Intraspecific variation in the shell ornamentation of benthic Ostracoda (Crustacea) from Kiribati, Pacific Ocean

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Abstract – Twenty four species of ostracod have been found on Tarawa Atoll and fifteen on Kuria Island, Republic of Kiribati in the western Pacific Ocean. Thirteen species are common to both atolls. A consistent difference has been discovered in the ostracod faunas of Tarawa and Kuria, with those from Kuria showing coarser texture in the ornamentation than their counterparts from Tarawa. The variation of carapace ornamentation has led to multiple names for a species. A characteristic ornamentation at a particular locality may be a due to a small number of specimens colonising the new locality and having a limited gene pool. Alternatively, any variation in the ornamentation may be a clue to multiple phases of colonisation within a small area. © 1999 Ifremer / CNRS / IRD / Éditions scientifiques et médicales Elsevier SAS

ostracods / atoll / benthic / Pacific / island

Résumé – Variation intraspécifique dans l'ornementation d'une coquille d'ostracode benthique (crustacé) de Kiribati, océan Pacifique. Vingt-quatre espèces d'ostracodes ont été trouvées sur l'atoll Tarawa et quinze sur l'atoll Kuria, en république de Kiribati (Micronésie) dans l'ouest de l'océan Pacifique. Treize espèces sont communes aux deux atolls. Une différence est observée entre les faunes des deux atolls, les ostracodes de Kuria présentant sans exception une structure plus grossière dans l'ornementation que leurs homologues de Tarawa. La variation de l'ornementation de la carapace a conduit à plusieurs dénominations pour une même espèce. L'ornementation caractéristique d'une certaine zone peut être due à un petit nombre d'individus la colonisant et ayant un pool génétique limité ; une variation dans l'ornementation peut être aussi l'indice de multiples phases de colonisation dans un secteur limité. © 1999 Ifremer / CNRS / IRD / Éditions scientifiques et médicales Elsevier SAS

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1. INTRODUCTION

The marine podocopid Ostracoda from Tarawa Atoll have been studied and twenty-four species were found to be present [5]. In that study, a number of changes were noted that had occurred both with time as shown in a core and by resampling the environment. When material was collected from other islands in the Gilbert Group (see *figure 1*), the texture of the ornamentation of the valve surface (or degree of sculpture) was found to change. The ornamentation is consistently coarser in the fauna from Kuria Island. Kuria is an island without a lagoon, but the lack of a lagoon is not considered significant for the purposes of this study as the atoll at Tarawa is incomplete and open on the western side. The significance of the material in this paper is that there are few variable factors such as climate, seasons, topgraphical relief and geological time which have been introduced in previous studies.

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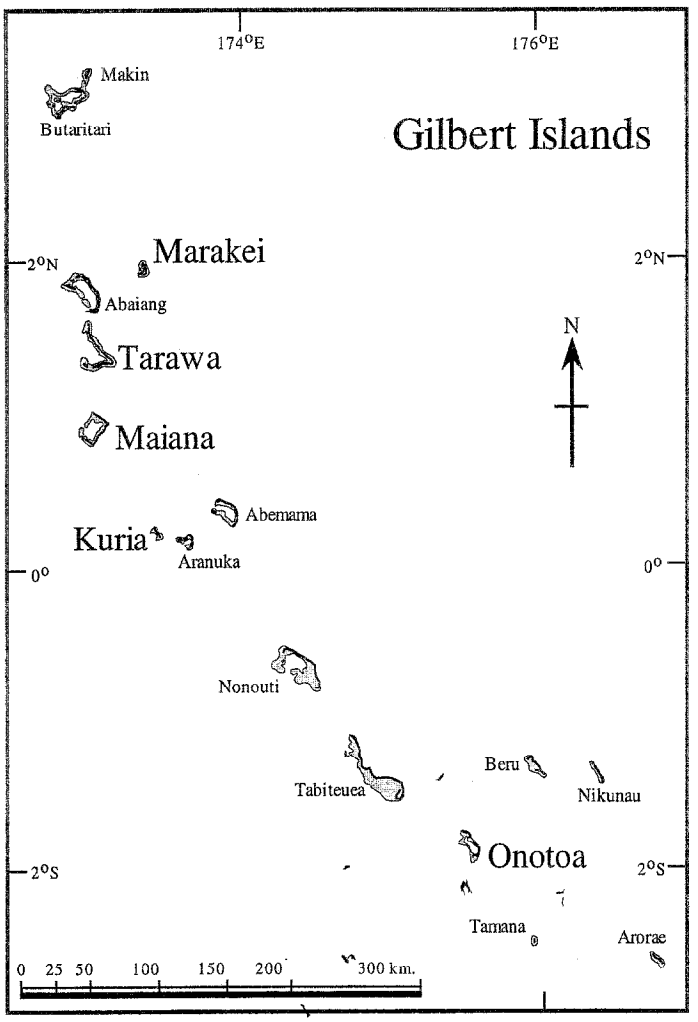

Figure 1. Map of the Gilbert Islands. Islands mentioned in the text are in large type.

Variations in the relief of the ornamentation on ostracod shells have been noted by other workers for various species in other parts of the world; Cronin [4], Hartmann and Kühl [9] and the reasons have been attributed to a plurality of speciation mechanisms, but mainly seasonal or ecological factors. Hartmann [7] has used the term 'morphotype' in order to emphasise the general similarity of shell appearance within each group.

The ostracods that form the subject of this paper were obtained from dried sediments collected between high and low tides and in bottom sediments from the lagoon (average depth 7 m). The localities were on the eastern side of Kuria just south of the causeway that links the two land masses and from many sites on Tarawa. The dominant winds and ocean currents are from the east for both islands. The islands do not have a marked influence on the shallow water masses that surround them. The salinity (35) is fairly consistent and there is little variation in the annual temperature (average 28 °C) of the surface water down to 10 m.

2. VARIATION IN INTRASPECIFIC ORNAMENTATION

Seven species of ostracods each from Tarawa and Kuria are illustrated in *plate I* and were selected to show a range of ornamentation from fine to accentuated. An examination of the fine detail of the external surface of the valves show that there are slight, but consistent differences in the thickness of the ribbing from atoll to atoll. A comprehensive set of samples has been collected from Tarawa by

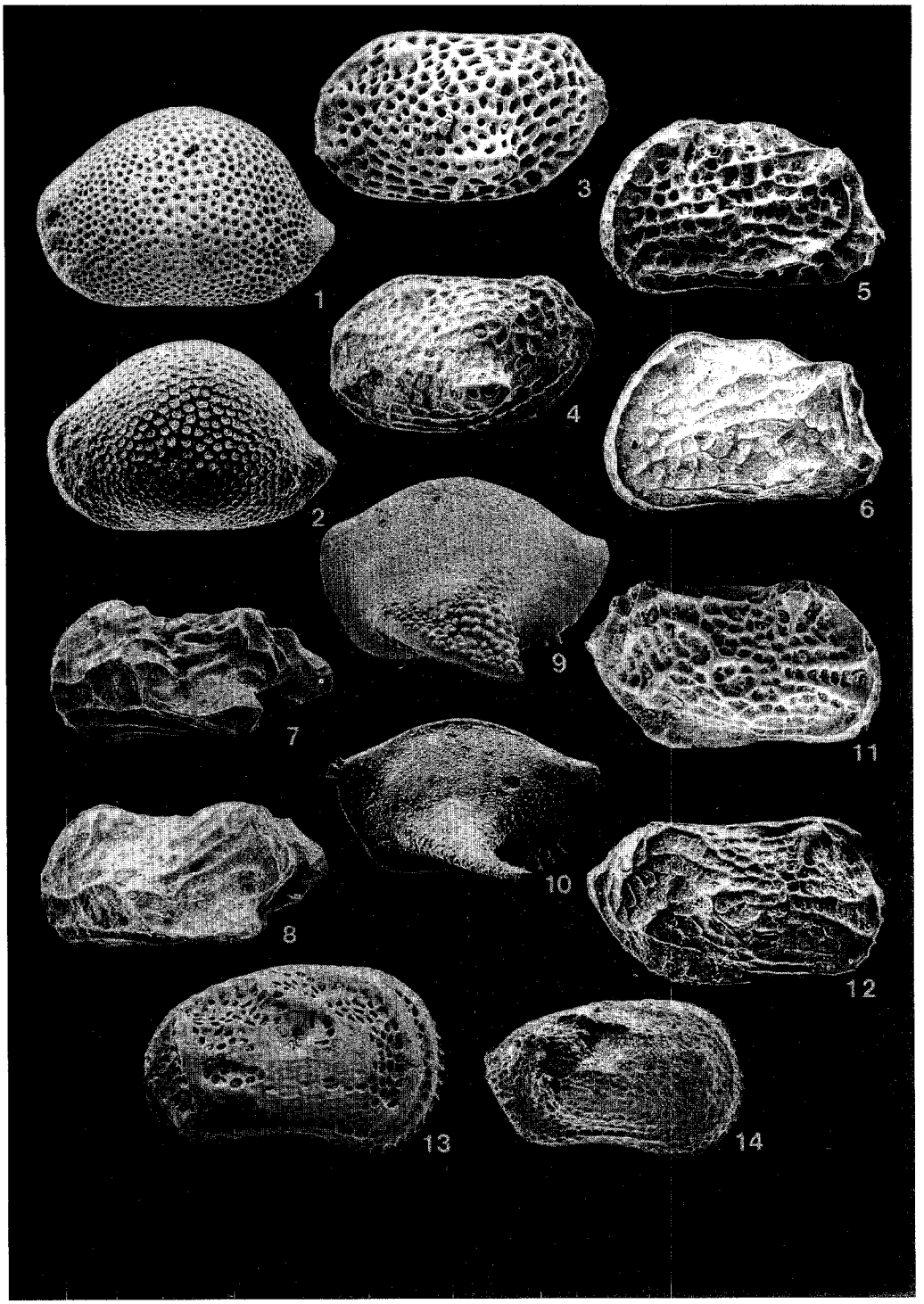

Plate I. 1. *Paranesidea stricta* Titterton & Whatley. Left valve. X 40. 2. *Paranesidea stricta* Titterton & Whatley. Left valve. X 40. 3. *Loxoconcha huahineensis* Hartmann. Left valve. X 100. 4. *Loxoconcha huahineensis* Hartmann. Left valve. X 100. 5. *Mutilus curvicostus* Howe & McKenzie. Left valve. X 60. 6. *Mutilus curvicostus* Howe & McKenzie. Left valve. X 60. 7. *Paracytheridea remanei* Hartmann. Left valve. X 100. 8. *Paracytheridea remanei* Hartmann. Left valve. X 100. 9. *Pterobairdia maddocksae* McKenzie & Keij. Left valve. X 75. 10. *Pterobairdia maddocksae* McKenzie & Keij. Left valve. X 75. 11. *Touroconcha marcida* (Brady). Right valve. X 100. 12. *Touroconcha marcida* (Brady). Right valve. X 100. 13. *Cytherelloidea fijiensis* (Brady). Right valve. X 75. 14. *Cytherelloidea fijiensis* (Brady). Right valve. X 75.

Eagar [5] and nowhere were coarsely-textured ostracods collected in the faunas, neither on the ocean side nor from the lagoon. Further material from Marekei and Maiana (see *figure 1*) was also examined and the results were similar to those from Tarawa. However, the elements (e.g. ribs, punctations, reticulation) that comprise the sculpture (ornamentation) of the ostracod valve surface are always present within a given species and it is a matter of degree how strongly these elements are displayed. This was observed by Hartmann and Kühl [9] using temperate species. Those ostracods shown in *plate I* are examples with a strong ornamentation and are, as a result, more easily identified such as the punctate *Paranesidea stricta* (*plate I*: *1, 2*) or the reticulate *Loxoconcha huahineensis* (*plate I*: *3, 4*) and the general appearance of *Mutilus curvicostus* (*plate I*: *5, 6*). The strongly alate species *Pterobairdia maddocksae* (*plate I*: *7, 8*) manifests valves which are generally thicker. The lower degree of ornamention and smoother forms found in species such as *Neonesidea* and *Xestoleberis* make identification and synonymy difficult to interpret.

3. DISCUSSION

The reason is not clear at present, but is likely to be genetic rather than environmental. Hartmann and Kühl [9] considered one of the reasons to be seasonal and related to the availability of calcium carbonate. They suggest that some species show dimorphism between males and females, but conclude that further studies are required. In the Gilbert Islands there are no seasons in the same sense as in the Northern Hemisphere. Hartmann [7] also noted the variation in the ornamentation of some subtropical species and still attributed the reason to temperature, but reserved judgement by stating that genetic and environmental factors should also be considered. He found the soft part morphology to be fairly consistent. Peypouquet et al. [13] made a comprehensive review of both fossil and living ostracods and proposed several models for the polymorphism.

The dispersal of shallow water benthic species poses a problem in biogeography. On the one hand there are species with a circumtropical distribution (e.g. *Triebelina sertata*) and on the other hand there are some (e.g. *Loxoconcha huahineensis*) occurring within the central equatorial region centred on the Melanesian Basin, Hartmann [8]. If sea level rises appreciably, there is no refuge for the shallow water species. In reality, the water level would rarely rise more than 4 m and they could adjust to the slight change. The colonisation of new atolls poses more of a problem. With a significant fall in sea level, the formation of a new atoll together with the added combination of growth of coral, the question of the movement of similar species around a region surrounded by deep water takes on a new dimension. For some non-ostracod species, large numbers of the zygote or gamete stage can be dispersed by currents. However, it would be possible for the dispersal of small numbers of ostracods to other atolls by being carried on floating algae. Those species which survived the journey would represent a particular gene pool, such that if they were from a strongly ornamented variety this island would have a characteristic fauna. Using the environment as the dominant factor for the sculpture, Benson [1] discussed the criteria for strengthening an ostracod shell using engineering principles. One solution was to increase the thickness and support making it possible to survive a more rigorous environment; this has led to a response by the organism to form a heavier shell. Buttressing and arching are more economical solutions to the engineering problem in the sense that they provide strength without the addition of excessive carapace bulk. However, similar material from Tarawa from the exposed coasts does not have this same form. It is clear that multiple factors contribute to the degrees of surface sculpture, but that the style and the elements forming that ornamentation are consistent within each species Hoskin [11], Liebau [15]. Therefore, one can conclude that either the fauna has descended from common stock and the isolation has triggered the different appearance or that the ecological conditions are not considered to influence the appearance, but rather that the disposition of the genetical inheritance can produce a stronger ornamentation.

A large number of ostracod species have been described from the Pacific. This has arisen as workers have assumed that species are endemic to individual islands or when scientists have worked in isolation. Furthermore, because they have been working with dried and empty shells, the species have been seen as morphospecies and any small differences or variations have been regarded as a licence to erect new species. As many of the types of earlier-described species are re-examined with the Scanning Electron Microscope (SEM) so that they can be directly compared with those found today, the synonymy lists will grow as the valid species are re-established at the expense of the invalid ones. Furthermore, there are many SEM photographs published which are slightly

oblique, which distort the image and can confuse the observer (compare *plate I: 9, 10*).

The need to examine the appendages and other soft parts is even more pressing particularly for those species with similar ornamentation. For example, Chapman [3] established ten species of *Bairdia* from Funafuti. The dried Funafuti material in the Natural History Museum, London has been examined by the author who is of the opinion that there are fewer species present in the material than previously claimed.

When subsequent studies are made in similar regions the species found should be similar. Whatley et al. [18], Howe and McKenzie [12] both worked in an area that is not far from one visited by HMS Challenger, Brady [2]. Howe and McKenzie [12] and Brady [2] record five bairdiaceans each. Whatley et al. [18] have 28 species of bairdiaceans from five duplicated samples, in the case of the latter they note that some post mortem transport has taken place and many species are listed under open nomenclature. In the experience of the present author, the ostracod shells on Tarawa do not survive much transport, especially close to the high tide mark. Above the high tide there are often no specimens of ostracods present at all. Further north in the Solomon Islands, Titterton and Whatley [16] recorded 21 bairdiaceans. Some allowance must be made for morphological variability within a species.

The numbers of species recorded are consistently higher for the high standing islands such as the Solomon Islands Whatley and Titterton [19] with 160; and 141 species from Pulau Seribu, Java Sea Whatley and Watson [20] whereas the low coral reef atolls have smaller faunas, for example, Tarawa 24 species Eagar [5]; Onotoa 32 species Weisslander et al. [17] and Funafuti, Ellice Islands (now Tuvalu) has 30 species from shallow water Chapman [3]. This may represent multiple phases of colonisation or that time to evolve more than one species within a genus has occurred.

Syntheses are taking place Hartmann [8]. It has been noted by Titterton and Whatley [16] and others that there are provinces in the Pacific region with several species of ostracod in common. Working with foraminifera, Lessard [14] also noted that members of this group are also found in provinces.

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