

# THE SIGNIFICANCE OF A NEW NEPHROPID LOBSTER FROM THE MIOCENE OF ANTARCTICA

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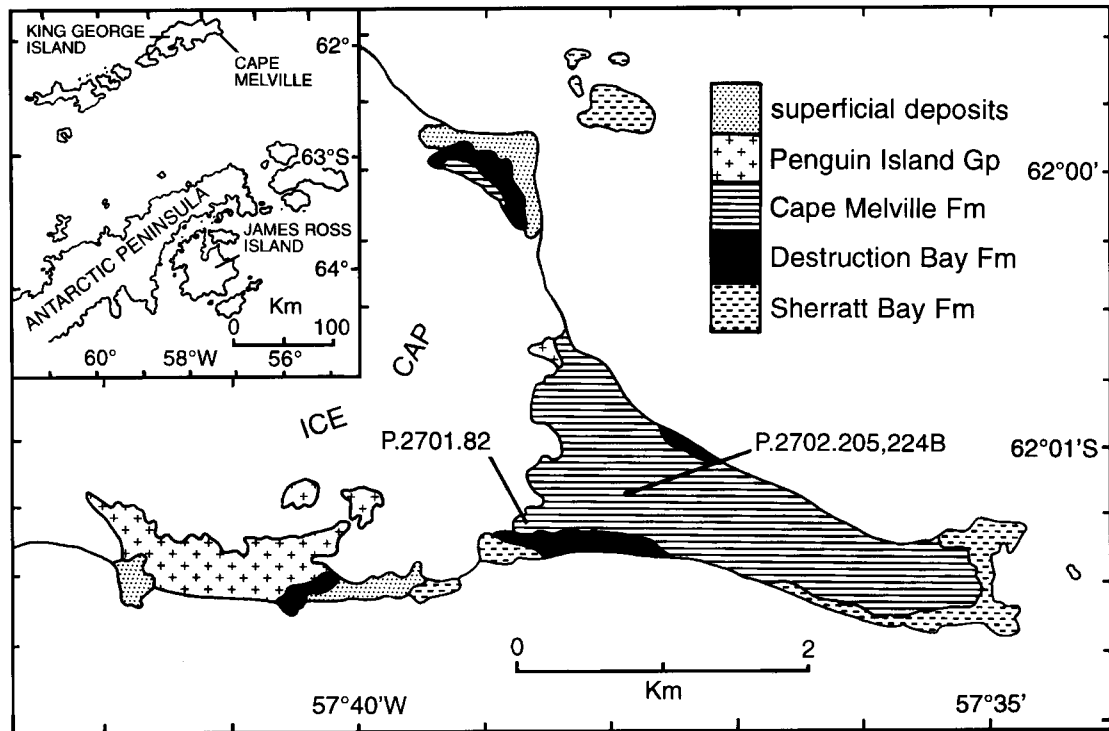
**ABSTRACT.** The nephropid lobster, *Hoploparia gazdzicki* sp. nov., is described from Early Miocene glacio-marine sedimentary rocks of King George Island, South Shetland Islands, Antarctica. Such an occurrence considerably extends the stratigraphical range of a widespread lobster genus that reached its acme in the Late Cretaceous. The previous youngest records were from the Eocene of western Europe, and it would appear that, by the Early Miocene, the genus may have become a relict in relatively cold and deep waters in Antarctica. Although the full phylogenetic implications of this extension to the stratigraphical range are not yet apparent, there are some important palaeoecological ones. This occurrence can be taken as a further indication that certain benthic decapods were able to survive the onset of glacio-marine conditions in Antarctica. Perhaps other factors, such as the availability of food, habitat space, or decline in seasonal temperature fluctuation, ultimately controlled the decline of this major benthic group in the Southern Ocean.

THE fossil record of decapod crustaceans in Antarctica is remarkably robust in rocks ranging in age from Late Jurassic through to Eocene (Feldmann and Tshudy 1989). However, there are currently only two known occurrences of fossil decapods on the continent in post-Eocene rocks and there are only a few living pelagic decapods known from the region today. The decapods are certainly one of the key benthic groups to be grossly under-represented in the living Antarctic marine fauna and their demise has often been linked in a general way to Cenozoic climatic deterioration (Clarke and Crame 1989; Arntz *et al.* 1997). The two post-Eocene records of decapods in Antarctica are those of the homolodromiid crab, *Antarctidromia inflata* Förster, from the Cape Melville Formation (CMF) on King George Island, South Shetland Islands (Förster *et al.* 1985; see below), and an extremely fragmentary specimen of a palinurid lobster from the Pliocene of the Vestfold Hills, Princess Elizabeth Land (Feldmann and Quilty 1997). Although such a sparse record may be due to the restricted onshore occurrences of Cenozoic marine sedimentary rocks in Antarctica, it is also thought to reflect a very real decline in taxonomic diversity (Clarke and Crame 1989).

In this context, it is particularly significant that a new species of fossil lobster has been collected from the Lower Miocene at Cape Melville, King George Island (Text-fig. 1). It is even more noteworthy that this lobster, *Hoploparia gazdzickii* sp. nov., represents a significant upward extension in the stratigraphical range of a lineage whose acme was reached in the Late Cretaceous, and whose youngest known representative, prior to this discovery, was from the Eocene of the northern hemisphere. It is the purpose of this paper to describe this new species and to speculate on the implications of this occurrence for both decapod evolution and biogeography in the high southern latitudes.

## GEOGRAPHICAL AND STRATIGRAPHICAL SETTING

The three specimens to be described here were collected from a sequence of glacio-marine sedimentary rocks which is virtually unique to the Cape Melville peninsula (Text-fig. 1). Collectively, the sequence comprises the CMF, which is in turn a component of the Moby Dick Group, King George Island Supergroup (Birkenmajer 1987). Estimated to be between 175 and 200 m thick, the CMF is in sharp contact at its easternmost extremity with underlying columnar-jointed basalts/andesites of the Sherratt Bay Formation. On the western margins of the peninsula,



TEXT-FIG. 1. Locality and geological sketch map for Cape Melville, King George Island, South Shetland Islands. Localities of type specimens shown. Geological information based on Birkenmajer (1987, fig. 5).

the CMF is underlain by a further sedimentary unit, the Destruction Bay Formation (Birkenmajer 1987; Text-fig. 1). The CMF is overlain to the west by sub-Recent volcanic rocks assignable to the Penguin Island Volcanic Group.

The predominant lithology within the CMF is a pale grey/green/brown-weathering mudstone to silty mudstone bearing conspicuous, small to very large limestones. Occasionally, the matrix coarsens to fine- or even medium-grained sandstone, and in places there are irregular seams and lenses of very coarse- to pebbly-sandstones. The limestones comprise an extremely wide range of igneous, metamorphic and sedimentary lithologies, and are undoubtedly glacial dropstones. Some of them are of only local (i.e. northern Antarctic Peninsula) origin, but others, such as archaeocyath-bearing limestones, ripple cross-laminated red sandstones, and pink-weathering polymict conglomerates, indicate a source region as far distant as the Transantarctic Mountains (i.e. at least some 2000 km to the south).

The CMF varies from a subhorizontal structural disposition to a gentle east or north-east dip of about 5°. It is cut by a prominent north-west-south-east trending dyke swarm, which is in turn cut by a later series of north-north-east-south-south-west trending normal faults. Two of these andesitic-basaltic dykes have been dated radiometrically (K-Ar) at 20 Ma, and this puts a minimum age constraint on the entire Moby Dick Group (Birkenmajer 1990). In addition, a tuff from close to the base of the Destruction Bay Formation has been dated (K-Ar) at 23 Ma, and both brachiopods and foraminifera from the same unit have strong Lower Miocene affinities. A consensus of radiometric and palaeontological age determinations indicates that the CMF is best regarded as Early Miocene (Birkenmajer 1987, 1990).

All three specimens were collected from the plateau surface extending along the top of the peninsula (Text-fig. 1). The holotype, P.2701.82, comes from the south-western corner, close to the

moraine material associated with the edge of the ice cap; the two paratypes (P.2702.205, 224B) were collected from the eastern slopes of 'Crab Creek'. Such locations indicate a stratigraphical position within approximately the uppermost 75 m of the CMF, and a close association with a rich benthic marine invertebrate assemblage dominated by infaunal bivalves, gastropods, solitary corals and crabs.

As might be expected in such a mud-rich environment, the bivalve assemblage is dominated by deposit-feeding nuculids and nuculanids. Other taxa include limopsids, several small heteroconchs, and a comparatively large number of anomalodesmatans. The prolific crab remains range from disarticulated chelae and incomplete carapaces to whole, articulated specimens associated with burrow structures. They have been assigned to just one taxon, *Antarctidromia inflata* Förster (Förster *et al.* 1985, 1987). The solitary corals have been identified as *Flabellum rariseptatum* (Roniewicz and Morycowa 1987), and the common gastropods include a medium-large volutid, at least two types of buccinid, a large turrid (*Austrotoma*), and several forms of naticid. Brachiopods, echinoids, scaphopods, bryozoans and large foraminiferans are also present, and overall the assemblage has a relatively deep-water, outer-shelf aspect.

#### SYSTEMATIC PALAEOONTOLOGY

Order DECAPODA Latreille, 1803  
 Infraorder ASTACIDEA Latreille, 1803  
 Family NEPHROPIDAE Dana, 1852  
 Genus HOPLOPARIA McCoy, 1849

*Type species.* *Astacus longimanus* G. B. Sowerby, 1826, by subsequent designation of Rathbun, 1926.

#### *Hoploparia gazdzickii* sp. nov.

Text-figures 2–3

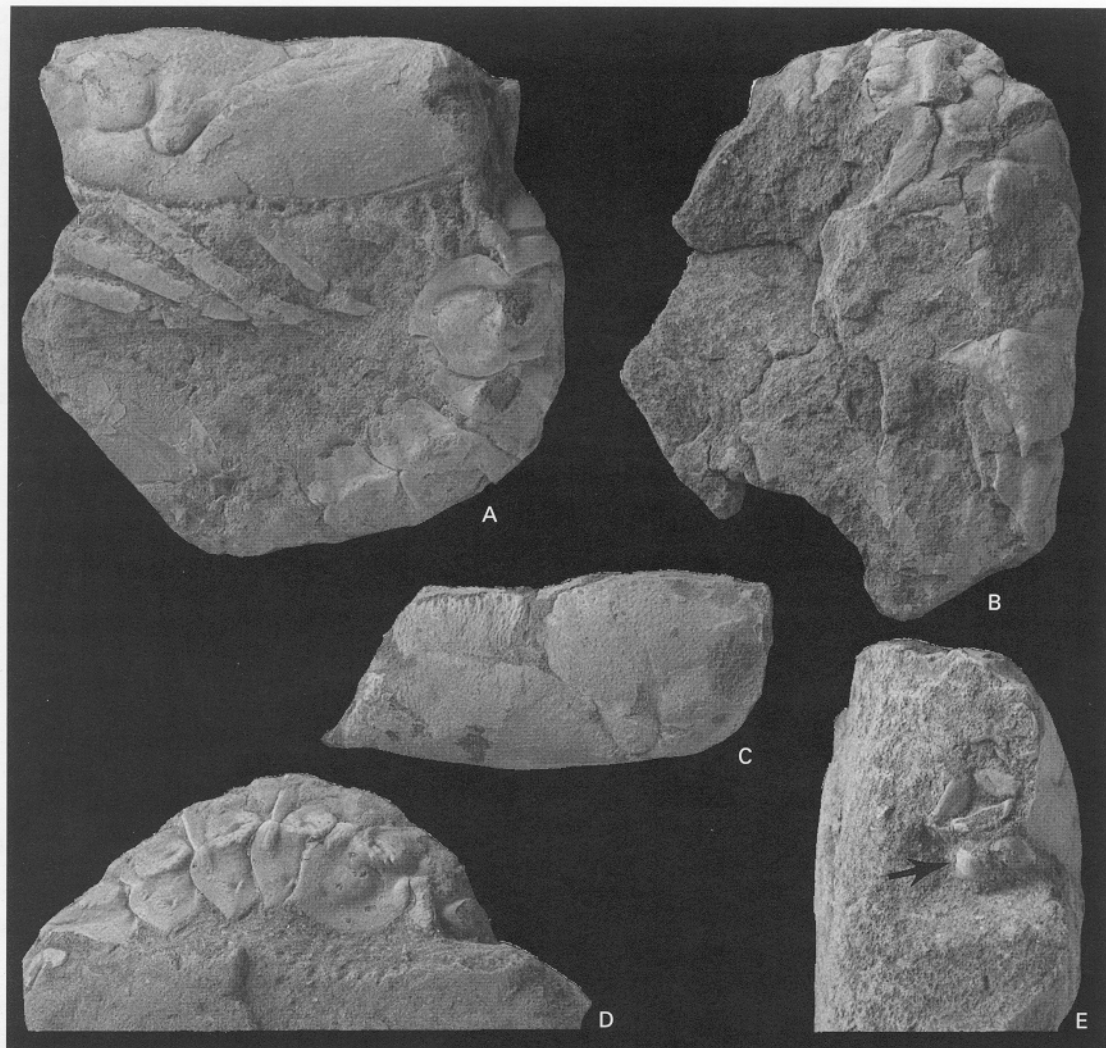
*Derivation of name.* The trivial name recognizes the significant contributions of Andrzej Gaździcki, Polish Academy of Sciences, Warszawa, to the study of the geology and palaeontology of King George Island.

*Types.* The holotype, P.2701.82, and two paratypes, P.2702.205 and 2702.224B, are deposited in the collections of the British Antarctic Survey, Cambridge, England.

*Description.* Moderate to small sized (for genus) carapace more than twice as long as high, with diminutive cephalic spines, and with well defined groove pattern.

Dorsal margin biconvex with postcervical groove crossing midline behind midlength. Posterior margin incomplete, convex. Ventral margin smoothly convex with narrow marginal rim and furrow. Frontal margin broken but with shallow, rimmed orbital margin. Rostrum not preserved. Two weak spine rows developed on dorso-anterior portion of cephalic region. Rostral spine row with four spines of which anteriormost is largest. Supraorbital spine row with three spines increasing in size anteriorly. Single, prominent antennal spine. Carapace grooves narrow, deeply incised, distinct. Cervical groove (e of Text-fig. 3) originates at point about one-third total height from midline, becoming narrower and better defined ventrally; curving anteriorly in smooth arc terminating abruptly against nearly straight, anteriorly-inclined antennal groove (b). Gastroorbital groove (d) an indistinct depression. Postcervical groove (c) with straight dorsal segment crossing midline behind midpoint of carapace, weakly convex-forward midsection inclined at about 45° to dorsum, and short anterior section curving toward cervical groove. Branchiocardiac groove (a) smoothly convex forward, coalescing with postcervical groove at midsection and merging with deeply incised, tightly curved hepatic groove (b<sub>1</sub>) defining presumed position of adductor testis muscle insertion ( $\chi$ ) which is swollen and bears several fine granules. Region of mandibular external articulation ( $\omega$ ) broadly and subtly swollen. Branchiostegite with very fine, uniformly spaced setal pits overall and few very fine pustules along ventral margin.

Abdomen with well differentiated tergal and pleural surfaces separated by distinct convex-downward ridge (Text-fig. 3). Terga with coarsely punctate irregularly undulating axial regions and transversely ovoid, irregular



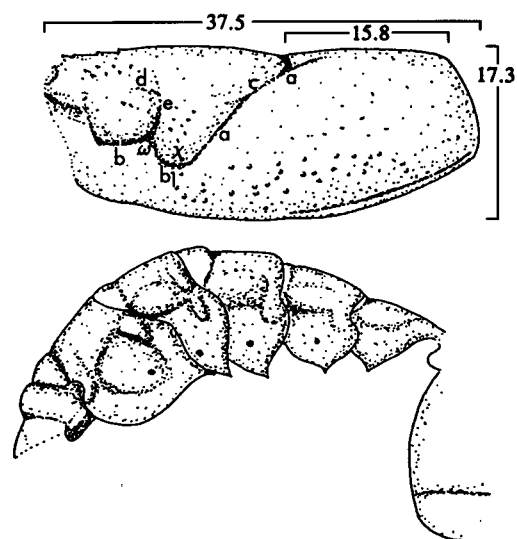
TEXT-FIG. 2. *Hoploparia gazdzickii* sp. nov. A, left lateral view of holotype, P.2701.82, showing nearly complete cephalothorax and abdomen. B, left lateral view of paratype, P.2702.205, showing incompletely preserved abdomen. C, right lateral view of paratype, P.2702.244B, showing crushed, incomplete cephalothorax. D, right lateral view of abdomen of holotype. E, frontal view of holotype showing mandibles (arrow) and fragments of maxillipeds. All  $\times 1.5$ .

swellings laterally. Posterior rim of each tergum smooth, elevated. Pleura smoother than terga, domed medially, swollen at posterodorsal corner where somites articulate. Pleuron of first somite small, triangular, anteriorly, directed; that of second somite larger than any of the others, broadly obovate with posteriorly directed acute spine. Remaining pleura lanceolate with acute tips directed slightly toward posterior. Single pit situated at midpoint of pleura 3–5. Telson margins not preserved; axis depressed, bounded by two broadly elevated longitudinal ridges diverging slightly toward posterior. Uropods large, elongate, oval, with diarsis.

Mandibles strongly inflated, occlusal surface of right mandible overlaps that on left. First pereopods not known. Proximal elements of pereopods 2–5 of uniform size, long, narrow, cylindrical.

*Measurements.* Dimensions of carapace, in mm, are given on Text-figure 3.

TEXT-FIG. 3. Line drawings of *Hoploparia gazdzickii* sp. nov. showing the positions of the carapace features, orientation of measurements taken, in millimetres, and details of morphology of the abdomen (composite drawing based primarily on the holotype) a, branchiocardiac groove; b, antennar groove; b<sub>1</sub>, hepatic; c, postcervical; d, gastroorbital; e, cervical; ω, position of mandibular external articulation; χ, inferred position of 'adductor testis' muscle attachment.



*Remarks.* *Hoploparia*, along with other nephropid lobsters, was recently subjected to a cladistic analysis (Tshudy and Babcock 1997) which tested morphological characters used to define genera as well as the affinities of included genera. On the basis of this, and previous works, representatives of the genus *Hoploparia* may be distinguished from those in the closely related genus *Homarus* in several ways. With reference to the specimens described above, the development of a cervical groove that extends dorsal to the level of the gastroorbital groove, possession of a postcervical groove that is strongly developed throughout and that extends toward the cervical groove, projection of the branchiocardiac groove ventral to the presumed attachment site of the adductor testis muscle merging with the hepatic groove to intercept the cervical groove, and development of strong ornament on the abdomen resulting in clear demarcation of the tergal and pleural regions, are all characters that permit confident assignment to *Hoploparia*. Other distinguishing features, including the nature of the rostrum and the conformation of the chelae (Glaessner 1969), cannot be used because they are not preserved on the available material.

Species within the genus are distinguished on the basis of carapace ornament, relative degrees of development of the carapace grooves, morphology of the chelae, and details of the ornament on the abdomen. The combination of the characters exhibited by *Hoploparia gazdzickii* sp. nov. clearly distinguishes it from previously described species. It possesses an antennar groove that is nearly straight, instead of smoothly curved, and that is steeply inclined in an anterodorsal direction; this feature is unique. In addition, the carapace of the new species is nearly devoid of nodes, spines, or other ornament. In this regard, it more closely resembles species of *Homarus*. The only distinctive carapace ornament is that of the two rows of spines on the cephalic region and a large antennar spine, characters exhibited by all, or nearly all, species within the genus. Those spines, however, are diminutive in *H. gazdzickii* sp. nov. Finally, although the carapace is nearly smooth, the abdomen is heavily ornamented.

The type species of the genus, *Hoploparia longimanus* (G. B. Sowerby), from the Upper Cretaceous of England, possesses rows of nodes just posterior to the cervical and postcervical grooves, pustulose ornament on the cephalic region, an antennar groove that is nearly parallel to the ventral carapace margin, and highly ornamented abdominal pleura; none of these characters is evident on *H. gazdzickii*.

Two species of *Hoploparia* have been described previously from Antarctica. *Hoploparia stokesi* (Weller 1903), has been collected from numerous sites on Snow Hill, Seymour, James Ross, and Vega islands in rocks ranging from Campanian through to Paleocene (Feldmann and Tshudy 1989).

Individuals within this species can be distinguished readily from *H. gazdzickii*. *Hoploparia stokesi* tends to be much larger, exhibits a more granular carapace, more strongly developed spines on both the mandibular articulation and the adductor testis region, a prominent spine on the ridge separating the abdominal pleura from the terga, a nodose surface on the telson, and keeled uropods. *Hoploparia antarctica* Wilckens, 1907, is known from the Campanian of James Ross Island as well as the Campanian–Maastrichtian of southern and central Patagonia, Argentina. This latter species bears a prominent row of antennal spines, moderate to weakly developed intermediate and branchial carinae on the branchiostegite, nearly smooth tergal surfaces, and strongly inflated borders on the abdominal pleura.

#### DISCUSSION

Prior to this study, the youngest occurrences of *Hoploparia* were those in the Eocene of Europe; there are, for example, references to *Hoploparia* sp. from both Germany (Ebert 1887) and Italy (Ristori 1889). The overall pattern of distribution for the genus would appear to be one of origin in the Early Cretaceous, at least by the Hauterivian (Feldmann 1974), and possibly as early as the Berriasian–early Valanginian in the Americas (Aguirre Urreta 1989). By the Late Cretaceous, the genus was distributed world-wide: in the epicontinental seaways of North America, the Atlantic Ocean basin, Europe, Madagascar, South America and Antarctica. The geographical range of the genus declined significantly during the Paleogene, after which it was thought to have vanished, either by true extinction or by giving rise to one or more of the modern nephropid genera (Aguirre Urreta 1989). However, it is now apparent that the genus persisted as a relict in the Antarctic region at least into the Early Miocene.

There remain unanswered questions regarding the origins of the modern nephropid genera. Although that topic is not directly relevant to the present work, this new discovery of a Miocene *Hoploparia* does raise the question of whether it formed the rootstock of at least some of the modern genera or whether it was a contemporary of genera which had arisen earlier. *Metanephrops* Jenkins, 1972 is reported to have arisen at least by the Late Cretaceous in the form of *Metanephrops jenkinsi* Feldmann, 1989, from the James Ross Basin, Antarctica. Tshudy and Babcock (1997) concluded that the genera most closely allied to *Hoploparia* arose in the Early Cretaceous. Difficulty in testing the relationships of the other nephropids using palaeontological evidence arises because most of the modern nephropids are inhabitants of outer shelf and slope habitats (Holthuis 1974), and these are not well represented in the fossil record.

There are also unresolved questions regarding the palaeoecological implications of the occurrence of *Hoploparia* in the CMF fauna. Certainly the preponderance of occurrences of the genus throughout its geological history have been in inner shelf, moderate to high energy settings (Aguirre Urreta 1989). In almost all instances too, biotic associations indicate normal marine settings. As fossil occurrences of *Hoploparia* range from as far north as Greenland to as far south as Antarctica, this could be taken to represent original water temperatures ranging from cool-temperate to subtropical. Nevertheless, the outer limit of the bathymetric range has never been adequately constrained, and these records from the Lower Miocene of Antarctica indicate that the genus also inhabited moderately deep waters. A comparison can be made here with modern *Homarus* Weber, which is known to occur at virtually all depths on the continental shelf and, before active capture by humans, was observed in tide pools in intertidal settings (Herrick 1911).

Finally, it is striking how two quite different benthic decapod genera, *Antarctidromia* and *Hoploparia*, co-occur in the CMF. This is without doubt a glacial deposit, for the dropstones could only have been deposited from very large icebergs originating along the southernmost margins of the Weddell Sea (present day Ronne Ice Shelf). Thus, at least two distinct decapod taxa were able to survive cold-water (glacial) conditions and it may be that there was no simple link between the onset of glaciation and the extinction of many benthic marine taxa (Clarke and Crame 1989). Perhaps the extinctions were phased over a long period of time, or factors other than low temperature *per se* were of paramount importance. There is a growing volume of evidence to suggest that the ability to cope with oligotrophic conditions may be just as important to survival within the

present-day Southern Ocean benthos as the ability to withstand near-freezing conditions (Arntz *et al.* 1997).

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