OBSERVATIONS ON THE AMPHIPOD *PARATHEMISTO GAUDICHAUDI* (GUER.) OFF THE WEST COAST OF SOUTH AFRICA

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INTRODUCTION

This report is based on data that were obtained from plankton collections made from April 1954 to May 1960, during which time R.S. *Africana II*, of the Division of Sea Fisheries, occupied a number of offshore and inshore stations in the neighbourhood of the commercial fishing area of St. Helena Bay. This network of stations, known as the routine area, was visited once a month as part of the Division's pilchard and maasbanker research programme. The total area covered was approximately 4,800 square miles (see Figure 1).

Parathemisto gaudichaudi (Guer.) is one of the most characteristic and abundant members of the "edible", inshore plankton off the west coast of southern Africa. The species must be regarded as an important element in the over-all biomass of the routine area.

METHODS

During the monthly voyages of R.S. *Africana II* three plankton hauls were made at each station. The plankton nets were of the standard types as used by R.R.S. *Discovery I* (Kemp, Hardy and MackIntosh 1929).

The nets were used in the following manner, viz. the N70V was hauled vertically from 100 metres to the surface; the N100H towed for ten minutes just below the surface with the ship moving at about 1½–2 knots while at the same time an oblique N100B net was towed at an angle of 60° to the vertical, from 150 metres to the surface. At the shallower stations where the depth was less than 100 metres, nets were hauled from five metres above the bottom to the surface. All plankton hauls were made during the hours of daylight only.

Plankton catches were treated as follows:

(a) the settled volumes of the N70V net catches were measured at each station after "inedible" forms (cf De Jager 1954) such as large salps and medusae had been removed. The measurements were made almost immediately after the catch had been brought aboard;

(b) whole plankton samples were preserved in ten per cent neutral (borax) formalin. In the case of extra large catches, accurate fractional samples were obtained by means of a Folson plankton-sample splitter;

(c) plankton samples were brought ashore to the laboratory for detailed analysis. A special plankton log sheet was used to record the genera. The number of individuals of each genus present was expressed as arbitrary units of relative abundance (De Jager 1954);

(d) during the period April 1958 to May 1960, all amphipods were extracted from the samples for detailed examination;

(e) all *Parathemisto* individuals were extracted from each N100B sample obtained at the following coastal stations: R, Q, O, L, M and N (see Figure 1). A reduced sample of approximately 200 individuals from each station was selected and each individual measured from the anterior margin of the head to the tip of the telson, by means of a low-power, binocular microscope fitted with a micrometre eyepiece. All lengths were read to the nearest millimetre;

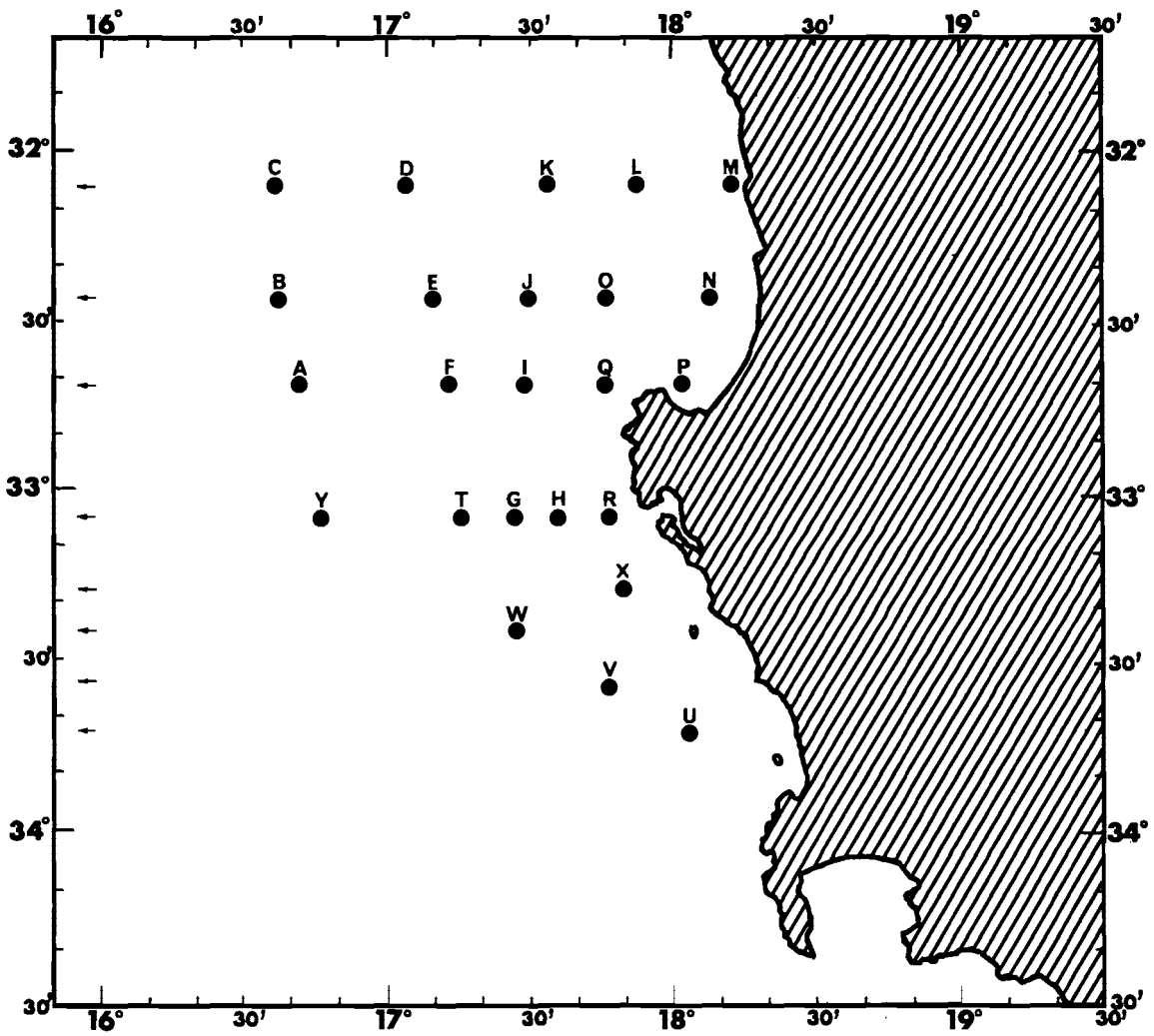

Figure 1. Research Area showing positions of stations A-Y

(f) individuals were examined for sex and degree of maturity. Calculations were based on appearance of oostegites and antennae and internal examination of gonads;
(g) the gut contents of 25 individuals selected at random, from each monthly sample were examined and identified.

Hydrological observations included the taking of sea-water samples at standard international depths for temperature and salinity determinations.

DISTRIBUTION

P. gaudichaudi occurs in the temperate regions of both hemispheres, extending into the Arctic and Antarctic.

TABLE 1. PERCENTAGE OCCURRENCE OF *P. GAUDICHAUDI* (PER NET HAUL) AT ROUTINE STATIONS

Period	Gear	Coastal Stations	Other Stations	All Stations combined	Total No. Net Hauls
April 1954–March 1957	N70V	72·0%	54·0%	59·0%	842
Jan. 1955–Dec. 1956	N100B	87·8%	72·0%	76·0%	561
Jan. 1955–Dec. 1956	N100H	65·7%	35·5%	43·4%	561

It is most abundant in the sub-Antarctic and sub-Arctic regions. Vosseler (1901) records a single specimen from the tropics at 7°S. latitude. It is a common and at times most abundant species in the cool neritic water of the west coast of southern Africa (Siegfried 1963).

At the inshore stations of the routine area within and along the 100 fathom line, it occurs with such regularity throughout the year, that it must be considered a characteristic member of the inshore plankton (see Table 1).

At times the species is extremely abundant and catches yielding over 500 cc. settled volume have been recorded on a number of occasions. Mackintosh (1934) remarks upon the patchy distribution of the species in the Antarctic but within the routine area it is distributed fairly evenly and the large hauls may be attributed to the occurrence of dense local concentrations.

Bigelow (1926) considers that, in the Gulf of Maine, the species prefers water below 14° C with an optimum range of between 4° and 12° C for adults. Whitley (1948) states that temperatures above 15° C and below 5° C are apparently unfavourable. Figures 2–5 show the relationship between temperatures and the distribution and relative abundance of the species within the routine area off the western Cape coast.

Figure 6 shows the seasonal variation in the abundance of the species over a three-year period at the coastal stations.

Classification of seasons is as follows:

(i) Spring—September, October and November;
(ii) Summer—December, January and February;
(iii) Autumn—March, April and May;
(iv) Winter—June, July and August.

From Figure 6 it is evident that *P. gaudichaudi* is more abundant during periods of rela-

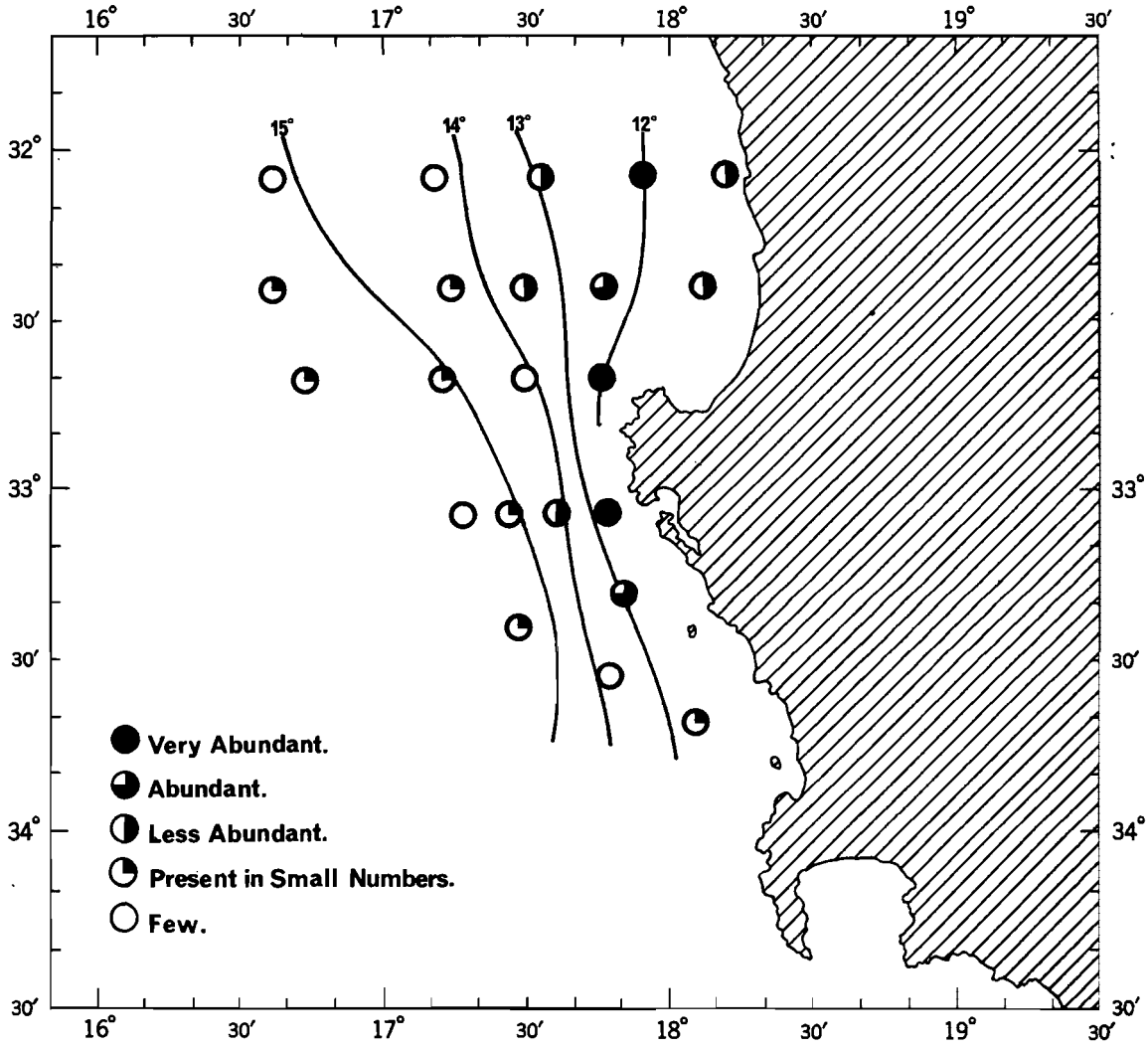

Figure 2. Density Distribution of *P. gaudichaudi* and average of 0-50 metres mean integral Temperatures, April, 1954-March, 1955.

tively low temperature and salinity values. This cooler nutrient rich water is the result of upwelling which occurs mainly during the spring and summer. Phytoplankton organisms undergo a period of florescence during these seasons which in turn permits the growth and increase of zooplankton. The graphs illustrate how closely the fluctuations in abundance of *P. gaudichaudi* correspond with the settled volume values of the plankton.

No attempt was made to investigate whether the species performs vertical migration.

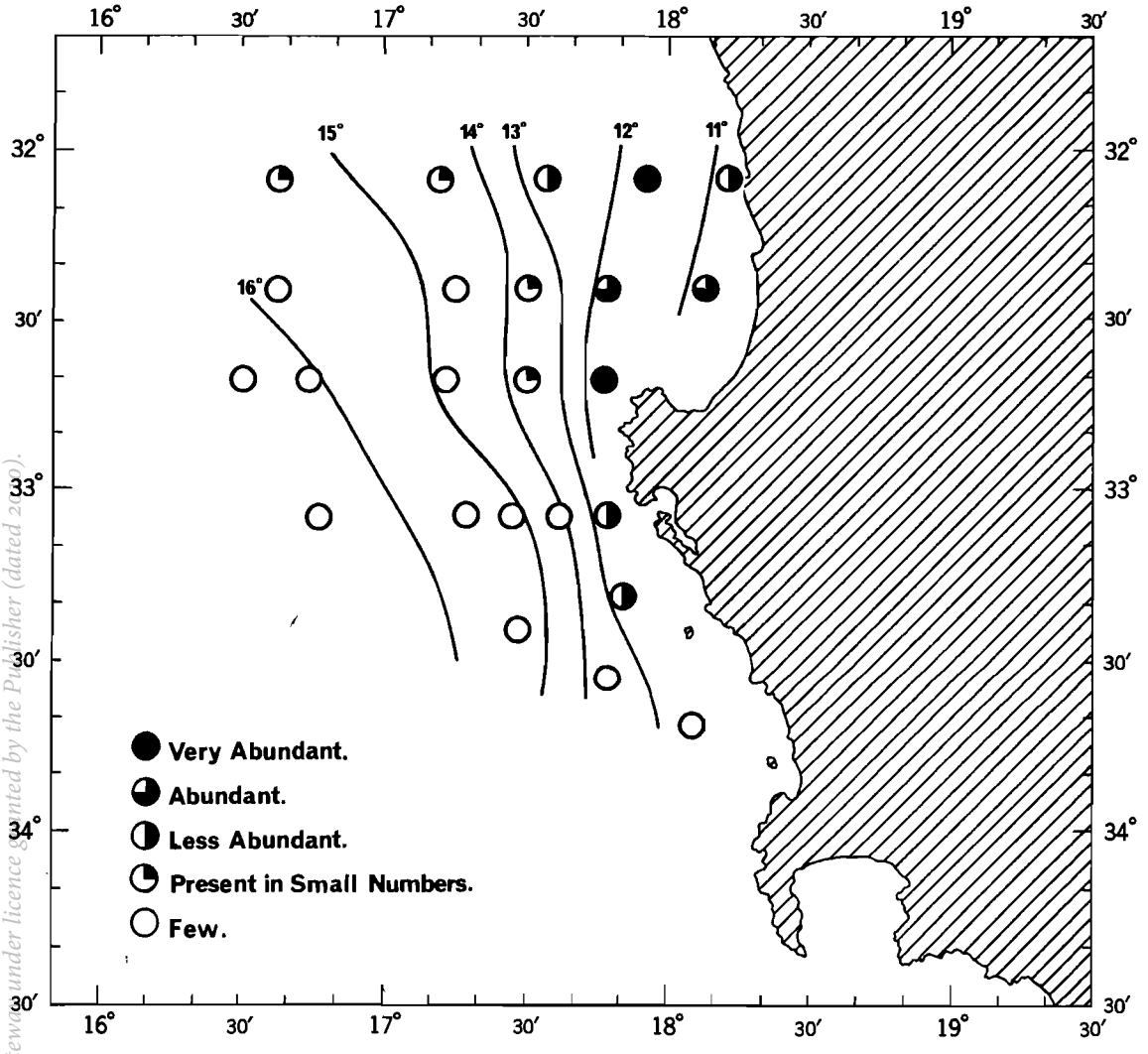

Figure 3. Density Distribution of *P. gaudichaudi* and average of 0-50 metres mean integral Temperatures, April, 1955-March, 1956.

All nets were operated during the hours of daylight only and little can be said of diurnal variation. It is of interest, however, to note from Table 1 the high incidence of positive surface catches made in the area.

Mackintosh (1934) found that although *P. gaudichaudi* showed quite a marked diurnal variation at some stations, the species was actually caught in both large and small numbers almost as often during the day as during the night by the N100B net.

Hardy and Gunther (1935), in the Antarctic, state that *P. gaudichaudi* shows a gradual rise towards the surface beginning some three hours before darkness and a corresponding fall in the early hours of the morning after sunrise and that for the most part, in the daytime, numbers

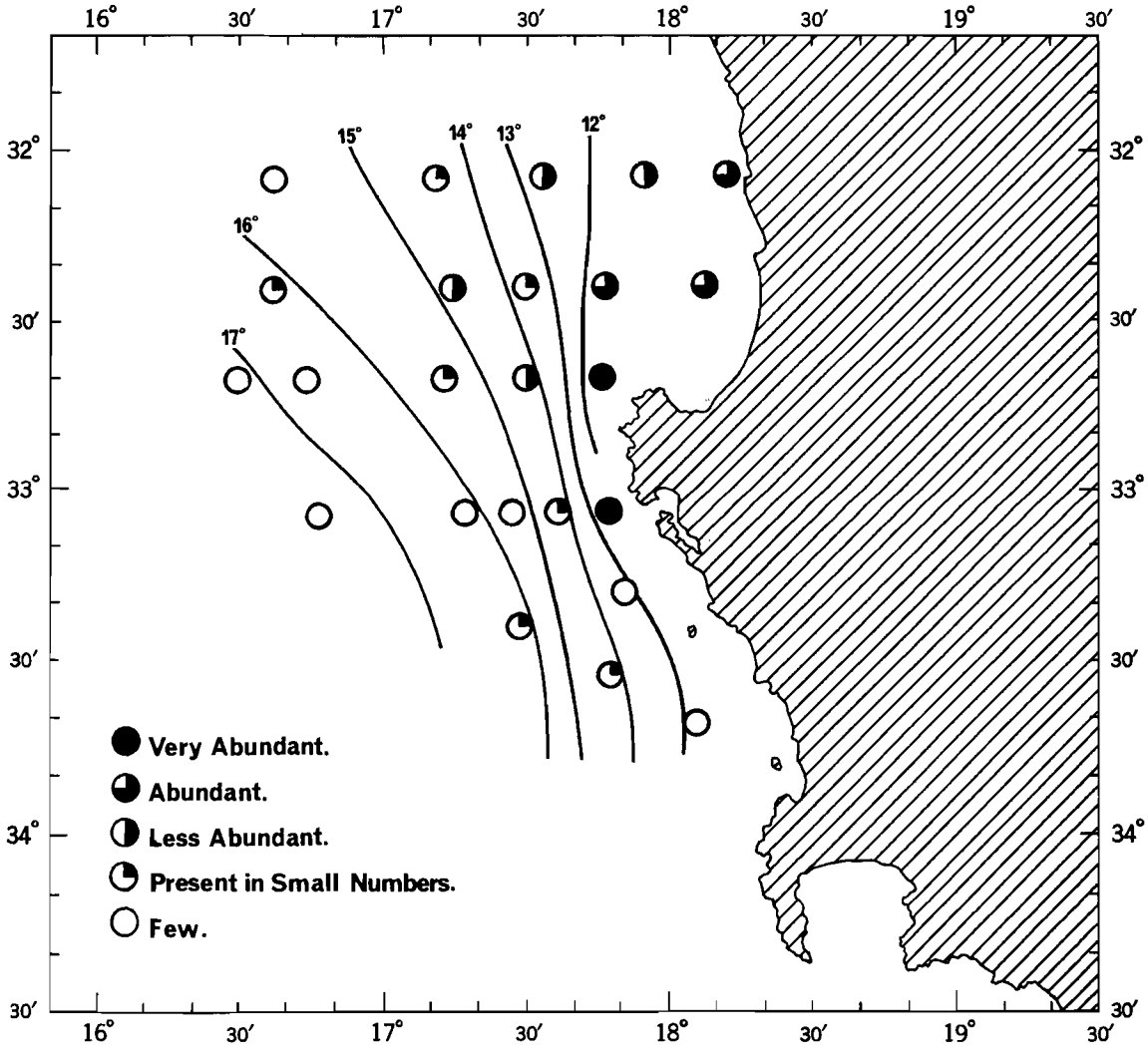

Figure 4. Density Distribution of *P. gaudichaudi* and average of 0-50 metres mean integral Temperatures, April, 1956-March, 1957.

taken in the upper 50 metres are small. They conclude that whilst it may occasionally be taken from depths below 500 metres or even 750 metres, it is essentially an inhabitant of the surface layers more often being found in the upper 100 metres.

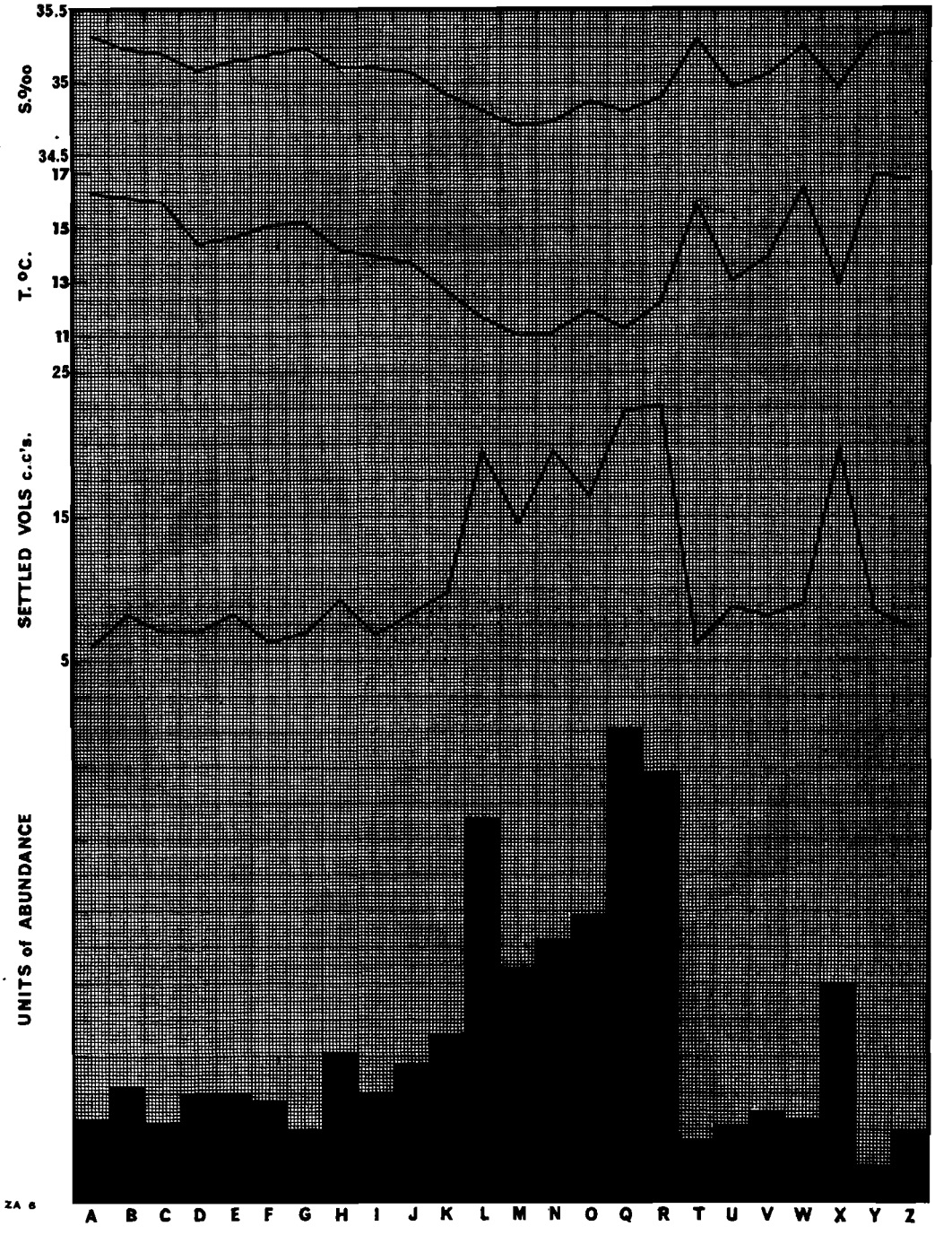

FIGURE 5. Average units of Abundance of *P. gaudichaudi*, mean integral Temperature and Salinity (0–50 metres layer), and average Settled Volumes at each Station, April, 1954–March, 1957.

Dunbar (1942 and 1946) considers that *Themisto libellula* might be positively phototropic as it is frequently caught in great quantity at the surface on days of bright sunshine and on cloudy days is found a little lower. Referring to the purple pigmentation of the genus, Dunbar suggests that a possible correlation might exist between this dark colouration and heliotropism because other planktonic forms which are darkly pigmented, such as *Limacina*, are commonly found close to the surface during periods of bright sunlight.

According to Bigelow (1926) the bathymetric distribution of young *Euthemisto* in the Gulf of Maine, differs from that of the adults—"the fact that we have taken them in swarms in the surface nets at several stations where their parents (or at least females with eggs) were plentiful at deeper levels is evidence that they rise through the water immediately after they are hatched."

This same phenomenon occurred at times in the routine area and the N100H net would, on the average, contain a catch of individuals much smaller than that of the N100B net hauled simultaneously. On the other hand, mixed catches of all sizes were more frequently taken.

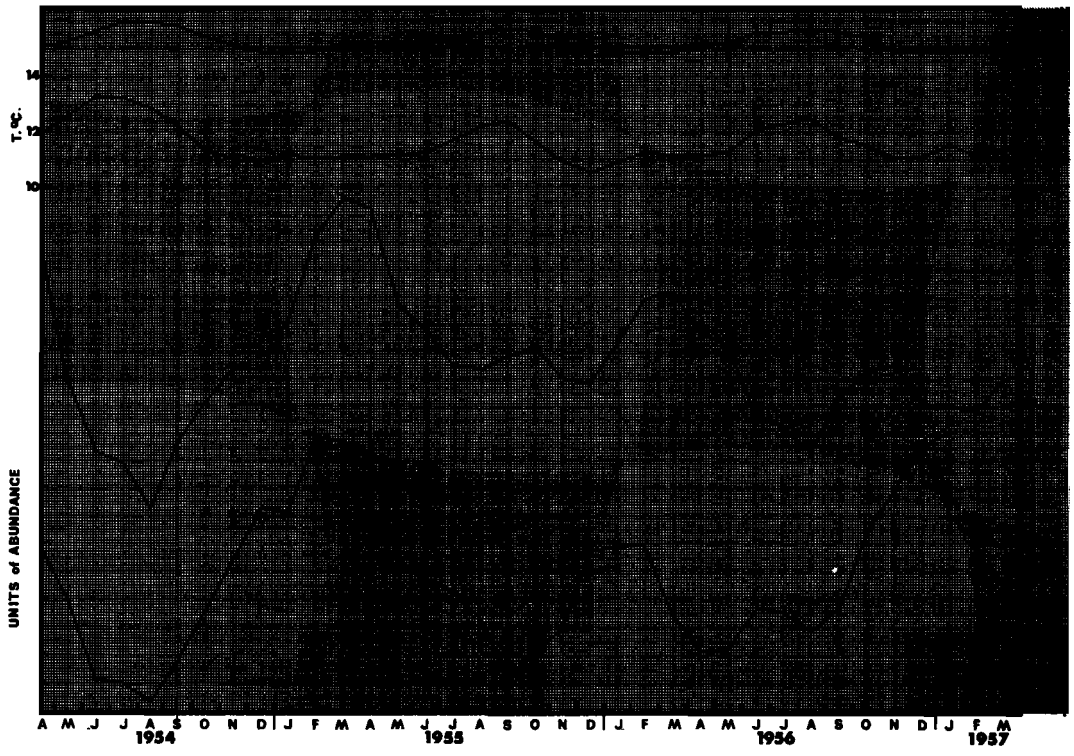

FIGURE 6. Monthly Variation of average *P. gaudichaudi* Abundance, Settled Volumes and 0–50 metres mean integral Temperatures and Salinities (curves plotted according to three-month moving average) at the Coastal Stations, April, 1954–March, 1957.

REPRODUCTION

During the period April 1958 to May 1960, mature females with eggs or young in the brood-pouch were observed in each monthly sample examined with only two exceptions—the months of June and July 1960. It is thus evident that *P. gaudichaudi* in the routine area has no sharply demarcated breeding period and that breeding occurs to a greater or lesser extent throughout the year.

From Figure 7 it is apparent that the percentage of ovigerous females in the samples is highest during the spring months and lowest during the winter. The maximum reproductive activity displayed during spring is reflected by the increase in abundance of the species during summer and autumn (see Figure 6).

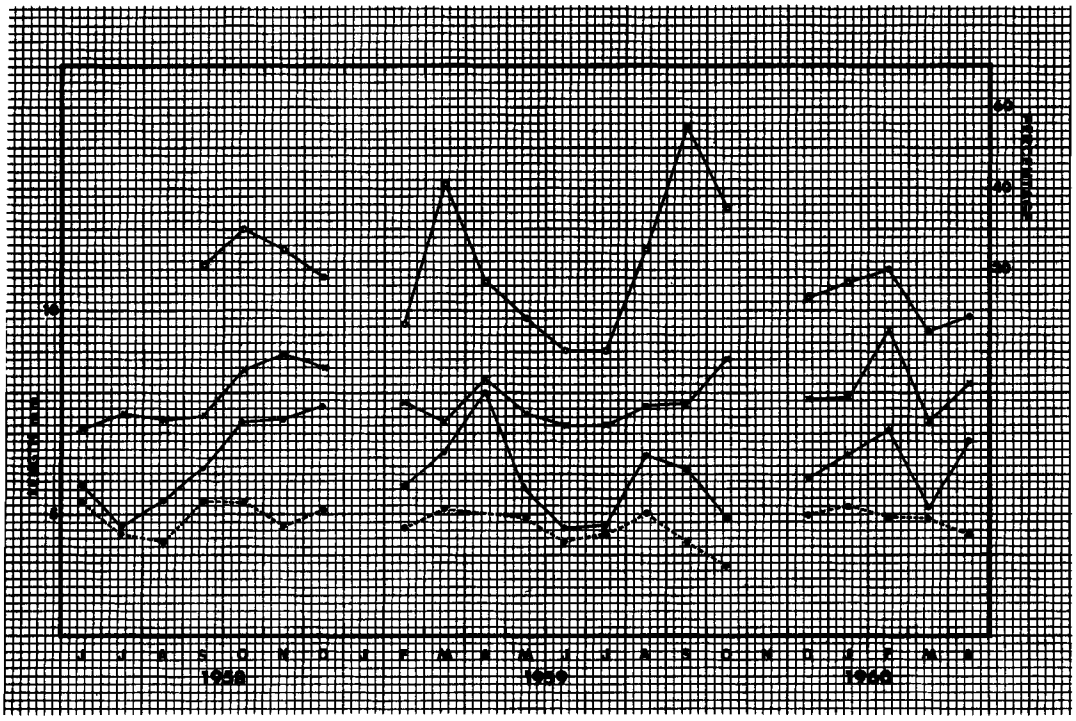

FIGURE 7. *P. gaudichaudi:* Relationship between the percentage of ovigerous females and the average size lengths of the monthly samples, June, 1958–April, 1960.
O———O Percentage ovigerous females, 6 mm. +.
– – – – – – 0–6 mm. Class length group.
X———X 7 mm. + Class length group.
——————— Average length of whole sample.

Nepgen (1957) found that in the routine area the largest number of euphausiid eggs (probably *Euphausia lucens*) occurred a month or two before the adult euphausiids were most abundant. The eggs were also recorded in smallest numbers a month or two before euphausiids were least abundant.

The size frequency data for *P. gaudichaudi* in the routine area show that relatively small individuals are present throughout the year (see Figure 8).

In the Antarctic the species breeds in the spring and summer months (Barnard 1932). Bigelow (1926) considers that although breeding continues for almost the whole year in the Gulf of Maine, summer is the main season. In the Mediterranean and North Atlantic spawning is most intense during summer but breeding occurs throughout the year (Stephensen 1924).

Dunbar (1957) referring to the work of Orton (1920), suggests that *Themisto libellula* is stimulated to breed (if directly affected by temperature at all) at a fall below a critical point for the species and that some factor other than temperature, perhaps light, might well be more important.

In the routine area it is doubtful whether temperature directly controls the spawning of *P. gaudichaudi*. Figure 6 shows that in the coastal area minimum temperatures occur as a result of upwelling during spring and summer, which is the main spawning period. In the outer offshore area, however, maximum temperatures are experienced during summer (Buys 1957 and 1959). From an examination of a limited number of offshore N100B samples it appears as if the main spawning period for the species also occurs at these stations during spring and summer.

A single female produces more than one brood, sometimes in rapid succession. A number of specimens carrying embryos in the brood-pouch were observed to have well developed ovaries, the ova being loose and almost ready for extrusion. Exactly how many broods a single female can produce and the time necessary for the development of the eggs from the moment of extrusion to the liberation of the young from the brood-pouch is not known.

The number of eggs carried in the brood-pouch at one time is not high, the average count for females of all sizes being 40 eggs (range, 20–80) per brood-pouch. The young at hatching measure a little over one millimetre in length.

Once a brood has been liberated, the oostegites as far as can be ascertained, do not atrophy but persist to receive the next batch of eggs as long as spawning continues.

Over the study period the percentage of males in the monthly samples varied between eight and 37 per cent, about a mean of 27 per cent.

At a minimum length of five to 6 millimetres, females are already carrying eggs in the brood-pouch. Males, apparently, can attain maturity at the same size judging by the development of the antennae; unfortunately the testes were not examined in conjunction with the antennae.

It does not follow that all males and females measuring six millimetres and more have attained maturity; females as long as ten millimetres at times show small ovaries and oostegites. Males considerably larger than six millimetres are found with antennae that show very little development, which seems to indicate that these specimens have yet to attain maturity. That the females in question are passing through a resting period after spawning, and that the

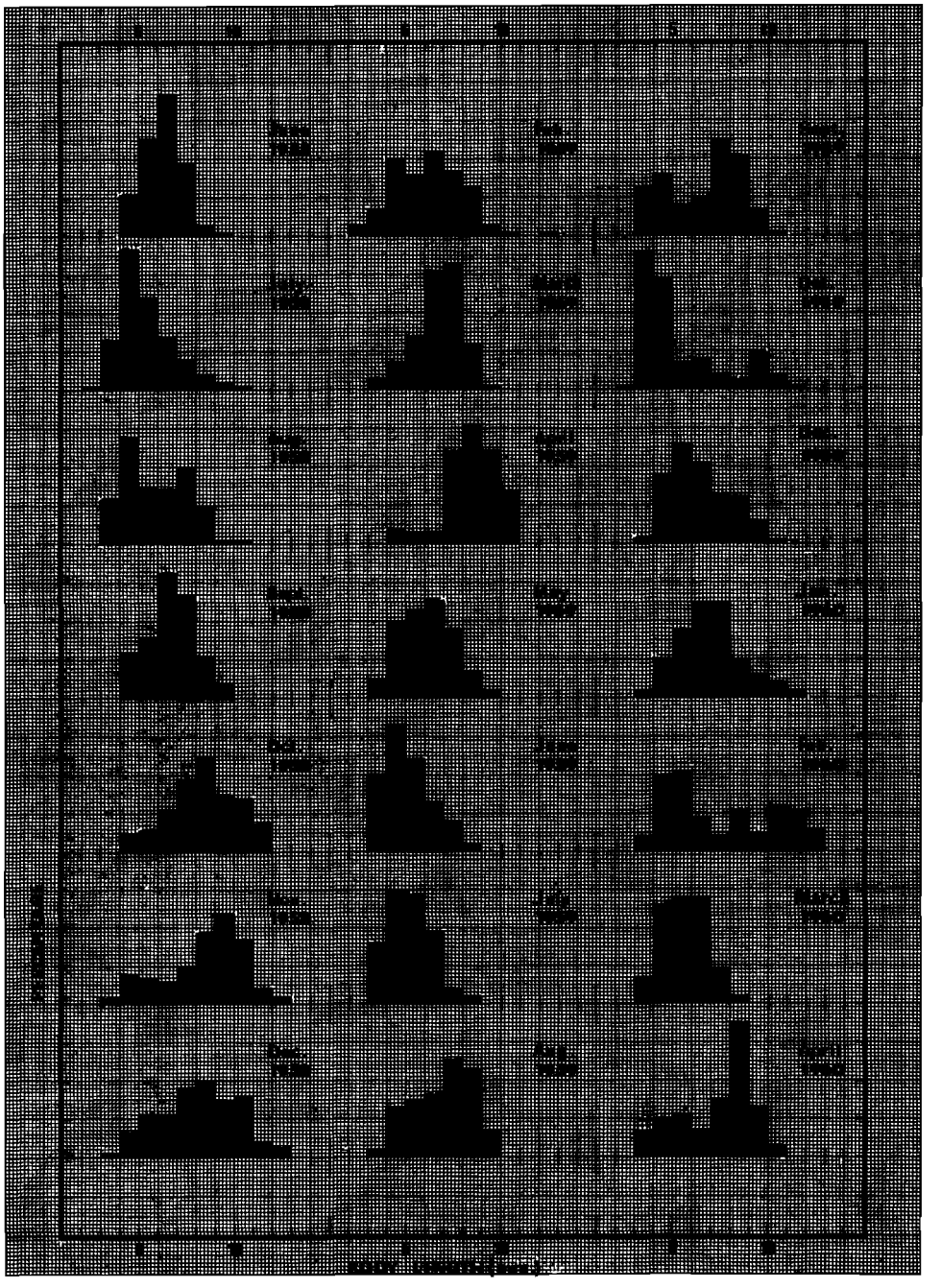

FIGURE 8. *P. gaudichaudi:* Percentage size composition at the Coastal Stations, June, 1958–April, 1960.

oostegites will again assume breeding proportions once spawning recommences, seems unlikely. If these large individuals, both male and female, with immature sexual characteristics, have yet to spawn, then it appears as if the size at which maturity is attained can vary, possibly as a result of changes in the environment—temperature, food availability, etc.

In the colder Antarctic water *P. gaudichaudi* grows to a larger size than in the routine area (Barnard 1932). The population inhabiting the colder regions of higher latitudes probably has a longer life, slower rate of growth and attains maturity at a larger size than the population of the routine area. In both the northern and southern hemispheres there are known examples of marine poikilothermic animals which display differences between populations of the same species (Sverdrup, *et al* 1946).

In the Arctic, *Themisto libellula* breeds once only and then dies, the life cycle of the individual being between 18 months and two years but a life cycle of one year is not impossible (Dunbar 1946 and 1957).

In the more temperate waters of the routine area *P. gaudichaudi* has a life cycle of less than one year. Young individuals liberated during spring grow rapidly in the plankton-rich upwelled water and appear to reach maturity and to spawn approximately 2–3 months after liberation. This would entail a rate of growth in length of about 2–3 millimetres a month. The relatively fast growth and early attainment of maturity allows for the production of a number of successive generations each spring and summer which maintain the very abundant population of the routine area.

With the coming of autumn specimens in the 7 mm. plus class range decrease in numbers (see Figures 7 and 8). Large, senescent individuals were noted as being relatively common in the samples during the late spring and late autumn months. The young, immature group liberated at the end of the breeding season survives the winter period of quiescence and comparatively slow growth. This group is dominant in the length frequency samples for the early winter months (see Figure 8). With the onset of spring, rapid growth and intense spawning commence again.

FEEDING HABITS

The following is a list of food organisms found in the gut contents of *P. gaudichaudi:*

Zooplankton: Copepods, copepodids and larvae; euphausiid eggs, larvae and juveniles; nauplius and cypris larvae; mysids; *Podon* and *Evadne*; decapod larvae; stomatopod larvae; *P. gauduichadi* young; fish larvae.

Phytoplankton: *Thalasiosira; Fragilaria; Dinophysis; Prorocentrum; Peridinium.*

That *P. gaudichaudi* is a voracious predator of plankton is a well-known fact. The species is not very selective in its feeding probably devouring anything smaller than itself, including its own kind. In most cases the frequency of occurrence of the prey organisms in the gut reflects the frequency with which they occur in the water. This fact was borne out on a number of occasions by a comparison of the relative amounts of certain genera in the water with the relative amounts of such genera in the gut of *P. gaudichaudi* at the same station.

Juveniles were found to feed on phytoplankton to a greater degree than adults, amongst

which copepods and to a lesser extent euphausiid larvae and juveniles constituted the main food items.

Van Zyl (1960) found that the young stages of *P. gaudichaudi* constitute one of the main items in the diet of salps off the west coast of South Africa. The species is also taken by the larger ctenophores (*Pleurobrachea*, *Beroe*) and on one occasion it was recorded from the gut of a juvenile *Loligo*.

The pilchard *Sardinops ocellata*, the maasbanker *Trachurus trachurus* and the stockfish *Merluccius capensis* are three of the commonest fish occuring in the routine area and are commercially caught on a large scale. The pilchard feeds primarily on phytoplankton (Davies 1957) and amphipods are of no importance to this fish. Maasbanker stomachs are often packed with *P. gaudichaudi* and unpublished data of the Division of Sea Fisheries reveal that the species forms a considerable part of the diet of this fish when it occurs inshore along the west coast. *P. gaudichaudi* has been found in the stomachs of stockfish from time to time but no detailed records are available.

SUMMARY

1. This report deals with the bionomics of the hyperiid Amphipod *Parathemisto* (*Euthemisto*) *gaudichaudi* (Guer.) off the west coast of southern Africa.
2. The frequency of occurrence of the species is highest in the cool inshore waters of the routine area.
3. At the coastal stations the species is most abundant during late spring, through summer to the middle of autumn.
4. The species inhabits primarily the upper water layers.
5. Breeding occurs to some extent throughout the year. Maximum reproductive activity, however, occurs during the spring and summer—minimum activity during the winter.
6. The life cycle of the species is adapted to allow for the production of a number of successive generations as long as favourable conditions prevail.
7. The food of the species consists of the smaller zooplankton, mainly Copepoda; phytoplankton is also taken. There is no special selection of food items and in most cases the frequency of occurrence of the prey organisms in the gut reflects the frequency with which they occur in the water.

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