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DISCOVERY OF DEEP-SEA CRABS (*CHACEON* SP.) IN FRENCH POLYNESIA (DECAPODA: GERYONIDAE)

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ABSTRACT

Deep-sea crabs (*Chaceon* sp.) were discovered in French Polynesia. Most of the catches were made around the Marquesas islands at depths ranging from 370–1,050 m. In this archipelago, two trapping surveys caught 628 kg (709 crabs). Males outnumbered the females by 610 to 99. The mean carapace width was 13.19 cm (940.8 g) and 10.99 cm (547.4 g) for the males and females, respectively. The mean catch rate was 1.4 kg (1.6 crabs)/trap/night. Catch rate was mainly affected by the depth, with greatest catches obtained between 700–800 m. The highest result for a single trap was 11.5 kg (13 crabs)/trap/night. The mean weight of the catches (0.9 kg) and the yields obtained are high enough to initiate a small-scale fishery but severe management rules should be taken to protect the species.

RÉSUMÉ

Des crabes de profondeur (*Chaceon* sp.) ont été découverts en Polynésie Française. La plupart des captures ont été faites aux îles Marquises, à des profondeurs comprises entre 370 et 1,050 m. Dans cet archipel, deux campagnes de pêche aux casiers ont permis de capturer 628 kg (709 crabes). Les mâles dominent largement dans les captures avec 610 prises contre seulement 99 pour les femelles. La largeur moyenne de la carapace est de 13.19 cm (940.8 g) et de 10.99 cm (547.4 g) pour les mâles et les femelles respectivement. Le rendement moyen est de 1.4 kg (1.6 crabes)/casier/nuit. Il est principalement influencé par la profondeur, les résultats les plus élevés étant obtenus entre 700–800 m. Le meilleur résultat pour un seul casier est de 11.5 kg (13 crabes)/casier/nuit. Le poids moyen élevé des captures (0.9 kg) et les rendements obtenus permettent d'envisager une exploitation commerciale à petite échelle mais des mesures strictes de gestion doivent être prises pour protéger l'espèce.

Chaceon is a deep-sea crab found in almost all oceans in depths ranging from about 100 m to 3,500 m. In the Pacific ocean, *Chaceon* is known from Chile (Chirino-Gálves and Manning, 1989), Emperor seamount Chain and Japan (Sakai, 1978), Palau (Saunders *et al.*, 1989), Fiji (King, 1984), New Caledonia (Intès, 1978), Australia (Griffin and Brown, 1976), and New Zealand (Manning *et al.*, 1990; Webber *et al.*, 1990). This genus has not previously been reported from French Polynesia. During a trapping survey that mainly targeted the deep-dwelling caridean shrimps in the exclusive economic zone of French Polynesia (Poupin *et al.*, 1990), some *Chaceon* were incidentally caught around the Marquesas islands in 1988 and 1989. This finding prompted further investigation in 1990 and 1991 to learn aspects of the biology and ecology of the species and to determine the extent of this potential fishery resource.

MATERIALS AND METHODS

The exclusive economic zone of French Polynesia is a vast marine area stretching from 131°W to 158°W and from 5°S to 31°S (Fig. 1). It includes four archipelagos: Marquesas, Tuamotu-Gambier, Society, and Australs. Cruises were made in the Marquesas in August–September 1990 and in January 1991 on board the Direction des Centres d'Expérimentation Nucléaire (DIRCEN) fishing vessel *Marara*. Three more cruises were made in the other French Polynesian islands: Tuamotu (May–June–October 1990), Society (June 1990), and Australs (November 1990 and August 1991).

Two commercially available trap designs were used to sample crabs. The *Paimpolais* traps are conical and are 65 cm and 50 cm in diameter at the base and top, respectively, and 40 cm in height. The top entrance funnel is 20 cm in diameter. The *Noirmoutier* traps are cylindrical and are 65 cm long and 44 cm high. This design is mainly used for shrimp trapping. The diameter of the two opposite entry funnels have been enlarged from 8 to 15 cm to permit entry of crabs. Fifteen traps were attached at 40-m intervals to a groundline. They were baited with 0.2–0.6 kg of reef fishes and set at night; the average soaking time was 14 h.

A total of 676 traps (466 *Paimpolais* and 210 *Noirmoutier*) were set around the Marquesas islands (Fig. 1), in depths ranging from 320–1,050 m. Although we tried to sample all depths equally (Table 1), the stratification by 100 m was done a posteriori. Around the other islands of French Polynesia, 1,125 more traps (278 *Paimpolais* and 847 *Noirmoutier*) were set between 60–1,050 m.

The crabs in each trap were counted and individually sexed and weighed. Accuracy in weighing, which was

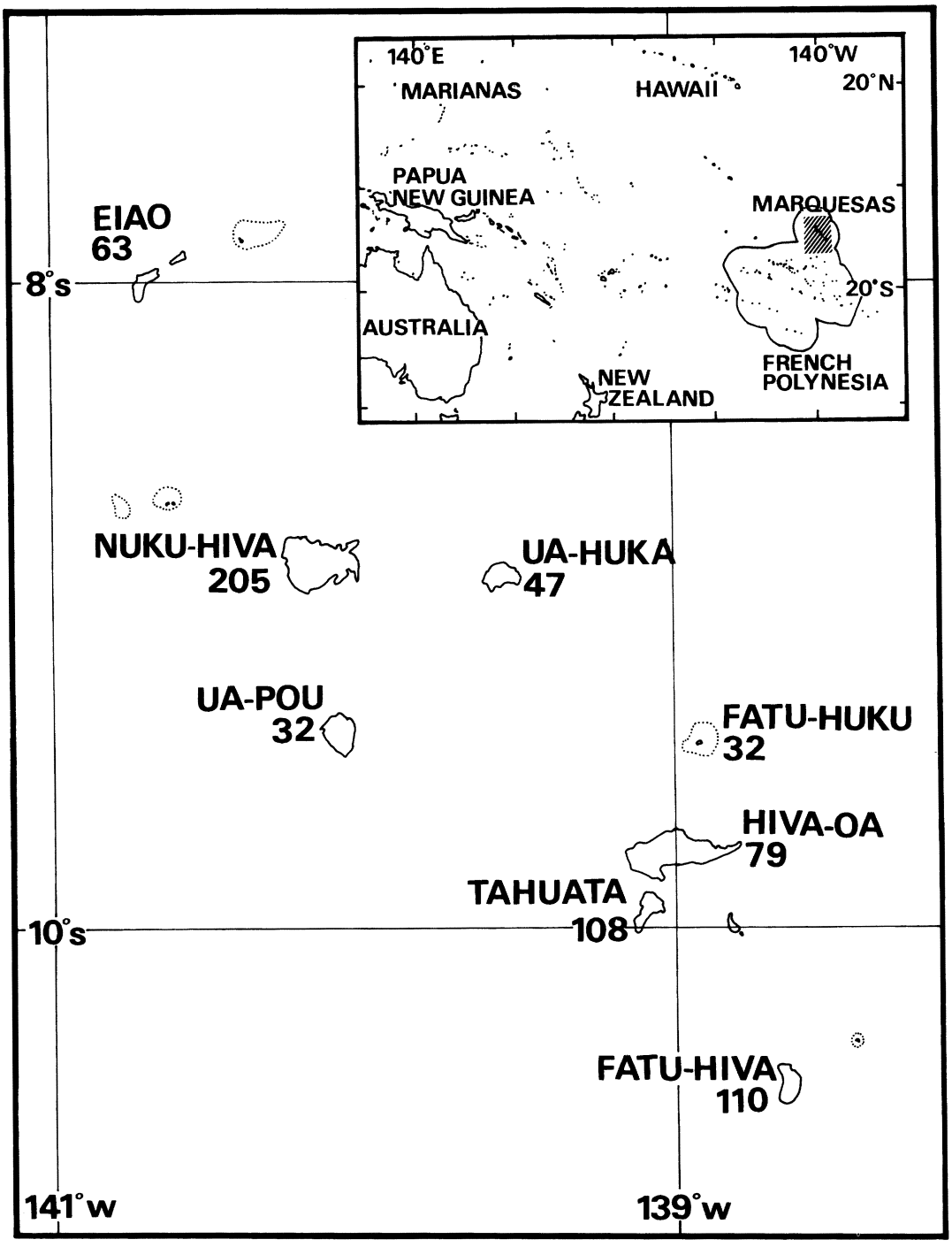

Fig. 1. Marquesas islands and location of French Polynesia. Numbers indicate the number of traps set around each island.

done aboard ship, depended on sea-state conditions. In most cases weight was recorded to the nearest gram. Each crab was measured to the nearest 0.1 millimeter using calipers: carapace width, CW, distance between the tips of the fifth lateral spines; carapace length, CL, distance from the diastema between the rostral teeth to the posterior edge of the carapace, along midline; abdomen width, AW, distance between the lateral edges of the sixth abdominal segment, along midline; abdomen length, AL, distance from the tip of the ab-

domen to the posterior edge of the abdomen (third abdominal segment), along midline. The number of missing chelae and pereiopods was recorded for each crab, as was molt condition and presence of chitinolytic lesions and poecilasmatid barnacles on the exoskeleton. Molt condition consisted of three categories: (1) postmolt—carapace at medium strength with no fouling, (2) intermolt—carapace hard, fouled by at least some barnacles, and (3) old—carapace strong, heavily fouled by barnacles and abraded or blackened by chitinolytic bacteria.

Female *Chaceon* were examined for the presence of eggs or remnants of eggs on pleopods and for the size of vulvae. The Mann-Whitney U-test was used to determine whether a significant difference occurred in median size between two samples. A Kruskall-Wallis test was used to compare the mean catch rate among islands. The significance of the deviations of the samples from the expected or theoretical 1:1 sex ratio was tested using a chi-square test.

Information on the bottom types was obtained by 92 dredgings conducted between 40–1,020 m: 38 in the Tuamotu, 27 in the Marquesas, 14 in the Society, and 13 in the north Austral islands. The equipment was a *Charcot* dredge, 77 cm wide and 30 cm high. Data about water temperature and salinity were also obtained in August 1990 off the Marquesas, from the surface to 1,000 m, by means of expendable bathythermographs (XBT) and reversing bottles equipped with thermometers.

Results

Site Characterization.—The slopes surrounding the islands in French Polynesia are very steep and the bottoms encountered were generally very rough. On 92 dredgings, 54 dredges were damaged because of the hard nature of the bottom. The softest grounds were found around the Marquesas islands on a smooth slope between 40–150 m, with mud or earth collected in the dredge. Deeper around these islands, very hard bottoms discouraged us to conduct operations. Few rocks of volcanic origin and old remains of dead coral were collected between 350–980 m, from only 8 operations. In the Society, Tuamotu, and north Austral islands the sediment collected between 50–1,020 m was composed of gravels and blocks, always of coral origin.

Off the Marquesas in August, large temperature and salinity gradients, respectively, from 27.5°C to 9°C and from 35.55 ppt to 34.75 ppt, existed from the surface to 400 m. Below 400 m the temperature and salinity decreased gradually, respectively, to 5°C and 34.50 ppt at 1,000 m.

General Results.—*Chaceon* sp. was caught mainly around the Marquesas islands from 350–1,050 m, the deepest waters prospected. The crab was never caught around the Society, Tuamotu, and north Austral islands, despite the fact that we set 1,110 traps between 60–1,050 m in these areas. However, in August 1991, three *Chaceon* were discovered at a depth of 870 m off Rapa, the southernmost island of French Polynesia, which is about 2,000 km from the Marquesas archipelago. This finding, obtained from limited fishing operations (only 15 *Noirmoutier* traps) is discussed later. The following results apply only to the fishing operations conducted in the Marquesas.

Table 1. Fishing effort, expressed in number of traps by depth, around the Marquesas islands, for the two trap types (*Paimpolais* and *Noirmoutier*). Traps were set at night witin the 320–1,050-m depth range; the average soaking time was 14 h. The stratification by 100 m was done a posteriori.

Strata (m)	*Paimpolais*	*Noirmoutier*	Total
<400	26	50	76
4/499	47	44	91
5/599	71	39	110
6/699	90	6	96
7/799	92	20	102
8/899	79	17	96
9/999	29	18	47
>999	32	16	48
Total	466	210	676

A total of 709 crabs weighing 628 kg were caught around the Marquesas islands. Males comprised 86% of the total catch, outnumbering females by 610 (574 kg) to 99 (54 kg). Several other decapod crustaceans were caught incidentally, mainly shrimps (*Oplophorus typus* H. Milne Edwards, 1837; *Acanthephyra eximia* Smith, 1884; *Nematocarcinus* sp.; *Plesionika* spp.; *Heterocarpus ensifer* A. Milne Edwards, 1881; *Heterocarpus laevigatus* Bate, 1888) and crabs (*Homola orientalis* Henderson, 1888; *Randallia serenei* Richer de Forges, 1983; *Progeryon mararae* Guinot and Richer de Forges, 1981).

Morphometric Characteristics.—Males of *Chaceon* were significantly larger (Mann-Whitney, $P < 0.01$) than females, with mean sizes (CW) of 13.19 cm and 10.99 cm, respectively (Table 2). Carapace widths of males ranged from 5.09–17.41 cm and modal width was 15 cm (Fig. 2). The mean weight was 940.8 g, with individuals ranging from 45–1,965 g. Females ranged in cara-

Table 2. Size and weight statistics of male (N = 610) and female (N = 99) *Chaceon* sp. off the Marquesas. CW = carapace width; CL = carapace length; SE = standard error.

	CW (cm)		CL (cm)		Weight (g)	
	Male	Female	Male	Female	Male	Female
Mean	13.19	10.99	11.70	9.81	940.8	547.4
(SE)	(0.09)	(0.32)	(0.09)	(0.27)	(16.95)	(35.20)
Minimum	5.09	4.56	4.51	3.93	45	28
Maximum	17.41	15.27	15.53	13.90	1,965	1,212

pace width from 4.56–15.27 cm, and modal widths were 7 cm and 13 cm. The mean weight was 547.4 g, with extremes of 28–1,212 g.

Weight (W)-width (CW) linear least-squares equations of crabs with no appendages missing were calculated separately for each sex, using a log-log transformation on the multiplicative equation $W = a(CW)^b$ (Table 3). For purposes of comparing carapace width (CW) with carapace length (CL) reported in other papers, the linear relationships relating CL and CW were also calculated.

Distribution by Depth.—Larger crabs tended to inhabit shallower waters. The mean size of male and female crabs calculated by 100-m depth strata decreased with increasing depth (Fig. 3). This trend was less regular for the females, but because of the small size of some samples, resulting in very large confidence intervals, some means were not very reliable. The relative abundance expressed as mean number of crabs caught per trap was calculated by 100-m depth strata (Fig. 4). For male crabs, abundance reached a single maximum in moderately deep waters (700–900 m). The abundance of females was greatest in shallow waters (400–500 m), then decreased at intermediate depths (500–800 m), and increased again in deep waters (900–1,050 m). Dominance of males was highly significant at depths from 500–999 m (chi-square test, $P < 0.01$) (Table 4). Overall within these depths males were 8 times as numerous as females. In the deepest stratum sampled (1,000–1,050 m), the dominance of males was only about 2:1 (chi-square test, $P < 0.05$). Females outnumbered males between 300–499 m, although no significant difference was noted (chi-square test, $P > 0.05$).

Female Maturity.—Two vulval forms were identified among the 99 females examined: 29 females (CW ≤ 9 cm) had a closed, slit-like, or partially opened vulva, while 70 females (CW > 9 cm) had a fully opened vulva. The change in abdomen width was used to estimate the size at sexual maturity of females. The ratio length/width (AL/AW) of the abdomen was plotted against the carapace width (Fig. 5). Two subsets of data were visually recognized, one on each side of the 9-cm (CW) boundary. The abdomen width of small females increased faster than the abdomen length leading to a decrease of the ratio AL/AW with increase in body size. On the other hand the ratio AL/AW remained fairly stable around a mean of 1.15 for females larger than 9 cm. A straight line was fitted through the first subset of data using a least-squares linear regression, and the intersection of that line with the mean of the second subset of data was used to estimate the size at sexual maturity, which was 8.2 cm. A similar analysis for the males gave no significant results; the ratio AL/AW remained stable with increase in body size.

Ovigerous Females.—Of the 99 females collected, only three were bearing numerous eggs (3%). They were caught in shallow waters (435–460 m) in August/September (two crabs) and in January (one crab). Egg remnants were found on 22 females, caught within the 435–880-m depth range, in the two seasons (six in August/September; 19 in January).

Molt Condition.—Most of the 709 *Chaceon* were in the intermolt stage (89%). Some (10%) were in the postmolt condition, and only 1% were in the old stage, most of them being females (6 of 8 individuals). A total of 382 crabs (54%) were parasitized by ex-

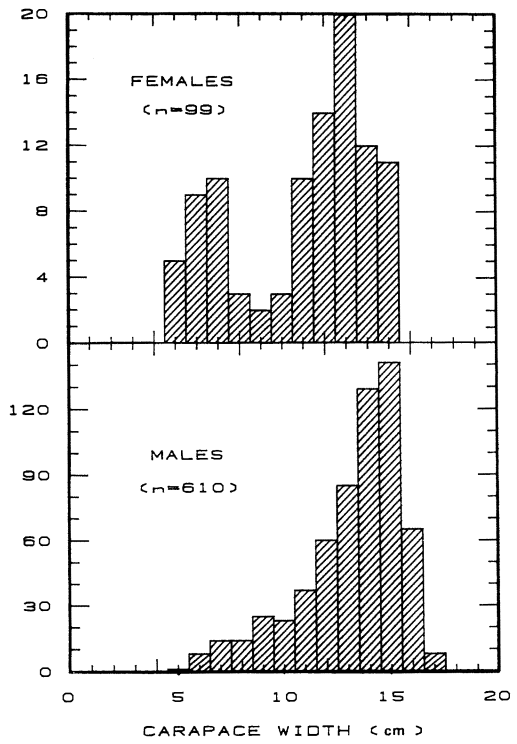

Fig. 2. Size-frequency distribution of male and female *Chaceon* sp. caught in the Marquesas islands.

ternal barnacles. The crabs smaller than 7.95 cm (CW) were never parasitized.

Yields.—The hard nature of the fishing grounds led to an 8.7% loss of traps (39 *Paimpolais* and 20 *Noirmoutier*). The mean catch rate for the 427 remaining *Paimpolais* traps was 1.4 kg (1.6 crabs)/trap/night, the best result being 11.5 kg (13 crabs)/trap/night. Only 6.5% of the crabs were caught in the *Noirmoutier* traps. The mean catch rate per trap for this design (0.15 kg (0.2 crabs)/trap/night) was negligible when compared with the *Paimpolais* trap. We therefore consider that the *Noirmoutier* traps are inadequate for catching *Chaceon,* and the following results apply only for the more efficient *Paimpolais* traps.

Mean catch per trap increased from 109 g/trap/night in the shallowest stratum to a maximum of 2,012 g/trap/night in the 700–799-m depth zone (Fig. 6). Catches then declined regularly with increasing depths. Although depth appears to be the main factor affecting the catch rate, we have tried to determine regional and seasonal influences. Only the fairly homogeneous and more productive 500–999-m stratum was considered. Regional variations in catch rates range from 2,148 g/trap/night (Ua-Pou) to 1,083 g/trap/night (Fatu-Huku). However, the difference between these maxima was not significant (Mann-Whitney, $P > 0.05$) nor was the mean catch rate among all islands (Kruskall-Wallis, $P > 0.05$) (Fig. 7). No significant difference was noted in the mean catch rate between August/September (1,886 g/trap/night) and January (1,535 g/trap/night) (Mann-Whitney, $P > 0.05$).

Discussion

In the vast fishery conservation zone of French Polynesia, the geryonids were discovered only in two very distinct geographic areas: Marquesas in the north (9°S), and the island of Rapa at the extreme south (28°S). The *Chaceon* caught in the Marquesas is related to *C. bicolor* Manning and Holthuis, 1989, from New Caledonia. However, the color is uniform and does not show the purple and tan color pattern of *C. bicolor.* In addition to color pattern, the Marquesas specimens also differ from *C. bicolor* by morphological differences, justifying the creation of a new species (Manning, personal communication). The Marquesas crab must therefore be considered as a new species, whose description will be published

Table 3. Least-squares linear equations of weight (W) and carapace length (CL) on carapace width (CW) for each sex of *Chaceon* sp. off the Marquesas. Weight and length units are centimeters and grams, respectively. N = number of individuals; r^2 = coefficient of determination.

Sex	Least-squares equation	N	r^2
Male	$\text{Log}_n W = 3.106(\text{Log}_n CW) - 1.250$	513	98.2%
	$CL = 0.885(CW) + 0.026$	610	98.5%
Female	$\text{Log}_n W = 3.022(\text{Log}_n CW) - 1.123$	83	99.3%
	$CL = 0.896(CW) - 0.043$	99	98.3%

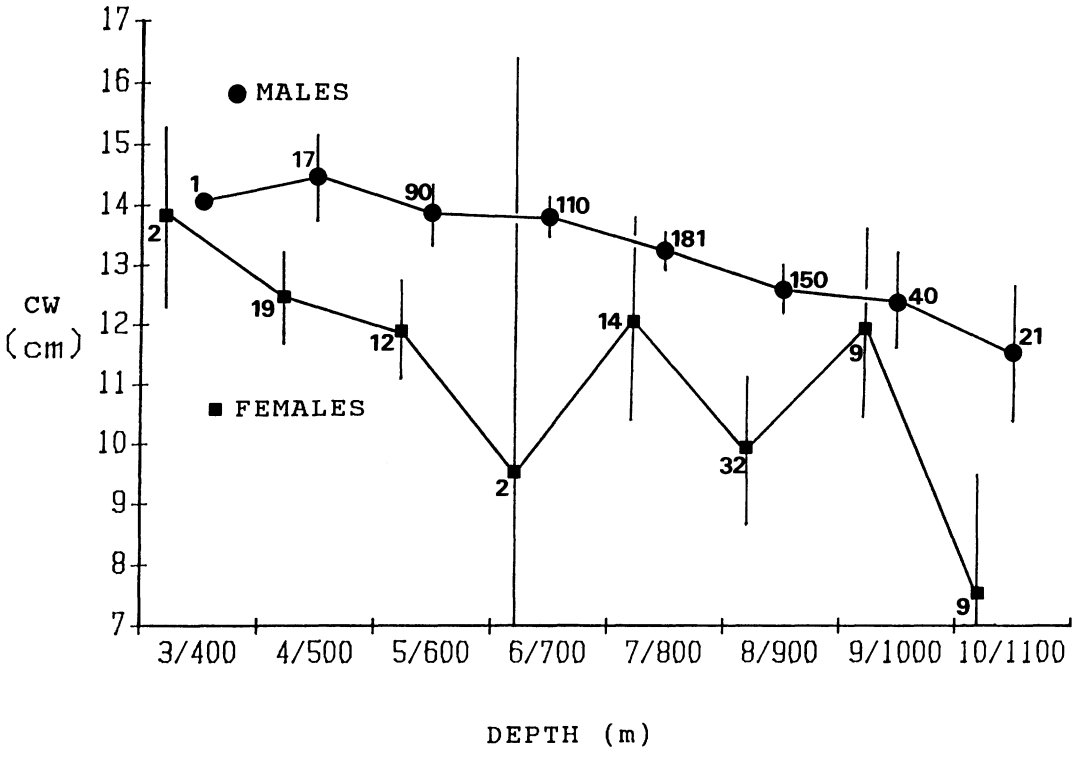

Fig. 3. Mean carapace width (CW, mm) by 100-m depth strata of male and female *Chaceon* sp. off the Marquesas islands. Bars indicate confidence interval at 95%. Numbers show sample size for each stratum.

soon. Whether the three crabs collected recently around Rapa belong to the same new species remains to be determined, and more fishing operations are necessary around that isolated island to determine the abundance of the species.

The absence of the geryonids between the Marquesas and Rapa (Tuamotu, Society, and north Austral islands) is surprising. Movements of adult geryonids appear to be substantial and could cause significant dispersal of the species. During a mark/recapture study on *C. maritae* Manning and Holthuis, 1981, the farthest distance a crab moved was 380 km (Melville-Smith, 1987a). However, about 500 km separate the Marquesas from the closest island in the Tuamotu (Napuka), and Rapa from the closest island in the north Australs (Raivavae); moreover, the sea floor is 3,000–4,000 m deep between these islands. Therefore, the dispersion of the species from the Marquesas or from Rapa is more likely to occur through dispersion of the larvae than through migrations of the adults. The TOGA Pan Pacific Surface Current Study has shown that, in the north at least, surface currents exist from the Marquesas to the Tuamotu and Society islands (Reverdin, personal communication). In the Mid-Atlantic Bight, the dispersal range of *C. quinquedens* (Smith, 1879) has been suggested as being up to 955 km depending on water temperatures, development times of the larvae, and current velocities (Kelly *et al.*, 1982). Although we do not have information about the development times of the larvae and current velocities, distances of such a magnitude could easily allow the larvae to colonize all the islands of French Polynesia from the Marquesas or even from Rapa. Since the crabs were found only in the Marquesas and around Rapa, we suggest that the deep habitat around the other islands is not favorable to the successful settlement of the geryonids.

The geryonids live in a very desolate environment of low productivity and must be highly dependent, directly or not, on the flux of organic matter coming from the shallowest levels. This flux, from the seashore towards the deep waters, is certainly more important around the Marquesas or Rapa,

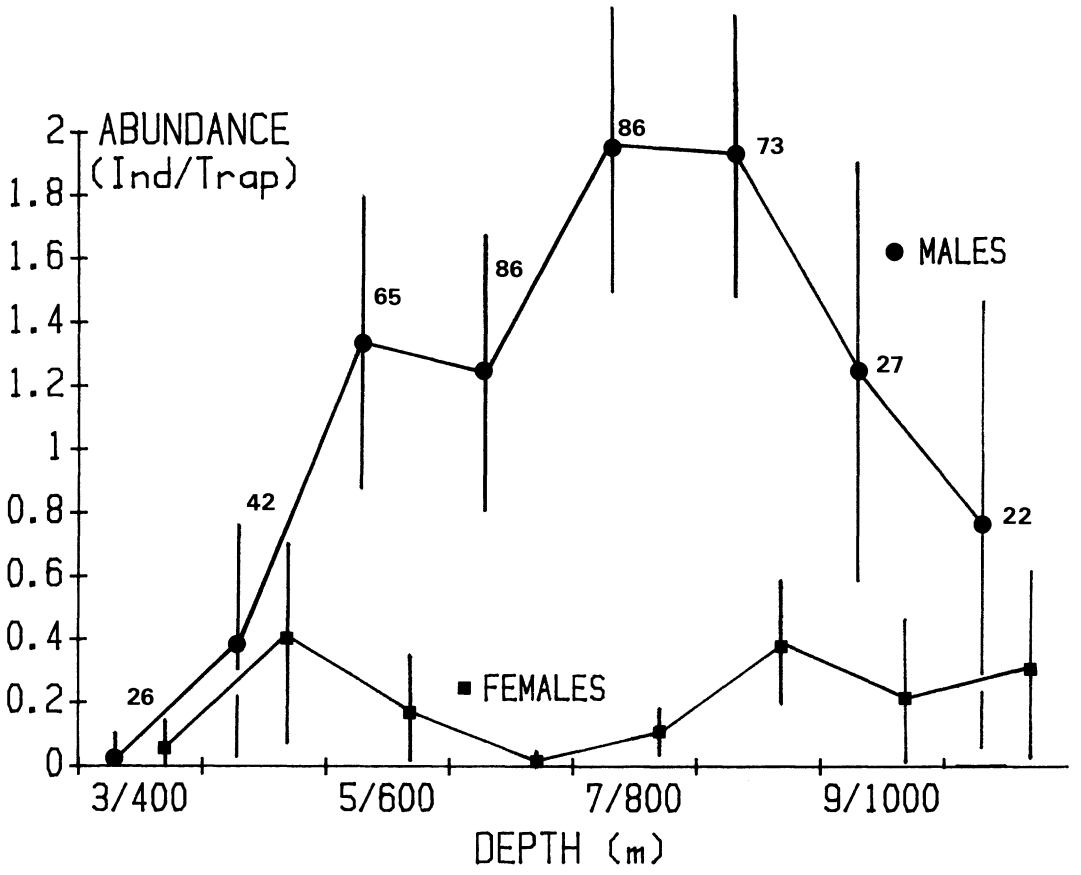

Fig. 4. Relative abundance (in mean individuals/trap) by 100-m depth strata of male and female *Chaceon* sp. off the Marquesas islands. Bars indicate confidence interval at 95%. Number of traps used to calculate the means is indicated for each stratum.

which are high mountainous islands with large bays opening directly in the sea, than around all the other prospected islands, which have either a barrier reef or very small elevations. Moreover, the marine productivity in the Tuamotu, Society, and north Austral islands is among the lowest in the world (Jacques and Tréguer, 1986), and the net flux of nutriments towards the deep bottoms is certainly very low in these areas.

In addition to these nutritional considerations, the nature of the bottom could also explain the geographic distribution of the polynesian geryonids. The Marquesas *Chaceon* have laterally compressed dactyls which may allow easier movement over hard substrates (Manning, *in* Lindberg and Wenner, 1990). Our dredgings around the Marquesas have indeed revealed hard bottoms of volcanic origin within the depths colonized by *Chaceon*. However, the geryonids have often a digging behavior and we suspect that these crabs also need some areas of soft sediment. The great abundance of

Table 4. Frequency of male and female *Chaceon* sp. within each depth stratum off the Marquesas. Asterisks denote significant deviation from 1:1 by chi-square analysis (** $P < 0.01$; * $P < 0.05$).

	Strata (m)							
Sex	3/399	4/499	5/599	6/699	7/799	8/899	9/999	10/1,050
Male	1	17	90**	110**	181**	150**	40**	21*
Female	2	19	12	2	14	32	9	9

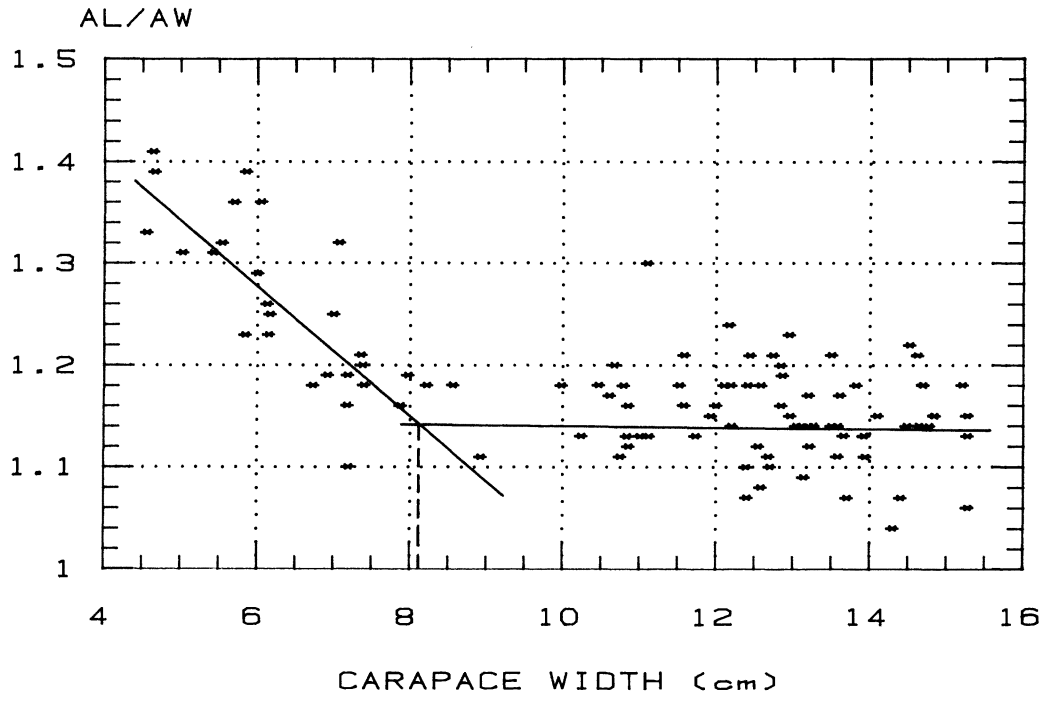

Fig. 5. Ratio of abdomen length/width (AL/AW) by carapace width (CW, mm) of female *Chaceon* sp. off the Marquesas islands. The straight line through the data less than 9 cm (CW) was plotted using a linear regression. The vertical line through the data greater than 9 cm represents the mean of this subset. The intersection between the two lines gives an estimate of size at sexual maturity (8.2 cm).

terrigenous sediment found during this study between 40–150 m around the Marquesas is an indication that limited accumulations can also occur deeper, along the slope colonized by *Chaceon*. As an indirect proof of that hypothesis, many scaphopod molluscs were collected alive in a dredge at 620-m depth off Eiao, on one of the best fishing grounds (see Fig. 7). These organisms are usually half buried in soft substrates. No sediment was found in that dredge perhaps because of only a superficial penetration into the substrate and/or a washing phenomenon during the raising. Around Rapa, no data about the bottom type are available, but the similar geomorphology of the island must lead to the constitution of a deep habitat comparable to the Marquesas fishing grounds. In the other areas, the coral nature of the oceanic slopes could be not convenient for the geryonids. The terrigenous sedimentation is not possible around the atolls of the Tuamotu, because of the coral nature of these islands and their insignificant elevations, and it could be limited around the high islands of the Society and north Australs because of barrier reefs usually surrounding the mountains.

Despite our prospection in the Tuamotu, Society, and north Australs, we cannot absolutely be sure that the deep-sea crabs are absent from these areas. If the terrigenous and nutriment sedimentation was indeed the main factor limiting the settlement of the

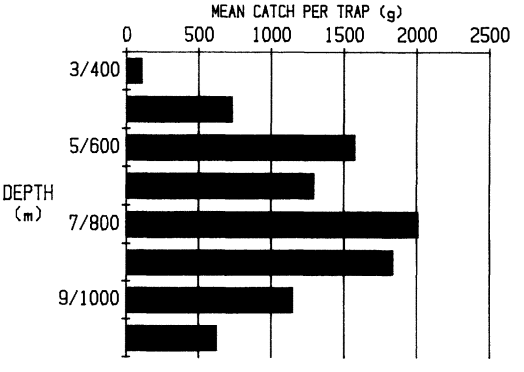

Fig. 6. Mean catch rate (g/trap/night) by 100-m depth strata of *Chaceon* sp. off the Marquesas islands. Data from *Paimpolais* traps only.

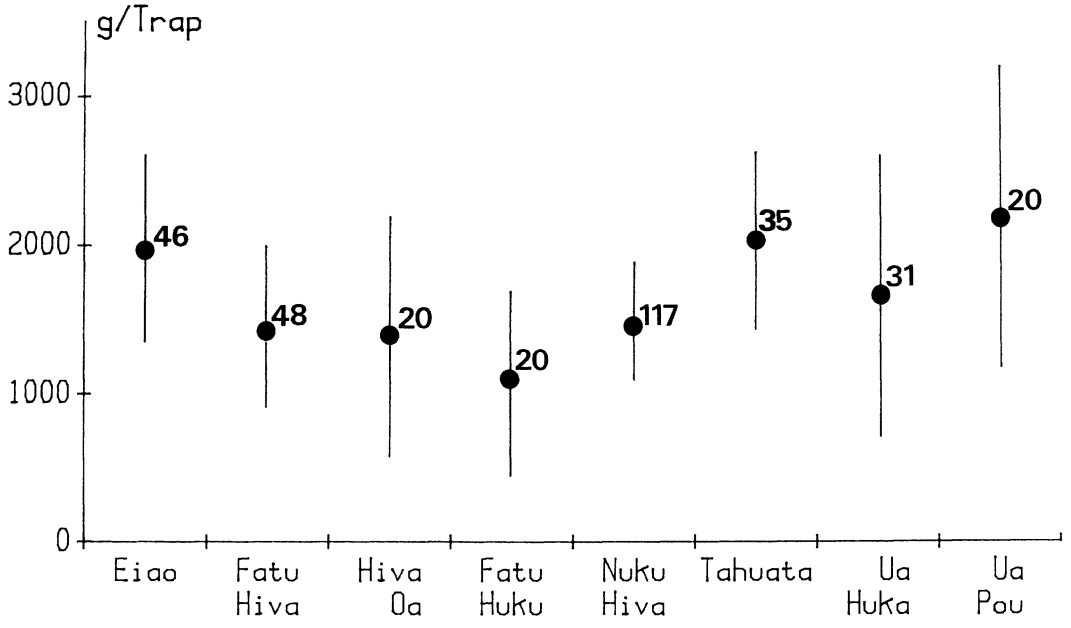

Fig. 7. Mean catch rate (g/trap/night) of *Chaceon* sp. among islands (500–999-m depth stratum) in the Marquesas. Bars indicate confidence interval at 95%. Number of traps used to calculate the means is indicated for each island.

geryonids, then the possibility to find them exists in some limited areas, such as in front of the main pass of some high islands in the Society islands (Tahiti, Moorea, Raiatea), or along some coasts where the barrier reef is not continuous (Tahiti in the Society islands, and Rurutu in the north Australs). These particular areas, poorly prospected during our study, need further attention in the future. In situ studies from submersibles, as was done for the golden crab *C. fenneri* Manning and Holthuis, 1984, off South Carolina (Wenner and Barrans, 1990), would also be of great interest in order to complete our fragmentary data about bottom types, and to confirm the importance of the substrate on the distribution of the geryonids in French Polynesia.

The smallest crab caught during this study was 4.6 cm CW. The first adult size reported for *C. quinquedens* is 2 cm CW (Van Heukelem *et al.*, 1983). Thus, it is surprising that we have never caught juveniles between 2 and 4.6 cm CW, despite the use of the *Noirmoutier* traps that are very efficient in catching small crabs (*Carcinoplax* sp.) with a carapace width between 1–2 cm (Poupin *et al.*, 1990). This suggests that recruitment occurs outside the depth range surveyed here.

The mean size of crabs decreases with depth. This observation is common among the geryonids: *C. quinquedens* off northeastern America (Wigley *et al.*, 1975); *C. maritae* off the Ivory coast (Intès and Le Loeuff, 1976), Angola (Dias and Machado, 1973), and Namibia (Beyers and Wilke, 1980); and *Geryon trispinosus* Herbst, 1803 in the northeast Atlantic (Attrill *et al.*, 1990). One exception to this general trend is *C. fenneri* off South Carolina and Georgia where the largest males and females were caught in the deepest strata sampled (Wenner *et al.*, 1987). The most common interpretation of this depth-related size distribution is that recruitment in deep waters is followed by a migration of the juveniles towards shallower depths. A similar recruitment pattern has also been formulated for the deep-water anomuran crabs *Lithodes ferox* Filhol, 1885, off Namibia (Abelló and Macpherson, 1990). However, as pointed out by Hines (*in* Lindberg and Wenner, 1990), it is also possible that recruitment of the juveniles occurs at all depths but is followed by higher mortality at shallower depths.

For ease of sampling only two main forms of the vulvae were recognized during this study, although Haefner (1977) described

up to six forms for *C. quinquedens.* The marked difference between the closed slit or partially opened forms and the fully opened form indicates that the vulvae undergo a drastic change of shape after the pubertal molt as mentioned for *C. maritae* off South West Africa/Namibia (Melville-Smith, 1987b). The abdomen shape also changes markedly at maturity and allows us to determine a size at sexual maturity of 8.2 cm. Although a more sophisticated computer technique has been used for estimating size at sexual maturity from crab morphometric data (Somerton, 1980), our result is quite in agreement with the values reported, based on histological examinations of the gonads, for *C. maritae* (8.5–9.6 cm) (Melville-Smith, 1987b) and for *C. quinquedens* (8.0–9.1 cm) (Haefner, 1977). According to this result, it appears that females located in the shallower waters (400–500 m) are mature individuals, whereas juveniles predominate in the second group of females located deeper than 800 m.

Very few gravid crabs have been caught during these fishing operations. This observation is common for *Chaceon* caught either by trap (Le Loeuff *et al.,* 1978; Stone and Bailey, 1980; Melville-Smith, 1987b; Wenner *et al.,* 1987) or by trawl (Wigley *et al.,* 1975; Melville-Smith, 1987b). The small number of gravid crabs could be the result of a modified behavior and/or inadequate sampling techniques. As shown for *C. quinquedens* (see Haefner, 1978) and *C. maritae* (see Melville-Smith, 1987b), gravid crabs were caught in the shallower depths (435–460 m), in the warmer waters colonized by *Chaceon.* The time of larval development is strongly reduced by increase in temperature (Kelly *et al.,* 1982). Therefore, gravid females could settle mainly in the shallower warmer waters in order to enhance egg development. Although females represent only 14% of the catches, some areas of high abundance occur at 435 m around Nuku-Hiva where as many as seven females were caught per trap. Such a patchy distribution on the bottom is also mentioned for females of *C. quinquedens* off Canada (McElman and Elner, 1982).

Since none of the crabs smaller than 7.95 cm were parasitized by poecilasmatid barnacles, we can conclude that the intermolt period is shorter for these juveniles than for the larger individuals and does not allow time for settlement of barnacles. This observation is consistent with the growth model proposed for *C. maritae,* where the intermolt period increased with increased body size (Melville-Smith, 1989). Melville-Smith (1989) has suggested that, although females of *C. maritae* are capable of molting after maturity, the intermolt period of mature animals is probably very lengthy. The high proportion of females observed in the old stages (75%), despite the low representation of the females in the catches (14%), corroborate this hypothesis.

The mean catch rate of 1.4 kg (1.6 crabs)/trap/night is lower than most of the mean results reported for other species. Wenner *et al.* (1987) mentioned for *C. fenneri* a mean catch rate of 11.4 crabs/*Florida* trap/20 h off South Carolina and Georgia, and Melville-Smith (1986) reported for *C. maritae* a mean of 31.4 crabs/trap/16–19.5 h off South West Africa. Although the density of *Chaceon* around the Marquesas could be lower than for other geographical areas, this discrepancy can be mainly attributed to the much smaller size of our traps which are two to five times smaller than the traps used in the two studies mentioned. The yield could therefore be substantially increased by using bigger traps. Moreover, the mean size of the catches is important, and taking into consideration a minimum acceptable commercial size of 11.4 cm CW (Wigley *et al.,* 1975), 80% of the *Chaceon* were of commercial interest. Because of the high costs of deep fishing operations and the long distances between the Marquesas fishing grounds and Tahiti where the crabs could be marketed, the potential for developing a large-scale fishery, as done by the Japanese fleet off South West Africa, is minimal. Nevertheless, the crabs could be harvested on a small scale by the tuna fishing fleet operating in the polynesian waters. To reduce the time spent for these subsidiary operations, some large traps could be set for two or three nights, as done for the golden crab (*C. fenneri*) off Florida (see Nielson, *in* Lindberg and Wenner, 1990), and the main fishing time reserved for tuna fishing.

Geryonids are slow growing crabs with old age at first reproduction and infrequent recruitment (Hines, *in* Lindberg and Wenner, 1990). Even with an activity restricted

to the few polynesian fishing boats, severe management measures should be taken at the beginning of any fishing project, in order to avoid overexploitation. From our results, it is possible to suggest fishing operations between 500–800 m, to limit the catches of the largest females and the juveniles, mainly located, respectively, between 300–500 m and under 800 m. The capture of ovigerous females should be prohibited. Due to the strong constitution of this crab, ovigerous females released after a catch would probably survive. A quota system and fishing seasons could also be established, but more data are required to estimate the density of *Chaceon* on the fishing grounds, and to learn their reproductive cycle.

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