

NEW CRETACEOUS AND EOCENE CALLIANASSOIDEA (THALASSINIDEA, DECAPODA) FROM ALGARROBO, CHILE

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A B S T R A C T

New decapod crustacean fossils collected from Eocene rocks of Algarrobo, Chile, have yielded a new genus and species of callianassid, *Melipal chilensis*. The large sample size makes it possible to recognize marked sexual dimorphism of the major cheliped and pronounced heterochely in the new taxon. Cretaceous fossils from Algarrobo are referred to *Protocallianassa saetosa* (Förster and Stinnesbeck, 1987) new combination. That genus is rather large and unwieldy as currently understood, but examination of type material will be necessary to revise it.

INTRODUCTION

Recent work has greatly increased the number of fossil decapods known from Chile (Feldmann et al., in press). New collections of Cretaceous and Eocene fossils from coastal Chile have yielded a new genus and species of callianassid, *Melipal chilensis*, and have extended the geographic range of *Protocallianassa saetosa* (Förster and Stinnesbeck, 1987) within Chile. In addition, an indeterminate callianassid chela is illustrated (Fig. 4L), and a possible hermit crab finger is described.

Geologic Setting

Fossil samples were collected from Upper Cretaceous and Eocene marine strata that crop out at Algarrobo, about 100 km west of Santiago, in the Coastal Cordillera of Central Chile. The Coastal Cordillera is a subdued mountain range some 40–50 km wide that trends north-south, parallel to the Peru-Chile Trench, with most summits ranging from 1,000 to 2,000 m above sea level. At the location of Algarrobo (33°21'S, 71°41'W), this mountain range is largely comprised of extensive Mesozoic granitoid batholiths as well as outcrops of Paleozoic metamorphic and plutonic basement rocks. The marine sedimentary rocks are represented by Upper Cretaceous, Eocene, and Neogene successions. Upper Cretaceous marine sedimentary rocks are exposed in the coastal cliffs west of Litueche (~34°S) and in Algarrobo, where they are overlain by the only known outcrop of Eocene marine rocks in the region (Brüggen, 1915). Neogene marine sedimentary deposits are widely distributed mostly south of Algarrobo, and are represented by the Navidad, La Abarca, La Cueva, and Horcón formations (Brüggen, 1950; Tavera, 1960; 1979).

The fossiliferous locality of Algarrobo is situated at a small beach located in the old marina of the town of the same name (Fig. 1). Samples were collected from Cretaceous and Eocene beds that crop out in the tidal platform. This locality was

studied for the first time by Landbeck in 1866 and subsequently by Philippi (1887), who described the fossiliferous content of the area. Brüggen (1915) was the first worker to recognize two distinct marine sedimentary successions. The lower unit corresponds to the Estratos de Quebrada Municipalidad (Gana et al., 1996), which was assigned to the Maastrichtian (Upper Cretaceous) by Tavera (1980). This formation is equivalent to the Quiriquina Formation that crops out extensively in southern Chile in the vicinity of Concepción (37°S), the latter of which is considered as the type locality for marine Upper Cretaceous strata in Chile (Biró-Bagóczy, 1982). The upper unit belongs to the Estratos de Algarrobo (Gana et al., 1996), which were assigned to the upper middle–upper Eocene by Tavera (1980).

The Upper Cretaceous succession overlies the Paleozoic granitic basement and consists of about 40 m of fine, massive sandstone and scarce conglomerate (Brüggen, 1950). It contains a fossil fauna of bivalves, gastropods, ammonites, vertebrates, and abundant wood fragments (Tavera, 1980; Brito and Suárez, 2003; Suárez and Cappetta, 2004) in addition to the decapods described here (Fig. 2).

The Eocene succession unconformably overlies the Upper Cretaceous beds and consists of 95 m of fine massive sandstone, with abundant *Ophiomorpha* and *Thalassinoides*, and scarce conglomerate (Fig. 2). Although coal beds are characteristic of Eocene marine beds at Arauco (Brüggen, 1950), which is considered the type locality for this succession, they are not present in Algarrobo strata. The Algarrobo Eocene beds contain a fossil fauna consisting of bivalves, gastropods, cephalopods, crustaceans, echinoids, fish, and wood fragments (Tavera, 1980). The Estratos de Quebrada Municipalidad and Estratos de Algarrobo formations are both interpreted as having been deposited in a shallow marine, probably deltaic environment, during two marine transgressions that took place during the Late Cretaceous and Eocene respectively.

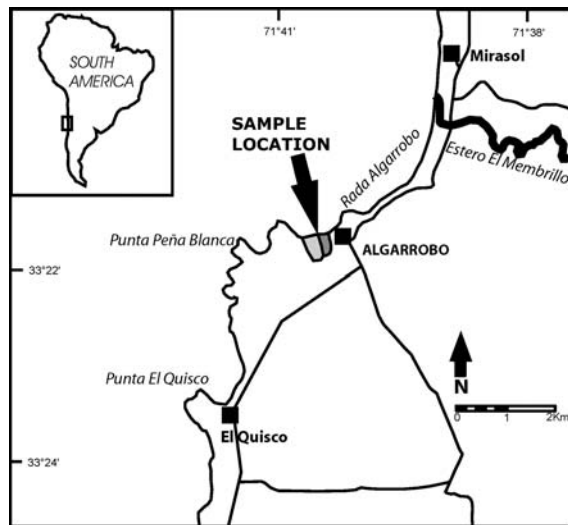


Fig. 1. Location map for collecting localities described in this paper, near Algarrobo. Light gray indicates upper middle–upper Eocene exposures of the Estratos de Algarrobo, and dark gray indicates Maastrichtian (Late Cretaceous) exposures of the Estratos de Quebrada Municipalidad.

SYSTEMATIC PALEONTOLOGY

Order Decapoda Latreille, 1802

Infraorder Thalassinidea Latreille, 1831

Superfamily Callianassoidea Dana, 1852

Family Callianassidae Dana, 1852

Remarks.—Families within the Callianassoidea are distinguished based upon features of the dorsal carapace, antennae, pleopods, and uropods (Manning and Felder, 1991), which are absent in both the Cretaceous and Eocene material. Thus, *Melipal* new genus is placed within the Callianassidae because it most closely resembles several genera within that family. The genera to which *Melipal* new genus is most similar are in two different subfamilies, the Callichirinae Manning and Felder, 1991, and Eucalliicinae Manning and Felder, 1991. However, because the same types of criteria are used to distinguish subfamilies as families (Manning and Felder, 1991), it is not possible at this time to assign *Melipal* to a subfamily. The distinctive high angle of the articulation between the propodus and the carpus is sufficient for the genus *Protocallianassa* to be placed within a monotypic subfamily as originally suggested by Beurlen (1930).

Subfamily Protocallianassinae Beurlen, 1930

Included Genus.—*Protocallianassa* Beurlen, 1930.

Diagnosis.—As for genus.

Genus *Protocallianassa* Beurlen, 1930

Type Species.—*Callianassa archiaci* A. Milne-Edwards, 1860, by original designation.

Included Species.—*Protocallianassa antiqua* (Roemer, 1841), as *Callianassa*; *P. archiaci* (A. Milne-Edwards, 1860), as *Callianassa*; *P. australica* Glaessner, 1956; *P. bohémica* (Fritsch, 1867), as *Callianassa*; *P. brevis* (Fritsch, 1867), as *Callianassa*; *P. caucasica* O. Aliev and R. Aliev,

1980; *P. cenomanensis* (A. Milne-Edwards, 1860), as *Callianassa*; *P. cliffwoodensis* Roberts, 1962; *P. elongata* (Fritsch, 1867), as *Callianassa*; *P. faujasi* (Desmarest, 1822), as *Pagurus*; *P. gracilis* (Fritsch, 1867), as *Callianassa*; *P. mortoni* (Pilsbry, 1901), as *Callianassa*; *P. patagonica* Aguirre Urreta, 1983; *P. pilsbryi* (Rathbun, 1935), as *Callianassa*; *P. pleuralum* Beikirch and Feldmann, 1980; *P. praecepta* Roberts, 1962; *P. russelli* Bishop, 1985; *P. saetosa* (Förster and Stinnesbeck, 1987), as *Callianassa*; *P. tourtia* (Fritsch, 1867), as *Callianassa*.

Diagnosis.—Callianassid in which the carpus/propodus articulation lies at an angle of more than 90° , and typically 120° , to the long axis of the propodus; distal margin of hand with no notch or only a reduced notch.

Remarks.—Of the species of *Protocallianassa* recognized by Mertin (1941), some are represented by carapace and abdomen material as well as by chelipeds. The above diagnosis treats only the elements of the claws because these are the most diagnostic features and, certainly, the most widely applicable to fossil forms. Discussions with the late R. B. Manning (personal communication to RMF) confirmed that the inclined carpus/propodus joint clearly separated *Protocallianassa* from all extant genera. Subsequent examination of material by us has confirmed that observation; however, examination of the illustrations of species currently assigned to *Protocallianassa* suggests that detailed work with available types might well lead to division of the genus into several genera.

Recently, Karasawa (2003) pointed out that *Protocallianassa* Beurlen, 1930, was a junior subjective synonym of *Mesostylus* Bronn and Roemer, 1852. However, Karasawa argued that frequent use of *Protocallianassa* in the past 50 years and disuse of *Mesostylus* for over 100 years rendered the latter generic name a nomen oblitum and *Protocallianassa* a nomen protectum. We concur.

Protocallianassa saetosa (Förster and Stinnesbeck, 1987)

Fig. 3A–E

Callianassa sp. ex.aff. d'*Archiaci* Wetzel, 1930, p. 93, Fig. 5.

Protocallianassa aff. d'*archiaci* Stinnesbeck, 1986, p. 114.

Callianassa saetosa Förster and Stinnesbeck, 1987, p. 53, pls. 1, 2, pl. 3, fig. 6.

Holotype.—BSP 1987 IV 2, deposited in the Bayerischen Staatssammlung für Paläontologie und historischen Geologie, München, Germany, is a right claw with part of the carpus.

Material Studied.—Nine specimens, SGO.PI.6392 – 6400, are deposited in the National Museum of Chile, Santiago, Chile.

Description of Material.—Moderate sized claws for genus; manus more or less quadrate, compressed, longer than high; carpus-propodus articulation inclined to long axis of propodus; hand and fingers bearing distinct pattern of setal pits arrayed in clusters; fixed finger keeled; minor claw proportionally longer than major claw.

Outer surface of manus smooth, uniformly convex. Upper and lower margins straight to slightly curved, narrow, converging slightly distally. Proximal margin straight,

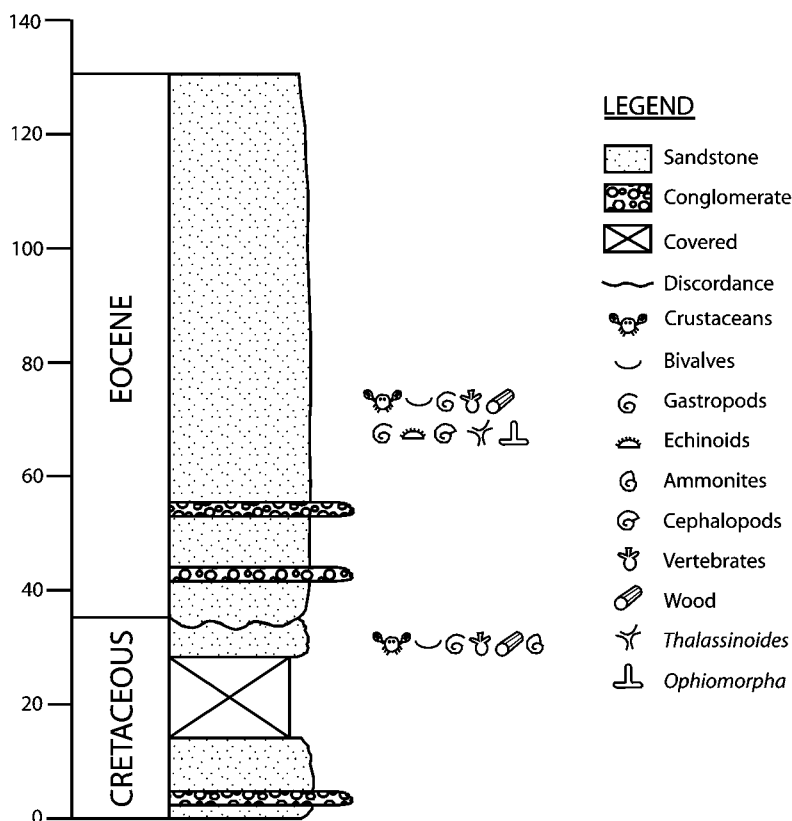


Fig. 2. Stratigraphic section, in meters, for the Algarrobo locality. Crustacean-bearing levels are indicated as in the legend.

bearing narrow elevated rim. Distal margin inclined from upper margin downward and distally to base of fixed finger. Inner surface weakly convex, compressed along upper and lower margins, smooth over most of surface; a row of about 10 equally spaced, distinct ridges, each about 0.7 mm long, situated along upper edge of inner surface, are inclined in echelons downward and distally at about 45° angle to margin; distal face of ridges bear 8–10 setal pits.

Fixed finger triangular, tapering in height uniformly to tip, curved slightly downward and inward; bearing keel extending from base of finger to tip; row of more than 8 large setal pits lie along upper surface of keel. Occlusal surface with one prominent domed denticle at about midlength; a row of about 16 pits extend along occlusal surface between base of finger and large denticle; similar pits extend distal to large denticle.

Dactylus stout, lanceolate in cross section. Outer surface convex, with two pits, rimmed proximally, each bearing numerous tiny setal pits directed distally. Upper surface with about seven similar rimmed depressions, each bearing about 8 distally directed setal pits. Occlusal surface apparently edentulous.

Measurements.—Measurements (in mm) are given in Table 1.

Occurrence.—Estratos de Quebrada Municipalidad unit of Gana et al. (1996), which is the equivalent of the Quiriquina Formation on Quiriquina Island, Late Cretaceous (Maastriichtian), from coastal exposures along the public beach at Algarrobo, Chile.

Remarks.—Förster and Stinnesbeck (1987) named this species based upon material collected over the past 75 years from a site referred to by Wetzel (1930) as La Cucaracha, and currently known as Las Tablas, at the northwest end of Quiriquina Island, near Concepción, Chile (Förster and Stinnesbeck, 1987). Although the latter authors assigned the species to *Callianassa*, Stinnesbeck (1986) had previously considered it to be *Protocallianassa* in recognition of the inclined axis of rotation of the carpus/propodus joint.

The material basis for the emended description was collected from a very small exposure of the Estratos de Quebrada Municipalidad unit of Gana et al. (1996), which is the equivalent of the Quiriquina Formation on Quiriquina Island. At Algarrobo, the Estratos de Quebrada Municipalidad crop out below Eocene rocks along the coast at extremely low tides.

Comparison of the Algarrobo material with the type series leads to the conclusion that the material is conspecific. The outlines of the major and minor claws are virtually identical and the size of the hands falls within the defined range of variation of sizes of the type series. The most distinctive features that ally the Algarrobo material with the type series are the development of the oblique ridges with setal pits on the upper and lower margins of the inner surface of the hands and the strong keel extending along the outer surface of the fixed finger. The one feature that may differ in the two collections is the nature of the occlusal surface of the fixed finger of the major claw. That surface on both the type and the new material bears a single large denticle positioned in the inner half of the finger. The

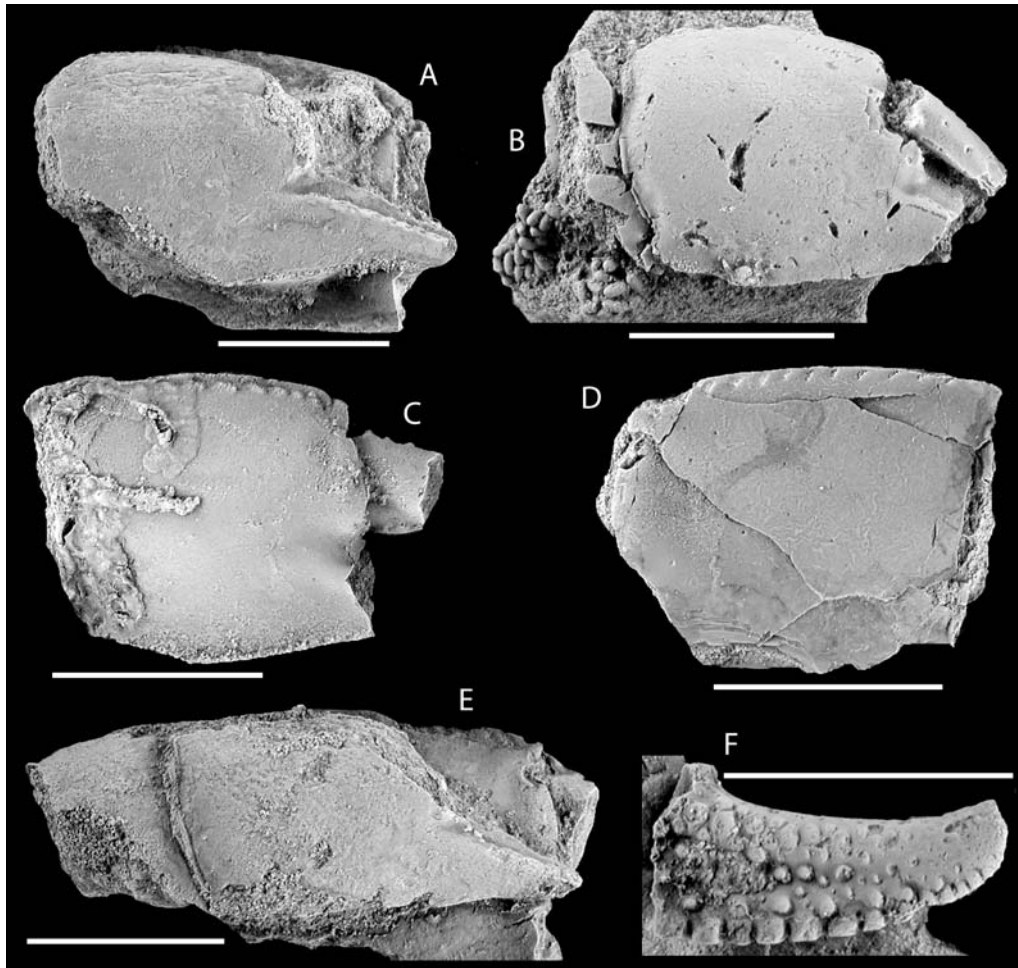


Fig. 3. *Protocallianassa saetosa* (Förster and Stinnesbeck, 1987) (A–E) and Anomura (F). A, outer surface of minor chela, SGO.PI.6395; B, outer surface of major chela, SGO.PI.6400; C, inner surface of major chela, SGO.PI.6393; D, inner surface of major chela showing setal pits, SGO.PI.6399; E, outer surface of minor chela, SGO.PI.6398; F, finger of hermit crab?, SGO.PI.6408. Scale bars equal to 1 cm.

surface proximal and distal to that tooth has a serrated appearance as a result of development of tiny, transversely ovate depressions. Illustrations of the type material suggest that the ovate depressions are larger on those specimens. Whether or not these depressions are external features or whether they represent sites in which smaller denticles were positioned in life has not been determined. Regardless, this distinction is not of great enough significance to warrant erection of a new species.

Presence of the same species of callianassid in the type area of the Quiriquina Formation and in the rocks at Algorrobo lends further biotic evidence of the temporal and possibly physical equivalence of the rocks in these two areas separated by a linear distance of about 375 km.

Subfamily Uncertain
Genus *Melipal* new genus

Type Species.—*Melipal chilensis* new species, by present designation.

Diagnosis.—As for species.

Description.—As for species.

Etymology.—The genus name is the Mapudungún word for the Southern Cross constellation. Mapudungún is the language of the Mapuche people, native to Central and southern Chile (www.eso.org/outreach/eduoff/edu-prog/catchstar/). The name refers to the occurrence of the new genus in the southern hemisphere and Chile. The gender is masculine.

Remarks.—No previously described genus can accommodate the new material. The combination of a keeled, serrate merus; long carpus relative to its height that narrows considerably distally; unornamented or occasionally serrate (in males) lower margin of the carpus; and marked indentation above the fixed finger of the manus appear to be unique among the Callianassoidea. *Melipal* new genus bears some similarity to the genera *Calliax* de Saint Laurent, 1973; *Eucalliax* Manning and Felder, 1991; *Neocallichirus* Sakai, 1988; *Sergio* Manning and Lemaitre, 1994; *Grynaminna* Poore, 2000; and *Callichirus* Stimpson, 1866, but may be distinguished from each. *Calliax* is characterized by a short carpus and a merus with several ventral spines of varying sizes, which *Melipal* lacks. *Eucalliax* is probably the most similar to the new genus but has a merus with no

Table 1. Measurements (in mm) taken on elements of *Protocallianassa saetosa* (Förster and Stinnesbeck, 1987). L1, length of manus including fixed finger; L2, length of manus excluding fixed finger; H, maximum height of manus; Angle, angle between proximal margin and lower margin of manus; Hand, handedness of chelae. All are major chelae except if otherwise marked.

Specimen number	L1	L2	H	Angle	Hand
SGO.PI.6395A	23.4	15	12.1	—	R
SGO.PI.6395B (minor)	—	20.2	15.4	99°	L
SGO.PI.6393	—	16.5	14.7	104°	R
SGO.PI.6398B (minor)	—	19.2	12.8	~99°	R
SGO.PI.6398A	—	18	13.1	~101°	L
SGO.PI.6399	—	>18.5	14.1	—	R
SGO.PI.6400	—	19.7	14.1	103°	L
SGO.PI.6396	—	>18.9	14.8	—	R
SGO.PI.6397	—	18.2	14.2	102°	R

ornamentation on the lower margin and a shorter carpus than that seen in *Melipal*. In addition, *Eucalliax* lacks an indentation in the distal margin of the manus above the position of the fixed finger as seen in *Melipal*. Both *Neocallichirus* and *Sergio* have serrate ventral margins of the meri, but they also have distinctly serrate distal margins of the manus which *Melipal* lacks. The carpus of both *Neocallichirus* and *Sergio* is also quite short as compared to the long carpus of *Melipal*. Species of *Callichirus* have a long carpus and a marked indentation in the distal margin of the manus just above the position of the fixed finger as in *Melipal*, but the merus of some species of *Callichirus* have a very large meral hook, not seen in *Melipal*. In addition, the merus of *Callichirus* is not typified by a keel as seen in *Melipal*. *Grynaminna* has a short, high manus similar to that of *Melipal*; however, it lacks the indentation above the fixed finger and the pronounced projected area positioned above the indentation as seen in *Melipal*. Thus, *Melipal* is a unique taxon.

There are two size classes of chelae herein assigned to *Melipal*. The larger cheliped elements assigned to *Melipal* are distinctly dimorphic but are nevertheless clearly referable to the same taxon. The two morphologies are of the same overall size and are nearly identical in all regards, except that one morphological group is considerably more robust than the other. This type of dimorphism has previously been attributed to gender differences, the males exhibiting the more robust form (Biffar, 1971; Dworschak, 1988; 1998; Felder and Lovett, 1989; Manning and Felder, 1991; Felder and Rodrigues, 1993; Schweitzer-Hopkins and Feldmann, 1997; Nates and Felder, 1999; Pinn et al., 2001). In an example of sexual dimorphism exhibited in both extant and extinct fossil forms within the Callianassoidea, that seen in *Callianopsis* de Saint Laurent, 1973, males exhibit more robust mani and fixed fingers than do females, and the ornamentation of the male elements is better developed (Schweitzer-Hopkins and Feldmann, 1997). Although the chelae of *Melipal* are not ornamented, the mani and fixed fingers of one morphological group are much heavier and more robust than those of the other. Following the pattern seen in *Callianopsis*, we have referred to the more robust forms of *Melipal* as males and to the less robust forms as females.

Numerous small chelae were collected associated with the large chelipeds assigned as males and females of *Melipal*;

Table 2. Measurements (in mm) taken on elements of *Melipal chilensis* new genus and species. L1, length of manus including fixed finger; L2, length of manus excluding fixed finger; L3, maximum length of carpus; L4, maximum length of merus; H1, maximum height of manus; H2, maximum height of carpus; H3, maximum height of merus; G, gender, where known; Hand, handedness of chelae. SGO.PI.6391 and 6408–6412 are minor chelae; the remainder are major.

Specimen number	L1	L2	H1	L3	H2	L4	H3	G	Hand
SGO.PI.6386	18.3	12.3	—	—	—	—	—	F	R
SGO.PI.6387	14.8	11.4	8	—	—	—	—	F	R
SGO.PI.6388	16	11.9	9.3	13.7	10.3	9.9	5.5	F	R
SGO.PI.6385	13.8	8.7	7.4	8.9	7.5	6.1	3.5	F	R
SGO.PI.6390	10.7	8.6	6.2	—	—	—	—	F	R
SGO.PI.6382	17.1	12.7	10.1	>11.0	10.1	7.5	4.4	M	L
SGO.PI.6378	14.7	13.5	10.7	10.6	9.3	—	—	M	L
SGO.PI.6379	19.6	13	15	11.5	—	—	—	M	R
SGO.PI.6383	>11.3	10	8	10	8.3	—	—	M	R
SGO.PI.6381	>14.0	>6.0	>10.0	—	—	—	—	M	L
SGO.PI.6401	>12.0	10.7	8.6	—	—	—	—	M	L
SGO.PI.6389	16.6	11.5	10.6	—	—	—	—	F	R
SGO.PI.6380	>12.6	10.1	8.9	—	—	—	—	M	R
SGO.PI.6402	11.3	9.6	9.1	—	—	—	—	—	L
SGO.PI.6403	19.4	12.6	11.3	—	—	—	—	—	R
SGO.PI.6404	15.2	13.9	10.4	—	—	—	—	—	R
SGO.PI.6405	16.4	10.2	8.7	—	—	—	—	—	L
SGO.PI.6406	13.4	9.1	>6.6	—	—	—	—	—	L
SGO.PI.6407	9.7	5.7	6.2	—	—	—	—	—	L
SGO.PI.6409	>10.5	8.5	8.2	—	—	—	—	—	R
SGO.PI.6410	9.9	7.1	5.7	—	—	—	—	—	L
SGO.PI.6412	—	—	—	—	—	—	—	—	L
SGO.PI.6411	>10.4	>7.0	6.4	—	—	—	—	—	L
SGO.PI.6408	>9.2	7.3	6.2	—	—	—	—	—	L
SGO.PI.6391	13.2	9.8	7.8	—	—	—	—	—	L

we consider these as possible minor chelae. These chelae are significantly smaller than those referred to as female and male major chelae; they have edentulous fingers typical of minor chelae; and they were collected in close association with large numbers of what are clearly major chelae. In addition, the majority of the major chelae, male and female, are right chelae, while nearly all of the chelae referred to as minor chelae are left chelae. Thus, it seems most likely that the smaller chelae are minor chelae of *Melipal*, not a completely separate taxon.

Callianassoid chelae clearly identifiable as minor chelae are considerably more uncommon than major chelae in the fossil record. An especially good example is those known from *Callianopsis clallamensis* (Withers, 1924), in which they were preserved within the same concretions as the major chela along with other elements of the body in a rare occurrence of remarkable preservation within Callianassoidea (Schweitzer-Hopkins and Feldmann, 1997). Other minor chelae occurrences include those of *Protocallianassa* spp. (A. Milne-Edwards, 1860); "*Callianassa*" spp. (in Karasawa, 1993; 1998), and *Neocallichirus grandis* Karasawa and Goda, 1996.

Interestingly, nearly all of the genera to which *Melipal* bears some similarity are known from the Americas. Of the Eucalliinae, *Eucalliax* is known from northwestern Atlantic localities, while *Calliax* does not have American occurrences. Of the Callichirinae, *Callichirus* is known from the Atlantic and Pacific Americas and *Neocallichirus* and *Sergio* are known from numerous Atlantic localities. *Callichirus* has a possible fossil record in the Eocene of Antarctica (Feldmann and Zinsmeister, 1984; Schweitzer

and Feldmann, 2000), and *Neocallichirus* is well represented in Eocene Tethyan localities, including the Pacific Americas (Schweitzer and Feldmann, 2002; Schweitzer et al., 2004). Not enough is known about these genera in terms of the fossil record to determine whether there are relationships among them; as more callianassoid material with well-preserved proximal elements of the chelipeds is collected and described, relationships may be identified.

Melipal chilensis new species

Fig. 4A–K, 4M

Types.—The holotype, SGO.PI.6385, and paratypes SGO.PI.6378–6384, 6386–6390, 6401–6407, 6391–6415, are deposited in the National Museum of Chile, Santiago, Chile.

Diagnosis.—Merus of female cheliped with serrate lower margin, merus of males and females keeled; carpus of males and females considerably longer than high, becoming markedly higher distally, lower margin of males serrate in larger specimens; manus of males robust, with bulbous swelling and indentation above fixed finger on distal margin, movable finger robust along entire length, with hooked tip; manus of females much like that of males except more gracile, movable finger slender along length, without hooked tip. Minor chela smaller, with edentulous fingers.

Description.—Merus of female major cheliped about twice as long as high; proximal margin short, at oblique angle to upper margin, rounding into lower margin; lower margin convex, serrate; upper margin sinuous, with weak concavity in proximal half; distal margin with straight upper segment, remainder unknown; outer surface weakly keeled, keel extending from upper one-third of distal margin parallel to upper margin about one-half to two-thirds the distance proximally.

Carpus of female major cheliped about three-quarters as high as long at highest point, becoming higher distally; proximal margin with short extension at upper corner which articulates with merus, extension followed by concavity, then becoming broadly convex for remainder of height; lower margin very weakly convex, weakly rimmed; upper margin convex; distal margin with broad, shallow concavity centrally; outer surface highly vaulted from upper to lower margin, appearing to have been smooth.

Manus of female major cheliped rectangular, about twice as long as high, becoming less high distally; proximal margin weakly convex centrally, remainder straight; lower margin straight, rimmed; upper margin poorly known; distal margin initially at about 90 degree angle to upper margin, with weakly inflated area positioned above fixed finger, weak indentation just above fixed finger; outer surface moderately vaulted from upper to lower margin; inner surface with finely serrate distal margin.

Fixed finger of female major chela slightly down turned, narrowing considerably distally, with one triangular tooth proximally on occlusal surface; row of setal pits parallel to occlusal surface, remainder serrate. Movable finger of female major chela slender, narrowing distally, with rows of setal pits paralleling occlusal surface and along upper margin.

Merus of male cheliped about 60 percent as high as long; proximal margin straight, short, at about 95 degree angle to upper margin; lower margin proximally rounded, remainder unknown; upper margin sinuous, with weak concavity in proximal half; distal margin with straight upper segment, remainder unknown; outer surface keeled, keel extending along mid-height from distal margin about three-quarters the distance proximally.

Carpus of male major cheliped about 80 percent as high as long at highest point, becoming higher distally; proximal margin with short extension at upper corner which articulates with merus, extension followed by concavity, then becoming broadly convex for remainder of height; lower part of proximal lower and proximal portion of distal margin markedly serrate in large specimens, weakly so or not at all in small specimens; distal margin very weakly convex, weakly rimmed; upper margin very weakly convex; distal margin with broad, shallow concavity centrally; outer surface highly vaulted from upper to lower margin, appearing to have been smooth.

Manus of male major cheliped rectangular, robust, about 60 percent as high as long, becoming slightly less high distally; distal margin with thickened “collar” for articulation with carpus; lower margin straight, rimmed; upper margin weakly convex; distal margin initially at about 85 degree angle to upper margin; large, bulbous region positioned above fixed finger, followed by indentation just above fixed finger; highly vaulted from upper to lower margin; considerably thicker than female manus; inner surface smooth, with row of setal pits parallel to lower margin.

Fixed finger of male major chela triangular, narrowing distally; occlusal surface paralleled by row of setal pits; large, blunt tooth proximally. Movable finger of male major chela robust, remaining high for most of its length, tip narrowed and down turned into a hook; with large, blunt teeth proximally.

Manus of possible minor chela longer than high, height about 60 percent length, narrowing distally; proximal margin weakly concave centrally; upper margin weakly convex; lower margin weakly convex, rimmed, becoming straight near base of fixed finger; distal margin initially at 90 degree angle to upper margin, then extending at about 120 degree angle, merging with occlusal surface of fixed finger, blunt node at base of fixed finger; outer surface smooth, with row of setal pits parallel to lower margin.

Fixed finger of possible minor chela edentulous, narrowing distally, occlusal surface and lower margin of outer surface paralleled by setal pits. Movable finger of possible minor chelae slender, edentulous.

Measurements.—Measurements (in mm) are given in Table 1. Length of movable finger: SGO.PI.6385 = 7.2; SGO.PI.6401 = 6.6.

Occurrence.—All of the specimens were recovered from the Estratos de Algarrobo (Gana et al., 1996), which were assigned to the late middle–upper Eocene by Tavera (1980), exposed at a public beach at Algarrobo, Chile.

Remarks.—All of the female major chelae are right, and among the males, major chelae are mostly rights. Nearly all of the minor chelae are lefts. Distinct patterns of handedness

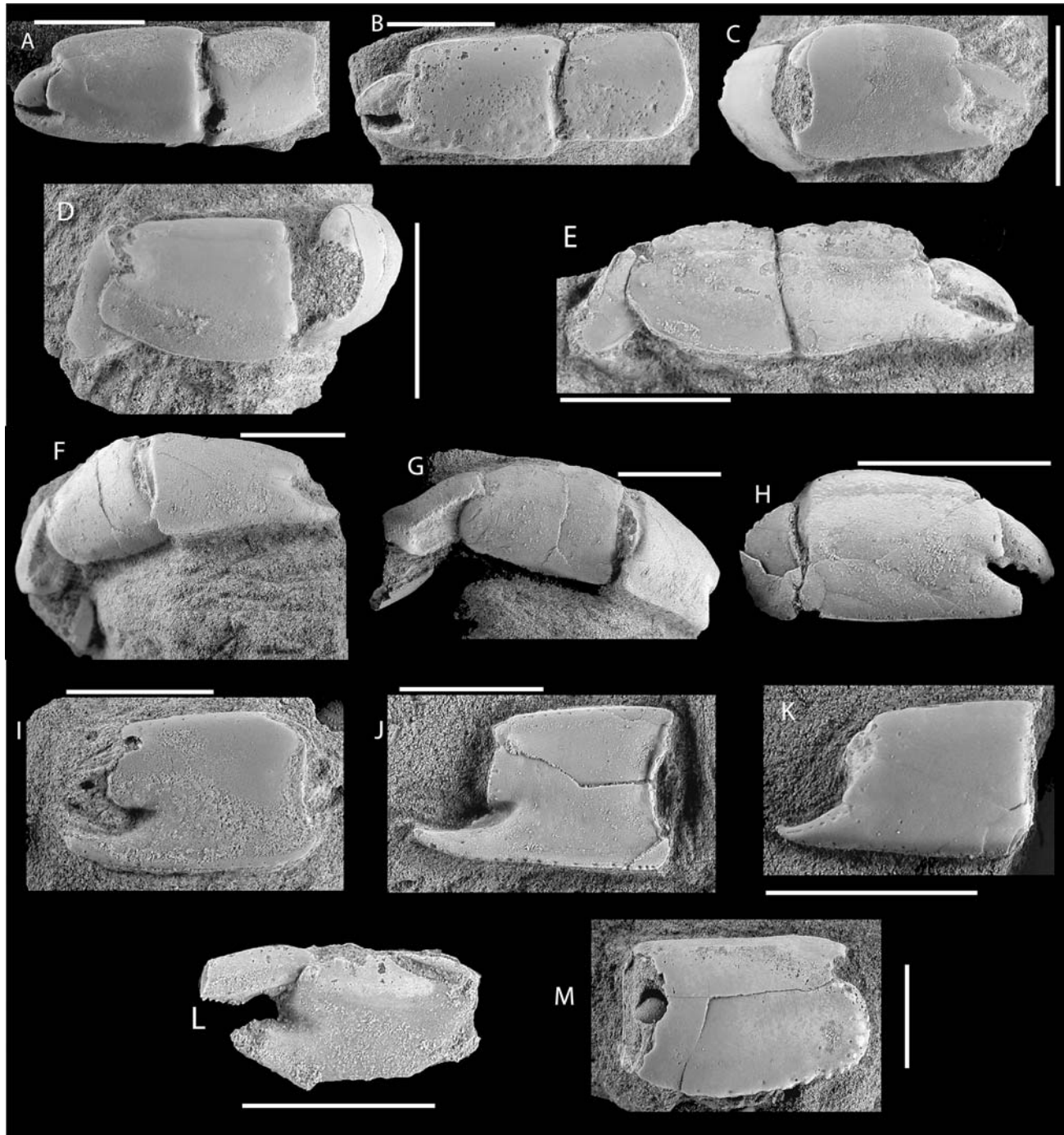


Fig. 4. *Melipal chilensis* new genus and species (A–K, M) and indeterminate Callianassidae (L). A, paratype, manus and carpus of left male major cheliped, SGO.PI.6382; B, paratype, manus and carpus of left male major cheliped, SGO.PI.6378; C, paratype, manus and part of carpus of right male major cheliped, SGO.PI.6383; D, paratype, part of manus, carpus, and merus of right male major cheliped, SGO.PI.6383; E, holotype, manus, carpus, and merus of right female major cheliped, SGO.PI.6385; F, paratype, manus and part of carpus of right female major cheliped, SGO.PI.6388; G, paratype, part of manus, carpus, and merus of right female major cheliped, SGO.PI.6388; H, paratype, outer surface of male major chela, SGO.PI.6401; I, paratype, inner surface of male major chela, showing large indentation above position of fixed finger, SGO.PI.6380; J, paratype, inner surface of female major chela, SGO.PI.6389; K, paratype, minor chela of indeterminate gender, SGO.PI.6391; L, unusually preserved chela, SGO.PI.6409; M, paratype, carpus of male major cheliped showing marked serrations on lower and proximal margins, SGO.PI.6384. Scale bars = 1 cm.

in callianassoids are not commonly reported. Dworschak (1998) reported that handedness in one extant species of *Callianassa* appeared to be controlled by collecting locality, while a related species found in the same geographic area displayed no pattern of handedness. The extinct *Callianop-*

sis clallamensis (Withers, 1924) exhibits a preference for right handedness in females but no preferential handedness in males (Schweitzer-Hopkins and Feldmann, 1997). Thus, it appears that either ecological or gender factors may play a role in determining handedness.

Infraorder Anomura H. Milne Edwards, 1832

Hermit Crab?

Fig. 3F

Material Examined.—A single broken tip of a finger, probably the dactylus, SGO.PI.6408, is deposited in the National Museum of Chile, Santiago, Chile.

Occurrence.—Estratos de Quebrada Municipalidad unit of Gana et al. (1996), which is the equivalent of the Quiriquina Formation on Quiriquina Island, Upper Cretaceous (Maastriachian), from coastal exposures along the public beach at Algarrobo, Chile.

Discussion.—A single finger collected from the Cretaceous strata differs significantly from the callianassids described herein and is likely referable to the hermit crabs. The specimen is approximately 1 cm long, is slightly curved, has a bluntly rounded distal termination, bears pustulose ornamentation that is coarsest on the lower margin and becomes finer toward the edentulous occlusal surface. The tip and the occlusal surface exhibit evidence of wear.

This morphology does not provide any evidence that would unequivocally place the specimen within any of the currently recognized families of hermit crabs and their relatives. The classification of these families remains in flux so that, for example, Martin and Davis (2001) recognize six families including the king crabs within a single superfamily Paguroidea Latreille, 1802; and Forest et al. (2000) array the hermit crabs, exclusive of Lithodidae, within two superfamilies Coenobitoidea Dana, 1851, and Paguroidea Latreille, 1802. The two superfamilies are distinguished largely upon whether the left chelipeds are larger, as in the former superfamily, or whether the right chelipeds are larger, as in the latter. Additionally, characters of the third maxilliped, not commonly preserved in fossils, also distinguish the superfamilies. Many of the characters necessary to distinguish members of paguroid families are characters of the carapace and pleopods; again, not preserved in the fossil record commonly. Surface morphology of the claws, particularly the fingers, simply cannot be considered diagnostic.

From the above discussion, therefore, it is clear that the single finger in this collection documents the presence of a hermit crab but that a more precise identification is not possible.

ACKNOWLEDGEMENTS

Research was supported by Proyecto Fondecyt 1010691, Programa MECE Educación Superior UCH0010, Beca PG/50/02 of the Departamento de Postgrado y Postítulo-Universidad de Chile. We thank J. Le Roux for his comments on the manuscript. Discussions with the late R. B. Manning, United States National Museum of Natural History, Washington, DC, clarified systematic placement of fossil callianassids. Helpful reviews by H. Karasawa, Mizunami Fossil Museum, Japan, and an anonymous reviewer, improved the manuscript.

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RECEIVED: 15 March 2005.

ACCEPTED: 15 August 2005.