace. In the collection that I have, *Spirorbis* shells are present in fewer numbers even in small lobsters 8·1 and 10·3 cm. long. Angot found that after a severe storm when the sea conditions were rough disturbing the sargasam beds, individuals of all the three colour phases mentioned above were found to occur mixed. However, one or two days following the storm segregation according to depth was again re-established. Grua (1960) has also commented on these colour phases.

5. During the entire fishing season from January to April 1950, Angot found that not a single female lobster was 'in berry' except one female captured on 15 January which had a few stray eggs attached to the pleopods. Hence he concludes that these months do not correspond with the period of reproduction of this lobster. On 8–4–1964, in addition to the few that I had collected, several more lobsters had been caught that day, but none were 'in berry' which I understand from the resident meteorologists occurs prior to November and seldom are berried females seen after this until about the middle of the next winter, which is June. In the material Angot studied, he found that individual females showed much more developed genital glands during March than at the beginning of January.

6. Grua (1963, 1964) has shown that egg-laying occurs in May and June and hatching takes place in August and September. In females at both the islands during this period the ovigerous setae become variable in size due to damage caused by the removal of the empty egg shells by the animals themselves. Grua studied this phenomena by an original biometric method involving size ratios, the validity of which he discusses (Grua, 1964). Pilosity becomes complete once again by March, owing to a molt distinct from the prebreeding ones.

In the specimens in my collection, three shell conditions, namely "hard new shell", "hard old shell" and "soft new shell' are present (Table I). No freshly moulted specimens were seen nor were any moulted shells seen among the rocky inter-tidal areas which were extensively searched both to the west and south-east of Camp Heurtin. Angot also found that from January to the beginning of April not one specimen captured was found to have moulted, the carapace in all being hard. Apparently the moult in the month of March in females mentioned by Grua (1964) may not be a general phenomena, but restricted to a particular stage.

7. Angot (1951) has given the length frequency of lobsters caught during the "Sapmer" Expedition in 1950. Briefly stated the results are as follows:

Locality	No. (sexes combined)	Mean length*	No. of males	Mean length*	No. of females	Mean length*	F/M
							%
St. Paul Island ..	1,106	24·3	948	27·9	158	20·7	16·9
New Amsterdam Island ..	978	22·8	886	26·1	92	19·5	10·3
Total ..	2,084	23·6	1,834	..	250	..	13·6

* Mean lengths are given in centimetres.

It may be noted that the mean lengths differ for the sexes in both the islands. A similar trend was also noticed by Grua (1960) for the period 1958–59 sesson, which was as follows:

Sex	St. Paul Island	New Amsterdam Island
Males ...	24·1 (−3·8 cm.)†	21·9 (−4·2 cm.)
Females ..	20·3 (−0·4 cm.)	19·6 (+0·1 cm.)
Mean for males and females ..	23·53 (−0·8 cm.)	21·7 (−1·1 cm.)

† The figures in paranthesis indicate the differences from the mean observed between the figures given by Angot for the 1950 season and Grua for the 1958–59 season.

8. The graphs given by Angot (1951) are reproduced here (Fig. 19) in order to illustrate the significant point of marked disparity in the sex ratio. The proportion of females is least in New Amsterdam, being only 10·3%, and 16·9% at St. Paul Island. However, a size-wise analysis shows that the females in both the islands predominate over the males upto about 17·0 cm. length. From this size to about 20 cm. length the males predominate, but very slightly over the females. However, beyond this length the gulf is very great as the largest female taken is not more than 25 cm. while the male grows upto 35 cm. In my collection out of six juveniles and adults, only two are females.

However, there are indications that there could be fluctuations in the sex ratio and Grua (1960) remarks that the percentage of females may fluctuate between 5% and 35%. Thus there is evidence of a constant predominance of males over females. This phenomena to a much lesser degree is seen in South-West Africa where Mathews (1962) found the sex ratio of males to females in *J. l. lalandei* to be 59:41 with constant predominance of males over females of 18%. A latitude-wise analysis given by Mathews (1962) showed that in 1959, 64·7% of the lobsters of the southern areas were males, while only 51·9% were males in the northern areas; in 1960 it was 63·3% and 59·3%; and in 1961 it was 64·4% and 50·3% respectively. However, in the case of the lobsters at St. Paul and New Amsterdam Islands which are situated hardly 60 miles apart the situation is very disquieting.

A significant reduction in the female is bound to have a very marked effect on the reproductive rate and the recruitment into the area each year. In fact, the sex ratio is such that it is only reasonable to presume that if intensive fishing is resorted during any particular season or consecutive seasons resulting in the greater depletion of the females and thus a greater imbalance of the sex ratio, the entire lobster population around the islands will be adversely affected.

9. Grua (1960) suggests that the males and females may segregate when the females are "in berry'. Fortunately though, the period of reproduction does not coincide with the main

fishing season, the great disparity in the sex ratio seen in samples obtained during the fishing season as already mentioned is highly significant.

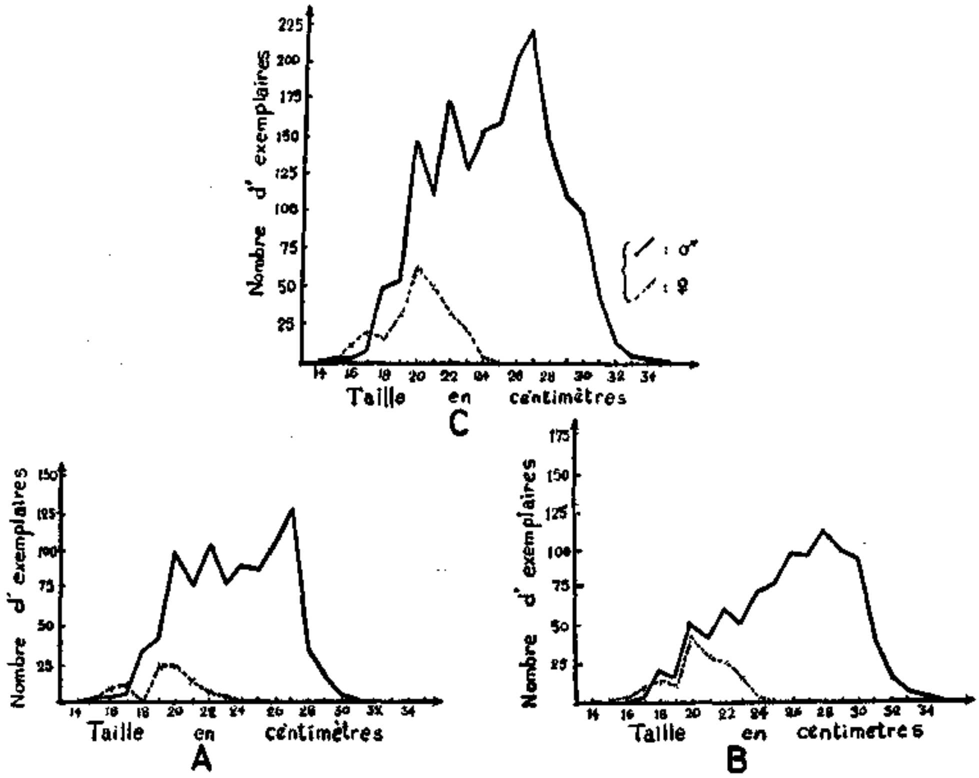


FIG. 19. Sex ratio of *Jasus lalandei* (= *J. l. frontalis*)[1] at A: New Amsterdam Island; B: St. Paul Island; and C: From both islands combined (After Angot, 1951 *a*) [[1]=*J. paulensis* (Heller)].

10. On the basis of the mean size differences of the specimens at St. Paul and New Amsterdam Islands Angot (1951) concluded that the growth of the lobsters after the larval stage at both these islands was independent of the other. The data on size and growth given by Grua (1960, 1963) also points to the same conclusion. In other words, adults do not migrate to and from between the islands, though separated by hardly 60 miles of sea. A depth barrier, as well as temperature differences of the waters surrounding the two islands are important considerations. Smith (1948) speaking of the spiny lobster fishery off British Honduras remarks that "There is no evidence that adult lobsters are able to cross deep straits and these act at least as a partial barrier to migration." The deepest part between St. Paul and New Amsterdam Islands is about 1685 metres and this may act as an effective barrier in restricting the adult populations to the narrow shelves around the two islands. Temperature as a factor affecting the sizes of adult lobsters in both the islands has been drawn attention to by Angot (1951) and Grua (1960, 1963). Both surface as well as subsurface temperatures, especially the latter show the differences very clearly as can be seen from the following:

*Mean monthly surface temperature (° C.) at St. Paul and New Amsterdam Islands**

Months ..	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
St. Paul ..	16·5	16·8	16·6	15·9	14·8	13·4	12·6	12·4	12·3	12·9	13·8	14·8
New Amsterdam ..	16·8	17·37	16·92	15·9	14·86	13·61	12·95	12·71	12·73	13·26	14·04	15·59

* After Treussart, 1951 and Grua, 1963.

Temperature at 400 and 600 m. off the coast at St. Paul and New Amsterdam Islands†

Date	Position	Actual depth (m.)	Depth of sampling (m.)	Temperature (°C.)
		1. St. Paul Island		
7-1-1959 ..	E.	28	20	13·99
12-1-1959 ..	N.E.	30	25	13·73
29-1-1959 ..	E.	29	24	13·97
		2. New Amsterdam Island†		
18-1-1959 ..	E.S.E.	33	28	17·8
21-1-1959 ..	W.	25	20	17·71
30-1-1959 ...	N.N.E.	33	25	18·09
2-3-1959 ...	W.	39	31	17·14
11-3-1959 ...	N.W.	45	40	17·88

† On 15-12-1958, 2 miles N.N.W. of this island where the depth to bottom is 1,000 m. the temperatures at 5 and 10 m. depths were 16·6 and 16·3°C respectively.

Thus a difference of about 4° C. is noticeable in the subsurface waters off the islands in the month of January and similar differences may be prevalent during the other months as well. The lobsters at St. Paul Island where the waters are cooler are relatively larger in size. I may add here that it is not unlikely that increased fishing effort around New Amsterdam Island could also result in a reduction in the size of the lobsters caught there, as compared to those taken around St. Paul Island which may not be so frequently exploited.

11. Angot (1951) records some difference in the behaviour of the lobster populations of the crater lake on St. Paul Island and those occurring outside the lake. In the lake area where the water is about five metres deep , not one lobster was seen during daytime, but at dusk the 'littoral area' of the lake was invaded by large numbers of lobsters which disappeared at dawn. No such phenomena was noted by him along the fringe of the island. During our visit to New Amsterdam Island a similar 'invasion' of the intertidal rocky area (between Pointe Goodenough and Pointe Hosken off Camp Heurtin) by lobsters at dusk was noticed and I was told that this is not unusual. The effect, the phase of the moon may have on such movements is not known, but our visit on 8-4-1964 was four days prior to New Moon.

2. *Fishery*

A fortnight prior to R. V. ANTON BRUNN'S visit to New Amsterdam Island, two lobster fishing boats from Reunion Island had spent about three weeks in the area chiefly fishing lobsters, returning with a catch of about 30,000 lobsters. From November to April a few fishing boats visit St. Paul and New Amsterdam Islands from Reunion Island and besides lobsters a few other fish such as the 'Poisson Blue' or blue fish (*Chilodactylus macropterus*), the 'Morue' (*Latris hecateia*), the 'Tazart (*Thyrsites atun*), and the 'Cabot' (*Polyprion americanus*) are caught with handlines. Lobster meat is usually used as bait for catching the fish, and in turn the fishermen have found that the flesh of the 'Poisson Blue' attracts more lobsters to the traps than any other bait. There were no lobster traps on the island at the time of our visit as these are used only from the fishing boats and for local needs any number of lobsters could be caught at dusk by hand or using baited hooks in the rockpools, Angot (1951) gives a brief description of the trap used, which is closely akin to the type used along the French coast and the Gulf of Maine. The trap is a semicylindrical case with a rectangular basal plate and with two openings located along the upper median line. The flat bottom enables the trap to rest in the proper position even on irregular bottom. The trap is said to be inexpensive, made of wood and capable of capturing large quantities of lobsters. Angot remarks that 50–70 kg. of lobsters are caught per trap per day, and each boat uses about 15–20 traps.

Paulin (1957) reported that while lobsters were caught in small quantities during most of the months, in the two months November-December, 1956, upto 255 tonnes were landed. The average estimated annual catch of lobsters from St. Paul and New Amsterdam Islands for the 7-year period 1951–52 to 1958–59 (excluding 1957–58 when fishing was suspended) was about 212 tonnes. Grua (1960) notes that for the 1958–59 season the limit was fixed at 200 tonnes and the estimated catch for the season was 201 tonnes. Of this, 53% of the catch was composed of 'petites' or small-sized lobsters 14–18 cm.; 32% 'moyennes' or medium-sized lobsters 18–23·5 cm.; and 15% 'grosses' or large lobsters 23·5–35 cm. and upwards, the largest specimen caught during the 1958–59 season being 37·4 cm. Since the fishing areas around the islands are greatly limited in extent, there is a great need for a judicious exploitation of this resource.

Attempts had been made earlier to establish a canning factory for canning lobster tails at St. Paul Island and one functioned for a brief period from 1928 to 1931, but had to be abandoned due to various difficulties. The factory was established in the crater, but the crater mouth was always not accessible for boats to leave or enter, so much so fishing periods had to be restricted. The inclement weather conditions and utter loneliness had a telling effect on the health and morale of the men, and so the project was abandoned in 1931.

The 'Sapmer' Expedition of 1950 was chiefly undertaken to explore the possibilities of a factory ship doing also fishing, working in the area during the summer months. This had a definite advantage as whole lobsters could be frozen or only the tails so that the rest could be reduced to lobster meal. However, it was found that the consumer preference was for whole lobsters and freezing often resulted in the damage of the appendages of the lobster. The highly oily nature of the other fish caught at the islands were not advantageous for salt curing (partly also due to limitations of ship space and the climatic conditions being unfavourable) or even canning of this product.

Concluding Remarks

From these, a few points worth mentioning are that although there is a marked disparity in the sex ratio of the lobsters here, it is not known whether this great reduction in the number of females seen in this area is really nature's control to limit the annual recruitment into this area to the extent that such a restricted area could sustain. Whether this is a periodic phenomena or a regular feature is not clear as information as to fluctuations in the sex ratio of the lobsters over a period of years is wanting. If future sampling shows that this ratio of males to females is characteristic for these islands, this may be yet another important clue as to the homogeneity of the lobster population in this area, and the unlikelihood of any influx of larvae from other areas such as South Africa, or Western or South East-Australia. Such information from other insular areas, such as Tristan da Cunha and Juan Fernandez Islands where *Jasus* occurs will be of considerable interest in this connection.

We have hardly any information regarding predation of lobsters around St. Paul and New Amsterdam Islands by other animals, especially marine mammals (the 'Elephants de Mer' *Mirounga leonina*, and the 'Otaries') and the sea brids and fish except the brief comments of Angot (1951).

Angot (1951) has perhaps rightly pointed out that there is a need to limit the fishing of lobsters to only males which will not be difficult to implement as the fishermen could be easily trained to distinguish the sexes. In fact, the females are smaller in size and so few in numbers that the fishermen may not lose much by releasing these back. Fortunately, inclement weather conditions for about six months in the year when the female lobsters are mostly 'in berry' acts as a natural control on fishing. All told, in view of the isolated position of these two islands remote from other land areas, the "lobster problem" here is one of interest not merely on account of its fishery value. It is equally interesting to the taxonomist and the biogeographer. There are many gaps in our knowledge, especially the species problem, the life-history stages and natural distribution of larvae by ocean currents all of which call for early and detailed attention.

PART II

Annotated Bibliography on the Taxonomy, Biology and Fishery of Species of the Genus *Jasus* Parker

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Sheard, K., 1949, 1962
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Von Bonde, C. and J. M. Marchand, 1935 *a*

'Blue Meat'
Von Bonde, C. and J. M. Marchand, 1935 *b*

Cancer Homarus
Muller, P. L. S., 1775

Canning
Anonymous, 1961 *b*
Dewberry, E. B., 1954
Droesti, G. M., and R. P. Van De Merwe, 1948, 1949 *a*, 1949 *b*
Le Roux, G. R. and R. P. Van Der Merwe, 1952
Le Roux, G. R., R. P. Van Der Merwe and J. A. Jackson, 1951
Von Bonde, C. and J. M. Marchand, 1935 *a*, 1935 *b*

Cape Crawfish
Gilchrist, J. D. F., 1913 *a*, 1918 *b*
Von Bonde, C., 1924, 1928, 1936, 1937, 1938
Von Bonde, C. and J. M. Marchand, 1935 *a*, 1935 *b*

Cape Lobster
Davis, D. H., 1955
Gilchrist, J. D. F., 1918 *b*

Capture methods—see under Fishing Methods and Gear

Catch statistics
Anonymous, 1956, 1957 *b*, 1957 *c*, 1958 *a*, 1958 *b*, 1958 *c*, 1958 *d*, 1958 *f*, 1961 *b*, 1961 *c*, 1961 *d*, 1963 *a*, 1963 *c*
Gilchrist, J. D. F., 1913 *a*
Grua, 1963
Mathews, J. P., 1962
Neal-May, W. M., 1950
Sardone, L. T., 1960
Sheard, K., 1949, 1962

Chatham Island (Occurrence)
Chilton, C., 1911
Young, M. W., 1929

Chemical analysis and chemical composition
Clements, F. W. AND R. C. HUTCHINSON, 1939 (ash constituent)
Goodwin, T. W., 1960
Joubert, F. J., 1954 (Haemocyamin)
Ligthelm, S P., L. M. Novellie, H. M. Schwartz, and M. M. Von Holdt, 1953 (composition of hepatopancreas oil)
Neal-May, W. M., 1950 (crawfish meal composition)
Nouvellie, L. M., 1952 (unknown amino-acid)
Nouvellie, L. M. and H. M. Schwartz, 1954 (occurrence of sarcosine)
Southall, C. L. and N. J. Van Rensburg, 1949 (chitin in crayfish)
Vinogradov, A. P., 1953
Von Bonde, C. and J. M. Marchand, 1935 *b*

Chile (Distribution)
Albert, F., 1898
Bahamonde, N. N., 1948
Balss, H., 1924
Leinz, H., 1902
Milne-Edwards, H., 1837
Nicolet, H., 1849
Quijada, B., 1910
Rathbun, M. J., 1910
White, A., 1847

Classification
Chace, F. A. Jr. and W. H. Dumont, 1949
Holthuis, L. B., 1946
Huxley, T. H., 1878
Parker, T. J., 1883, 1884 *a*, 1884 *b*
Von Bonde, C. and J. M. Marchand, 1935 *a*

Closed season (see under Fishing seasons)

Cold storage
Anderson, K. W., 1957
Anonymous, 1957 *a*, 1962 *b*
Von Bonde, C. and J. M. Marchand, 1935 *a*

Commercial exploitation—possibilities (see under resources)

Common names (listed in alphabetical order in index)

Conservation (also see regulations and legislations)
Anonymous, 1957 *c*, 1958 *b*, 1958 *d*
Grua, P., 1960 *a*, 1963
Mathews, J. P., 1962
Von Bonde, C. and J. M. Marchand, 1935 *a*

Contents of stomach (see under food and feeding habits)

Crawfish
Anonymous, 1948 *a*, 1948 *c*, 1948 *d*
Chopra, B., 1936
Drossti, G. M., 1948 *a*, 1948 *b*
Drossti, G. M. and R. P. Van Dər Mərwə, 1948, 1949
Droesti, G. M. and C. L. Southall, 1947, 1949
Gilchrist, J. D. F., 1913 *a*, 1918 *a*
Joubert, F. J., 1954
Kalm, R. A., 1950
Neel-May, W. M., 1950
Sibson, F. H., 1925
Southall, C. L. and N. J. Van Rensburg, 1949

Crawfish meat (see under spiny lobster meat)

Crayfish
Anonymous, 1956, 1957 *a*, 1958 *c*, 1958 *e*, 1958 *f*, 1959 *b*, 1962 *b*
Archey, G., 1916
Challenger, T., 1943
Huxley, T. H., 1878
Parker, T. J., 1890
Sardone, L. T., 1960
Sheard, K., 1949, 1950, 1962

Crayfish meat (see under spiny lobster meat)

Description (eggs to adult inclusive)
Angot, M., 1951 *a*
Archey, G., 1916
Balss, H., 1913, 1916, 1924, 1925, 1956–57
Barnard, K. H., 1950
Bate, C. S., 1888
Gilchrist, J. D. F., 1913 *b*, 1916, 1920
Grua, P., 1960 *a*, 1963, 1964
Gruvel, A., 1911 *a*, 1911 *b*, 1911 *c*
Gurney, R., 1936, 1942
Hann, W. de, 1841
Hale, H. M., 1927 *a*
Holthuis, L. B., 1946
Hutton, F. W., 1875 *a*, 1875 *b*
Milne-Edwards, H., 1851
Parker, T. J., 1887
Pesta, O., 1915
Prasad, R. R., and P. R. S. Tampi, 1959
Stebbing, T. R. R., 1900, 1902, 1914
Stimpson, W., 1860
Thompson, D' A. W., 1901
Thompson, G. M., 1907
Von Bonde, C., 1936, 1937, 1938
Von Bonde, C. and J. M. Marchand, 1935 *a*

Development (see under fertilization, embryology, egg-extrusion, egg-attachment, hatching, metamorphosis, prenaupliosoma stage, naupliosoma stage, phyllosoma stages, puerulus stage and post-puerulus stage)

Distribution (spatial, vertical, also occurrence)
Anderson, B. H., 1938
Anderton, T., 1906
Andre, M., 1932
Bahamonde, N. N., 1948
Balss, H., 1913, 1916, 1924, 1925
Barnard, K. H., 1950
Bate, C. S., 1888
Boas, F. E. V., 1880
Chace, F. A. Jr., and W. H. Dumont, 1949

Chilton, C., 1911
Chun, C., 1903
Dana, J. D., 1852
Filhol, H., 1885, 1886
Gilchrist, J. D. F., 1913 *b*, 1916, 1920
Gronovius, L. T., 1764
Grua, P., 1960 *a*, 1960 *b*, 1963, 1964
Gruvel, A., 1910, 1911 *a*, 1911 *b*, 1911 *c*
Hann, W. de, 1841
Hale, H. M., 1927 *a*, 1927 *b*
Haswell, W. A., 1882
Heller, C., 1862, 1865
Harklots, J. A., 1861
Holthuis, L. B., 1946, 1952
Hutton, F. W., 1875 *a*, 1875 *b*, 1882, 1904
Huxley, T. H., 1878
Kershaw, J. A., 1906
Krauss, F., 1843
Lenz, H., 1902
Lenz, H. and K. Strunk, 1914
McCoy, F., 1890
Man, J. G. de, 1916
Mathew, J. P., 1962
Miers, E. J., 1876
Milne-Edwards, H., 1837, 1838, 1851
Monad, Th. and C. Pitit, 1929
Moorehouse, F. W., 1957
Müller, P. L. S., 1766, 1771, 1775
Nicolet, H., 1849
Odhner, T., 1923
Ortmann, A., 1891
Parker, T. J., 1887
Pesta, O., 1915
Pfeffer, G., 1881
Powell, A. W. B., 1947
Prasad, R. R. and P. R. S. Tampi, 1959
Rathbun, M. J., 1910
Stebbing, T. R. R., 1893, 1900, 1902, 1910, 1914
Stimpson, W., 1860
Studer, Th., 1889
Talvas, 1939
Thompson, D' A. W., 1901
Thompson, G. M., 1907, 1913
Tubb, J. A., 1937
Velain, C., 1878
Von Bonde, C., 1938
Von Bonde, C. and J. M. Marchand, 1935 *a*
White, A., 1847
Whitelegge, T., 1890
Yaldwyn, J. C., 1957
Young, M. W., 1929

Ecdysis (*see under moulting*)

Economics (*see under production*)

Ecology (*other than oceanographic conditions or food*)
Angot, M., 1951 *a*, 1951 *b*
Bradstock, C. A., 1950
Fielder, D. R., 1964 *a*
Grua, P., 1960 *a*, 1960 *b*, 1963, 1964
Von Bonde, C., and J. M. Marchand, 1935 *a*

Egg counts—method
Bradstock, C. A., 1948

Egg attachment
Grua, P., 1960 *a*, 1963, 1964
Von Bonde, C., 1936

Egg extrusion
Mathews, J. P., 1962
Von Bonde, C., 1936

Embryonic development
Von Bonde, C., 1936

Export statistics
Anonymous, 1957 *b*, 1957 *c*, 1958 *c*, 1958 *e*, 1959 *a*, 1960 *e*, 1961 *d*, 1963 *a*, 1963 *b*, 1963 *c*, 1963 *d*, 1964 *a*
Neal-May, W. M., 1950

Fecundity
Anonymous, 1958 *b*
Grua, P., 1960 *a*
Mathews, J. P., 1962
Von Bonde, C., 1936

Fertilization
Fielder, D. R., 1964 *b*
Von Bonde, C., 1936
Mathews, J. P., 1962

Figures (*see under illustrations*)

Fishery
Anonymous, 1948 *b*, 1957 *c*, 1958 *c*, 1958 *f*, 1959 *b*, 1960 *f*, 1960 *g*, 1961 *b*, 1961 *c*
Firth, F. E., 1962
Fuess, J. C., 1949
Gilchrist, J. F. D., 1913 *a*
Grua, P., 1960 *a*, 1963
Jensen, A. C., 1962
Mathews, J. P., 1962
Neal-May, W. M., 1950
Paulian, P., 1957
Sheard, K., 1949, 1962
Sibson, F. H., 1925
Von Bonde, C., and J. M. Marchand, 1935 *a*

Fishing effort
Anonymous, 1961 *b*
Grua, P., 1960 *a*, 1963
Mathews, J. P., 1962
Sheard, K., 1949, 1962
Von Bonde, C. and J. M. Marchand, 1935 *a*

Fishing—experimental or exploratory
Anonymous, 1960 *b*, 1960 *c*, 1960 *d*
Gilchrist, J. D. F., 1918 *a*

Fishing grounds
Angot, M., 1951 *a*
Anonymous, 1957 c
Mathews, J. P., 1962
George, R. W., 1957
Gilchrist, J. D. F., 1913 *a*
Grua, P., 1960 *a*
Sheard, K., 1949, 1962
Von Bonde, C. and J. M. Marchand, 1935 *a*

Fishing grounds—destruction to
Anonymous, 1962 *b*

Fishing methods and gear (*methods of capture, trapping, etc.*)
Angot, M., 1951 *a*
Anonymous, 1956, 1958 *b*, 1958 *c*, 1958 *d*, 1960 *b*, 1960 *c*, 1960 *d*

Firth, F. E., 1962
Neal-May, W. M., 1950
Mathews, J. P., 1962
Sheard, K., 1949, 1962
Von Bonde, C. and J. M. Marchand, 1935 *a*

Fishing seasons (also closed season for fishing)
Anonymous, 1958 *b*, 1958 *d*, 1958 *f*, 1959 *b*, 1960 *a*, 1961 *a*, 1961 *b*, 1962 *a*
Mathews, J. P., 1962
George, R. W., 1957
Grua, P., 1960 *a*, 1963
Sheard, K., 1949, 1962
Von Bonde, C. and J. M. Marchand, 1935 *a*

Fishing vessels
Anonymous, 1956, 1961 *b*
Mathews, J. P., 1962
Von Bonde, C. and J. M. Marchand, 1935 *a*

Food and feeding habits
Anonymous, 1958 *b*
Chace, F. A. Jr. and W. H. Dumont, 1949
Fielder, D. R., 1964 *d*
Grua, P., 1960 *a*
Mathews, J. P., 1962
Von Bonde, C. and J. M. Marchand, 1935 *a*

Freezing
Anderson, K. W., 1957
Anonymous, 1957 *a*, 1961 *b*
Von Bonde, C. and J. M. Marchand, 1935 *a*

Grading
Anonymous, 1954 *b*, 1957 *a*
Mathews, J. P., 1962

Growth (in nature and in captivity–of adults)
Chace, F. A. Jr. and W. H. Dumont, 1949
Fielder, D. R., 1964 *a*
George, R. W., 1957
Grua, P., 1960 *a*, 1963
Mathews, J. P., 1962
Sheard, K., 1949, 1962
Von Bonde, C., 1936
Young, M. W., 1926

Handling—Care in
Sheard, K., 1950

Hatching
Grua, P., 1964
Mathews, J. P., 1962
Von Bonde, C., 1936

Hermaphroditism (see also pseudo-hermaphroditism)
Burger, O., 1902, 1904

Homarus
Müller, P. L. S., 1766, 1771

Hydrography of fishing grounds
Mathews, J. P., 1962

Illustrations (of species)
Angot, M., 1951 *a*
Archey, G., 1916
Balss, H., 1956–57
Barnard, K. H., 1950
Bradstock, C. A., 1950
Chace, F. A. Jr. and W. H. Dumont, 1949
Dakin, W. J. and A. W. Colefax, 1940
Gilchrist, J. D. F., 1913 *b*, 1916, 1920
Grua, P., 1960 *a*, 1963, 1964
Gruvel, A., 1911 *b*
Gurney, R., 1936
Hickman, V. V., 1945
Holthuis, L. B., 1946
Lebour, M. V., 1954
Milne-Edwards, H., 1851
Müller, P. L. S., 1766, 1771
Prasad, R. R., and P. R. S. Tampi, 1959
Quijada, B., 1910
Thompson, G. M., 1907
Von Bonde, C., 1936, 1937, 1938
Von Bonde, C. and J. M. Marchand, 1935 *a*

Industry
Anonymous, 1948 *a*, 1948 *c*, 1948 *d*, 1954 *a*, 1955, 1961 *b*, 1961 *c*, 1962 *b*, 1963 *d*, 1964 *a*, 1964 *b*
Chopra, B., 1936
Dewberry, E. B., 1954
Gates, D. J., 1962
Gilchrist, J. D. F., 1913 *a*
Hjul, P., 1961
Kalm, R. A., 1950
Neal-May, W. M., 1950
Rebelo, D. J. S., 1964
Sardone, L. T., 1960
Sibson, F. H., 1925
Von Bonde, C. and J. M. Marchand, 1935 *a*, 1935 *b*

Industry--damage to
Anonymous, 1962 *b*

Jasus Parker
Barnard, K. H., 1950
Chace, F. A. Jr. and W. H. Dumont, 1949
Holthuis, L. B., 1946
Man, J. G. de, 1916
Parker, T. J., 1883

Jasus edwardsii
Chilton, C., 1911
Hutton, F. W., 1904
Thompson D' A. W., 1901
Thompson, G. M., 1913
Young, M. W., 1929

Jasus frontalis
Bahamonde, N. N., 1948, 1951

Jasus hugelii
Archey, G., 1916
Moorehouse, F. W., 1957
Powell, A. W. B., 1947

Jasus lalandei (Jasus lalandii, J. lalandi, J. lalandii J. lalandi, and J. lalandei lalandei)
Anderson, B. H., 1938
Angot, M., 1951 *a*, 1951 *b*
Anonymous, 1955, 1957 *a*, 1957 *b*, 1957 *c*, 1958 *a*, 1958 *b*, 1958 *c*, 1959 *a*, 1959 *b*, 1960 *a*, 1960 *b*, 1960 *e*, 1961 *a*, 1961 *b*, 1961 *c*, 1961 *d*, 1963 *a*, 1963 *b*
Archey, G., 1916
Balss, H., 1913, 1916, 1924, 1925, 1956–57
Barnard, K. H., 1950
Bradstock, C. A., 1950, 1954

Chace, F. A. Jr. and W. H. Dumont, 1949
Davis, D. H., 1955
Fielder, D. R., 1964 *a*, 1964 *b*, 1964 *c*, 1964 *d*, 1965
George, R. W., 1957
Gilchrist, J. D. F., 1916, 1918 *a*, 1918 *b*, 1920
Grua, P., 1960 *a*, 1960 *b*
Gruvel, A., 1910, 1911 *a*, 1911 *b*, 1911 *c*
Gurney, R., 1936, 1942
Hale, H. M., 1927 *a*, 1927 *b*
Hickman, V. V., 1945, 1946
Holthuis, L. B., 1946
Hutton, F. W., 1904
Joburt, F. J., 1954
Lebour, M. V., 1954
Man, J. G. de, 1916
Neal-May, W. M., 1950
Novellie, L. M., 1952
Novellie, L. M., and H. M. Schwartz, 1954
Odhner, T., 1923
Olsen, A. M., 1960
Ortmann, A., 1891
Pesta, O., 1915
Powell, A. W. B., 1947
Prasad, R. R. and P. R. S. Tampi, 1959
Rand, R. W., 1959, 1960 *a*, 1960 *b*
Sardone, L. T., 1960
Scattergood, L. W. and D. A. McKown, 1951
Sheard, K., 1949, 1950, 1962
Sibson, F. H., 1925
Southall, C. L. and N. J. Van Rensburg, 1949
Stebbing, T. R. R., 1900, 1902, 1910, 1914
Tubb, J. A., 1937
Vinogradov, A. P., 1953
Von Bonde, C., 1924, 1928, 1936, 1937, 1938
Von Bonde, C. and J. M. Marchand, 1935 *a*, 1935 *b*
Von Bonde, W., 1918
Wolvekamp, H. P. and T. H. Watermann, 1960
Young, M. W., 1926

Jasus lalandii var. *edwardsii*
Dakin, W. J. and A. N. Colefax, 1940
Man, J. G. de, 1916

Jasus lalandii var. *frontalis* (*J. lalandei* var. *frontalis*)
Anonymous, 1962 *a*, 1962 *b*
Chace, F. A. Jr. and W. H. Dumont, 1949
Holthuis, L. B., 1946
Yaldwyn, J. C., 1957

Jasus parkeri [*nec Jasus*, but *Projasus* George and Grindley (1964)]
Barnard, K. H., 1950
George, R. W. and J. R. Grindley, 1964
Man, J. G. de, 1916
Stebbing, T. R. R., 1910

Jasus paulensis
Grua, P., 1963, 1964

Jasus verreauxi
Anonymous, 1958 *a*
Dakin, W. J. and A. N. Colefax, 1940
Holthuis, L. B., 1946
Man, J. G. de, 1916
Pesta, O., 1915
Sardone, L. T., 1960

Juan fernandez (*Chile*) (*Occurrence*)
Albert, F., 1898

Bahamonde, N. N., 1948
Balss, H., 1924
Lenz, H., 1902
Rathbun, M. J., 1910

Key for identification
Barnard, K. H., 1950
Chace, F. A. Jr. and W. H. Dumont, 1949
Holthuis, L. B., 1946
Pesta, O., 1915

Kreef
Von Bonde, C., 1938
Von Bonde, C. and J. M. Marchand, 1935 *a*, 1935 *b*

Laccadive Sea (*Occurrence*)
Prasad, R. R. and P. R. S. Tampi, 1959

Lady Julia Percy Island, Australia (*Occurrence*)
Tubb, J. A., 1937

Larvae (*see under the different larval stages*)

Legislation (*see under regulations*)

Length-weight relationship
Fielder, D. R., 1964 *a*
Grua, P., 1960 *a*, 1963
Mathews, J. P., 1962

Lobster meal (*spiny lobster meal or rock lobster meal*)
Anonymous, 1961 *b*, 1961 *d*
Lewis, A. M., G.J. Le Roux, and N. Plumbridge, 1951
Neal-May, W. M., 1950

Lobster meat (*spiny lobster meat*)
Anonymous, 1961 *b*
Bradstock, C. A., 1950
Von Bonde and J. H. Marchand, 1935 *b*

Lobster tail (*spiny lobster tail or rock lobster tail*)
Anonymous, 1950, 1951, 1954, 1961 *b*, 1961 *d*
Mathews, J. P., 1962
Von Bonde, C. and J. M. Marchand, 1935 *a*

Lobster traps (*see under fishing methods and gear*)

Locomotor activity
Fielder, D. R., 1965

Marketing
Anonymous, 1949, 1957 *c*

Mating
Fielder, D. R., 1964 *b*
Mathews, J. P., 1962
Von Bonde, C., 1936

Maturity (*sexual maturity*)
Angot, M., 1951 *a*
Bradstock, C. A., 1954
Fielder, D. R., 1964 *b*
Gilchrist, J. D. F., 1918 *a*, 1918 *b*
Grua, P., 1960 *a*
Heydron, A. E. F., 1964, 1965
Mathews, J. P., 1962
Sheard, K., 1949, 1962
Von Bonde, C., 1936
Von Bonde, C. and J. M. Marchand, 1935 *a*

Meal—lobster (see under Lobster meal)

Meat—canned (see under Canned lobster meat)

Meat—spiny lobster (see under Lobster meat)

Metamorphosis (see under the different larval stages)

Mortality
Anonymous, 1962 *b*
Von Bonde, C., 1928

Migration
Anonymous, 1958 *b*
Fielder, D. R., 1965
Gilchrist, J. D. F., 1918 *a*
Grua, P., 1960 *a*, 1963
Mathews,. J. P., 1962
Von Bonde, C., 1928
Von Bonde, C. and J. M. Marchand, 1935 *a*

Morphology (see under Anatomy and description)

Methods of capture (see under Fishing methods and gear)

Moulting (or ecdysis)

Bradstock, C. A., 1950
Drach, P., 1939
Fielder, D. R., 1964 *a*
George, R. W., 1957
Grua, P., 1960 *a*, 1963
Mathews, J. P., 1962
Von Bonde, C., 1928
Von Bonde, C. and J. M. Marchand, 1935 *a*
Young, M. W., 1926

Natural History
Challenger, T., 1943
Gilchrist, J. D. F., 1918 *b*
Hickman, V. V., 1946
Olsen, A. M., 1960
Talvas, 1939
Von Bonde, C., 1938
Von Bonde, C. and J. M. Marchand, 1935 *a*

Naupliosoma stage
Archey, G., 1916
Gilchrist, J. D. F., 1913 *b*
Von Bonde, C., 1936

Nomenclature—Discussion (see under Taxonomic notes)

New Amsterdam Island (Distribution)
Angot, M., 1951 *a*, 1951 *b*
Grua, P., 1960 *a*, 1960 *b*, 1963, 1964

New Zealand (Distribution)
Anonymous, 1954 *b*, 1956, 1957 *c*
Archey, G., 1916
Bradstock, C. A., 1954
Hutton, F. W., 1875 *a*, 1875 *b*, 1882, 1904
Miers, E. J., 1876
Parker, T. J., 1883, 1884 *a*, 1884 *b*, 1887, 1890
Powell, A. W. B., 1947
Thompson, D' A. W., 1901
White, A., 1847

Occurrence (see under Distribution)

Palinostus frontalis
Lenz, H., 1902

Palinostus lalandii
Bate, C. S., 1888

Palinosytus Lalandii
Stebbings, T. R. R., 1893

Palinustus frontalis
Rathbun, M. J., 1910

Palinurus edwardsii (P. edwardsli , P. Edwardsi, P. edwardsi)
Anderton, T., 1906
Filhol, H., 1885, 1886
Haswell, W. A., 1882
Heller, C., 1865
Hutton, F. W., 1875 *a*, 1875 *b*
Miers, E. J., 1876
Thompson, G. M., 1907

Palinurus frontalis
Albert, F., 1898
Boas, F. E. V., 1880
Burger, O., 1902, 1904
Milne-Edwards, H., 1837, 1851
Nicolet, H., 1849
Quijada, B., 1910
White, A., 1847

Palinurus lalandei [*P. lalandii, P. lalandi, P. lalandii, P. lalandi* also *P. lalandei* (in part) and references to also *P.l. frontalis* which have not been subspecifically differentiated]
Andre, M., 1932
Anonymous, 1948 *a*, 1948 *b*, 1950
Boas, F. E. V., 1880
Chun, C., 1903 (= *J. l. frontalis*)
Dana, J. D., 1852
Filhol, H., 1885, 1886
Herklots, J. A., 1861
Kershaw, J. A., 1906
Krauss, F., 1843
Lenz, H. and K. Strunck, 1914
McCoy, F., 1890
Miers, E. J., 1876
Milne-Edwards, H., 1837, 1838, 1851
Pfeffer, G., 1881
Stimpson, W., 1860
Studer, Th., 1889
Velain, C., 1878
White, A., 1847
Whitelegge, T., 1890

Palinurus paulensis
Heller, C., 1862

Palinurus (Jasus) edwardsii
Parker, T. J., 1883, 1884 *a*, 1884 *b*, 1887, 1890

Palinurus (Jasus) lalandii
Gilchrist, J. D. F., 1913 *a*, 1913 *b*
Parker, T. J., 1884 *a*, 1884 *b*, 1887
Zoond, A. and D. Slome, 1928

Palinustus frontalis
Rathbun, M. J., 1910

Phyllosoma stages
Barnard, K. H., 1950
Dakin, W. J. and A. N. Colefax, 1940
Gilchrist, J. D. F., 1916
Gurney, R., 1936, 1942
Lebour, M. V., 1954
Prasad, R. R. and P. R. S. Tampi, 1959
Von Bonde, C., 1936
Von Bonde, C. and J. M. Marchand, 1935 *a*

Physiology (see also—Chemical composition)
Krijgsman, J. B. and N. E. Krijgsman, 1954
Wolvekamp, H. B. and T. H. Waterman, 1960 (Blood oxygen capacity)
Zoond, A. and D. Slome, 1928

Possession Island (S.-W. Africa) (Occurrence)
Balss, H., 1913

Portobello (New Zealand) (Occurrence)
Anderton, T., 1906
Thompson, G. M., 1907, 1913

Post-puerulus stage
Gilchrist, J. D. F., 1920
Von Bonde, C., 1936

Predators—Jasus as food of fish
Grua, P., 1960 *a*

Predators—Jasus as food of sea birds
Davis, D. H., 1955
Grua, P., 1960 *a*
Rand, R. V., 1960 *a*, 1960 *b*
Yaldwyn, J. C., 1957

Predators—Jasus as food of seals
Grua, P., 1960 *a*
Rand, R. W., 1959
Yaldwyn, J. C., 1957

Production
Anonymous, 1950, 1955, 1957 *b*, 1957 *c*, 1958 *a*, 1958 *c*, 1959 *a*, 1961 *a*, 1961 *b*, 1961 *c*, 1963 *a*, 1963 *b*, 1963 *c*
Sardone, L. T., 1960
Sheard, K., 1962

Prenaupliosoma stage
Von Bonde, C., 1936

Projasus
George, R. W. and T. R. Grindley, 1964

Pseudo-hermophroditism
Hickman, V. V., 1945
Von Bonde, C., 1937

Puerulus stage
Archey, G., 1916
Calman, W. T., 1909
Gordon, I., 1953
Pesta, O., 1915
Von Bonde, C., 1936
Von Bonde, C. and J. M. Marchand, 1935 *a*

Quality
Anonymous, 1954 *b*

Rearing (see under Artificial rearing)

Recommendations
Grua, P., 1960 *a*, 1963
Von Bonde, C. and J. M. Marchand, 1935 *b*

Reevesby Island (S. Australia) Occurrence
Anderson, B. H., 1938

Regulations (and legislations)
Anonymous, 1954 *b*, 1958 *a*, 1958 *d*, 1958 *f*, 1960 *a*, 1961 *a*, 1962 *a*
Grua, P., 1960 *a*, 1963
Heydron, A. E. F., 1964, 1965
Von Bonde, C. and J. M. Marchand, 1935 *a*

Reproduction
Fielder, D. R., 1964 *b*
Grua, P., 1960 *a*, 1963, 1964
Heydron, A. E. F., 1964, 1965
Von Bonde, C., 1936
Von Bonde, C. and J. M. Marchand, 1935 *a*

Reproductive organs
Hickman, V. V., 1945 (abnormality)
Von Bonde, C., 1936

Resources
Anonymous, 1948 *a*, 1958 *b*
George, R. W., 1957
Gilchrist, J. D. F., 1913 *a*
Grua, P., 1960 *a*, 1963
Mathews, J. P., 1962
Sheard, K., 1949, 1962
Von Bonde, C. and J. M. Marchand, 1935 *a*
Walford, L. A., 1958

Rock lobster
Anonymous, 1954 *a*, 1959 *a*, 1960 *b*, 1961 *d*
Droesti, G. M., and G. H. Stander, 1951
Le Roux, G. K., R. P. Van der Merwe and J. A. Jackson, 1951
Lewis, A. M., G. J. Le Roux and N. Plumbridge, 1957
Ligthelm, S. P., L. Novellie, H. M. Schwartz, and H. M. Von Holdt, 1953
Mathews, J. P., 1962
Novellie, L., 1952
Novellie, L., and H. M. Schwartz, 1954
Van der Merwe, R. P., 1951
Van der Merwe, P. P. and J. R. Le Roux, 1952

Rock lobster meat (see under Lobster meat)

Saint Paul Island (Indian Ocean)
Andre, M., 1932
Angot, M., 1951 *a*, 1951 *b*
Balss, H., 1925
Chun, C., 1903
Grua, P., 1960 *a*, 1960 *b*, 1963, 1964
Heller, C., 1862, 1865
Lenz, H. and K. Strunck, 1914
Studer, Th., 1889
Taivas, 1939
Velain, C., 1878

Saltwater crayfish
Hickman, V. V., 1945

Sexual dimorphism
Angot, M., 1951 *a*
Mathews, J. P., 1962

Von Bonde, C., 1936
Von Bonde, C. and J. M. Marchand, 1935 *a*

Sexual maturity
Grua, P., 1960 *a*, 1963
Mathews, J. P., 1962
Von Bonde, C., 1936
Von Bonde, C. and J. M. Marchand, 1935 *a*

Sex ratio
Angot, M., 1951 *a*, 1951 *b*
Bradstock, C. A., 1950
Grua, P., 1960 *a*, 1963, 1964
Mathews, J. P., 1962
Von Bonde, C. and J. M. Marchand, 1935 *a*

Size
Angot, M., 1951 *a*, 1951 *b*
Anonymous, 1958 *d*, 1961 *a*
Barnard, K. H., 1950
Bradstock, C. A., 1950
Fielder, D. R., 1964 *a*
Grua, P., 1960 *a*, 1963, 1964
Mathews, J. P., 1962

Size composition
Grua, P., 1960 *a*, 1963
Mathews, J. P., 1962

Size limit (for fishery) (see under Regulations)

Southern crayfish
Sheard, K., 1962

Species synopsis
Olsen, A. M., 1960 (*J. lalandei*)

Spiny crayfish
Bradstock, C. A., 1950, 1954

Spiny lobster
Anonymous, 1954 *b*, 1955, 1957 *b*, 1957 *c*, 1960 *a*, 1960 *d*, 1960 *e*, 1961 *a*, 1961 *b*, 1961 *c*, 1963 *b*, 1963 *c*
Calman, W. T., 1909
Chace, F. A. Jr. and W. H. Dumont, 1949
Dawson, C. E., 1954
Fielder, D. R., 1964 *a*, 1964 *b*, 1964 *c*, 1964 *d*, 1965
Sheard, K., 1949
Von Bonde, C. and J. M. Marchand, 1935 *a*, 1935 *b*

Spiny lobster meat (see under Lobster meat)

Stewart Island (New Zealand) (Occurrence)
Anonymous, 1962 *a*
Filhol, H., 1885, 1886

Stomach contents (see under Food and feeding habits)

Statistical data (see under Catch statistics)

Synonyms
Angot, M., 1951 *a*
Balss, H., 1925
Barnard, K. H., 1950
Gruvel, A., 1911 *b*
Holthuis, L. B., 1946
Man, J. G., de, 1916

Table Bay (South Africa) (see under Union of South Africa)

Tagging
Bradstock, C. A., 1950
Von Bonde, C., 1928

Tasmanian Marine crayfish
Hickman, V. V., 1945

Taxonomy (nomenclatorial discussions, etc.)
Barnard, K. H., 1950
Holthuis, L. B., 1946, 1960
Parker, T. J., 1883, 1887

Technology (Methodology, etc.)
Droesti, G. M., 1948 *a*, 1948 *b*
Droesti, G. M. and R. P. Van Der Merwe, 1948, 1949
Droesti, G. M. and G. H. Stander, 1951
Droesti, G. M. and C. L. Southall, 1947, 1949
Le Roux, G. R., R. P. Van Der Merwe, and J. A. Jackson, 1951
Van Der Merwe, R. P., 1951
Van Der Merwe, R. P. and G. J. Le Roux, 1952
Von Bonde, C. and J. M. Marchand, 1935 *b*

Teratology (see under Abnormality)

Transplantation and acclimatisation
Albert, F., 1898

Traps (see under Fishing methods and gear)

Trapping pots (see under Fishing and methods gear)

Tristan da Cunha (South Atlantic)
Anonymous, 1948 *c*, 1948 *d*, 1962 *b*
Bate, C. S., 1888
Gurney, R., 1936
Stebbing, T. R. R., 1893

Union of South Africa, and South-West Africa (Cape of Good Hope, Cape Town, False Bay, Luderitz Bay, Possession Island, Saldana Bay, Table Bay, etc. and general occurrence)
Anonymous, 1948 *a*, 1948 *b*, 1950, 1954 *a*, 1959 *a*, 1960 *b*, 1960 *e*, 1961 *b*, 1961 *c*, 1961 *d*, 1963 *a*, 1963 *b*
Balss, H., 1913, 1916, 1925
Barnard, K. H., 1950
Dana, J. D., 1852
Davis, D. H., 1955
Dewberry, E. B., 1954
Gilchrist, J. D. F., 1913 *a*, 1916, 1918 *a*, 1920
Gronovius, L. T., 1764
Holthuis, L. B., 1952
Krauss, F., 1843
Mathews, J. P., 1962
Milne-Edwards, H., 1837, 1838, 1851
Müller, P. L. S., 1766, 1771, 1775
Neal-May, W. M., 1950
Odhner, T., 1923
Ortmann, A., 1891
Pfeffer, G., 1881
Rand, R. W., 1959, 1960 *a*, 1960 *b*
Sibson, F. H., 1925
Stebbing, T. R. R., 1900, 1902, 1910, 1914
Stimpson, W., 1860
Von Bonde, C., 1924, 1928, 1936, 1938
Von Bonde, C. and J. M. Marchand, 1935 *a*, 1935 *b*
Von Bonde, W., 1918, 1930
White, A., 1847

ADDENDUM

Since presenting this paper at the Symposium in January 1965, I have been able to see a recent paper entitled "Preliminary description of some new species of Palinuridae (Crustacea Decapoda, Macrura Reptantia)" by Dr. L. B. Holthuis [*Koninkl. Nederl. Akademie van Wetenschappen, Amsterdam, Proceedings, Series C*, **66** (1): 54–60 (1963)] wherein he has described two new species of *Jasus*, while recognising a total of six species under the genus as follows:

1. *Jasus lalandii* (H. Milne-Edwards, 1837) from South Africa.
2. *Jasus paulensis* (Heller, 1863) from St. Paul and Amsterdam Islands.
3. *Jasus* novæhollandiæ new species—from S. E. Australia and Tasmania.
4. *Jasus edwardsii* Hutton (1875) from New Zealand.
5. *Jasus frontalis* (H. Milne-Edwards, 1837) from Juan Fernandez, Chile.
6. *Jasus tristani* new species—from Tristan da Cunha.

My reasons for considering the representatives of *Jasus* from St. Paul and New Amsterdam Islands as *Jasus lalandei frontalis* were based on Holthuis's earlier work (Holthuis, 1946) discussed elsewhere in this paper. However, Holthuis (1963) has shown that in *J. frontalis* there is no sculpturation on the first somite, in which it would differ from the representative of the genus from St. Paul and New Amsterdam Islands which show sculpturation on the first somite in a narrow band just behind the transverse groove. When consistent, this is reason good enough to separote the two types and use the name *J. paulensis* for the St. Paul and New Amsterdam lobsters.

However, from the examination of the material as well as familiarity with the literature, I feel that in *Jasus lalandii* we may have a good instance of a polytypic species, rather than several independent species in the different geographical areas of distribution of the genus. This I mention as a matter of individual opinion. For instance, the nature and disposition of the squamiform sculpturation in the posterior half of the first abdominal somite in *J. paulensis* and *J. tristani* are the same, for the diagnosis of the last said species is given by Holthuis (1963) as: "....the present new species has the anterior half of the first abdominal somite perfectly smooth and without sculpturation. A narrow transverse row of small squames is placed just behind the transverse groove of the somite, but the larger part of the posterior half is smooth. The following siomtes have a rather wide transverse smooth area along the anterior and along the posterior margins, these smooth areas are clearly visible even in fully stretched animals. The squamae of the abdominal somites are broad and large they are placed in 2 or 3 transverse rows per somite." "The large spines on the carapace are similar to those of *Jasus frontalis* being as long as wide and much longer than the smaller spines." But for the fact that some of the larger spines mostly in the anterior half of the carapace are slightly longer than broad in larger specimens of *J. paulensis*, the very close similarity of *J. tristani* to this is clearly indicated. In *J. paulensis* also, the smooth areas of the second and third somites are clearly visible even in fully stretched animals of different sizes. These convergent trend in the sculpturing of the somites in these two insular representatives of the genus is interesting. Having not examined any material of *Jasus* from Tristan da Cunha, I am unable to comment on any other subtle differences between *J. tristani* and *J. paulensis*.

Jasus has been reported from S. W. Australia as *J. lalandii* by some workers. However, in the light of Holthuis's recent work on the genus (Holthuis, 1963), the status of *Jasus* in this area will need elucidation. The recognition of six different species in six different geographical areas makes the task of the commercial fisherman and fishery worker easy in assigning his material from a particular area to a species. However, as already discussed, there is an almost complete lacunae in our knowledge as to the paths and patterns of dispersal of phyllosoma of *Jasus* in the different areas specially in relation to ocean currents prevalent in the areas, the duration of larval phases, the effect of prolonged larval phase as reflected in the development of adult characters such as the sculpturation on the abdominal somites, and even the presence or absence of intergrades between two or more species in the different areas. Until we know more about these, a proper evaluation of the taxonomic status of the various nominal species of *Jasus* described in literature may not be possible.

A supplementary list of recent references pertaining to species of the genus *Jasus* Parker is appended below to make the bibliography complete as far as possible. However, these are not included in the section 'Index by Subject,' nor is Part I of this paper indexed.

CHITTLEBOROUGH, R. G. AND L. R. THOMAS 1967. Notes on Phyllosoma larvae from the Eastern Indian Ocean *Australia/New Zealand Meeting on Decapod Crustacea, Sydney*, Oct. 24-28, 1967. ANZDC 67/2/5, 1-9, 7 tables, and 4 figs.

[Mentions of phyllosoma of one species of *Jasus* as occurring in the eastern portion of the Indian Ocean.]

COPE, C. E. 1959. Spiny lobster gear and fishing methods. *U.S. Fish and Wildl. Serv. Fisheires Leaflet*, **487**: 1-17.

DEES, L. T. 1961. Spiny lobsters. *Ibid.*, **523**: 1-7.

FISHER, R. L., *et al.* 1964. A preliminary report on Expeditions *MONSOON* and *LUSIAD* 1960-1963—Scripps Institution of Oceanography Investigations in the Indian Ocean during IIOE. *Univ. Calif., San Diego, S.I.O. Reference* 64-19: 1-237.

HUGHES, W. D. 1965. Holding wells in cray boats. *Commercial Fishing*, 3 (9): 31-33.

KABERRY, A. C. AND R. B. PIKE 1967. The New Zealand crayfishery. *Australia/New Zealand Meeting on Decapod Crustacea, Sydney*, Oct. 24-28, 1967. ANZDC 67/2/17, 1-9, with 19 figs.

[*Jasus edwardsii* and *J. vereauxi*; history of New Zealand cray fishery; crayfishing grounds; export figures; size composition and sex ratio in *J. edwardsii*; regional landings of crayfish; carapace length-total length, and tail width-total length relationships of crayfish from different areas around New Zealand; size composition of crayfish boats; number of licences issued from 1938 to 1965 as compared with total landings, as well as North Island and South Island landing].

KENSLER, C. B. 1967 *a*. Notes on laboratory rearing of juvenile spiny lobster, *Jasus Edwardsii* (Hutton) (Crustacea: Decapoda: Palinuridae). *N.Z.J. Mar. and Freshw. Res.*, 1 (1): 71-75 (March 1967). Also in: *Australia/New Zealand Meeting on Decapod Crustacea*, ANZDC/67/2/9: 1 p. Summary.

[Rearing of large adult *J. edwardsii* from post-puerulus specimens and juveniles in laboratory possible; growth studies for periods upto 12 months, the animals fed every other day with fresh mussels and fresh fish; Juveniles actively 'grazing' on calcarcous algae *Carallina officinalis* L., present on rocks.]

——— 1967 *b*. An annotated bibliography of the marine spiny lobster *Jasus verreauxi* (H. Milne Edwards (Crustacea: Decapoda: Palinuridae). *Trans. Roy. Soc. N.Z. Zool.*, **8** (19): 207-210.

——— 1967 *c*. Size at first maturity in females of the spiny lobster *Jasus verreauxi* (Crustacea: Decapoda: Palinuridae). *Australia/New Zealand Meeting on Decapod Crustacea*, ANZDC/67/2/10. pp. 1-8 with 4 tables and 6 figures (Memio.).

[*J. verreauxi*—detection of smallest size-class with external eggs, and incidence of egg-carrying females per size class intervals based on 834 females measured and examined at Spirits Bay, New Zealand in Mid-October and late December 1966.]

——— 1967 *d*. Fecundity in the marine spiny lobster *Jasus verreauxi* (H. Milne Edwards) (Crustacea: Decapoda: Palinuridae). *N.Z.J. Mar. and Freshw. Res.* (in Press).

——— 1967 *e*. Notes on fecundity in the spiny lobster *Jasus edwardsii* (Hutton) (Crustacea: Decapoda: Palinuridae). *Ibid.* (in Press).

——— 1967 *f*. The distribution of New Zealand spiny lobsters. (Crustacea: Decapoda: Palinuridae). *Ibid.* (in Press).

—— AND W. SKRZYNSKI 1967 *g*. Commercial landings of the spiny lobster *Jasus verreauxi* in New Zealand (Crustacea Decapoda: Palinuridae). *Ibid.* (in Press).

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THOMAS, L. R. 1963. Phyllosoma larvae associated with Medusae. *Nature*, **198** (4876): 208.
[Reports also instance of feeding of Hydromedusae to phyllosoms of *Jasus lalandii* in laboratory.]

8-68. Printed at The Bangalore Press, Bangalore-18