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The shallow-water marine Mollusca of the Estero Elefantes and Laguna San Rafael, southern Chile

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SYNOPSIS. Taxonomically, the Mollusca of southern Chile are moderately well known, but the literature is scattered, there is little information on their habitats, and distributional records are scarce for the Chilean archipelago lying between Isla Chiloé and Tierra del Fuego. In 1998 a survey was made of the marine biodiversity of the Laguna San Rafael National Park and an area of the Chonos Archipelago immediately to the north (approximately 46°S). The Laguna consists of a basin of low salinity, strongly influenced by glacial meltwater, and the Estero Elefantes is a complex fjord system with both brackish and fully marine environments, including sheltered bays and exposed coasts. Collections of molluscs were made at 26 stations, from intertidal habitats, kelp plants and by dredging from depths of up to 15 m. A total of 62 species was recorded, consisting of 9 Polyplacophora, 33 Gastropoda and 20 Bivalvia. In order to facilitate future studies in the region, these are briefly described and all the shelled species illustrated (12 of these photographed for the first time). Notes are given on habitats, depth and salinity, and geographical ranges are reviewed. Biogeographically, the area lies at the poorly known southern extreme of the transitional zone between the Magellanic and Peruvian faunal provinces. As a result, 27% of the species records are extensions to the known ranges, representing northern limits of Magellanic forms and southern limits of Peruvian ones. Of the 62 species found, 48% could be classed as Magellanic (found in the transitional zone and southwards) and 8% as Peruvian (found in the transitional zone and northwards), while the remainder occurred in both provinces.

INTRODUCTION

The archipelago or fjordland of southern Chile is a remote and relatively inaccessible area where little marine research has previously been carried out. In the heart of the fjordland (at a latitude of 46°S) lies the Laguna San Rafael National Park, a protected area of 1.7 million hectares. In recognition of its importance as a wilderness area covering a wide range of habitat types, with no significant human impact, the park has been declared a UNESCO Biosphere Reserve. Knowledge of the biodiversity of the area, and in particular that of the marine habitats, remains poor. Therefore, in 1996 a biodiversity research programme was initiated as a collaboration between the administrative authority of Chilean protected areas, the Corporación Nacional Forestal (CONAF), the youth development charity Raleigh International, the Museo Nacional de Historia Natural in Santiago, the Natural History Museum in London and the World Conservation Monitoring Centre in Cambridge. This report describes the results of the initial survey in 1998 of the marine molluscs of the Laguna San Rafael and southern Estero Elefantes that lie within the park, and an area of the Estero Elefantes in the vicinity of Isla Traiguén immediately to the north of the present park boundary. A preliminary report on the general marine survey of this area has been prepared by Paterson *et al.* (in press).

Dell (1971) has outlined the history of malacological investigations in southern Chile, and only a brief account will be repeated here. Owing to its strategic importance, the Magellan Strait was the object of several British surveys by H.M.S. 'Beagle' and 'Adventure' during 1826 to 1830, from which the Mollusca were described by King & Broderip (1832). Although this work is scarce and not illustrated, it nevertheless contains the first descriptions of many of the common shallow-water species of the Magellanic region. From about 1822 to 1831 the notable collector Hugh Cuming was based in Chile, where he amassed a great collection which was eventually acquired by the British Museum. This material was the source of many of the new species described by Sowerby (1833a, b, 1834, 1835, 1838, 1840) and by Reeve, later illustrated in Reeve's *Conchologia Iconica* (1843–1878). The largest single work on the Mollusca of South America was d'Orbigny's monumental *Voyage dans l'Amérique Méridionale* (1834–1847), based on the results of his own extensive travels in the southern part of the continent. Malacological knowledge of Chile was further advanced by the collections of Gay, described by Hupé (1854), and by the arrival in Santiago in 1851 of Philippi. As a result, by the middle of the nineteenth century the molluscan fauna of southern South America was remarkably well known.

Towards the end of the nineteenth and in the early twentieth century a number of important expeditions continued the biological survey of the Magellanic region and dredging activities revealed more of the subtidal fauna. Molluscs from the 'Alert' expedition were described by E. A. Smith (1881), those from the French Mission to Cape Horn by Mabille & Rochebrune (1889), from Swedish and German expeditions by Strebel (1904–1907) and from the 'Discovery' cruises by Powell (1951) and Dell (1964). Two later expeditions are the source of most of the little existing knowledge of the fauna of the fjordland between Puerto Montt and the Magellan Strait. First was the Lund University Chile Expedition which made extensive collections in the vicinity of Puerto Montt and Isla Chiloé (41–43°S) during 1948–1949, and also sampled a few localities further south in the Chonos Archipelago (44–46°S) and Magellan Strait (52–54°S). Important taxonomic accounts of the Polyplacophora (Leloup, 1956), Cephalopoda (Thore, 1959), Bivalvia

(Soot-Ryen, 1959) and Lamellariacea and Opisthobranchia (Marcus, 1959) were produced, but no report on the Gastropoda appeared (although some of the new records were published by Brattström & Johanssen, 1983). The second was the Royal Society Expedition to Southern Chile in 1958–1959. Again collections were made around Isla Chiloé, and also at Isla Wellington (49°S) and to the south of Tierra del Fuego at Isla Navarino (55°S). The Mollusca from this expedition were described by Dell (1971). Although Marincovich's (1973) study of the intertidal molluscs of Iquique relates to an area in the north of Chile (20°S), it is a useful account of the more common Peruvian species, some of which extend to the southern part of the country; it is also unique among all previous reports in being comprehensively illustrated. Recently, an extensive dredging programme has been carried out in the Beagle Channel (55°S) (Linse, 1997). A number of useful catalogues have appeared: of the molluscs of Argentinian Patagonia (Carcelles, 1950); of the molluscs of the Magellanic region (Carcelles & Williamson, 1951; and a notable series of 14 papers by Castellanos and others, 1988–1993); of the bivalves of Chile (Osorio & Bahamonde, 1970); of the bivalves of the entire eastern Pacific Ocean (Bernard, 1983) and of the Sacoglossa and Nudibranchia of Chile (Schrödl, 1996).

Later in the twentieth century the production of faunistic works declined and emphasis shifted towards monographic revisions of taxonomic groups at a regional or wider level. Among those that have included Chilean species are monographs of *Chiton* (Bullock, 1988), other polyplacophoran families (Kaas & Van Belle, 1985–1994), Nacellidae (Powell, 1973), *Fissurella* (McLean, 1984), rissoiform gastropods (Ponder & Worsfold, 1994), *Acanthina* (Wu, 1985), *Xymenopsis* (Pastorino & Harasewych, 2000), Volutidae (Weaver & duPont, 1970), Protobranchia (Villarroel & Stuardo, 1998), Mytilidae (Soot-Ryen, 1955), *Chlamys* (Waloszek, 1984) and Teredinidae (Turner, 1966).

In conclusion, therefore, there is an impressive array of literature available for the identification of the molluscs of southern Chile. Nevertheless, this literature is difficult for the non-specialist to use, for it is widely scattered and most of the potentially useful faunistic reports and catalogues are not illustrated, or only inadequately so. There are also deficiencies in geographical coverage, for the majority of collecting effort has been expended on the Magellan Strait, Tierra del Fuego and the Patagonian Shelf in the south, and to a lesser extent on Isla Chiloé and the central region of Chile. Consequently, geographical ranges are poorly known (Brattström & Johanssen, 1983; Schrödl, 1997). Furthermore, this inadequate sampling makes it difficult to evaluate cases of geographical variation as either clines, allopatric subspecies or partially sympatric sibling species (examples include *Chiton magnificus*, *Nacella magellanica*, *Scurria ceciliana*, *Acanthina monodon*, *Malletia magellanica*, *Felaniella inconspicua* and *Carditella tegulata*). With the exception of commercial species, anatomical and genetic work on molluscs of the region has only just begun. There are already several cases of developmental and radular studies that have distinguished species with closely similar or identical shells (e.g. Clench & Turner, 1964, on *Adelomelon* and *Odontocymbiola*; Gallardo, 1979, on *Crepidula*), and more such examples can be anticipated as detailed investigations by local workers continue. Some Magellanic molluscs show confusing variability in shell characters, and numerous nominal species have been described. Among the bivalves, examples include the genera *Mulinia* and *Zygochlamys*; in the latter case availability of an enormous series of shells has led Waloszek (1984) to synonymize several poorly defined species in one variable taxon. In the gastropod genera *Acanthina*, *Trophon*, *Xymenopsis* and *Pareuthria* shell variability may be connected with local adaptation facilitated by the nonplanktonic development that is common at high latitudes, or perhaps by ecophenotypic effects. Almost three decades after Dell's (1971) review of the state of systematic malacology in Chile, it remains true that these confusing taxa are, in his words, 'outstanding examples of groups demanding modern treatment by workers on the spot'.

A review of ecological research on molluscs in southern Chile is beyond our scope here. Suffice it to say that distribution and life history of the several commercially important species have received most attention, as reviewed by Osorio, Atria & Mann (1979). Marine molluscs are an important resource in Chile, and intertidal and shallow-water species are widely collected by artisanal fishermen ('divers-mariscadores' and 'recolectores de orilla'). National statistics for 1997 indicate that 7554 fishermen extracted 93269 tonnes of molluscs (Servicio Nacional de Pesca, 1998). Examples of recent field studies on commercial species include work on *Concholepas concholepas* (Castilla & Durán, 1985; Moreno, Reyes & Asuncio, 1993), *Choromytilus chorus* (Navarro, 1988; Moreno, 1995), *Ensis macha*, *Tagelus dombeii* and *Venus antiqua* (Clasing, Brey, Stead, Navarro & Asencio, 1994; Urban, 1994, 1996; Urban & Tesch, 1996). Some of the more common intertidal molluscs have been mentioned in studies of zonation and community structure (Jara & Moreno, 1984; Alvarado & Castilla, 1996), including a series of investigations on the influence of human predation on the organization of intertidal communities (Moreno & Jaramillo, 1983; Durán, Moreno, Lunecke & Lepez, 1986; Castilla & Oliva, 1987). In general, however, field research has been concentrated on the central Chilean coast and around Isla Chiloé (Ramorino, 1968; Brattström, 1990; Santelices, 1991), together with a few studies in the Magellan Strait and Beagle Channel (Guzman, 1978; Miranda & Acuña, 1979; Ojeda & Santelices, 1984; Castilla, 1985; Benedetti-Cecchi & Cinelli, 1997; Linse, 1997; Linse & Brandt, 1998). To our knowledge, there has been but one previous report on marine ecology within the Laguna San Rafael National Park, an account of the impoverished brackish-water ecosystem of the Laguna itself (Davenport *et al.*, 1995) that mentioned only two molluscs. The taxonomic reports of the exploratory cruises mentioned earlier did mostly include depth ranges and habitat notes for the species encountered.

Such, then, is the status of research on molluscs in southern Chile. With this in mind, we have the following objectives in the present survey. To facilitate future marine ecological work in this neglected part of southern Chile we briefly describe the 62 species discovered during the exploration of the Laguna San Rafael National Park and adjacent area, and clearly illustrate the 59 species with external shells (in 12 cases these are the first photographic illustrations of the species). We give notes on habitats and station lists; of interest here is the gradient of reduced salinity towards the San Rafael Glacier, and the differential penetration of brackish water by the species. As a guide to the scattered taxonomic literature we give abbreviated synonymies, and point out those taxa requiring systematic revision. The geographical range of each species is critically reviewed, based on literature records and museum collections. Since the study area lies within such a poorly studied region of the Chilean coast, and in the zone of transition between Magellanic and Peruvian faunal provinces, many of our records represent significant range extensions.

THE ENVIRONMENTAL SETTING AND MOLLUSCAN ASSOCIATIONS

The fjordland of southern Chile is formed from sunken ranges of coastal mountains. Within this area the fjord system of the Laguna

San Rafael and Estero Elefantes is situated at a latitude of 46°S, between the Chonos Archipelago and Taitao Peninsula to the west, and the Andean Cordillera to the east. Immediately to the south east lies the extensive San Valentin Icefield, and from this the San Rafael Glacier descends to sea level, calving directly into the Laguna. This is an enclosed body of water up to 15 km in diameter, cut off from the open ocean of the Golfo San Esteban by a low-lying marshy moraine. The only outlet from the Laguna is a narrow channel to the north, the Río Témpanos, that connects with the Golfo Elefantes at the head of the fjord system. The Golfo in turn is delimited at its northern end from the main Estero Elefantes by a series of spits and islets. Beyond these, the main fjord varies in width from 3 to 10 km and is fed by several river systems from the mountains to the east, while to the north and west it eventually connects with the open sea through a complex system of channels between the large islands of the Chonos Archipelago. Rainfall in the region is heavy throughout the year, with up to 4000 mm annually (Viviani, 1979; Davenport *et al.*, 1995), and both freshwater runoff and glacial meltwater have a strong local influence, lowering the seawater salinity in the vicinity of the numerous rivers and streams. Mean monthly temperature varies between about 5 and 15°C (Viviani, 1979). The area covered by our survey extends from the Laguna San Rafael to Isla Traiguén, a distance of 120 km. As a result of the physical configuration of the fjord system, three somewhat distinct regions can be distinguished: the Laguna San Rafael, the Golfo Elefantes and the Estero Elefantes (Figure 1). A general description of physical features and marine zonation has been provided by Paterson *et al.* (in press), and here only a short account of the main habitats and molluscan assemblages will be given.

The Laguna San Rafael (technically an estuarine ob) is 80–250 m deep and contains icebergs from the glacier. The shoreline is mainly of rocks and gravel (stations 29, 30; Table 1), moderately sheltered from wave action except in the immediate vicinity of the glacier where waves are produced by calving icebergs. On the shallower and more sheltered northeastern shore there is development of mudflats and some salt marsh (station 31). The salinity is low (15–17‰) and the water column is well mixed (Davenport *et al.*, 1995). Diversity of algae and invertebrates is low, and only three mollusc species were found: *Mytilus edulis chilensis* on boulder shores and in the sublittoral fringe, *Malletia magellanica* in soft sediment to a depth of 10 m and *Chilina patagonica* on mud among saltmarsh vegetation.

The Golfo Elefantes is characterized by increasing salinity (15–21‰ at surface) and moderate wave action. The shoreline of the investigated area (station 25) consisted of low conglomerate cliffs, boulders and semi-sheltered coves of muddy sand. In the littoral zone the diversity of molluscs was low and just four species were abundant on hard substrates: *Perumytilus purpuratus*, *Mytilus edulis chilensis*, *Nacella magellanica* and *Siphonaria lessonii*. The chiton *Plaxiphora aurata* was occasional and *Bankia martensi* common boring in driftwood. Valves of *Mulinia edulis* were found on a beach, suggesting its presence in shallow-water sediments, and living *Aulacomya atra* washed up on the shore indicated a possible subtidal population. Dredging on a bottom of silt and cobbles revealed a community dominated by the brachiopod *Magellania venosa*, and a sparse but more diverse molluscan fauna of 10 species, including the predatory whelks *Trophon plicatus*, *Xymenopsis muriciformis*, *Pareuthria powelli*, and occasional examples of *Leptochiton medinae*, *Iothia coppingeri*, *Margarella violacea*, *Eumetula pulla*, *Lamellaria ampla*, *Malletia magellanica*, and *Venus antiqua*. In the estuary of the Río Gualas (station 26) a heavily silted boulder shore was encrusted with the barnacle *Elminius* and the green alga *Enteromorpha*, and the only living molluscs were *Mytilus edulis chilensis*, *Perumytilus purpuratus* and *Plaxiphora aurata*.

Along the Estero Elefantes (including the southern shores of Isla Traiguén at its northern end) there were a variety of shore types and a wide range of wave-exposures. Surface salinity readings ranged between 5–15‰ in estuaries, 15–22‰ in the southeastern corner of the Estero, and elsewhere approached fully marine conditions (27–33‰). The depth of the Estero varies between 185 and 440 m (with a sill of 150 m at its northern end), with a halocline at 7–8 m and deep salinity of 32‰ (Pickard, 1971). Only here were strongly wave-exposed (stations 16, 17) and moderately wave-exposed (stations 5, 12, 13, 14) rocky shores encountered. A characteristic zonation was developed on such shores which, from the perspective of molluscan distributions, can be summarized as follows. At the upper limit of the eulittoral zone the only mollusc was *Nodilittorina araucana*, abundant on rocks partly encrusted with the red alga *Hildenbrandia*. Below, in the upper mid eulittoral, a band of small barnacles (*Notochthamalus*) was present, sometimes with the algae *Iridaea* and *Porphyra*, and associated molluscs were *Nodilittorina araucana*, *Siphonaria lessonii* and, in the interstices of the barnacles, the minute bivalve *Lasaea miliaris*. The mid and lower eulittoral was generally dominated by dense beds of *Mytilus edulis chilensis*, sometimes together with *Perumytilus purpuratus* in the upper part (especially in more sheltered areas or where freshwater runoff occurred), and (only in the most exposed sites, stations 13, 17) replaced by *Aulacomya atra* in the lowest eulittoral and sublittoral fringe. Other characteristic molluscs of the *Mytilus* belt included *Scurria parasitica* attached to the mussels, the predatory *Acanthina monodon* and the herbivores *Nacella magellanica*, *Tegula atra*, *Fissurella picta* and *Chiton granosus*. On some shores it appeared that density of these grazers was sufficient to produce a narrow bare zone devoid of macroalgal cover in the lowest eulittoral. On exposed shores the rock surfaces in the sublittoral fringe were encrusted by calcareous red algae, sea urchins were abundant, and at the top of this zone clumps of the large barnacle *Austromegabalanus* were frequent. Mollusca of the sublittoral fringe included *Tegula atra*, *Argobuccinum pustulosum ranelliforme* and, in one strongly exposed site (station 16), *Concholepas concholepas*. Sheltered microhabitats on these exposed shores, such as large rock pools and among boulders, harboured a more diverse range of molluscs including the gastropods *Crepidula dilatata*, *Trochita trochiformis*, *Trophon plicatus*, *Pareuthria fuscata*, *P. powelli*, *Nassarius gayii* and *Tritonia challengeriana*, and the chitons *Chaetopleura peruviana*, *Ischnochiton stramineus*, *Chiton magnificus*, *Tonicia atrata* and *T. chilensis*.

In bays and inlets of the Estero Elefantes, relatively sheltered from wave action, both bedrock and boulder shores were dominated by algae (stations 1, 7, 8, 20). In the upper eulittoral zone filamentous algae such as the red *Bostrychia* and green *Enteromorpha* were common, together with barnacles, but replaced in the mid and low eulittoral by large fleshy algae among which the red *Mazzaella* and *Nothogenia* were most abundant. On sheltered shores of this type the limpets *Nacella magellanica*, *Scurria ceciliana* and *Siphonaria lessonii* were common on rock surfaces on the upper shore, and *Diloma nigerrima* beneath boulders. Lower on these shores a diverse assemblage of molluscs occurred among boulders, including *Chiton magnificus*, *Tonicia atrata*, *Plaxiphora aurata*, *Fissurella nigra*, *Tegula atra* and *Acanthina monodon*. In areas of low salinity diversity was reduced (stations 6, 11, 21, 22), and on such shores the molluscan fauna resembled that of corresponding areas of the Golfo Elefantes. As in the Laguna San Rafael, the only molluscs on muddy, estuarine shores of lowest salinity (5‰, station 28) were *Mytilus edulis chilensis* and *Chilina patagonica*. Sedimentary shores with normal salinity were scarce in the Estero Elefantes; only one sheltered sandy bay was examined (station 1). Here the bivalves

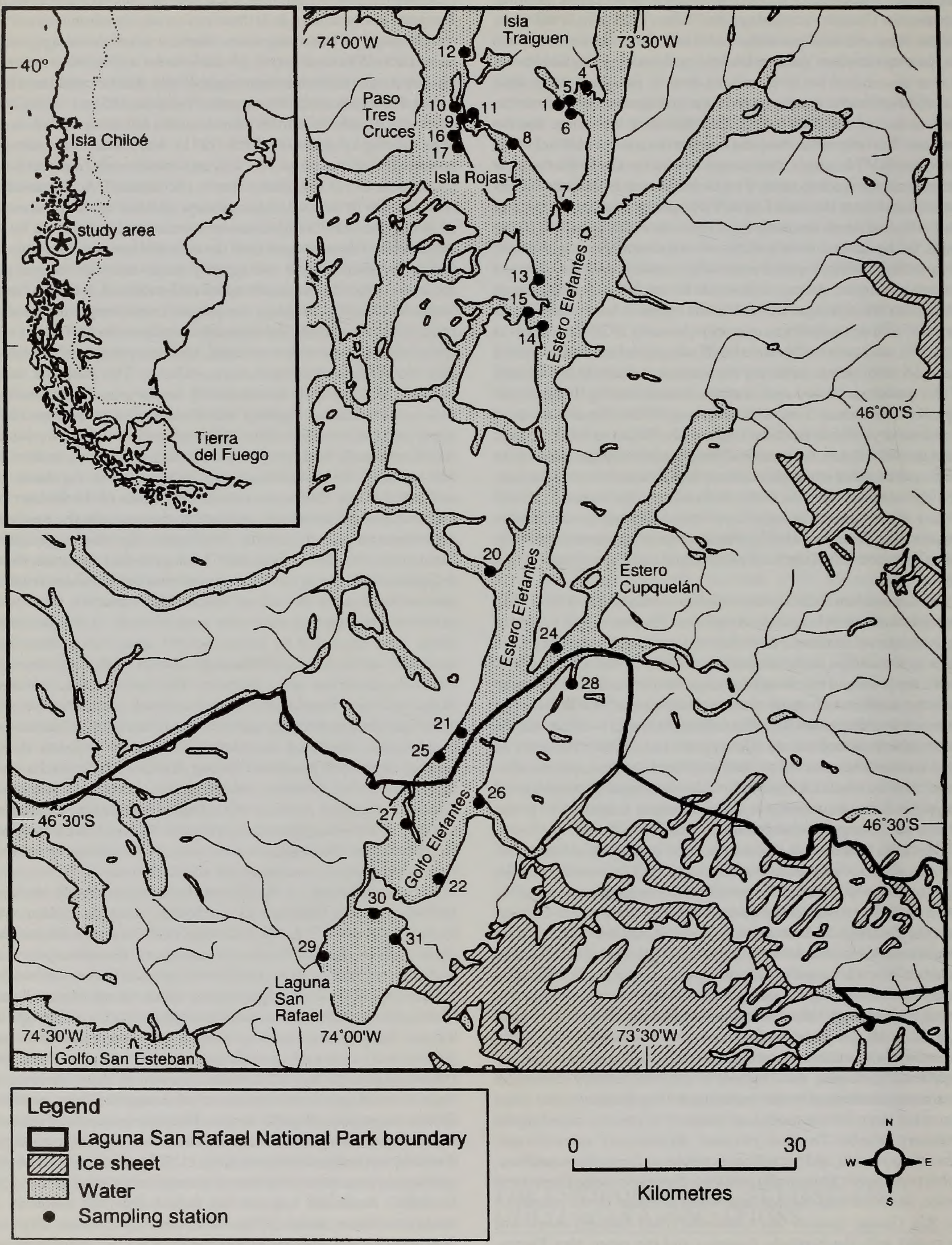


Fig. 1 Survey stations in the Laguna San Rafael, Golfo Elefantes and Estero Elefantes. See Table 1 for coordinates, salinity and temperature data.

Venus antiqua, *Tagelus dombeii* and *Ensis macha* were recorded. On muddy shores of intermediate salinity the bivalve *Mulinia edulis* was frequent (station 20).

Dredging to a depth of 15 m in the Estero Elefantes (stations 1, 9, 14, 22) yielded the most diverse molluscan assemblage encountered during the entire survey, although numbers of individuals were always low. The 25 species found were *Chiton magnificus*, *Tonicia chilensis*, *Ischnochiton pusio*, *Leptochiton medinae*, *Puncturella conica*, *Iothia coppingeri*, *Margarella violacea*, *Homalopoma cunninghami*, *Crepidula dilatata*, *Xymenopsis muriciformis*, *X. subnodosus*, *Pareuthria powelli*, *Glypteuthria meridionalis*, *Nassarius gayii*, *Adelomelon ancilla*, *Nucula pisum*, *Zygochlamys patagonica*, *Felaniella inconspicua*, *Carditella tegulata*, *Carditopsis flabellum*, *Cumingia mutica*, *Venus antiqua*, *Retrotapes exalbidus*, *Tawera gayi* and *Hiatella solida*.

Much of the shore of the Estero Elefantes was fringed by extensive beds of the giant kelp, *Macrocystis pyrifera* (sampled at stations 1, 7, 14, 22), growing from depths of about 10 m. In fully marine situations the laminae of the kelp supported occasional animals of *Nacella mytilina* and *Flabellina falklandica*, while in the holdfasts were found *Fissurella oriens* and *Aulacomya atra*. In conditions of lower salinity in the southern part of the Estero (station 22) the species *Leptochiton medinae*, *Plaxiphora aurata*, *Aulacomya atra* and *Hiatella solida* were present in the holdfasts.

MATERIAL AND METHODS

The majority of the material was collected during intertidal surveys. Sampling was by general collecting and by quantitative transect methods (the results of which will be reported elsewhere). A limited amount of dredging was carried out in depths of up to 15 m, using a small handmade apparatus (aperture 70 by 15 cm, with sacking attached) dragged behind an inflatable boat. Plants of the giant kelp *Macrocystis* were pulled up from depths of up to 10 m, and both holdfasts and laminae examined for molluscs. Searches for micromolluscs were made by washing dredged and hand-collected samples of algae in freshwater, and also by close examination of dredged sediments. Strandlines were searched for dead shells but, unless otherwise noted, all records refer to living specimens. Collections and observations were made at a total of 26 stations (Table 1, Figure 1). Surface salinity and temperature were noted. Material was preserved in 10% seawater formalin and later transferred to 80% ethanol for storage. Duplicate collections are deposited in both the Natural History Museum, London (NHM) and the Museo Nacional de Historia Natural, Santiago (MNHNS). All figured material is in the NHM; registered specimens carry the prefix 'BMNH'.

In the Systematic Descriptions an abbreviated synonymy is given for each species. This includes the reference to the original description, one or more references to the most recent taxonomic accounts that can be consulted for complete synonymies, and significant recent systematic works. References to the key works on the molluscs of the region (Leloup, 1956; Soot-Ryen, 1959; Osorio & Bahamonde, 1970; Dell, 1971; Marincovich, 1973) are provided for all species. Where previous authors have used names other than the ones we consider to be valid, these are usually synonyms; cases of misidentification are indicated by 'not' followed by the original authority of the name. The descriptions and dimensions of shells are based on the present material, with additions from other sources as noted. Dimensions are the greatest linear dimension of the shell, unless otherwise indicated. All figured specimens are from this survey, except for three species in which the material was too fragmentary, in which case specimens from the collection of the NHM have been substituted, as noted. The designation of zones on the shore follows that of Lewis (1964). Records of geographical distribution refer only to the Chilean coast, as far south as Cape Horn, including the Magellan Strait, Tierra del Fuego and the Beagle Channel.

SYSTEMATIC DESCRIPTIONS

Class Polyplacophora

Family **LEPTOCHITONIDAE**

Leptochiton (Leptochiton) medinae (Plate, 1899)

(Figure 6A, C)

Lepidopleurus medinae Plate, 1899: 82–89, pl. 5, figs 204–206. Leloup, 1956: 13–15, fig. 2.
Leptochiton medinae – Kaas & Van Belle, 1998: 122.
Leptochiton (Leptochiton) medinae – Kass & Van Belle, 1985: 80–83, fig. 35, map 37 (synonymy).

DESCRIPTION. Valve area to 10.0 by 6.0 mm, maximum width of girdle 1.1 mm; valves sculptured with numerous fine rows of small granules, arranged longitudinally on central areas, radially on lateral triangles and terminal valves; shell colour cream, often stained with black deposits; girdle fawn, covered with minute, longitudinally grooved, conical spicules (Fig. 6C); gills restricted to posterior part of pallial groove (merobranchial).

HABITAT. Commonly dredged from 3–15 m; in *Macrocystis* holdfasts; on cobbles encrusted with calcareous red algae; on pebbles and shells lying on silt; at salinities down to 15–22‰. This has been recorded as a common sublittoral species in 15–30 m (Dell, 1971; Kaas & Van Belle, 1985), and to a depth of 250–300 m (Leloup, 1956); Dell (1971) also noted one collection from the intertidal *Iridaea* zone.

RECORDS. Stations 7, 22, 25. Elsewhere Puerto Montt to Tierra del Fuego and Magellan Strait (Leloup, 1956; Kaas & Van Belle, 1985). Range: 40–56°S.

REMARKS. This species should not be confused with the similarly small, cream species *Ischnochiton stramineus*, which possesses slitted insertion plates, quincuncial (not longitudinal) granular sculpture and holobranchial gills.

Family **ISCHNOCHITONIDAE**

Chaetopleura (Chaetopleura) peruviana (Lamarck, 1819)

(Figure 2A)

Chiton peruvianus Lamarck, 1819: part 1: 321.
Chaetopleura peruviana – Leloup, 1956: 37–40, figs 18–20. Dall, 1971: 218. Marincovich, 1973: 43–44, fig. 101. Ferreira, 1983: 220–221. Kaas & Van Belle, 1998: 142–143.
Chaetopleura (Chaetopleura) peruviana – Kaas & Van Belle, 1987: 62–64, fig 27, map 11 (synonymy).

DESCRIPTION. Valve area to 49 by 22 mm, maximum width of girdle 11 mm; valves relatively flattened; valves sculptured with radiating rows of fine pustules; shell colour marbled olive brown,

Table 1 List of collecting stations for Mollusca in Laguna San Rafael, Golfo Elefantes, Estero Elefantes and Isla Traiguén, January to February 1998.

Station number	Locality	Coordinates	Surface Salinity (%)	Sea Temp. (ºC)	Survey
1	Bay, E side I. Traiguén	45°38.917'S 73°37.238'W	27	14	S, D, K
4	Midden, E side I. Traiguén	45°38.201'S 73°36.299'W			M
5	Point, E side I. Traiguén	45°38.713'S 73°36.944'W	27		S
6	Bay, E side I. Traiguén	45°39.009'S 73°37.131'W			S
7	Bay, E of Punta Jaime, SE side I. Traiguén	45°45.137'S 73°37.027'W			S, D, K
8	Bay, SE side I. Traiguén	45°41.038'S 73°43.809'W	30		S
9	Midden, SW side I. Traiguén	45°40.162'S 73°47.483'W			S, K, M
10	Midden, S tip I. Acuao, SW side I. Traiguén	45°39.545'S 73°48.272'W	32–33	15	S, M
11	Lagoon, SW side I. Traiguén	45°39.818'S 73°46.738'W	30	15	S, D
12	Islet, W side I. Traiguén, Paso Tres Cruces	45°36.121'S 73°46.982'W	29	14	S
13	Cliff, NE side I. Simpson, Estero Elefantes	45°50.862'S 73°40.375'W			S
14	Islet, NE side I. Huemules, Estero Elefantes	45°55.219'S 73°39.522'W	31		S, D, K
15	Channel between I. Simpson and I. Huemules, Estero Elefantes	45°54.961'S 73°41.044'W	25–30	17	D
16	Cliff, W side I. Rojas, Paso Tres Cruces	45°42.230'S 73°47.686'W			S
17	W side I. Rojas, Paso Tres Cruces	45°42.330'S 73°47.624'W			S
20	Punta Sobenes, S side I. Nalcayec, Estero Elefantes	46°12.125'S 73°44.512'W	10–24	12	S
21	I. Leonor, SW corner of Estero Elefantes	46°23.138'S 73°46.199'W	22	12	S
22	Bay, SE corner of Estero Elefantes	46°23.322'S 73°41.634'W	15–22	12	S, D, K
24	Cliff, SW side Estero Cupquelán	46°17.216'S 73°37.066'W	17	16	S
25	Cove, W side Golfo Elefantes	46°25.134'S 73°48.692'W	21		S, D, K
26	E of Punta Huidobro, Río Gualas, Golfo Elefantes	46°28.270'S 73°44.426'W	21		S
27	I. Observacion, Golfo Elefantes	46°31.543'S 73°51.282'W	15–16	8	S
28	Estuary, Caleta Huillines, Estero Elefantes	46°19.642'S 73°35.983'W	5	12	S
29	W shore, Laguna San Rafael	46°40.120'S 74°00.962'W	15		S, D
30	NE shore, Laguna San Rafael	46°36.601'S 73°54.670'W	14–15	8	S, D
31	Airfield, Laguna San Rafael	46°37S 73°52'W			S

Survey types: D, dredging to 15 m; K, kelp (*Macrocystis*) plants; M, ancient midden site; S, shore survey.

with radiating flecks of black and turquoise; girdle profusely covered with long (to 7 mm), brown, corneous hairs, with dense minute spicules beneath.

HABITAT. Under rocks in lowest eulittoral, on moderately exposed shores. It has been recorded from throughout the tidal zone and to a depth of 40 m (Leloup, 1956; Kaas & Van Belle, 1987). It appears to be scarce on the shores of central and northern Chile (Guiler, 1959a; Marincovich, 1973; Otaíza & Santelices, 1985).

RECORDS. Stations 12, 17. Kaas & Van Belle (1987) gave a range from Cape San Lorenzo (Ecuador) to the Chonos Archipelago, and our records are therefore at the southern extreme. However, Leloup (1956) mentioned occurrence in the Magellan Strait (53°S), but without details. Range: 1–46°S.

REMARKS. Both Kaas & Van Belle (1987) and Ferreira (1983) mentioned that the girdle hairs characteristically protrude from the sutures between the valves, but this was not the case in our material. Dell (1971) also noted the lack of sutural hairs in some specimens from Punta Pulga (42°S), and suggested that this might be due to exposure.

Family **ISCHNOCHITONIDAE**

Ischnochiton (Ischnochiton) stramineus (Sowerby, in Broderip & Sowerby, 1832)

(Figure 6B, D)

Chiton stramineus Sowerby, in Broderip & Sowerby, 1832: 104.
Ischnochiton (Ischnochiton) stramineus – Kaas & Van Belle, 1990: 173–176, fig. 78, map 38 (synonymy).
Ischnochiton stramineus – Kaas & Van Belle, 1998: 178.
Ischnochiton imitator E.A. Smith, 1881 – Leloup, 1956: 42–43, fig. 22.

DESCRIPTION. Valve area to 12.0 by 5.6 mm, maximum width of girdle 1.0 mm; valves rather flattened; lateral triangles not raised or differentiated; sculpture of fine, quincuncially arranged granules; shell colour cream to fawn, sometimes stained with black deposits; girdle cream to fawn, densely covered with short, imbricating scales, each with about 6 ribs, converging towards recurved top of scale (Fig. 6D); gills throughout pallial groove (holobranchial).

HABITAT. Under stones and cobbles resting on silt, in large sheltered rock pool, 0.3–0.5 m below low water of spring tide. Leloup (1956) recorded it throughout the intertidal zone and to a depth of 22 m.

RECORDS. Station 14. Elsewhere from Islay (Peru) to Tierra del Fuego and Magellan Strait (Kaas & Van Belle, 1990). Range: 17–54°S.

REMARKS. Compare with *Leptochiton medinae*.

Ischnochiton (Haploplax) pusio (Sowerby, in Broderip & Sowerby, 1832)

(Figures 2D, 6E)

Chiton pusio Sowerby, in Broderip & Sowerby, 1832: 105.
Ischnochiton pusio – Leloup, 1956: 44–45, fig. 23.
Ischnochiton (Haploplax) pusio – Kaas & Van Belle, 1994: 67–69, fig. 27, map 18 (synonymy). Kaas & Van Belle, 1998: 153–154.

DESCRIPTION. Valve area to 15.7 by 8.4 mm, maximum width of girdle 1.7 mm; valves smooth, very fine quincuncial granulation visible at high magnification; shell colour brown to blackish brown, usually with radiating flecks of white or turquoise; girdle rather wide, brown to black, often banded, covered with relatively large, stout, smooth, glossy, imbricating scales with square base, scales becoming smaller towards inner and outer margins of girdle (Fig. 6E).

HABITAT. Under stones on gravel in shallow tidal channel, just sublittoral; 10–15 m depth in sheltered bay, on substrate of cobbles encrusted with calcareous red algae. This species has been reported to be common intertidally, and to a depth of 90 m (Leloup, 1956; Dell, 1971; Brattström, 1990; Kaas & Van Belle, 1994).

RECORDS. Stations 7, 15. Elsewhere Tumbes (Peru) to Tierra del Fuego (Kaas & Van Belle, 1994). Range: 12–54°S.

REMARKS. This is superficially similar to small specimens of *Chiton magnificus bowenii*, but in that species the valves are glossy, the girdle shows a definite inner zone of smaller scales and the scales do not become smaller at the outer margin.

Family **MOPALIIDAE**

Plaxiphora (Plaxiphora) aurata (Spalowsky, 1795)

(Figure 2B)

Chiton auratus Spalowsky, 1795: 88, pl. 13, figs 6a, b.
Plaxiphora aurata – Leloup, 1956: 25–26. Kaas & Van Belle, 1998: 26.
Plaxiphora (Plaxiphora) aurata – Kaas & Van Belle, 1994: 266–269, fig. 108, maps 5, 28, 41 (synonymy).
Plaxiphora carmichaelis (Gray, 1828) – Ferreira, 1982: 43–45, figs 1–8 (synonymy).

DESCRIPTION. Valve area to 75 by 30 mm, maximum width of girdle 16 mm; valves frequently eroded; jugal and pleural areas smooth; lateral triangles defined by two nodulose radiating ribs, one diagonal and one posterior; shell colour purple black with radiating lines and stripes of pink or turquoise; girdle wide, fleshy, brown, with minute spicules and sparse tufts of long (to 8 mm) corneous hairs, frequently fouled with algae.

HABITAT. On and under rocks in low eulittoral, on sheltered and sometimes muddy shores; in *Macrocystis* holdfasts, 3–5 m depth; tolerant of reduced salinity (range 15–31‰). Leloup (1956) recorded this species from throughout the intertidal zone, Brattström (1990) in its lowest part and Dell (1971) noted it also to a depth of 12 m. At an intertidal estuarine site in Argentina it was reported to occur only on shaded vertical rock walls, reaching densities of 7–12 per m^2 (Lopez-Gappa & Tablado, 1997); in contrast, it was generally scarce in the present study area.

RECORDS. Stations 1, 7, 14, 20, 22, 25, 26. Elsewhere Valparaiso to Tierra del Fuego and Magellan Strait (Leloup, 1956; Dell, 1971; Kaas & Van Belle, 1994), and outside the Chilean region on the subantarctic islands and South Island, New Zealand (Kaas & Van Belle, 1994). Range: 31–54°S.

REMARKS. This and *Leptochiton medinae* were the only chitons to be found in the areas of significantly reduced salinity in the Golfo Elefantes.

Family **CHITONIDAE**

Chiton (Amaurochiton) magnificus bowenii King & Broderip, 1832

(Figures 2C, 6F)

Chiton bowenii King & Broderip, 1832: 338–339. Kaas & Van Belle, 1998: 34.
Chiton (Amaurochiton) magnificus bowenii – Bullock, 1988:165–166, figs 55, 56, 71, 76 (synonymy).
Chiton latus Sowerby, 1825 – Leloup, 1956: 50–54, figs 26, 27 (includes nominate subspecies).

DESCRIPTION. Valve area to 46 by 24 mm, maximum width of girdle 5 mm (total length up to 86 mm, Bullock, 1988); valves flattened to carinate, glossy; jugal and pleural areas smooth; lateral triangles, head and tail valves with indistinct radiating ribs; shell colour entirely black, dark red, orange-pink or blue-grey, often with strong pattern of longitudinal streaks on central region and radial streaks on lateral triangles; girdle black, red or brown, with large, glossy, imbricating scales, the innermost one third of the width of the girdle with slightly smaller and narrower scales than the rest (Fig. 6F).

HABITAT. Common under rocks in lower eulittoral; small juveniles dredged on cobbles at 10–15 m depth; moderately sheltered to exposed coasts. Leloup (1956; as *C. latus*) recorded the species both intertidally and to 2–5 m depth, and Dell (1971; as *C. latus*) mentioned a maximum depth of 13 m. In central Chile the typical subspecies inhabits pools and boulder fields from high to low tide, is larger and more common in exposed localities, but absent from rock walls (Otaíza & Santelices, 1985; as *C. latus*).

RECORDS. Stations 1, 5, 7, 12, 14, 15, 17. Elsewhere I. Chiloé, Magellan Str. and Tierra del Fuego (43–53°S); typical subspecies I. San Lorenzo (Peru) to I. Chiloé (Bullock, 1988) (12–43°S). Total range of species: 12–53°S.

REMARKS. Bullock (1988) distinguished *C. m. bowenii* from the typical northern subspecies by its smooth sculpture, more carinate valves, more elongate outline, brighter coloration and smaller girdle scales. He noted the 'nearly complete geographical isolation of the two', although this is probably a sampling artefact. In Isla Chiloé he reported that both types could be found, together with intermediates, and this appears to question the validity of the subspecific distinction. The present material shares the smooth sculpture, small scales and frequently bright coloration of the southern form, but the valve profile and outline are more variable. Additional material is required to determine whether the subspecies are indeed distinct entities, or if there is a latitudinal cline. The synonymy of the nominate subspecies is complex, and includes *C. striatus* Barnes, 1824, *C. latus* Sowerby, 1825, *C. olivaceus* Frembly, 1827 and *C. subfuscus* Sowerby, 1832 (see Bullock, 1988). Small specimens could be confused with *Ischnochiton pusio*.

Chiton (Chondroplax) granosus Frembly, 1827

(Figure 2J)

Chiton granosus Frembly, 1827: 200–201. Leloup, 1956: 48–50, figs 24, 25. Marincovich, 1973: 43, fig. 98. Osorio, Atria & Mann, 1979: 13, fig. 5. Kaas & Van Belle, 1998: 84.
Chiton (Chondroplax) granosus – Bullock, 1988: 185–187, figs 96, 97, 103, 140, 141, 143, 144.

DESCRIPTION. Valve area to 44 by 25 mm, maximum width of girdle 7 mm (total length up to 80 mm, Osorio *et al.*, 1979); central area with longitudinal striations; lateral triangles, head and tail valves with radiating rows of coarse nodules; valves usually eroded so that sculpture is not visible; shell colour dark brown to black, with broad longitudinal pale stripe on either side of jugal tract, striking even in eroded specimens; girdle with coarse black scales.

HABITAT. In wave-surge gullies and crevices, and on cliffs, in lower eulittoral, on exposed shores. This species is abundant in southern, central and northern Chile, mainly on exposed cliffs in the mid to low intertidal zone (Jara & Moreno, 1984; Otaíza & Santelices, 1985; Brattström, 1990), although it has also been reported from the undersides of rocks (Leloup, 1956; Marincovich, 1973) and at the high tide level (Frembly, 1827; Leloup, 1956; Brattström, 1990).

RECORDS. Stations 12, 13, 17. This extends the known range of Tumbes (Peru) to I. Chiloé (Bullock, 1988). Range: 12–46°S.

REMARKS. This species was found infrequently in the Estero Elefantes, and then only on the most wave-exposed of the sites visited. Moreno & Jaramillo (1983) reported that the main food of *C. granosus* is barnacle larvae.

Tonicia atrata (Sowerby, 1840)

(Figure 2K)

Chiton atratus Sowerby, 1840: 294.
Tonicia atrata – Leloup, 1956: 59–67, figs 31–35 (synonymy). Kaas & Van Belle, 1998: 25 (synonymy).

DESCRIPTION. Valve area to 85 by 30 mm, maximum width of girdle 13 mm; jugal area with deep longitudinal striae; lateral triangles not distinct; entire surface with fine, regular granulation (not evident in large, eroded specimens); mucro of tail valve almost central, post-mucronal slope convex; shell colour purplish black, beaks often pale pink, some specimens with fine concentric lines and irregular radial rays; girdle macroscopically smooth, with microscopic spicules, flesh pink.

HABITAT. Under stones and in pools, in lower eulittoral, on sheltered and moderately sheltered shores. Leloup (1956) and Brattström (1990) also recorded this species from the mid and low eulittoral, and Dell (1971) down to a depth of 10 m.

RECORDS. Stations 1, 5, 7, 12, 14, 15, 20. Elsewhere Puerto Montt to Tierra del Fuego (Leloup, 1956; Dell, 1971). Range: 40–54°S.

REMARKS. Leloup (1956) described the variation in valve form and sculpture in this species; the present specimens correspond with his figures of the synonymous *T. fastigiata* (Sowerby, 1843).

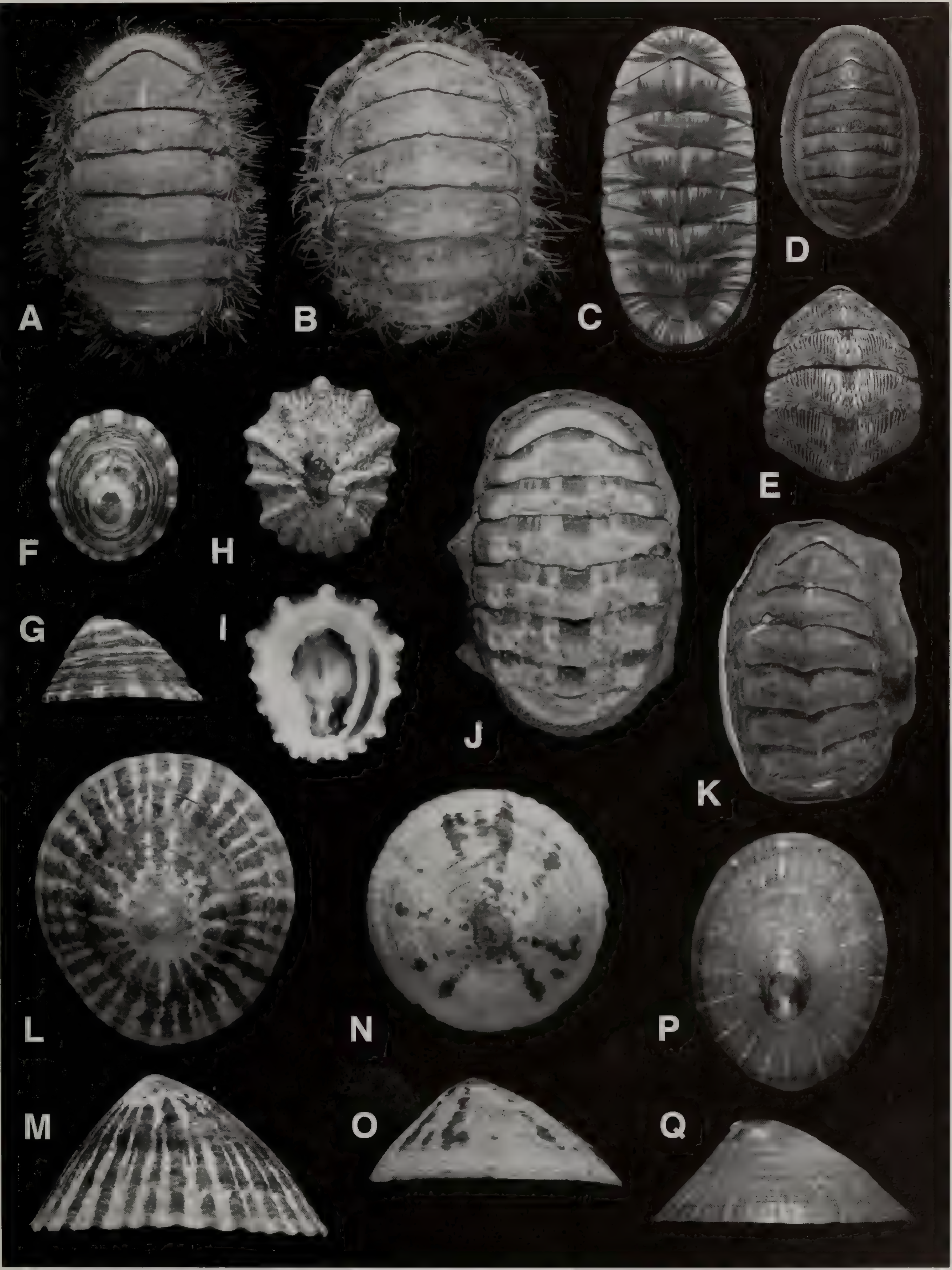
Tonicia chilensis (Frembly, 1827)

(Figure 2E)

Chiton chilensis Frembly, 1827: 204–205.
Tonicia chilensis – Kaas & Van Belle, 1998: 45 (synonymy).
Tonicia elegans (Frembly, 1827) – Leloup, 1956: 69–77, figs 38–46.

DESCRIPTION. Valve area to 37 by 15 mm, maximum width of girdle 6 mm (total length up to 70 mm, Kaas & Van Belle, unpubl.); jugal area with a few longitudinal striae, elsewhere almost smooth;

Fig. 2 **A.** *Chaetopleura (Chaetopleura) peruviana* (44 mm). **B.** *Plaxiphora (Plaxiphora) aurata* (42 mm). **C.** *Chiton (Amaurochiton) magnificus bowenii* (40 mm). **D.** *Ischnochiton (Haploplax) pusio* (14 mm). **E.** *Tonicia chilensis* (20 mm). **F, G.** *Scurria parasitica* (15 mm). **H, I.** *Scurria ceciliana* (19 mm). **J.** *Chiton (Chondroplax) granosus* (43 mm). **K.** *Tonicia atrata* (36 mm). **L, M.** *Nacella (Patinigera) magellanica* (typical form; 40 mm). **N, O.** *Nacella (Patinigera) magellanica* (form *venosa*; 37 mm). **P, Q.** *Nacella (Nacella) mytilina* (32 mm). (All specimens from study area; NHM collection).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lateral triangles often indistinct, but sometimes marked by a raised and nodulose diagonal line, and lateral triangles sometimes bearing small radial pustules; mucro of tail valve near anterior margin, post-mucronal slope concave; shell colour variable, pale pink, orange, pale green or turquoise, with fine red or purple longitudinal and radial lines, or finely marbled pattern; girdle macroscopically smooth, flesh pink.

HABITAT. Under stones in calcareous red algal zone of sublittoral fringe in large, sheltered, rock pool; dredged from 10–15 m in sheltered bay, on substrate of cobbles encrusted with calcareous red algae. At intertidal sites in central Chile this species was also mainly found submerged in pools (Otaíza & Santelices, 1985). Leloup (1956) recorded it from intertidal habitats both sheltered and exposed, and to a depth of 13 m.

RECORDS. Stations 7, 12. Elsewhere Tumbes (Peru) to Tierra del Fuego (Leloup, 1956; Dell, 1971). Range: 12–54°S.

REMARKS. Both colour and sculpture of this species are highly variable, resulting in a complex synonymy. Of the forms differentiated by Leloup (1956), the present specimens correspond with f. *lineolata* (Frembly, 1827), by virtue of their striking colour pattern and mainly smooth valves, although the sculpture sometimes approaches f. *grayii* Sowerby, 1832.

Class Gastropoda

Family **NACELLIDAE**

Nacella (Nacella) mytilina (Helbling, 1779)

(Figure 2P, Q)

Patella mytilina Helbling, 1779: 104–106, pl. 1, figs 5, 6.
Nacella mytilina – Dell, 1971: 201–202 (synonymy). Castellanos & Landoni, 1988: 27, pl. 4, figs 9, 10.
Nacella (Nacella) mytilina – Powell, 1973: 192, pl. 73, fig. 9, pls 173, 174 (synonymy). Ubaldi, 1985: 11–12, 17–18, figs 1–4.

DESCRIPTION. Shell to 32 by 24 mm, height 13 mm; shell thin, translucent; apex one third from anterior edge; surface almost smooth, but with faint radial riblets; horn colour, with radiating white streaks; interior silvery iridescent.

HABITAT. On fronds of *Macrocystis* growing from depth of 10–15 m near shore; rare, only 3 specimens found despite examination of many plants. It is a common member of the epibiotic community on *Macrocystis* further south in the Magellanic region (Castilla, 1985).

RECORDS. Stations 1, 14. Elsewhere I. Wellington, Magellan Strait and Tierra del Fuego (Dell, 1971; Powell, 1973). The present records are the northernmost. Range: 46–55°S.

REMARKS. The shell of this species is highly variable, ranging from semitransparent to moderately solid, and from smooth to ribbed. The position of the apex is also variable; in typical specimens (Powell, 1973: pl. 173, figs 1, 2) it is at the anterior end, whereas in the present material it is at about one third of the shell length from the anterior margin. It is notable that the Nacellidae are presently accorded full familial status in the superfamily Patelloidea (Sasaki, 1998: 208–209).

Nacella (Patinigera) magellanica (Gmelin, 1791)

(Figure 2L–O)

Patella magellanica Gmelin, 1791: 3703.
Patinigera magellanica – Dell, 1971: 204. Osorio, Atria & Mann, 1979: 14–15, fig. 8. Castellanos & Landoni, 1988: 2, pl. 3, figs 1–3.
Nacella (Patinigera) magellanica magellanica – Powell, 1973: 198, pl. 73, figs 14, 15, pl. 178, figs 1, 2 (synonymy).
Patella venosa Reeve, 1854: sp. 18, pl. 10, figs 18 a–c.
Nacella (Patinigera) magellanica venosa – Powell, 1973: 198–199, pl. 180.

DESCRIPTION. Shell to 71 by 63 mm, height 37 mm; shape variable, from smooth, low-conical (height/length 0.32), round (width/length 0.98) (form *venosa*, Fig. 2N, O) to radially ribbed, high-conical (height/length 0.77), oval (width/length 0.87) (typical *magellanica*, Fig. 2L, M); external colour also variable, typically grey with dark brown radial stripes, but form *venosa* may in addition be black, or cream with sparse streaks or chevrons; interior silvery iridescent with exterior pattern showing through, spatula always dark coppery iridescent.

HABITAT. This is an abundant species in a wide range of intertidal rocky habitats, on exposed and moderately sheltered shores, on cliffs and stones, from the lower barnacle zone, through the *Mytilus* zone, to the low water mark. The species does not occur subtidally. On moderately exposed vertical rock faces it is most common in a superficially bare zone between the *Mytilus* zone above, and the calcareous red algal zone below; in this intermediate region other herbivorous molluscs are also common (*Chiton granosus*, *Tegula atra*, *Fissurella picta*), and grazing pressure may maintain the bare rock surface. *Nacella magellanica* was found at stations with salinity down to 15–20‰. Larger specimens were found on open rock surfaces, smaller animals beneath stones and in crevices. After 2–3 days of diurnal low tides and clear sunny weather, animals towards the upper limit of distribution were observed (2–3 Feb. 1998) to suffer heat coma, dropping off the rock and dying. The distribution and density of this species have been studied in the Magellan Strait (Guzman, 1978).

RECORDS. Stations 1, 5, 6, 7, 8, 13, 14, 17, 20, 21, 22, 25. Else-where I. Chiloé to Tierra del Fuego and Magellan Strait (Powell, 1973; Dell, 1971). The northern limit of this species is uncertain. Brattström & Johanssen (1983) mention '*Patinigera deaurata* (Gmelin, 1791)' from six locations between Laguna San Rafael and Seno Reloncaví (41°29'33"S), and mention *P. magellanica* from Valparaíso to the Magellan Strait. Brattström (1990) recorded *N. magellanica* commonly in Seno Reloncaví and listed a single occurrence of *N. aenea* Martyn, 1784 (an invalid name for *N. deaurata*). *N. Nacella deaurata* is a species recognized by Powell (1973), who gave its range as the Magellan Strait, Tierra del Fuego and the Falkland Is.; in the Beagle Channel this species is common intertidally, together with *N. magellanica* (DGR, pers. obs.), but it was not seen in our study area. It seems likely that the records by Brattström & Johanssen (1983) of *deaurata* from the Chilean archipelago arose from misidentification of the ribbed form of *N. magellanica*, and accordingly we assign their record from Seno Reloncaví to that species. The source of their record of *N. magellanica* from Valparaíso is unknown, and we consider this unreliable. Range: 41–55°S.

REMARKS. The systematics of the genus *Nacella* are still somewhat confused. In the most recent monograph, Powell (1973) recognized the smoother, more round and more brightly coloured examples from Isla Chiloé as the geographical subspecies *N. m. venosa*, contrasting these with the more strongly ribbed, taller, more oval shells of the typical forms from the southern part of the range. In the present study the majority of specimens conformed to the northern subspecies (Fig. 2N, O), but at station 25 in the lower salinity (and perhaps colder) environment of the Golfo Elefantes, the shells were mainly of the typical form (Fig. 2L, M). Intermediates appear to connect these two forms and therefore we have not retained the subspecific distinction. *Nacella deaurata* (Gmelin, 1791) was recorded, probably erroneously, from 'Laguna San Rafael' by Brattström & Johanssen (1983; see above); this southern species is a more elongate oval shape, with nodular radial ribs. *Nacella magellanica* was reportedly one of the principal food species of the Fuegian Indians (Osorio *et al.*, 1979), but was not found in the middens on Isla Traiguén.

Family **LEPETIDAE**

Iothia coppingeri (Smith, 1881)

(Figure 7A)

Tectura (Pilidium) coppingeri E.A. Smith, 1881: 35, pl. 4, figs 12, 12a.
Lepeta coppingeri – Castellanos & Landoni, 1988: 32, pl. 1, fig. 6, pl. 3, fig. 9. Linse, 1997: 27.
Iothia coppingeri – Moskalev, 1977: 62–64, figs 5, 6. Dell, 1990: 105–106, figs 185, 186 (synonymy).

DESCRIPTION. Shell to 4.2 by 3.1 mm; delicate, translucent, apex close to anterior end; sculptured by numerous fine, scaly, radial riblets, but sculpture sometimes obsolete; colour usually white, sometimes orange brown, or dark brown with white rays.

HABITAT. 10–15 m depth, on substrates of cobbles encrusted with calcareous red algae, and of cobbles and shell debris on silt. It has been recorded from depths of 5–1108 m (Dell, 1990; Linse, 1997).

RECORDS. Stations 7, 14, 25. Elsewhere Tierra del Fuego and Magellan Strait, and more widely in Falkland Is and circum-Antarctic (Dell, 1990). According to Dell (1990) the northern limits are not well defined, so that our records may be the northernmost for this species. Range: 46–78°S.

Family **LOTTIIDAE**

Scurria ceciliana (d'Orbigny, 1841)

(Figure 2H, I)

Patella ceciliana d'Orbigny, 1841: 482, pl. 81, figs 4–6.
Patelloida ceciliana – Dell, 1971: 199–200 (synonymy).
Collisella ceciliana – Marincovich, 1973: 19–20, fig. 33 (synonymy). Castellanos & Landoni, 1988: 2, pl. 3, figs 10, 11, pl. 4, fig. 2.
Scurria ceciliana – Espoz, Guzmán & Castilla, 1995: 191–197, fig. 3d.

DESCRIPTION. Shell to 20 by 18 mm, height 7 mm; low-conical, apex at one third of shell length from anterior margin; sculptured by 12–15 rounded ribs that crenulate the margin; colour white, with fine black or brown tessellation between ribs, merging into radial lines at margin; interior white or greenish, exterior pattern shows through at margin, spatula irregular, dark brown or of several axial brown streaks.

HABITAT. On surface of rocks with green algae in barnacle zone, in upper eulittoral on moderately sheltered shores. Dell (1971) and Brattström (1990) recorded this species mainly from the mid and upper littoral, but also lower on the shore. In northern Chile, Marincovich (1973) found it in the middle and lower intertidal.

RECORDS. Stations 1, 8. Elsewhere Pucusana (Peru) to Tierra del Fuego and Magellan Strait (Dell, 1971; Marincovich, 1973). Owing to taxonomic confusion in this group (see below), the geographical distribution is uncertain. Provisional range: 12–54°S.

REMARKS. According to Lindberg (1988), the lottiid limpets of Chile are all assigned to the genus *Scurria*. These comprise a poorly known complex of species, much in need of critical revision (contrast the treatments by Dell, 1971; Marincovich, 1973; Ramirez, 1974; Hockey *et al.*, 1987; Espoz *et al.*, 1995). The present form is identified as *S. ceciliana*, since it corresponds with d'Orbigny's (1841) description and figure (the types are lost), and resembles specimens from the type locality in the Falkland Islands (NHM). This species is one of several which, when strongly eroded at the apex, can show a striking mimetic resemblance to a large barnacle. This is achieved by the exposure of the dark brown and streaked shell layers beneath the myostracum, which produces a pattern resembling the tergal and scutal plates of a barnacle (Hockey *et al.*, 1987). Erosion of the shell is facilitated by the lichen *Thelidium litorale* (Espoz *et al.*, 1995). In the present samples of *S. ceciliana* only a few specimens show this erosion pattern, and in these the mimicry is less striking than in *Scurria* species from further north on the Chilean coast.

Scurria parasitica (d'Orbigny, 1841)

(Figure 2F, G)

Patella parasitica d'Orbigny, 1841: 481, pl. 81, figs 1–3.
Scurria parasitica – Marincovich, 1973: 21–22, fig. 37 (synonymy).

DESCRIPTION. Shell to 15 by 13 mm, height 8 mm; high conical to tall cap-shaped, apex at one third of shell length from anterior margin; outline oval to almost round; plane of base often curved to fit shell substrate; radial sculpture weak, of fine striae, often eroded away or obsolete, occasionally developing weak radial ribs; colour variable, often varying in concentric zones on the same shell, usually with 13–20 broad radial white stripes, with brown or black marbled or lineated sectors between; may be uniformly blackish brown, or flecked with white; interior white with irregular brown spatula, external pattern showing through at margin.

HABITAT. On shells of large molluscs (*Nacella, Acanthina, Mytilus*) in eulittoral, on sheltered and moderately exposed shores; also on shell material on eroding edge of large midden. In central and northern Chile the species reaches larger size (29 mm) and inhabits large chitons, *Fissurella* and other *Scurria* species (d'Orbigny, 1841; Marincovich, 1973).

RECORDS. Stations 1, 7, 10, 12, 14. Elsewhere Callao (Peru) (NHM), Chincha Is (Peru) to Talcahuano (Marincovich, 1973), extended southwards by the present records. Range: 12–46°S.

Family **FISSURELLIDAE**

Puncturella (Puncturella) conica (d'Orbigny, 1841)

(Figure 7B)

Rimula conica d'Orbigny, 1841: 471, pl. 78, figs 10, 11.
Puncturella conica – Powell, 1951: 86–87 (synonymy). Powell, 1960: 127. Dell 1971: 178–179, pl. 5, figs 10, 11, 14, 15 (synonymy). Arnaud, 1972: 113–114. Castellanos & Landoni, 1988: 20, pl. 3, fig. 1
Puncturella cognata (Gould, 1852) – Powell, 1951: 86. Linse, 1997: 27.
Puncturella spirigera Thiele, 1912 – Powell, 1960: 127. Dell, 1990: 76, figs 125, 127.

DESCRIPTION. Shell 5.5 by 4.0 mm, height 3.5 mm (to 16 mm in length, Powell, 1951); tall cap-shaped with coiled apex; short longitudinal slit just anterior to shell apex; sculpture of 25 radial ribs made scaly by growth lines, with a smaller riblet in each interspace; white.

HABITAT. Single dead shell dredged in 10–15 m, on substrate of cobbles encrusted with calcareous red algae, near shore in sheltered bay. Dell (1971) recorded the species from 6–20 m in southern Chile, Powell (1951) from 60–342 m, and Dell (1990) to 2804 m in the Ross Sea (if the synonymy with *P. spirigera* is accepted).

RECORDS. Station 7 (single dead shell). Elsewhere I. Chiloé (Dell, 1971) to Magellan Strait, also Falkland Is (Powell, 1951) and perhaps circum-Antarctic (Dell, 1990). Range: 42–75°S.

REMARKS. The taxonomy of the southern species of *P. (Puncturella)* is unclear, and critical revision is required (Dell, 1990). They are closely similar to *P. (P.) noachina* (Linnaeus, 1771) from the northern Pacific and Atlantic Oceans, but are usually regarded as specifically distinct. The single shell found has been compared with the holotype (NHM) from the Falkland Islands, and closely resembles it in size and sculpture, although slightly less acutely conical. Previous authors differ in the number of species recognized in this group, according to their interpretation of differences in shell shape and degrees of sculpture. However, in view of the intraspecific variation in these features described in South African specimens by Herbert & Kilburn (1985), it is possible that only a single species may be involved.

Fissurella (Fissurella) nigra Lesson, 1831

(Figure 3A)

Fissurella nigra Lesson, 1831: 412–413. Osorio, Atria & Mann, 1979: 17, fig. 13. Castellanos & Landoni, 1988: 15, pl. 2, fig. 5. Oliva & Castilla, 1992: fig. 9.

Fissurella (Fissurella) nigra – McLean, 1984: 52–55, figs 200–211 (synonymy).

DESCRIPTION. Shell to 104 by 75 mm, height 40 mm (maximum length 140 mm, Bretos,Quintana & Ibarrola, 1988); outline elongate oval, narrowed anteriorly, base resting flat, foramen slightly anterior of centre; sculpture almost smooth in large shells, except for concentric growth lines, but with numerous fine radial ribs in juveniles; colour purple-black, foramen outlined in white (eroded to reveal inner aragonitic shell layer); interior white, margin (external calcitic layer) of outer black and inner translucent gray zone; head and tentacles black, sides of foot dark grey to black, with a row of small white tubercles.

HABITAT. Common beneath rocks on sheltered and moderately sheltered boulder and rocky shores, in mid to low eulittoral zone. Frequently in groups of up to 7 individuals under a single rock. A similar habitat was reported by McLean (1984), but it can also be found in the immediate subtidal zone (Bretos, Quintana & Ibarrola, 1988).

RECORDS. Stations 1, 7, 14, 15, 20, 21. Elsewhere Valparaíso to I. Navarino (McLean, 1984). Range: 33–55°S.

REMARKS. All the Chilean *Fissurella* species are edible, and the total extraction for 1997 was 3063 tonnes (SERNAP, 1998).

Fissurella (Fissurella) oriens oriens Sowerby, 1835

(Figure 3C)

Fissurella oriens Sowerby, 1835: 124.

Fissurella (Fissurella) oriens oriens – McLean, 1984: 49–52, figs 178–199 (synonymy).

Fissurella oriens oriens – Castellanos & Landoni, 1988: 14, pl. 2, figs 10, 11.

DESCRIPTION. Shell to 54 by 30 mm, height 12 mm (maximum length 70 mm, McLean, 1984); outline more or less narrowly oval, narrowed anteriorly, either sides or ends of shell slightly raised when on flat surface, foramen almost central; sculpture smooth, or with very fine indistinct striae in young shells; colour variable, white to pink, often with broad purple grey rays (not divided into lines), but pattern may be absent; interior white with narrow translucent margin; animal pale, head grey, sides of foot mottled pink and grey, tentacles and mantle margin yellowish.

HABITAT. Under rocks and in rock pools, in lowest eulittoral, on moderately sheltered and moderately exposed shores; juveniles found in holdfasts and on fronds of *Macrocystis*, 10–15 m depth. Unidentified fissurellids made up the major molluscan component of the invertebrate biomass associated with *Macrocystis* holdfasts in the Beagle Channel (Ojeda & Santelices, 1984). McLean (1984) recorded this species from the lower intertidal to 30 m depth.

RECORDS. Stations 1, 5, 9, 14, 17. Elsewhere Valparaíso to Tierra del Fuego, of which specimens north of about 37°S belong to the subspecies *F. o. fulvescens* Sowerby (McLean, 1984). Total range: 33–56°S.

REMARKS. This species is distinguished from the similar *F. picta* by its lack of radial ribs and by its paler, yellowish animal, and occupies a lower and more sheltered habitat. According to the detailed monograph of the Magellanic species of *Fissurella* by McLean (1984), an additional species, *F. radiosa* Lesson, 1831, occurs in the region and, although similar to *F. oriens*, can be distinguished by its strong radial ribs.

Fissurella (Fissurella) picta picta (Gmelin, 1791)

(Figure 3B)

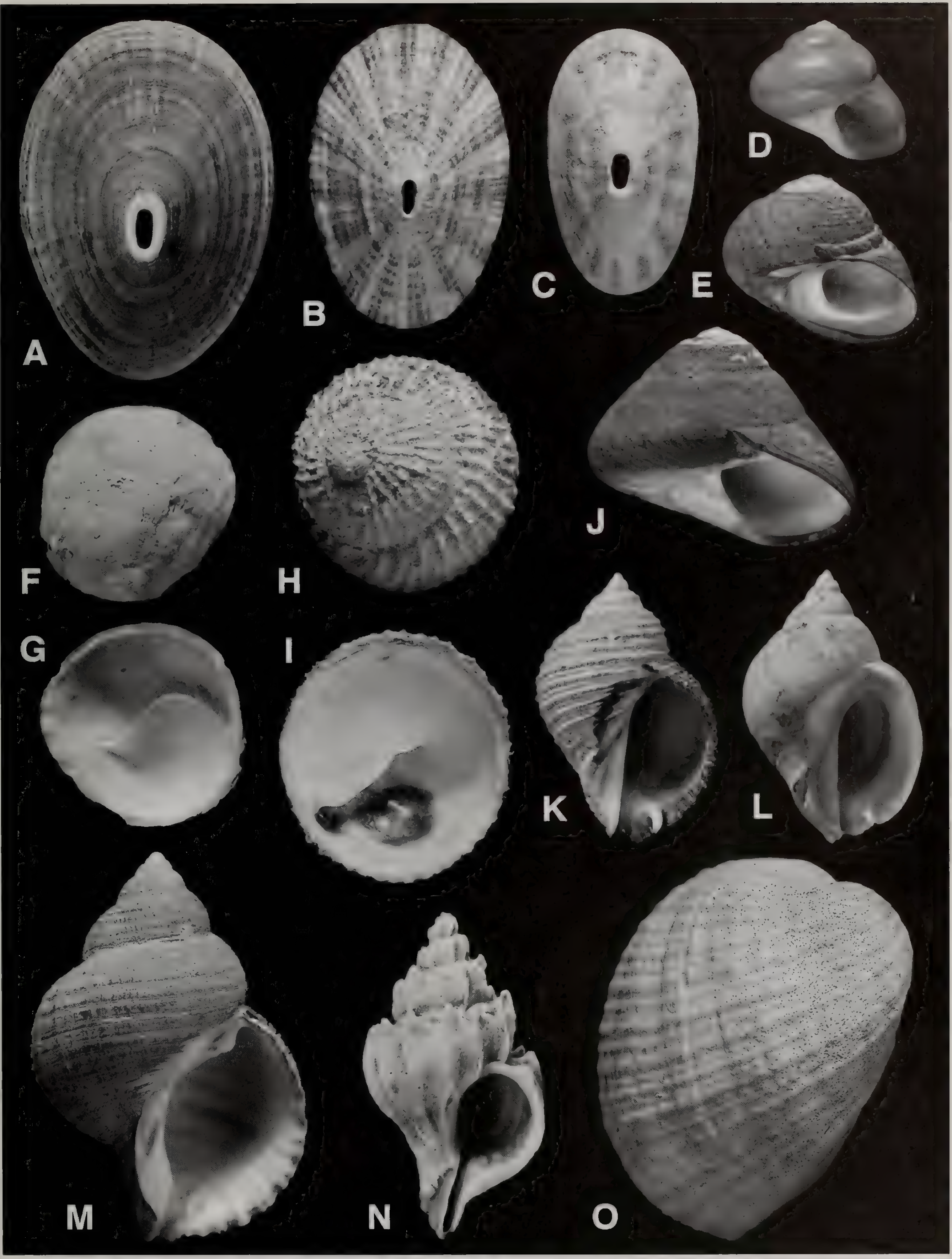
Patella picta Gmelin, 1791: 3729.

Fissurella (Fissurella) picta picta – McLean, 1984: 37–43, figs 123–146 (synonymy).

Fissurella picta – Osorio, Atria & Mann, 1979: 16, fig. 11. Castellanos & Landoni, 1988: 1, pl. 2, figs 3, 4. Oliva & Castilla, 1992: fig. 3.

DESCRIPTION. Shell to 88 by 56 mm, height 32 mm; outline narrowly oval, narrowed anteriorly, sides slightly raised when on flat surface, foramen slightly anterior of centre; sculpture of sharp narrow ribs of varying size, and irregular concentric growth lines; colour white to grey, with broad purple-black rays, each divided into several dark lines; interior white, margin (external calcitic layer)

Fig. 3 **A.** *Fissurella (Fissurella) nigra* (76 mm). **B.** *Fissurella (Fissurella) picta picta* (60 mm). **C.** *Fissurella (Fissurella) oriens oriens* (53 mm). **D.** *Margarella violacea* (7.1 mm). **E.** *Diloma nigerrima* (18 mm). **F, G.** *Crepidula dilatata (sensu lato)* (72 mm). **H, I.** *Trochita trochiformis* (54 mm). **J.** *Tegula (Chlorostoma) atra* (30 mm). **K.** *Acanthina monodon* (form *monodon* from exposed shore at station 14; 46 mm). **L.** *Acanthina monodon* (form *unicornis* from sheltered shore at station 1; 57 mm). **M.** *Argobuccinum (Argobuccinum) pustulosum ranelliforme* (78 mm). **N.** *Trophon plicatus* (51 mm). **O.** *Concholepas concholepas* (94 mm). (All specimens from study area; NHM collection).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showing external rayed pattern; head and tentacles dark grey to black, sides of foot dark grey, densely mottled with white tubercles.

HABITAT. On rock and in crevices, from mid eulittoral *Mytilus* zone to lowest eulittoral, on exposed coasts. Common in superficially bare grazed zone between *Mytilus* zone above and calcareous red algal zone of sublittoral fringe, on moderately exposed cliffs, together with *Nacella magellanica*, *Chiton granosus* and *Tegula atra*. This is an abundant species in southern Chile, reaching densities of 17 per m^2 in areas protected from humans (Jara & Moreno, 1984) and occurring in the mid to low eulittoral on both exposed and sheltered coasts (Bretos, Gutiérrez & Espinoza, 1988; Godoy & Moreno, 1989). It is restricted to the intertidal zone (McLean, 1984).

RECORDS. Stations 5, 9, 13, 14, 17. Elsewhere the species occurs from Valparaíso to Tierra del Fuego, with overlap between the nominate, southern subspecies and the northern *F. p. lata* Sowerby on I. Chiloé (McLean, 1984). Total range: 33–56°S.

REMARKS. This species is the major herbivore of the mid and low shore on exposed rocky coasts in southern Chile, grazing principally on *Iridaea*. It is one of the main species in commercial limpet catches. In the vicinity of human settlements, where collection pressure on this species is strong, algae proliferate on the shore. However, when humans were excluded from a shore near Valdivia the density of *F. picta* increased to 3 per m^2 and algal cover was reduced (Moreno & Jaramillo, 1983; Moreno, Sutherland & Jara, 1984; Duarte, Asencio & Moreno, 1996). On the more remote shores of the present study area the density of *F. picta* remains high in suitable habitats of moderate wave exposure, and grazing pressure by this and other herbivores appears to result in a low eulittoral zone without large macroalgae.

Family **TROCHIDAE**

Tegula (Chlorostoma) atra (Lesson, 1831)

(Figure 3J)

Trochus ater Lesson, 1831: 344, pl. 16, fig. 2, 2'.
Chlorostoma atra – Dell, 1971: 195 (synonymy).
Tegula (Chlorostoma) atra – Marincovich, 1973: 24, fig. 42 (synonymy).
Tegula atra – Osorio, Atria & Mann, 1979: 17–18, fig. 14. Castellanos & Landoni, 1989: 27, pl. 4, fig. 4.

DESCRIPTION. Shell to 39 by 41 mm (to 57 mm, Osorio *et al.*, 1979); trochoidal with rounded periphery; surface smooth; no umbilicus, blunt tooth at base of columella; colour dull purple black above, apex often eroded, base whitish; interior nacreous.

HABITAT. Abundant on rocky shores of sheltered and moderate exposure; on and under cobbles, boulders and on cliffs; mid to low eulittoral, from *Mytilus* zone to zone of calcareous red algae in sublittoral fringe, and an important herbivore of the bare, grazed belt between these two zones on moderately exposed cliffs; rarely sublittoral (one specimen from 7–9 m, station 22); rare at station 22 where salinity was recorded as 15–21‰. In central and northern Chile this species is typical of the *Lessonia* and *Lithothamnion* zone of the sublittoral fringe, on sheltered and moderately exposed coasts (Guiler, 1959a, b; Marincovich, 1973; Ruiz & Giampaoli, 1981).

RECORDS. Stations 1, 5, 7, 8, 10, 12, 14, 15, 17, 20, 21, 22. Elsewhere Pacasmayo (Peru) to Magellan Strait (Marincovich, 1973). Range: 7–54°S.

REMARKS. This is an edible species; the national harvest in 1997 was 159 tonnes (SERNAP, 1998).

Diloma nigerrima (Gmelin, 1791)

(Figure 3E)

Turbo nigerrimus Gmelin, 1791: 3597.
Diloma nigerrima – Dell, 1971: 195–197, pl. 1, fig. 8, pl. 2, fig. 2 (synonymy). Marincovich, 1973: 23–24, fig. 45. Powell, 1979: 53. Castellanos & Landoni, 1989: 29, pl. 4, fig. 6.

DESCRIPTION. Shell to 21 by 19 mm; turbinate; sculptured with indistinct spiral grooves, stronger on spire whorls, strongest groove just below suture; colour dull purple black, including base, apical whorls often eroded to reveal nacre; interior nacreous.

HABITAT. Abundant in clusters beneath stones in upper eulittoral, on moderately sheltered cobble and boulder shores. A similar habitat was noted by Dell (1971) and Brattström (1990) on I. Chiloé, with additional records from the mid and low eulittoral; in northern Chile Marincovich (1973) recorded it in clusters in the lower intertidal zone.

RECORDS. Stations 7, 8. Elsewhere Salaverry (Peru) to Magellan Strait (Marincovich, 1973). The same (Powell, 1979) or a closely related species (Dell, 1971) occurs in New Zealand. Range: 8–54°S.

REMARKS. This species was found at only two stations, where it was abundant and found at levels above those occupied by the superficially similar *Tegula atra*.

Margarella violacea (King & Broderip, 1832)

(Figure 3D)

Margarita violacea King & Broderip, 1832: 346. Sowerby, 1838: 24.
Photinula violacea – Strebel, 1905a: 145–152, pl. 5, figs 1–8, 12, 13.
Margarella violacea – Powell, 1951: 96. Deambrosi, 1969: 51–52, fig. 1 (radula). Dell, 1971: 194 (synonymy). Castellanos & Landoni, 1989: 16, pl. 3, fig. 4.
Promargarita violacea – Dell, 1990: 77–78.

DESCRIPTION. Shell to 6.0 by 6.7 mm (to 10.3 by 11.5 mm, Dell, 1971); trochoidal with rounded whorls, umbilicus minute or closed; surface smooth, shining; colour iridescent violet pink, white around umbilicus; interior nacreous; operculum corneous.

HABITAT. Dredged from 10–15 m depth, on substrates of cobbles with encrusting calcareous red algae, silt with scattered pebbles and shells, and shell gravel. Not common. In the original description it was noted that this species is found on the fronds of *Macrocystis* in the Magellan Strait (King & Broderip, 1832), and it has also been recorded from both fronds (Dell, 1971; Castilla, 1985) and holdfasts (Ojeda & Santelices, 1984) of kelp in the Beagle Channel; it was not found on *Macrocystis* in our survey. Dell (1971) recorded specimens from the intertidal and to a depth of 12 m.

RECORDS. Stations 7, 14, 25. Elsewhere Puerto Eden to Tierra del Fuego, also Falkland Is (Dell, 1971), so that ours are the most northerly records. Range: 46–55°S.

REMARKS. Confusion surrounds the specific identification, generic assignment and relationships of the Magellanic and Antarctic species variously classified in *Margarites*, *Margarita*, *Margarella* and *Promargarita*. The present specimens are smaller and have a slightly lower rate of whorl expansion than the types of the species (NHM) from the Magellan Strait, although shape is evidently variable

(Strebel, 1905a). The bright pink coloration of the shell fades in museum specimens, and this species is then more difficult to separate from the similar *Margarella expansa* (Sowerby, 1838); when fresh, the latter is usually olive in colour, with a vivid green iridescence on the spire whorls, and the shape is lower-spired with a more expanded final whorl (Strebel, 1905a; Powell, 1951). In a revision of the suprageneric classification of trochoideans, Hickman & McLean (1990) used a combination of gill and radular characters to distinguish the Margaritinae (including *Margarites*, mainly from high latitudes of the northern hemisphere) and Gibbulini of the Trochinae (including *Margarella* from southern high latitudes). However, they pointed out that both radular types can be found among the southern species, and that a revision is required. Using a different radular character, Deambrosi (1969) segregated two groups among the southern species, for which the names *Margarella* and *Margarites* were used, although the relationship with northern forms was not addressed. Later, Dell (1990) noted that the type species of *Margarella* in fact belonged to the '*Margarites*' group, and therefore used the next available generic name, *Promargarita*, for the former. Until these relationships are resolved, we have retained the familiar generic name *Margarella*.

Family **TURBINIDAE**

Homalopoma cunninghami (Smith, 1881)

(Figure 7F)

Collonia cunninghami E.A. Smith, 1881: 33, pl. 4, figs 10, 10a.
Homalopoma cunninghami – Dell, 1971: 193–194 (synonymy). Castellanos & Landoni, 1989: 31, pl. 2, fig. 2, pl. 4, fig. 7.

DESCRIPTION. Shell to 3.9 by 4.6 mm; globular; surface with fine spiral grooves, small umbilicus in young shells, becoming closed in adults; colour dark pink to magenta; interior nacreous; operculum calcified externally.

HABITAT. Dredged from 10–15 m depth, on substrates of cobbles with encrusting calcareous red algae, and on pebbles with shell gravel. Recorded from 66 m depth by Powell (1951).

RECORDS. Stations 7, 14. Elsewhere I. Chiloé to Magellan Strait (Dell, 1971) and Tierra del Fuego (Powell, 1951). Range: 43–55°S.

REMARKS. Superficially this species resembles *Margarella violacea*, with which it is found, but is distinguished by its pink (not violet) coloration, spirally striated surface and calcified operculum. The thickness of calcification on the operculum is apparently variable, being thick only at the margin and thinner centrally in the present specimens, although thick over the whole surface in the types (NHM).

Family **LITTORINIDAE**

Nodilittorina araucana (d'Orbigny, 1840)

(Figure 7C)

Littorina araucana d'Orbigny, 1840: 393, pl. 53, figs 8–10.
Littorina (Austrolittorina) araucana – Marincovich, 1973: 25, figs 48, 49 (synonymy).
Nodilittorina (Nodilittorina) araucana – Reid, 1989: 99.

DESCRIPTION. Shell to 12 by 7 mm; tall conical, solid; smooth or with fine spiral lines, but spire whorls usually eroded; colour purple black to purple brown; aperture black with basal white stripe.

HABITAT. Locally abundant, among uppermost barnacles and the crustose red alga *Hildenbrandia* in upper eulittoral on moderately exposed shores. Sometimes on algal rocks, shell midden material and among *Mytilus*, in upper and mid eulittoral on sheltered shores. In central and northern Chile this species is also typical of the upper eulittoral barnacle zone on exposed coasts (Ruiz & Giampaoli, 1981; Santelices, 1991), although Marincovich (1973) observed that, while generally common, it was absent from strongly exposed shores at Iquique. Dell (1971) and Brattström (1990) recorded this species from throughout the littoral zone.

RECORDS. Stations 1, 10, 12, 14. Elsewhere Salaverry (Peru) to I. Chiloé (D.G. Reid, unpublished), Canal Moraleda (45°S; Brattström & Johanssen, 1983), extended southwards by the present records. Range: 8–46°S.

REMARKS. Although very abundant on some shores, this species had an unpredictable occurrence in the Estero Elefantes. The pelagic egg capsules and planktotrophic reproduction of this species were described by Jordan & Ramorino (1975).

Family **CALYPTRAEIDAE**

Crepidula dilatata Lamarck, 1822 [*sensu lato*]

(Figure 3F, G)

Crepidula dilatata Lamarck, 1822: part 2: 25.
Crepipatella dilatata – Marincovich, 1973: 32, fig. 66 (synonymy). Castellanos,1990: 13, pl. 2, fig. 18 a–c.
Crepidula dilatata – Gallardo, 1977: 241–251 (development). Gallardo, 1979: 215–226, fig. 1 (synonymy).
Crepidula dilatata – Hoagland, 1977: 372 (synonymy).
Crepidula fecunda Gallardo, 1979: 215–226, fig. 2.

DESCRIPTION. Shell to 72 mm; irregularly oval to circular; marginal apex, twisted to right side; smooth; colour often entirely white; otherwise pinkish and marked externally with numerous fine radiating lines of purple brown and one central white stripe, interior variously marked with pinkish purple, septum white; animal greyish white, sides of foot, neck, head and mantle margin dark grey to black.

HABITAT. Common in pools and under rocks on rocky shores of moderate exposure; under stones on sand in lower eulittoral of sheltered bay; dredged on shell fragments to 15 m depth (to 18 m, Dell, 1971); on pebbles in shallow tidal channels. Found in maximum abundance densely packed on subtidal rocks at depths of up to 2 m, in entrance of lagoon with strong tidal currents (station 11). At Isla Chiloé Brattström (1990) recorded it commonly in the lower eulittoral zone. This species is a common epibiont on *Aulacomya atra* and large barnacles (Marincovich, 1973; Gallardo, 1979).

RECORDS. Stations 1, 11, 12, 14, 15, 20. Elsewhere I. Lorenzo (Peru) to Punta Arenas (Marincovich, 1973), possibly as far north as Mazatlan (Mexico) (23°N) (Hoagland, 1977). Range: 12–53°S.

REMARKS. Gallardo (1979) has shown that two sibling species can be recognized within this taxon, *C. dilatata s.s.* and *C. fecunda*, on the basis of their larval development. In *C. dilatata s.s.* the veliger larvae develop within the egg capsule, feeding on nurse eggs, and hatch as juveniles, whereas in *C. fecunda* planktonic veligers hatch from the capsule (Gallardo, 1977). Morphologically, the shells and animals of these two species are too similar for reliable identification, although *C. dilatata* is often white with a grey animal, whereas *C. fecunda* has a pink shell of larger size and a more darkly pigmented animal (Gallardo, 1979). No egg capsules were collected during the present survey and the available material displays aspects of both species. The large size attained (72 mm) and the generally black coloration of the animal suggest *C. fecunda*, although the shells are frequently white as in *C. dilatata*. At station 12 it was found that specimens from beneath rocks had white, circular shells and lightly-pigmented, predominantly yellow animals, whereas those from the sides of rock pools had purple, oval shells and black animals; it is not known whether these forms represent the two species. Gallardo (1979) noted that the two were often sympatric in the fjords of southern Chile, but that *C. dilatata* was the more common. Large shells were moderately common in the ancient shell middens on Isla Traiguén.

Trochita trochiformis (Born, 1778)

(Figure 3H, I)

Turbo trochiformis Born, 1778: 355.
Calyptraea (Trochita) trochiformis – Keen, 1971: 456, fig. 804. Marincovich, 1973: 31–32, fig. 65.
Trochita radians (Lamarck, 1822) – Rehder, 1943: 42–43, fig. 1 (synonymy).

DESCRIPTION. Shell to 54 mm; circular with central apex; sculpture of numerous sharp radial ribs; colour white, internally white stained with dark brown; animal unpigmented.

HABITAT. Attached to undersides of stones closely appressed to silty sediment in large tidal pool, in sublittoral fringe, sheltered from wave action, common (station 14); also under stones on moderately exposed rocky shores. In the north of Chile this species lives on wave-exposed coasts (Marincovich, 1973), on both intertidal and subtidal rock substrates (Cañete & Ambler, 1992).

RECORDS. Stations 12, 14. Elsewhere Manta (Ecuador) to Valparaíso (Rehder, 1943; Keen, 1971) and Canal Chacao (41°50'S; Brattström & Johanssen, 1983). The present records extend the confirmed range of this species. In addition, it has been mentioned from Tierra del Fuego and the Magellan Strait (Carcelles & Williamson, 1951), but confusion with the Magellanic species *T. pileus* (Lamarck) is likely. Range: 1–46°S.

REMARKS. The worldwide distribution of the five recognized living *Trochita* species shows a strong association with cold upwelling systems or (in the Magellanic *T. pileus*) with cold currents (Taylor & Smythe, 1985). The present records extend the distribution of *T. trochiformis* considerably beyond the upwelling zones on the Chilean coast, which extend only to 41°S (Brattström & Johanssen, 1983). Another peculiarity of these records is the unexpectedly sheltered microhabitat under stones, and even resting on silt. Elsewhere, this and the two most closely related species, *T. spirata* (Forbes) and *T. dhofarensis* Taylor & Smythe, are found in the low eulittoral and shallow sublittoral on rocky coasts exposed to strong wave action (Marincovich, 1973; Taylor & Smythe, 1985; D.G.Reid pers. obs. in Mexico and Cabo Verde). The intracapsular development of *T. trochiformis* has been described by Cañete & Ambler (1992). This edible species was occasionally found in shell middens on Isla Traiguén.

Family **LAMELLARIIDAE**

Lamellaria ampla Strebel, 1906

Lamellaria ampla Strebel, 1906: 145–146, pl. 11, figs 70, 71. Castellanos, 1990: 27, pl. 1, figs 9, 10.

DESCRIPTION. Animal 12 mm (to 32 mm, Strebel, 1906), shell 9 mm (to 19 mm, Strebel, 1906); shell fragile, transparent, auriculiform with small, low spire and enlarged, oval aperture; shell entirely covered by smooth mantle with oval outline and anterior notch, broadly overlapping the foot; in life mantle is orange yellow with indistinct dark markings; penis with conspicuous lateral flange and small terminal filament.

HABITAT. Single animal dredged from 10–15 m, on bottom of silt with scattered pebbles. Dredged from 40 m in Beagle Channel (Linse, 1997).

RECORDS. Station 25. Elsewhere Beagle Channel (Strebel, 1906; Linse, 1997). Range: 46–55°S.

REMARKS. The identification of this single specimen is tentative, and based on the form of the shell. Of the four species illustrated by Strebel (1906) and one by Smith (1881), *L. ampla* is the only one with a low-spired auriculiform shape as in the present example. However, the form of the penis is somewhat different from that outlined by Strebel (1906: pl. 11, fig. 70C). Marcus (1959: 85–86) listed the names of 12 lamellariids reported from Chile and noted that many were poorly known anatomically; this remains true and a thorough revision is necessary. Members of the genus *Lamellaria* prey upon ascidians.

Family **RANELLIDAE**

Argobuccinum (Argobuccinum) pustulosum ranelliforme (King & Broderip, 1832)

(Figure 3M)

Triton ranelliformis King & Broderip, 1832: 347.
Argobuccinum ranelliforme – Smith, 1970: 462–466, pl. 39, figs 2, 4, 6, 9, pl. 40, figs 2, 6, 7, 10–12, textfigs 2b, 5.
Argobuccinum (Argobuccinum) pustulosum ranelliforme – Beu, 1985a: 56.
Argobuccinum (Argobuccinum) argus – Carcelles, 1954: 244–246, figs 5, 6 (not Gmelin, 1791, which is the nominate subspecies).

DESCRIPTION. Shell to 82 mm; whorls rounded, two indistinct varices per whorl; sculptured by low spiral ribs intersecting with weak axial ribs to produce beaded sculpture, most pronounced on spire whorls, becoming obsolete on last 1–2 whorls; colour cream with chocolate brown ribs, interior white.

HABITAT. Common on beds of *Mytilus* in mid to low eulittoral zone, and in zone of coralline red algae in sublittoral fringe, on shores of moderate to strong wave exposure.

RECORDS. Stations 5, 14, 17. Elsewhere Caldera to Tierra del Fuego (Carcelles, 1954; Smith, 1970). Range: 27–55°S.

REMARKS. This is a large, edible species, of which 277 tonnes were collected nationally in 1997 (SERNAP, 1998). The diet consists of crustaceans and echinoids (Smith, 1970), and the egg capsules of the nominate subspecies from South Africa have been described (Kilburn & Rippey, 1982: 75–76).

Family **CERITHIOPSIDAE**

Eumetula pulla (Philippi, 1845)

(Figure 7D)

Cerithium pullum Philippi, 1845: 66–67. Strebel, 1905b: 652–655, pl. 23, fig. 40a–d.
Ataxocerithium pullum – Powell, 1951: 111–112, fig. I, no. 34

(radula), fig. N, no. 102 (protoconch) (synonymy). Castellanos, 1990: 8, pl. 2, figs 18, 21.
Eumetula pulla – Bouchet & Warén, 1993: 601.

DESCRIPTION. Shell to 8.8 by 3.5 mm (to 13 mm, Castellanos, 1990); narrowly elongate, thin-walled; spire whorls encircled by three spiral rows of square nodules, aligned in axial rows, two spiral ribs lacking nodules below periphery of last whorl; colour brown, spiral rows of nodules darker.

HABITAT. Dredged from 10–15 m depth, on substrate of silt with scattered pebbles and shells; uncommon. The species has been reported from depths of 8 to 251–313 m (Powell, 1951). Other members of the genus are known to live and feed on sponges, as do most cerithiopsids (Houbrick, 1987), and this may be the typical habitat of *E. pulla* also; one collection 'in sponge' was noted by Melvill & Standen (1912).

RECORDS. Station 25 (1 dead, 2 live specimens). Elsewhere Magellan Strait, Falkland Is and Burdwood Bank (Powell, 1951), so that our records are the northernmost. Range: 46–54°S.

REMARKS. The more familiar genus *Ataxocerithium* has usually been classified in the Cerithiidae, but was transferred to the Cerithiopsidae by Houbrick (1987). Bouchet & Warén (1993) transferred this species to the cerithiopsid genus *Eumetula* on the basis of radular characters.

Family **MURICIDAE**

Concholepas concholepas (Bruguière, 1789)

(Figure 3O)

Buccinum concholepas Bruguière, 1789: 252.
Concholepas concholepas – Beu, 1970: 44, pl. 4, figs 10–12. Dell, 1971: 210–211. Marincovich, 1973: 35, fig. 73. Osorio, Atria & Mann, 1979: 21–22, fig. 23. Kool, 1993: 173–176, fig. 7A–F. DeVries, 1995: 286, figs 4, 6, 8, 9, 11, 19 (synonymy).
Concholepas concholepas concholepas – Stuardo, 1979: 5–38, pl. 1, figs 1–8, pl. 3, figs 17, 23 (synonymy).

DESCRIPTION. Shell to 108 mm; body whorl greatly expanded to produce limpet-like form; sculptured by coarse spiral ribs, imbricated by raised axial growth lines; colour brown, interior white with brown margin.

HABITAT. In rock crevices at top of calcareous red algal zone, lowest eulittoral, on strongly exposed coast. In central Chile and further north, adult populations are mainly subtidal, reaching depths of 40 m (Rabí, Yamashiro & Quiroz, 1996), but the rarity of adults in the littoral zone appears to be a consequence of exploitation by humans. In reserves where this is prevented, large adults appear in the littoral zone and density may increase to as many as 1.6–4.3 per m^2 (Castilla & Durán, 1985; Moreno, Lunecke & Lepez, 1986; Durán, Castilla & Oliva, 1987). Settlement occurs in the low eulittoral, and juveniles move upwards as growth occurs (Moreno, Reyes & Asencio, 1993).

RECORDS. Station 16. Elsewhere I. Lobos de Afuera (Peru) to Cape Horn (DeVries, 1995). Range: 7–55°S.

REMARKS. This large species supports the most important gastropod fishery in Chile (Castilla, 1982); the catch has declined from 21236 tonnes in 1987 to 3154 tonnes in 1997 (SERNAP, 1998) and collection is now permitted for only a few days in the year. It is a common component of the ancient shell middens on Isla Traiguén. Collection by fishermen continues in the study area, but the intensity of exploitation is not known, nor to what extent this might influence the absence of this species from the more accessible coasts of moderate exposure. The egg capsules are cylindrical and stalked, 25 mm long; these have been described by Castilla & Cancino (1976) and the planktotrophic development of the larvae by DiSalvo (1988). This carnivorous species has a diet of barnacles, the ascidian *Pyura*, *Perumytilus* and other molluscs (Castilla, Guisado & Cancino, 1979; Castilla & Durán, 1985) and is able to bore into its shelled prey (Gruber & Carriker, 1990). As a top predator it has an important influence on community structure, and where human collection is prevented the cover of barnacles and *Perumytilus* declines significantly (Moreno, Lunecke & Lepez, 1986). There is a large literature on this species, reviewed by Rabí, Yamashiro & Quiroz (1996). The taxonomic status of the population on the Juan Fernández Islands, described as the subspecies *C. concholepas fernandezianus* Stuardo, 1979, requires investigation.

Acanthina monodon (Pallas, 1774)

(Figure 3K, L)

Buccinum monodon Pallas, 1774: 33, pl. 3, figs 3, 4.
Acanthina monodon – Dell, 1971: 208–210 (synonymy). Cernohorsky, 1977: 118 (synonymy). Osorio, Atria & Mann, 1979: 21, fig. 21.
Acanthina monodon monodon – Wu, 1985: 56–58, figs 13, 14, 24, 34, 52–58, 71 (radula, anatomy). Vermeij, 1993: 22.
Acanthina monodon unicornis (Bruguière, 1789) – Vermeij, 1993: 22.
Acanthina crassilabrum (Lamarck, 1816) – Dell, 1971: 210 (synonymy).
Acanthina monodon crassilabrum – Wu, 1985: 58–61, figs 15–17, 23, 35–37, 50, 51, 59, 71 (radula, anatomy).

DESCRIPTION. Shell to 57 mm; whorls rounded, spire pointed; usually sculptured by 20–30 raised spiral cords, often imbricated by raised axial growth lines; sculpture may be obsolete on body whorl, or eroded; outer apertural lip sharp, or thickened and with internal denticles, always with labral spine near anterior end of outer lip; colour polymorphic: purple brown, white, orange or banded with brown.

HABITAT. Eulittoral rocky shores, in lower barnacle zone and *Mytilus* zone, in exposed and moderately sheltered situations. Found at salinities down to 15 and 22‰.

RECORDS. Stations 1, 5, 7, 10, 12, 14, 15, 17, 20, 21, 22. Elsewhere from about 22°S to Magellan Strait (Dell, 1971) and Tierra del Fuego (Wu, 1985). Range: 22–55°S.

REMARKS. This was one of the most frequent intertidal gastropods in the study area. Members of this species are carnivorous, and small mussels are a major component of the diet (Moreno, 1995). The related Californian genus *Acanthinucella* feeds mainly on barnacles, which are attacked either by using the labral spine to prise or wedge open the opercular valves before inserting the proboscis, or alternatively by boring through the valves by means of the accessory boring organ and radula (Malusa, 1985; Perry, 1985). The egg capsules are small and flask-shaped, 15 mm in length, and laid in batches in crevices on the shore (Wu, 1985: figs 52, 53). The shell is remarkably variable in shape and sculpture, showing a much thicker, smoother shell with narrower aperture and stronger marginal denticles (Fig. 3L) in sheltered habitats, in contrast to a thinner, scaly shell in exposed situations (Fig. 3K). Similar variation occurs over a geographical scale, and some authors have distinguished a relatively smooth, northern species or subspecies *A. m. unicornis* (Bruguière, 1789) (= *A. crassilabrum*) from the typical southern *A. m. monodon* with scaly spiral cords, thinner shell and wider aperture (Dell, 1971; Wu, 1985; Vermeij, 1993). The two forms are said to overlap between 40 and 44°S and have been recorded sympatrically (Dell,1971; Wu, 1985), although characters evidently intergrade in this region (Cernohorsky, 1977; Wu, 1985). The present samples extend the geographical range of this overlap; both shape and sculpture vary such that no clear distinction can usefully be made on the basis of these characters, and the two forms are provisionally regarded as conspecific until more evidence becomes available. As in the similar ocenebrine muricid *Nucella* (e.g. Palmer, 1990), shell form might be a functional phenotypic response to the presence of crab predators, from which the snails are at greater risk on shores protected from wave action. Possible correlation of shell form with abundance of predatory crabs on local and geographical scales has not been investigated in *A. monodon*. However, it is notable that several intertidal *Littorina* species in the northern Atlantic show analogous variation in shell characters over a geographical scale, with thin-shelled forms present only at high latitudes where predatory crabs are rare or absent, producing a stepped cline (Reid, 1996).

Trophon plicatus (Lightfoot, 1786)

(Figure 3N)

Trophon laciniatus (Martyn, 1784) – Strebel, 1904: 199–203, pl. 3, figs 1–8 (non-binominal and therefore unavailable name).
Trophon (Stramonitrophon) laciniatus (Martyn, 1784) – Powell, 1951: 156.
Murex plicatus Lightfoot, 1786: 104.
Trophon plicatus – Cernohorsky, 1977: 117, fig. 18.
Trophon (Stramonitrophon) plicatus – Castellanos & Landoni, 1993: 5, pl. 1, figs 16–22.
Trophon (Stramonitrophon) lamellosa (Gmelin, 1791) – Dell, 1971: 212 (synonymy).

DESCRIPTION. Shell to 54 mm; fusiform with rounded whorls; sculptured by prominent, lamellose varices (10–15 on last whorl), each produced to a point on shoulder; colour white, eroded to purplish grey, interior purple.

HABITAT. In sheltered tidal pool, just sublittoral, under stones on silt; in rock pool with *Mytilus* in low eulittoral on moderately exposed shore (station 14); dredged from 10–15 m on bottom of silt with scattered pebbles and shells (station 25). To 88 m depth (Powell, 1951).

RECORDS. Stations 14, 25. Elsewhere above 49°S to Tierra del Fuego (Dell, 1971), extended northward by the present records. Range: 46–54°S.

REMARKS. The brachiopod *Magellania venosa* was abundant in the dredge samples from station 25, in which both this species and *Xymenopsis muriciformis* occurred. A few of the brachiopods showed boreholes in their shells, which may have been drilled by one or other of these two muricids.

Xymenopsis muriciformis (King & Broderip, 1832)

(Figure 4A)

Buccinum muriciforme King & Broderip, 1832: 348.
Xymenopsis muriciformis – Dell, 1972: 38–39, figs 31, 32 (synonymy). Cernohorsky, 1977: 118 (synonymy). Castellanos & Landoni, 1993: 16, pl. 3, figs 39, 40. Pastorino & Harasewych, 2000: 43–52, figs 1–42, 45–49, 83–95, 105–106 (synonymy).
Xymenopsis decolor (Philippi, 1845) – Dell, 1971: 212–213.
Xymenopsis liratus (Gould, 1849) – Powell, 1951: 158–159.

DESCRIPTION. Shell to 26 mm; elongate fusiform, with rounded whorls; sculptured by 13–15 rounded axial ribs, crossed by regularly spaced incised lines (14–18 on last whorl); apertural lip not thickened; colour white to purplish grey, interior white to purple.

HABITAT. Dredged from 7–15 m, on bottoms of gravel, or cobbles on silt with brachiopods. Dell (1971) recorded this species from the sublittoral to 18 m, and Powell (1951) from 17–170 m off the Falkland Islands.

RECORDS. Stations 14, 22, 25. According to Dell (1971), from about 45°S to Tierra del Fuego. Range: 45–54°S.

REMARKS. This genus shows a confusing diversity of shape and sculpture. Strebel (1904) recognized an improbable 22 species in his '*Trophon decolor*' group. This genus has recently been revised by Pastorino & Harasewych (2000).

Xymenopsis subnodosus (Gray, 1839)

(Figure 4B)

Buccinum subnodosa Gray, 1839: 118.
Xymenopsis subnodosus – Pastorino & Harasewych, 2000: 55–56, figs 96–103, 106.
Fusus cancellinus Philippi, 1845: 67. Philippi, 1846: 117–118, *Fusus* pl. 3, fig. 2.
Xymenopsis cancellinus – Powell, 1951: 158.

DESCRIPTION. Shell 23 mm; elongate fusiform with shouldered whorls; sculptured with rounded axial ribs (10 on last whorl), crossed by close-set spiral cords, alternately large and small (24 on last whorl); outer apertural lip thickened and denticulate within; colour whitish, anterior canal tinged purple.

HABITAT. Single shell dredged from 5–15 m in sheltered bay, on substrate of cobbles and shells.

RECORDS. Station 1. The type locality of *F. cancellinus* is the Magellan Strait (Philippi, 1845). Range: 46–54°S.

REMARKS. Besides the holotype of Philippi's *F. cancellinus*, this is the only specimen known (Pastorino & Harasewych, 2000). The denticulate lip is unlike other members of the genus.

Family **BUCCINIDAE**

Pareuthria fuscata (Bruguière, 1789)

(Figure 4C)

Buccinum fuscatum Bruguière, 1789: 282.
Pareuthria fuscata – Powell, 1951: 132 (synonymy).
Pareuthria plumbea (Philippi, 1844) – Powell, 1951: 133. Dell, 1971: 207–208 (synonymy). Castellanos, 1992: 13, pl. 3, fig. 37.
Pareuthria magellanica (Philippi, 1848) – Powell, 1951: 133 (synonymy).

DESCRIPTION. Shell to 30 mm; elongate fusiform; spire whorls sculptured with low, rounded axial ribs, becoming obsolete on last 1–2 whorls, otherwise smooth, but sometimes with indistinct spiral striae; aperture becoming somewhat thickened and lirate within in largest specimens; colour dark bluish or purplish grey, aperture purple.

HABITAT. Common in rock pools in *Mytilus* zone, among holdfasts, under stones and in shell gravel, on moderately exposed shores; also under stones on silt, in sheltered tidal pool, just sublittoral. Previous authors have recorded this species mainly from the lower eulittoral and shallow subtidal, but occasionally from depths of up to 16 m (Powell, 1951) or 40 m (Strebel, 1905a). It was found in a survey of *Macrocystis* holdfasts in the Beagle Channel (Ojeda & Santelices, 1984).

RECORDS. Stations 5, 12, 14. Elsewhere I. Chiloé to Magellan Strait and Tierra del Fuego (Strebel, 1905b); Dell (1971) records this species only as far north as 49°S. Range: 43–55°S.

REMARKS. The development of the axial ribs is variable, some examples being almost smooth, and both Strebel (1905b) and Powell (1951) distinguished three species on the basis of shell characters. A critical revision is required to confirm whether these are but forms of a single species (Dell, 1971).

Pareuthria powelli Cernohorsky, 1977

(Figure 4D)

Pareuthria rosea (Hombron & Jacquinot, 1854) – Powell, 1951: 133. Dell, 1971: 206–207 (synonymy) (junior primary homonym of *Fusus roseus* Anton, 1838).
Pareuthria scalaris (Watson, 1882) – Powell, 1951: 134 (synonymy). Cernohorsky, 1977: 109 (synonymy) (junior primary homonym of *Fusus scalaris* Lamarck, 1816).
Pareuthria powelli Cernohorsky, 1977: 109, fig. 5 (synonymy).

DESCRIPTION. Shell to 17 mm; elongate fusiform; sculptured with rounded axial ribs (9–12 on last whorl), crossed by fine spiral ribs (about 21 on last whorl) becoming finer and sometimes obsolete towards suture; apertural lip thin or (in thick-shelled specimens) slightly thickened and indistinctly denticulate within; colour pinkish purple or white.

HABITAT. Under stones on silt, in sheltered tidal pool, just sublittoral; dredged from 7–9 and 10–15 m, on bottom of silt with pebbles and shells, and on cobbles with encrusting calcareous algae. Recorded from depths of up to 201 m (Powell, 1951).

RECORDS. Stations 7, 14, 22, 25. Elsewhere from 47°48'S in northwest Patagonia (Watson, 1886: 203), 49°S to Magellan Strait (Dell, 1971) and Tierra del Fuego (Strebel, 1905b), so that the present records are the most northerly. Range: 46–55°S.

REMARKS. The synonymy above follows Cernohorsky (1977). If this is correct, this is a variable species in shell thickness, prominence of sculpture, elongation of spire and colour, but a critical reappraisal based on more material is necessary. Although somewhat eroded, the protoconch of the present specimens appears to be only about two-thirds of the size of that of shells from the area between the Falkland Islands and Patagonia.

Glypteuthria meridionalis (Smith, 1881)

(Figure 7E)

Euthria meridionalis E.A. Smith, 1881: 29–30, pl. 4, fig. 6.
Euthria (Glypteuthria) meridionalis – Strebel, 1905b: 627–629, pl. 21, fig 11, 11a–d.
Glypteuthria meridionalis – Powell, 1951: 138. Dell, 1972: 36, fig. 10 (synonymy). Castellanos, 1992: 19, pl. 1, fig. 11.

DESCRIPTION. Shell 6.2 mm (to 9 mm, Smith, 1881); narrowly fusiform; sculptured with rounded axial ribs (14 on last whorl), crossed by spiral grooves (about 13 on last whorl); apertural lip slightly thickened and smooth within; colour whitish.

HABITAT. Single specimen dredged from 10 m, on bottom of cobbles, gravel and shells. To 38 m (Powell, 1951).

RECORDS. Station 14. Elsewhere recorded only to the south from Portland Bay, St Andrew's Sound to Magellan Strait (Smith, 1881) and Tierra del Fuego (Strebel, 1905b). Range: 46–55°S.

Family **NASSARIIDAE**

Nassarius gayii (Kiener, 1834)

(Figure 4E)

Buccinum gayii Kiener, 1834: 71–72, pl. 21, fig. 79.
Nassarius gayi – Marincovich, 1973: 37, fig. 80. Castellanos, 1992: 23, pl. 2, fig. 18.
Nassarius gayii – Cernohorsky, 1975: 141–143, figs 44–49 (synonymy). Cernohorsky, 1984: 34 (synonymy).

DESCRIPTION. Shell to 14 mm; broadly fusiform; sculptured with axial ribs, becoming obsolete at end of last whorl, crossed by flat spiral ribs (10–11 on last whorl), forming low nodules at their intersections; apertural lip thickened and lirate within; colour pale brown with dark brown spiral ribs, aperture white with brown margin.

HABITAT. Among *Mytilus* holdfasts and on shell gravel, in rock pools in low eulittoral on moderately exposed shores; more commonly dredged from 6–15 m, on bottoms of cobbles encrusted with calcareous algae, on gravel, and on silt with shell fragments. At Iquique in northern Chile Marincovich (1973) recorded this species from the middle and lower intertidal, on the undersides of rocks in gravel. At Isla Chiloé Brattström (1990) found it commonly in the lower eulittoral zone.

RECORDS. Stations 1, 5, 7, 11, 12, 14. Elsewhere I. Lobos de Afuera (Peru) (Marincovich, 1973) to Puerto Rosario and Bahía Tom (50°S, Smith, 1881) and Magellan Strait (Dall, 1909). The southern limit is unclear; the species was common around 46°S in the present study, Smith (1881) recorded seven immature specimens (as '*Nassa taeniolata* Philippi, 1845') from 50°S, and Dall (1909) stated that the species ranged to the Magellan Strait (54°S), yet Dell (1971) did not record it in extensive collections between 42 and 55°S. Range: 7–54°S.

Family **VOLUTIDAE**

Adelomelon ancilla (Lightfoot, 1786)

(Figure 4F, M)

Voluta ancilla Lightfoot, 1786: 137.
Adelomelon ancilla – Powell, 1951: 160–163. Castellanos & Landoni, 1992: 8, pl. 1, fig. 1. Poppe & Goto, 1992: 21, 109–110, pl. 35 (in part).
Adelomelon (Adelomelon) ancilla – Clench & Turner, 1964: 152–154, pls 82, 83, 92–94 (synonymy, radula). Weaver & duPont,

1970: 102–103, fig. 20a–c, n, pl. 42A–C (synonymy). Osorio, Atria & Mann, 1979: 19–20, fig. 19.

DESCRIPTION. Shell to 186 mm (Clench & Turner, 1964); large, fusiform, with long narrow aperture; sculpture usually smooth but for very fine growth lines, but apical whorls may bear fine spiral striae and longitudinal ribs; apertural lip smooth, only slightly thickened, columella with 2–4 sharp folds; colour cream with sparse longitudinal zigzag brown lines, dark brown when covered by periostracum, interior pale orange.

HABITAT. 0–172 m (Powell, 1951), on sand bottoms to 310 m (Poppe & Goto, 1992). The single dead shell in the present material was dredged from 10 m on a gravel bottom.

RECORDS. Station 14. Elsewhere Magellan Strait to Falkland Islands and southern Brasil (Clench & Turner, 1964), I. Chiloé (M.G. Harasewych, pers. comm.). Range: 42–54°S.

REMARKS. This species is represented in the present collection by a single dead shell, a small juvenile of 18 mm (Fig. 4F), clearly assigned to the Volutidae by the large protoconch (with evidence of a pointed calcarella, see Clench & Turner, 1964: pl. 93) 5.2 mm in diameter. Identification to species has been based on the relatively narrow first whorl of the teleoconch (indicating a tall narrow spire) and on the teleoconch sculpture of spiral striae and slight axial folds. Many specimens of *A. ancilla* are smooth at the apex, but this sculptured form was described by Strebel (1906) as *Voluta martensi*, subsequently synonymized by Clench & Turner (1964). An adult shell of *A. ancilla* from the Falkland Islands is illustrated in Figure 4M. The taxonomy of this complex of large Magellanic volutes remains confused. Powell (1951) pointed out the similarity of the shells of *A. ancilla* and *A. magellanica* (Gmelin, 1791) and regarded them as extremes of a single variable species. However, Clench & Turner (1964) figured two very different radulae, and on this basis transferred the latter to the new genus *Odontocymbiola*, distinct at subfamilial level. Characters of the shell were not entirely diagnostic, but that of *O. magellanica* was said to be broader and more solid, and the protoconch apparently larger. This treatment was followed by Weaver & duPont (1970). However, in the most recent monograph of the family, Poppe & Goto (1992: 21, 109–110) have rejected the evidence of the radular differences, and on the basis of shell characters have synonymized these two, together with *A. paradoxa* (Lahille, 1895). Clearly, additional anatomical information is required to resolve this problem. The egg capsules are attached to hard substrates; one illustrated by Strebel (1906: pl. 10, fig. 52) is domed, 53 mm in diameter and contains seven embryonic shells up to 14 mm in length; capsule and embryos have also been figured by Carcelles (1944: pl. 3, figs 35–38).

Family **TRITONIIDAE**

Tritonia challengeriana Bergh, 1884

Tritonia challengeriana Bergh, 1884: 45–47, pl. 11, figs 16–19, pl. 12, figs 1–8 (anatomy, radula). Schrödl, 1996: 35, pl. 6, fig. 39 (synonymy).

DESCRIPTION. Animal up to 35 mm; oral veil with finger-like processes; rhinophores with basal sheaths; body approximately quadrilateral in cross section, along each lateral angle the mantle forms a row of 15–21 branched pallial gills; colour white.

HABITAT. Among and beneath stones in pools in lowest eulittoral, at top of red algal zone, on moderately sheltered shore. Recorded from depths up to 18 m by Schrödl (1996), and dredged from 315 m by the Challenger Expedition (Bergh, 1884). Members of this family mostly feed on alcyonarians (Thompson & Brown, 1984).

RECORDS. Station 14. Elsewhere I. Chiloé to Magellan Strait (Schrödl, 1996). Range: 42–54°S.

Family **FLABELLINIDAE**

Flabellina falklandica (Eliot, 1907)

Coryphella falklandica Eliot, 1907: 354, pl. 28, fig. 7 (radula).
Flabellina falklandica – Schrödl, 1996: 37, pl. 7, fig. 44 (synonymy).

DESCRIPTION. Animal up to 10 mm (to 40 mm, Schrödl, 1996); rhinophores smooth; rhinophores and oral tentacles of similar size; propodial tentacles present; dorsally with dense cerata, not arranged in groups; colour transparent whitish with orange brown cerata.

HABITAT. On *Macrocystis* (as also noted by Schrödl, 1996) at 5–15 m depth, where the animals presumably graze on epiphytic hydroids.

RECORDS. Stations 1, 14. Elsewhere Seno Reloncaví to Magellan Strait (Schrödl, 1996, 1997). Range: 42–54°S.

Family **SIPHONARIIDAE**

Siphonaria (Talisiphon) lessonii Blainville, 1827

(Figure 4G, H)

Siphonaria lessonii Blainville, 1827: 296, pl. 61, fig. 2, 2a.
Siphonaria (Pachysiphonaria) lessoni – Hubendick, 1946: 21–22, fig. 4, pl. 1, figs 1–3 (anatomy). Olivier & Penchaszadeh, 1968: 469–491, pl. 1, textfigs. 2, 3, 5 (radula, anatomy). Dell, 1971: 214–215 (synonymy).
Pachysiphonaria lessoni – Powell, 1951: 181.
Siphonaria (Talisiphon) lessoni – Morrison, 1963: 7 (synonymy). Marincovich, 1973: 42, fig. 95.
Siphonaria tristensis Leach, 1824 – Strebel, 1907: 170–172, pl. 3, figs 31–33.

DESCRIPTION. Shell to 20 mm; high (rarely low) conical to cap-shaped limpet, apex at about one third shell length from posterior margin, posterior slope sometimes concave, basal outline asymmetrically oval, with slight projection on right side (corresponding to pneumostome opening of animal); sculpture smooth or with slight radial ribs; colour pale with numerous fine dark brown to black radial lines, interior dark brown with pale margin where exterior dark rays show through.

HABITAT. Abundant on rocks on sheltered and exposed shores; in upper eulittoral together with barnacles and *Nodilittorina araucana*, extending into zones of *Nacella* and *Mytilus*, and often attached to

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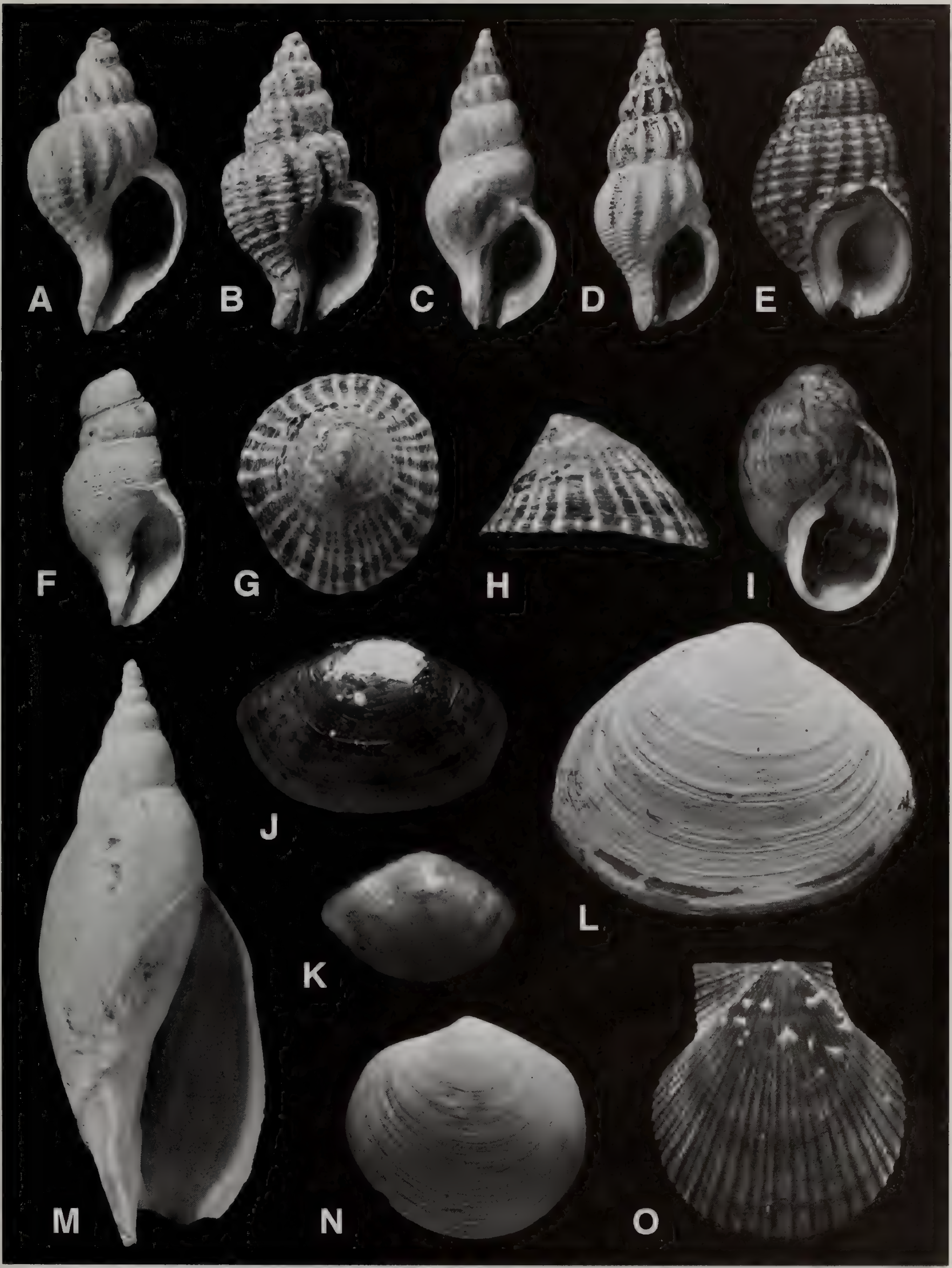
Fig. 4 **A.** *Xymenopsis muriciformis* (20 mm). **B.** *Xymenopsis subnodosus* (23 mm). **C.** *Pareuthria fuscata* (30 mm). **D.** *Pareuthria powelli* (17 mm). **E.** *Nassarius gayii* (12 mm). **F.** *Adelomelon ancilla* (juvenile; 18 mm). **G, H.** *Siphonaria (Talisiphon) lessonii* (15 mm). **I.** *Chilina patagonica* (15 mm). **J, K.** *Malletia magellanica* (19 mm, 14 mm). **L.** *Mulinia edulis* (60 mm). **M.** *Adelomelon ancilla* (adult; 200 mm; Falkland Islands). **N.** *Felaniella inconspicua* (18 mm). **O.** *Zygochlamys patagonica* (juvenile;17 mm). (All specimens from study area except **M**; all NHM collection).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these shells; on sheltered shores it is common even on silty rock surfaces; found at seawater salinities down to 20‰, but also frequent at mouths of streams where salinity must fall to very low levels at low tide or during rain. In northern Chile it is reported to be common in the barnacle zone and also in tidepools throughout the eulittoral (Guiler, 1959a; Marincovich, 1973), and is also common over a wide tidal range in the Magellan Strait (Benedetti-Cecchi & Cinelli, 1997). Together with lottiid limpets of the genus *Scurria*, *Siphonaria lessonii* is one of the most abundant herbivores of the mid-intertidal zone of southern Chile, reaching densities of 1317 per m^2 and grazing principally on *Iridaea* fronds (Jara & Moreno, 1984). In a marine reserve this species occured mainly in the mid and upper eulittoral; outside the reserve, where the competing dominant herbivore *Fissurella picta* is removed by human collection, *S. lessonii* was larger and extended its zonation to low tide level (Godoy & Moreno, 1989). A detailed study of the ecology of this species has been made in the Mar del Plata, Argentina (Olivier & Penchaszadeh, 1968).

RECORDS. Stations 1, 6, 8, 10, 11, 12, 14, 20, 21, 25. Elsewhere Paita (Peru) to Magellan Strait and Tierra del Fuego (Hubendick, 1946; Marincovich, 1973). Range: 5–54°S.

REMARKS. This is one of the most abundant molluscs in the upper intertidal zone in the study area. It is a pulmonate limpet, recognized by the pneumostome of the mantle to the right side of the foot. It should not be confused with *Scurria parasitica* which is a symmetrically oval limpet, with broader dark rays, and white interior with brown apex; these two limpets frequently occur together in beds of *Mytilus*.

Family **CHILINIDAE**

Chilina patagonica Sowerby, 1874

(Figure 4I)

Chilina patagonica Sowerby, 1874: *Chilina* sp. 11, pl. 3, fig. 11. Strebel, 1907: 166–168, pl. 8, figs 98, 102, 105a–c. Haeckel, 1911: 89–136, pls 7–11 (anatomy). Stuardo, 1961: 22 (synonymy). Castellanos & Gaillard, 1981: 34, pl. 5, figs 15, 16 (synonymy).

DESCRIPTION. Shell to 16 mm; cylindrical with produced spire, apex usually eroded away; shell thin and covered by thick periostracum; columella with one prominent fold; colour yellow brown with more or less distinct axial lines of dark brown which form four conspicuous spiral bands of chevrons or irregular axial marks, columella white.

HABITAT. Common among stones, *Enteromorpha* and on mud, in sheltered brackish inlet (salinity 5‰) near freshwater stream, also among saltmarsh vegetation on sheltered shores of Laguna San Rafael. Strebel (1907) recorded this species from marine fjords, and Davenport *et al.* (1995) found it commonly in streams and saltmarsh vegetation in the Laguna San Rafael. In Estero Reloncaví Brattström (1990) recorded *Chilina bulloides* Sowerby from similar low-salinity habitats.

RECORDS. Stations 28, 31. Elsewhere Puerto Montt to I. Picton (Strebel, 1907). Range: 41–55°S.

REMARKS. There are about 36 nominal species of *Chilina* recorded from Chile (Stuardo, 1961; Ituarte, 1997), mostly from freshwater habitats. Shells are variable in form and coloration, making identification difficult. A review of the Chilean species based on anatomical and radular characters is in progress (Valdovinos & Stuardo, 1995). Meanwhile, the identification of the present material has been based on comparison with dry syntypes (NHM) and on the interpretations of Strebel (1907) and Castellanos & Gaillard (1981). There are several anatomical accounts of *Chilina* species (Haeckel, 1911; Brace, 1983; Ituarte, 1997) and they are of evolutionary interest as primitive basommatophoran pulmonates.

Class Bivalvia

Family **NUCULIDAE**

Nucula (Nucula) pisum Sowerby, 1833

(Figure 7G)

Nucula pisum Sowerby, 1833a (January): 6, pl. 3, fig. 23. Sowerby, in Broderip & Sowerby, 1833 (March): 198. Dall, 1909: 250. Soot-Ryen, 1959: 12, pl. 1, figs 1, 2.
Linucula pisum – Dell, 1964: 144, pl. 2, figs 7, 8 (synonymy). Ramorino, 1968: 183–185, pl. 1, fig. 4, pl. 4, fig. 2. Osorio & Bahamonde, 1970: 187. Maxwell, 1988: 89.
Nucula (Linucula) pisum – Bernard, 1983: 10 (synonymy).
Nucula (Nucula) pisum – Villarroel & Stuardo, 1998: 129–131.

DESCRIPTION. Shell to 3.3 mm (to 5.4 mm, NHM); rounded trigonal; hinge taxodont, 9–14 anterior teeth, 5 posterior (Soot-Ryen, 1959); sculpture of strong concentric striae towards margin in larger shells, crossed by apparent radial lines throughout (these are subsurface prisms within outer shell layer) that crenulate the margin, radials on escutcheon are finer and divergent from the rest; colour fawn, stained by ferruginous deposit at umbos, interior nacreous.

HABITAT. Dredged from 10–15 m depth, among cobbles with encrusting calcareous red algae. Recorded from depths of 5–60 m on coarse or fine sand by Soot-Ryen (1959). Villarroel & Stuardo (1998) reported a maximum density of 848 per m^2 on sandy mud at 51–80 m in the Bahía de Valparaíso, and gave an overall depth range of 8–200 m; from the same locality Ramorino (1968) recorded densities of up to 4650 per m^2.

RECORDS. Station 7 (2 specimens). Elsewhere, the extent of the range is uncertain. Soot-Ryen (1959) gave Valparaíso (the type locality) and recorded specimens from 41–43°S. Dall (1909) gave 'Valparaíso to San Blas, Chile' (the latter presumably Estrecho San Blas, 51°S, but mis-quoted as San Blas, Argentina, a locality at 40°S, by Carcelles & Williamson, 1951, Soot-Ryen, 1959, and Osorio & Bahamonde, 1970). Carcelles & Williamson (1951) also included the Magellanic region and Falkland Islands. However, Dell (1964) noted possible confusion with *Nucula falklandica* Preston, 1912, in these southern parts of the range. Range: 25–54°S.

REMARKS. Maxwell (1988) and Villarroel & Stuardo (1998) have discussed the generic allocation of this species.

Family **MALLETIIDAE**

Malletia magellanica (Smith, 1875)

(Figure 4J, K)

Solenella magellanica Smith, 1875: 118–119.
Malletia magellanica – Smith, 1881: 39, pl. 5, fig. 3, 3a. Carcelles, 1950: 74, pl. 3, fig. 65. Carcelles & Williamson, 1952: 324. Osorio & Bahamonde, 1970: 188. Villarroel & Stuardo, 1998: 155–156.

DESCRIPTION. Shell to 31 mm (38 mm, Smith, 1881); ovate, more or less pointed posteriorly, delicate; surface smooth, with growth lines; periostracum thick, glossy; external ligament; hinge taxodont, 8–9 anterior teeth, 17–20 posterior teeth (but sometimes distorted when umbos are eroded); pallial sinus large, but distant from pallial line, so that meeting of the two is bluntly rounded; colour yellow brown to dark or olivaceous brown, interior white.

HABITAT. Dredged from 5–15 m depth on silt bottom, abundant in Laguna San Rafael at salinity of 15‰. Smith (1881) recorded this species from 4–58 m depth on mud in the northwestern Magellan Strait.

RECORDS. Stations 25, 29, 30. Elsewhere Islas Otter (52°S) and Caleta Cockle (Smith, 1881). Carcelles & Williamson (1951) give the Magellanic region and Kerguelen Islands. Range: 46–52°S.

REMARKS. Six nominal species of *Malletia* are recorded from southern Chile (Osorio & Bahamonde, 1970), and the chief distinguishing features are shell outline, numbers of hinge teeth and the form of the pallial sinus (Soot-Ryen 1959; Dell, 1964; Ramorino, 1968; Villaroel & Stuardo, 1998). Both the hinge and pallial line of the present specimens are identical to those of the syntypes in the NHM, but the largest syntype (and the figures of Smith, 1881, and Carcelles, 1950) shows a markedly more rostrate posterior. However, two of the three syntypes are less rostrate, and overlap with the most elongate examples of the present collections (e.g. Fig. 4K). Dell (1964) has observed variation in the development of the rostrum in another *Malletia* species. The majority of the samples from the Laguna San Rafael are, nevertheless, more oval in outline, and additional material is necessary to confirm our identification.

Family **MYTILIDAE**

Mytilus edulis chilensis Hupé, 1854

(Figure 5D, E)

Mytilus chilensis Hupé, 1854: 309–310, malacologia pl. 5, fig. 4. Reid, 1974: 179–184. Osorio, Atria & Mann, 1979: 25–26, fig. 27.
Mytilus edulis chilensis – Soot-Ryen, 1959: 24–25. Dell, 1964: 174. Osorio & Bahamonde, 1970: 191. Dell, 1971: 170–171.
Mytilus edulis Linnaeus, 1758 – Soot-Ryen, 1955: 19–22, pl. 1, figs 1, 2, textfigs 1, 2, 10, 11 (anatomy, synonymy). Olsson, 1961: 113, pl. 12, fig. 6. McDonald, Seed & Koehn, 1991: 323–333.

DESCRIPTION. Shell to 105 mm; beaks terminal, pointed; shell solid, but thinner and translucent in brackish habitats (Fig. 5D); 3–4 small tooth-like folds within umbos; chalky resilial ridge adjacent to ligament pitted by minute pores; posterior adductor and retractor scars continuous; radial sculpture absent; periostracum thick, glossy, with hairs in very small specimens; colour blue or sometimes pale brown, overlaid by black or brown periostracum, eroded at umbos; interior nacreous, silvery blue.

HABITAT. An abundant species in a wide range of intertidal habitats; on exposed shores it forms dense beds from the middle to lower eulittoral on rocks and cliffs (size increases towards lower levels and in more sheltered situations); on sheltered shores it occurs also among stones and boulders; in estuaries and lagoons it forms clumps on hard substrates in muddy situations, occurring adjacent to freshwater streams; in a brackish inlet (station 28) the species was still common on the muddy shore at a salinity of 5‰; in the Laguna San Rafael it occurred intertidally and was also dredged from 5–10 m, in clumps on mud and gravel, at salinities of 15‰. *Mytilus edulis chilensis* is an important component of the ecosystem of the Laguna, where its occurrence and zonation have been described by Davenport *et al.* (1995). Soot-Ryen (1959) notes that although the species is mainly intertidal, a few living specimens have been found at 25 m depth. Ecological studies of this species include those by Miranda & Acuña (1979) in the Magellan Strait and by Stotz (1981) in an estuary near Valdivia.

RECORDS. Stations 5, 6, 10, 12, 13, 14, 15, 17, 20, 21, 22, 24, 25, 26, 28, 29, 30, 31. Elsewhere, Soot-Ryen (1959) reports specimens from Iquique to Magellan Strait. The species is evidently scarce in central and northern Chile, for it is not reported in ecological or faunistic studies of this region (Marincovich, 1973; Romo & Alveal, 1977; Ruiz & Giampaoli, 1981). Range: 20–54°S.

REMARKS. *Mytilus edulis* has a wide, bipolar distribution in the north Atlantic and southern South America. Traditional morphological comparison of shells has failed to detect consistent differences between the northern and southern groups (Soot-Ryen, 1955), although they have often been recognized as distinct subspecies on account of their geographical separation (Soot-Ryen, 1959). More recently, multivariate morphometric analysis has shown that South American mussels are intermediate in shell shape between the northern *M. edulis* and *M. trossulus* Gould, 1850, but since allozyme analysis has revealed a closer similarity to northern *M. edulis*, this name has been tentatively applied to the southern forms also (McDonald *et al.*, 1991). Reid (1974) described the digestive system and claimed that Chilean material differed from a published account of northern *M. edulis*, but this requires confirmation. The presence of this species in South America is apparently not the result of recent human introduction from the north Atlantic, since there are some genetic differences and, furthermore, the species is present in pre-Colombian shell middens in Argentina (McDonald *et al.*, 1991). The modern information on classification and evolution of *Mytilus* has been reviewed by Gosling (1992) and Seed (1992). Until the geographical relationships of *M. edulis* are resolved, we retain subspecific distinction for the Chilean form. Well preserved specimens of *M. edulis chilensis* have a smooth surface, but care must be taken to distinguish eroded specimens from the longitudinally ribbed *Aulacomya atra* and *Perumytilus purpuratus*, with which they may occur on the same shore. *Choromytilus chorus* is externally similar to *M. edulis chilensis*, but reaches much larger size and is mainly found subtidally. Another large mytilid, *Perna perna* (Linnaeus, 1758), has been recorded from Concepción to the Magellan Strait (Carcelles & Williamson, 1952, as *Chloromya achatinus*; see Soot-Ryen,1955: 30); this is similar in shape to *M. edulis chilensis*, or slightly more elongate, externally brown or green, internally purplish or pink, with a wide separation between the posterior adductor and retractor scars. *Mytilus edulis chilensis* is an important edible species, of which the annual harvest was 13358 tonnes in 1997 (SERNAP, 1998) and is also cultivated commercially.

Choromytilus chorus (Molina, 1782)

(Figure 5F)

Mytulus chorus Molina, 1782: 202.
Choromytilus chorus – Soot-Ryen, 1955: 31, pl. 2, figs 7, 8, textfig. 5 (synonymy). Soot-Ryen, 1959: 26. Olsson, 1961: 115, pl. 12, fig. 10. Osorio & Bahamonde, 1970: 191. Osorio, Atria & Mann, 1979: 24–25, fig. 26. Bernard, 1983: 18 (synonymy).

DESCRIPTION. Shell to 186 mm (to 300 mm, Suchanek, 1985); beaks terminal, pointed; shell solid; single tooth-like fold within umbo of right valve, and corresponding groove in left valve; resilial ridge adjacent to ligament not pitted by pores; posterior adductor and retractor scars continuous; radial sculpture absent; periostracum very thick, glossy; colour blue to purple, overlaid by black periostracum, often eroded at umbos; interior nacreous, silvery blue.

HABITAT. No living specimens were found during the present study. Elsewhere, this mussel has been recorded in a variety of habitats; on the exposed rocky coasts of southern Chile it occurs in the sublittoral, and also in the low eulittoral in the absence of collection by humans (Moreno, 1995); it is also frequent in estuaries, sometimes on sedimentary substrates, and at reduced salinities (monthly average high tide salinity of 20‰, Navarro, 1988). A depth range of 4–20 m was given in a study of growth and reproduction by Lozada, Rolleri & Yañez (1971).

RECORDS. Stations 9 (midden material), 10 (fresh valves). Elsewhere Pacasmayo (Peru) to Tierra del Fuego (Soot-Ryen, 1955). Range: 7–56°S.

REMARKS. Superficially similar in shape to the smaller *Mytilus edulis chilensis*, this species is distinguished by its single hinge tooth and resilial ridge without pits. It is the largest and most esteemed of the edible mussels of the Chilean coast, and consequently is extensively collected; in 1997 the catch was 527 tonnes. Despite a considerable literature on the culture and laboratory behaviour of this species, there is little information about its natural ecology. At present, populations are almost entirely sublittoral throughout the region, although where shores are protected from human activity large numbers appear in the lower eulittoral (Moreno, 1995). This mussel is a major component of the large shell middens on Isla Traiguén; the age of these deposits is not known, but intact shells occurred at depths of up to 5 m in the eroding face of the midden at Station 9. In addition, fresh shells were found at Station 10, presumably recently discarded by fishermen. The species was an important item of food for the indigenous people of the Chonos Archipelago, who collected it by diving, and it is possible that the present restricted distribution is a consequence of exploitation over a long period of time (P.J. Curry, pers. comm.). In the north of Chile the species is likewise common in middens, but is now locally extinct, although whether this is a result of human activity is unclear (Viviani, 1979).

Aulacomya atra (Molina, 1782)

(Figure 5A, B)

Mytulus ater Molina, 1782: 202–203.

Aulacomya ater – Soot-Ryen, 1955: 33–34, pl. 1, fig. 6, textfigs 17, 18 (synonymy). Soot-Ryen, 1959: 26–27. Olsson, 1961: 116, pl. 14, fig. 9 (synonymy). Osorio & Bahamonde, 1970: 192. Marincovich, 1973: 8, fig. 3. Osorio, Atria & Mann, 1979: 22–24, fig. 24. Bernard, 1983: 17–18 (synonymy).

Aulacomya ater ater – Dell, 1964: 175–177 (synonymy). Dell, 1971: 171.

Aulacomya atra – Cazzaniga, 1994: 110.

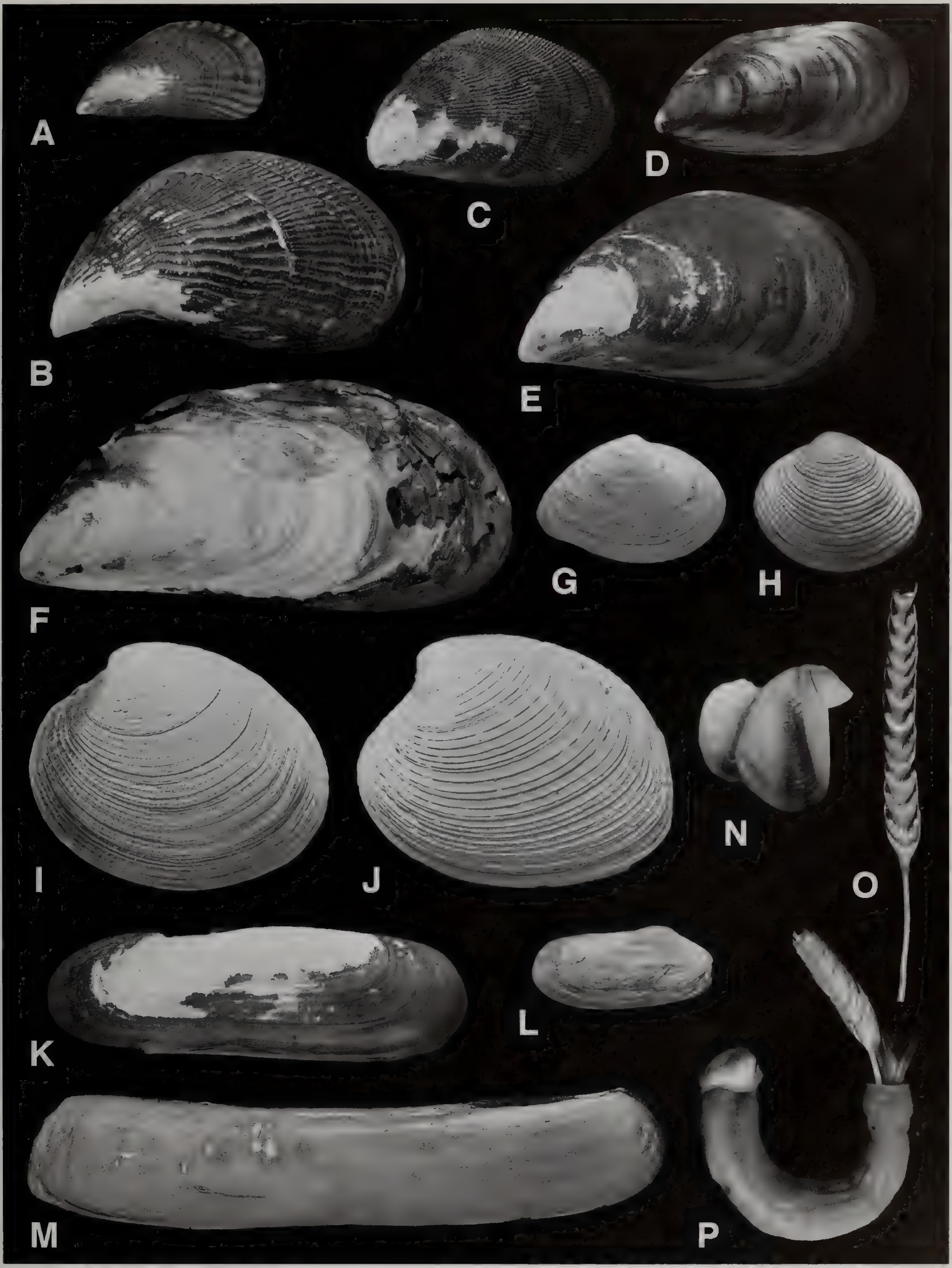
DESCRIPTION. Shell to 154 mm (to 200 mm, Suchanek, 1985); beaks terminal, pointed; shell solid; single broad tooth-like fold within umbo of left valve, and corresponding groove in right valve; resilial ridge adjacent to ligament not pitted by pores; posterior adductor and retractor scars broadly continuous; strong radial ribs present; periostracum thick, glossy; shells less than 40 mm white, overlaid by yellow to brown periostracum; larger shells purple to dark blue, overlaid by black periostracum, eroded at umbos; interior nacreous, silvery to purple.

HABITAT. Adults of this species were only found commonly on the shore at two relatively inaccessible sites on an exposed rocky shore and a cliff (Stations 13, 17), where they formed dense clumps at the top of the calcareous red algal zone in the sublittoral fringe. Elsewhere, juveniles (to 40 mm) were found in small numbers among the byssus of dense beds of *Mytilus edulis chilensis*, and under stones in the mid to lower eulittoral on moderately exposed and sheltered shores, but these individuals evidently died before reaching large size. On the sheltered shores of the southernmost Estero Elefantes and Golfo Elefantes, adults were occasionally found on the shore; some were freshly dead, with the byssus detached from the substrate, whereas others were only superficially attached; empty valves were common on the beaches in this region. It appears therefore that there may be considerable sublittoral populations in this area, from which living and dead mussels are washed up on the shore. The presence of beds of *Macrocystis* near the shore made dredging here difficult, but a living adult was dredged from 7–9 m (station 22), and a few others were brought up in the holdfasts of the kelp from 5–15 m. Salinities of 15–20‰ were recorded at the southern sites. Elsewhere, occasional living specimens have been recorded from 40 m at I. Chiloé (Soot-Ryen, 1959) and from 79 m in the Falkland Islands (Dell, 1964). It was common in the lower intertidal and subtidal at Iquique (Marincovich, 1973) and found in the mid to lower intertidal at Isla Chiloé (Brattström, 1990). This species does occur also in more sheltered situations, as in the Estero Castro, where a natural mussel bank was studied between depths of 4–9 m, but accumulation of mud caused mortality (Lozada, 1968).

RECORDS. Stations 1, 5, 13, 14, 17, 20, 22, 25. Elsewhere Callao (Peru) to Magellan Strait (Soot-Ryen, 1955). Range: 12–56°S.

REMARKS. Although almost universally referred to as *Aulacomya ater* in the recent literature, the name should be corrected to *A. atra* since, as pointed out by Cazzaniga (1994), the adjectival specific name should agree in gender with the feminine generic name. This species is easily distinguished from all other large mussels in the region by its radially ribbed shell; specimens less than 40 mm in length could be confused with *Perumytilus purpuratus*, but at this size the shells are yellow to pale brown, with less than 17 ribs, whereas those of *P. purpuratus* are purplish with a brown to black periostracum and have twice as many ribs and a more rounded outline. Like the preceding species, *A. atra* is a large mussel that is collected commercially in large quantities; the catch in 1997 was 6597 tonnes (SERNAP, 1998). It is unclear to what extent the present scarcity of intertidal populations is a result of over-exploitation. This species is the major component of the large shell middens on Isla Traiguén; these are of unknown age, but some are up to 5 m in height. Fresh valves at some sites suggests that collection continues.

Fig. 5 **A, B.** *Aulacomya atra* (juvenile 26 mm; adult 80 mm). **C.** *Perumytilus purpuratus* (39 mm). **D.** *Mytilus edulis chilensis* (thin-shelled form from low salinity habitat, station 29; 45 mm). **E.** *Mytilus edulis chilensis* (thick-shelled form from higher salinity habitat, station 22; 71 mm). **F.** *Choromytilus chorus* (186 mm). **G.** *Cumingia mutica* (25 mm). **H.** *Tawera gayi* (18 mm; Portland Bay and Port Rosario, Patagonia, 'Alert' Expedition, NHM 1879.10.15.60). **I.** *Venus antiqua* (67 mm). **J.** *Retrotapes exalbidus* (86 mm). **K.** *Tagelus (Tagelus) dombeii* (82 mm). **L.** *Hiatella solida* (11 mm). **M.** *Ensis macha* (129 mm; Punta Arenas, Magellan Strait, NHM 1868.7.1.22). **N–P.** *Bankia (Bankia) martensi* (**N,** shell 7.2 mm; **O,** pallet 30 mm; **P,** whole animal, length 50 mm approx.). (All specimens from study area except **H** and **M**; all NHM collection).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Perumytilus purpuratus (Lamarck, 1819)

(Figure 5C)

Modiola purpurata Lamarck, 1819: 113.
Brachidontes purpuratus – Soot-Ryen, 1955: 45, pl. 4, fig. 18, textfig. 30. Soot-Ryen, 1959: 28. Dell, 1971: 172. Bernard, 1983: 18 (synonymy).
Perumytilus purpuratus – Olsson, 1961: 117, pl. 12, fig. 1, pl. 14, fig. 1, 1a, 1b (synonymy). Osorio & Bahamonde, 1970: 192. Marincovich, 1973: 9, fig. 6. Osorio, Atria & Mann, 1979: 24, fig. 25.

DESCRIPTION. Shell to 50 mm; beaks almost terminal, rounded; shell solid; several small tooth-like crenulations within umbo; resilial ridge adjacent to ligament not pitted by pores; posterior adductor and retractor scars continuous; fine radial ribs present, crenulating margin; periostracum thick, glossy; shell white, purplish posteriorly, overlaid by dark brown to black periostracum, eroded at umbos, interior nacreous, silvery to purplish brown.

HABITAT. Frequent in a range of intertidal habitats: under stones in mid to upper eulittoral on sheltered boulder shores, forming partly buried accretions on upper shore of muddy shingle beaches, and sometimes together with *Mytilus edulis chilensis* in dense beds of small shells at top of *Mytilus* zone in mid-eulittoral on exposed rocky coasts. The species is especially abundant in sheltered habitats where there is a moderate freshwater input from streams or runoff, and was found at salinities down to 15–20‰. This is a strictly intertidal species (Soot-Ryen, 1959; Dell, 1971), but can be found throughout the intertidal zone in both southern and northern parts of its distribution (Marincovich, 1973; Brattström, 1990; Benedetti-Cecchi & Cinelli, 1997). In central and northern Chile *P. purpuratus* is the dominant organism in the mid-eulittoral on both sheltered and exposed shores, forming dense beds (Guiler, 1959a; Romo & Alveal, 1977; Ruiz & Giampaoli, 1981; Santelices, 1991; Alvarado & Castilla, 1996). The great abundance of this species may be a consequence of the removal of its major predator, the edible *Concholepas concholepas*, by humans (Castilla & Durán, 1985).

RECORDS. Stations 1, 5, 6, 10, 11, 12, 14, 17, 20, 21, 22, 25, 26. Elsewhere Yasila near Paita (Peru) (Olsson, 1961) to Magellan Strait (Soot-Ryen, 1955; Benedetti-Cecchi & Cinelli, 1997). Range: 5–54°S.

REMARKS. Discrimination from the only other ribbed mussel, *Aulacomya atra*, has been described earlier. *Perumytilus purpuratus* is seldom found in pure colonies, but almost always together with *Mytilus edulis chilensis*. When shells are well preserved, the two are easily separated by the fine radial ribs of the former. When shells are severely eroded (as is often the case in habitats of low salinity), the crenulated margin and purplish shell of *P. purpuratus* differentiate it from the blue, smooth-margined shells of *M. edulis chilensis*. The proportions of these two species in the mytilid zone appear to vary with exposure, tidal level and salinity. On exposed shores and at lower levels *P. purpuratus* is replaced by *M. edulis chilensis*. *Perumytilus purpuratus* becomes more frequent on sheltered shores, and wherever there is limited freshwater inflow. However, in estuarine areas of the lowest salinity (5–15‰, stations 28, 29, 30, 31) it is absent and here the presumably more euryhaline *M. edulis chilensis* occurs alone.

Family **PECTINIDAE**

Zygochlamys patagonica (King & Broderip, 1832)

(Figure 4O)

Pecten patagonicus King & Broderip, 1832: 337.
Chlamys patagonica – Soot-Ryen, 1959: 29. Osorio, Atria & Mann, 1979: 28, fig. 30. Waloszek, 1984: 207–276, pls 1-3, pls 5–9 (synonymy).
Chlamys patagonica patagonica – Beu, 1985b:1–11, pl. 1, figs 1–4.
Chlamys (Zygochlamys) patagonica – Dell, 1964: 178–179. Osorio & Bahamonde, 1970:193.
Zygochlamys patagonica – Waller, 1991: 28–30, pl. 2, figs 13, 14.
Chlamys patriae Doello Jurado, 1918 – Soot-Ryen, 1959: 29–31. Osorio & Bahamonde, 1970: 193.
Chlamys amandi Hertlein, 1935 – Soot-Ryen, 1959: 29–31, pl. 1, figs 7, 8. Osorio & Bahamonde, 1970: 193.

DESCRIPTION. Shell 16 mm (to 90 mm, Waloszek, 1984); a round, almost equivalved scallop; sculptured by 30–32 (22–41, Waloszek, 1984) primary radial ribs (excluding ears), with secondary ribs between, crossed by fine concentric laminae which may form minute scales on ribs or in interspaces; right (lower) valve pink, orange or brown, with darker ribs; left valve white with pink to orange ribs; interior white, flushed with pink or purple.

HABITAT. Single small specimen dredged from 10–15 m, among cobbles with encrusting calcareous red algae, in sheltered bay. Although occasionally taken in the shallow sublittoral, the typical habitat of this species is in deeper water, 25–100 m in the vicinity of I. Chiloé (Soot-Ryen, 1959), 15 to over 200 m off eastern Patagonia and the Falkland Islands (Dell, 1964; Waloszek & Waloszek, 1986).

RECORDS. Station 7. Elsewhere I. Chiloé to Magellan Strait, Tierra del Fuego and Cape Horn (Waloszek, 1984). Range: 42–56°S.

REMARKS. A detailed taxonomic study of this and other Magellanic scallops has revealed that the three species discriminated by Soot-Ryen (1959) are extremes of the range of a single taxon with variable microsculpture (Waloszek, 1984). The generic assignment has been discussed by Beu (1985b) and Waller (1991). This species is fished commercially in the Magellan Strait (Osorio *et al.*, 1979) and in 1997 the catch was 2598 tonnes (SERNAP, 1998). During the present study fossil specimens of an additional pectinid species, *Chlamys vitrea* (King & Broderip, 1832), were found in a clay cliff of an eroding raised beach on the southwestern shore of Isla Rojas. This species has a more delicate shell, transparent when young, with less distinct, rounded ribs and in life is associated with *Macrocystis* (Waloszek, 1984: pl. 4, fig. 5).

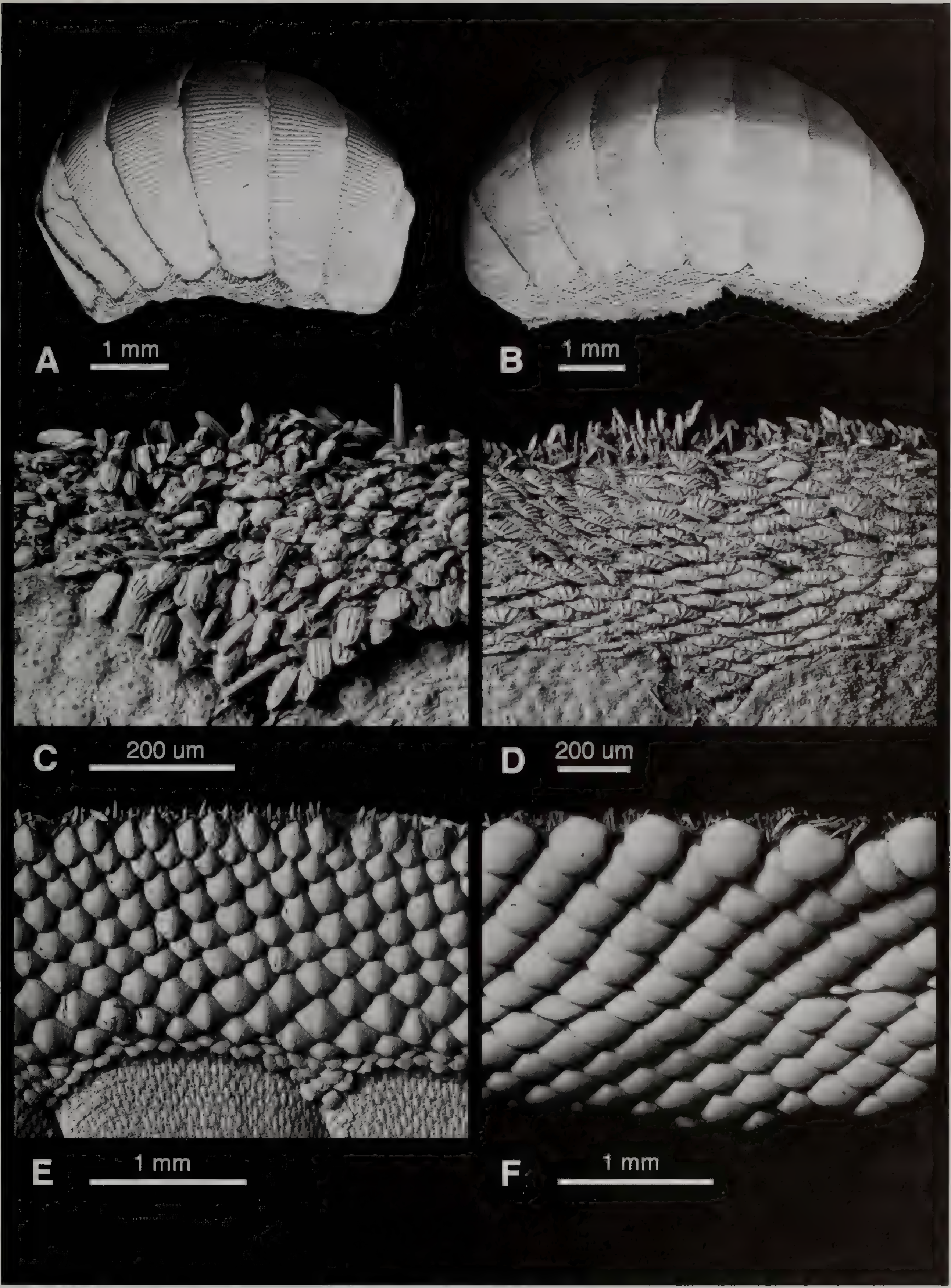
Family **UNGULINIDAE**

Felaniella inconspicua (Philippi, 1845)

(Figure 4N)

Diplodonta inconspicua Philippi, 1845: 53. Hupé, 1854: 357, malacologia pl. 8, fig. 4. Soot-Ryen, 1959: 43 (synonymy). Herm, 1969: 115, pl. 3, figs 5–7. Osorio & Bahamonde, 1970: 199. Dell, 1971: 173.

Fig. 6 Scanning electron micrographs of Polyplacophora. **A, C.** *Leptochiton (Leptochiton) medinae* (**C,** detail of girdle spicules). **B, D.** *Ischnochiton (Ischnochiton) stramineus* (**D,** detail of girdle scales). **E.** *Ischnochiton (Haploplax) pusio*, detail of girdle scales. **F.** *Chiton (Amaurochiton) magnificus bowenii*, detail of girdle scales. (All specimens from study area; NHM collection).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1 mm
B
1 mm
C
200 um
D
200 um
E
1 mm
F
1 mm

? *Diplodonta phillippii* Hupé, 1854: 357–358, malacologia pl. 8, fig. 5.
Felaniella inconspicua – Bernard, 1983: 30.

DESCRIPTION. Shell 19 mm (to 32 mm, Soot-Ryen, 1959); orbicular, thin-shelled, only moderately inflated; sculpture of fine concentric growth lines; the larger of two cardinal teeth in each valve bifid; pallial line entire, not indented, adductor muscle scars almost equal; colour white.

HABITAT. Dead valves dredged from 10–15 m depth, on bottoms of gravel, coarse sand and cobbles; scarce. This species has been recorded intertidally in sand, and living to depths of 36 m (Soot-Ryen, 1959) and 65 m (Ramorino, 1968).

RECORDS. Stations 7, 14. Elsewhere Tocopilla to Golfo Corcovado (Soot-Ryen, 1959). Range: 22–49°S.

REMARKS. The four valves in the present material are more delicate and less inflated than typical shells of *F. inconspicua*. In this they correspond with the description of *Diplodonta phillippii* from Isla Chiloé by Hupé (1854); although this was regarded only as a form of *D. inconspicua* by Soot-Ryen (1959), the status of the two taxa deserves further investigation.

Family **GALEOMMATIDAE**

Lasaea miliaris (Philippi, 1845)

(Figure 7H, I)

Kellia miliaris Philippi, 1845: 51.
Lasaea miliaris – Soot-Ryen, 1959: 51. Dell, 1971: 174–175, pl. 1, fig. 9, pl. 2, figs 3, 4. Castellanos, 1979: 136.

DESCRIPTION. Shell to 2.8 mm; orbicular, inflated, umbos prominent; sculpture of very fine, regular growth lines; colour pink to purplish red.

HABITAT. In empty barnacles in barnacle zone of upper eulittoral, on exposed and moderately exposed shores. At Isla Chiloé a similar (possibly identical) form, identified as *L. petitiana* Recluz, was abundant in the barnacle zone (Brattström, 1990).

RECORDS. Stations 12, 14. Elsewhere Magellan Strait, Tierra del Fuego, Falkland Is (Soot-Ryen, 1959; Dell, 1971). Range: 46–56°S.

REMARKS. Members of this genus are common components of the crevice fauna on rocky shores throughout the world. The taxonomy of this genus of minute bivalves was unsatisfactory when based only on rather variable shell features (Dell, 1971). However, it has now been thrown into further confusion by the discovery that most of the 'species' are highly polyploid asexual lineages, with nonplanktotrophic, brooded development (Ó Foighil & Smith, 1995). The present material has been compared with syntypes in NHM, but the specific name is used only in the sense of a morphospecies.

Family **CARDITIDAE**

Carditella tegulata (Reeve, 1843)

(Figure 7J)

Cardita tegulata Reeve, 1843: sp. 48, pl. 9, fig. 48. Reeve, 1844: 194.
Carditella tegulata – Lamy, 1922: 354–355, textfig. Carcelles & Williamson, 1951: 334. Dell, 1964: 194, textfig. 3, no. 8 (synonymy). Osorio & Bahamonde, 1970: 197. Bernard, 1983: 34.

DESCRIPTION. Shell to 7.5 mm; subtrigonal, solid; sculptured by 11–13 strong radial ribs, crossed by fine regular concentric ribs, producing lamellate appearance on radials; margin coarsely crenulated by radial ribs; small external ligament; colour whitish with yellow brown periostracum.

HABITAT. Dredged from 10 m on bottom of cobbles, gravel and coarse sand; uncommon. From 50 m at Valparaíso (Reeve, 1843).

RECORDS. Station 14 (5 specimens). Elsewhere Callao (Peru) to Magellan Strait (Carcelles & Williamson, 1951). Range: 12–54°S.

REMARKS. This species is closely similar to *Carditella pallida* Smith, 1881. Smith (1881) distinguished his species by the 14–15 ribs and almost centrally placed umbos, and these characters are confirmed by our examination of the two syntypes (NHM, type locality Valparaíso). In comparison, the three syntypes of *C. tegulata* (NHM, type locality Port Rosario, south Patagonia) have 11–12 coarser ribs and slightly more anterior umbones. However, these differences are slight. The four specimens in the present material resemble *C. tegulata* in sculpture, but the ribs are slightly less pronounced, 11–13 in number, and the shell outline is closer to that of *C. pallida*. Our specimens are therefore intermediate in form, as well as in locality, between these two taxa and suggest possible clinal variation between them. Dell (1964) emphasized the close relationship of this pair of species; further investigation is desirable. Care must be taken to distinguish this species from *Carditopsis flabellum*, with which it occurs. Our familial assignment of both these species follows Chavan (1969). The specimens figured by Soot-Ryen (1959: pl. 1, fig. 11) and Marincovich (1973: fig. 9) are not *C. tegulata*, but belong to the *C. naviformis* (Reeve, 1843) group, with more oblong shells (see Dell, 1964).

Family **CONDYLOCARDIIDAE**

Carditopsis flabellum flabellum (Reeve, 1843)

(Figure 7K)

Cardita flabellum Reeve, 1843: sp. 47, pl. 9, fig. 47. Reeve, 1844: 194.
Carditopsis flabellum – Lamy, 1922: 360. Soot-Ryen, 1959: 40. Ramorino, 1968: 204–206, pl. 2, fig. 2, pl. 6, figs 2, 3. Bernard, 1983: 35.
Carditopsis flabellum flabellum – Dell, 1964: 195, textfig. 3, nos 2, 3 (synonymy). Osorio & Bahamonde, 1970: 197. Linse, 1997: 59, pl. 2, figs 5–8, textfig. 12f.

DESCRIPTION. Shell to 4.3 mm; subtrigonal, solid; sculptured by 13–14 strong rounded radial ribs, crossed by concentric, slightly lamellose, growth lines; margin coarsely crenulated by radial ribs; no external ligament, internal resilium between beaks; colour whitish with yellow brown periostracum and black staining around umbos.

HABITAT. Dredged from 10 m on bottom of cobbles, gravel and coarse sand, and from 10–15 m on cobbles encrusted with calcareous red algae; uncommon. Ramorino (1968) found densities of up to 155 per m^2 in the Bahía de Valparaíso, on sandy mud at depths of 65–145 m. Reported from 25–135 m in the Magellan Strait (Linse, 1997).

RECORDS. Stations 7, 14 (3 specimens). Elsewhere Callao (Peru) to Magellan Strait (Soot-Ryen, 1959; Dell, 1964; Linse, 1997). Range: 12–54°S.

REMARKS. This species is extremely similar in external appearance to *Carditella tegulata*, which occurs in the same habitat. *Carditopsis flabellum flabellum* is recognized by the absence of an external ligament which, although small, is clearly visible behind the beaks of *Carditella tegulata*. A subspecies, *Carditopsis flabellum malvinae* (d'Orbigny, 1846), occurs in the Falkland Islands (Dell, 1964).

Family **MACTRIDAE**

Mulinia edulis (King & Broderip, 1832)

(Figure 4L)

Mactra edulis King & Broderip, 1832: 335.
Mulinia edulis – Soot-Ryen, 1959: 66. Osorio & Bahamonde, 1970: 205. Bernard, 1983: 40 (synonymy).
Mulinia byronensis (Gray, 1838) – Soot-Ryen, 1959: 65–66.
Mulinia sp. Osorio, Atria & Mann, 1979: 33–34, fig. 40.

DESCRIPTION. Shell to 77 mm; large, solid, rounded-trigonal, moderately inflated; sculpture smooth with strong concentric growth lines; hinge with large internal ligament in deep chondrophoral pit, cardinal teeth fused to form inverted V below beak; colour white, texture chalky, with yellow brown periostracum (usually eroded except near margin).

HABITAT. Living specimens partly buried in soft mud near low water level, on sheltered shores in brackish conditions (salinities 15–20 ‰), sometimes near freshwater stream outflows. This species is found at low tide in the Magellan Strait (Urban & Tesch, 1996) and on intertidal and subtidal sandbars, in sediments with a high silt and clay content, in the estuaries of southern Chile (Jaramillo, Mulson & Navarro, 1985; Gonzalez & Jaramillo, 1991).

RECORDS. Stations 20, 22, 25. Elsewhere Callao (Peru) to Magellan Strait (Soot-Ryen, 1959). Range: 12–54°S.

REMARKS. The taxonomy of this genus in southern South America is confused, as a result of variability in shell outline, and a revision is required (Soot-Ryen, 1959; Herm, 1969; Osorio *et al.*, 1979). The present specimens are most similar in shape to *M. byronensis* which is, however, probably only a form of the widespread *M. edulis*. Shells were present in the extensive shell middens of Isla Traiguén.

Family **PHARIDAE**

Ensis macha (Molina, 1782)

(Figure 5M)

Solen macha Molina, 1782: 203–204.
Ensis macha – Carcelles, 1950: 81, pl. 5, fig. 92. Soot-Ryen, 1959: 67. Osorio & Bahamonde, 1970: 206. Osorio, Atria & Mann, 1979: 34–35, fig. 41. Bernard, 1983: 41 (synonymy). von Cosel, 1990: 301.

DESCRIPTION. Shell estimated 130 mm (to 211 mm, NHM); thin-shelled, very elongate, slightly concave dorsally, margins parallel, ends truncated and gaping, beaks at extreme anterior end; sculpture smooth, with concentric growth lines; ligament external, hinge with 1 cardinal in right valve, 2 in left, 1 posterior lateral in each valve; colour white with strong yellow brown periostracum, eroded away at umbos, internally white.

HABITAT. Single broken dead shell dredged from 5–15 m on bottom of cobbles, mud and shell. This is a common deep-burrowing species found in fine sediments in shallow water in southern Chile, and has been reported at 2–10 m depth in sand and silt (Urban, 1994, 1996) and living in coarse sand at 13 m (to Soot-Ryen, 1959). Ramorino (1968) found juveniles in sand at 26 m in the Bahía de Valparaíso.

RECORDS. Station 1. Elsewhere Caldera to Magellan Strait (Soot-Ryen, 1959; Osorio & Bahamonde, 1970). Range: 27–54°S.

REMARKS. This is a commercially important edible species; the 1997 catch was 5361 tonnes (SERNAP, 1998). The family was more familiar by the name Cultellidae, but Pharidae has priority (von Cosel, 1990).

Family **SEMELIDAE**

Cumingia mutica Sowerby, 1833

(Figure 5G)

Cumingia mutica Sowerby, 1833b: 34. Soot-Ryen, 1959: 65. Olsson, 1961: 372, pl. 66, fig. 4. Osorio & Bahamonde, 1970: 205. Keen, 1971: 257, fig. 658. Dell, 1971: 176–177. Bernard, 1983: 46 (synonymy).

DESCRIPTION. Shell to 25 mm (to 30 mm, NHM); outline rounded anteriorly and produced posteriorly; sculpture of closely-spaced concentric growth lines with microscopic radial striae between; hinge with internal part of ligament attached to large cup-shaped chondrophore, cardinal teeth weak, strong lateral teeth in right valve only; colour white, with brown periostracum (worn away except near margin).

HABITAT. Dead valves dredged from 5–15 m on bottoms of cobbles, gravel and coarse sand; uncommon. Other authors have recorded this species intertidally on sandy mud (Sowerby, 1833b; Soot-Ryen, 1959) and to a depth of 18 m (Dell, 1971).

RECORDS. Stations 1, 7, 14. Elsewhere Guayaquil (Ecuador) to I. Wellington (Soot-Ryen, 1959; Dell, 1971). Range: 2–49°S.

Family **PSAMMOBIIDAE**

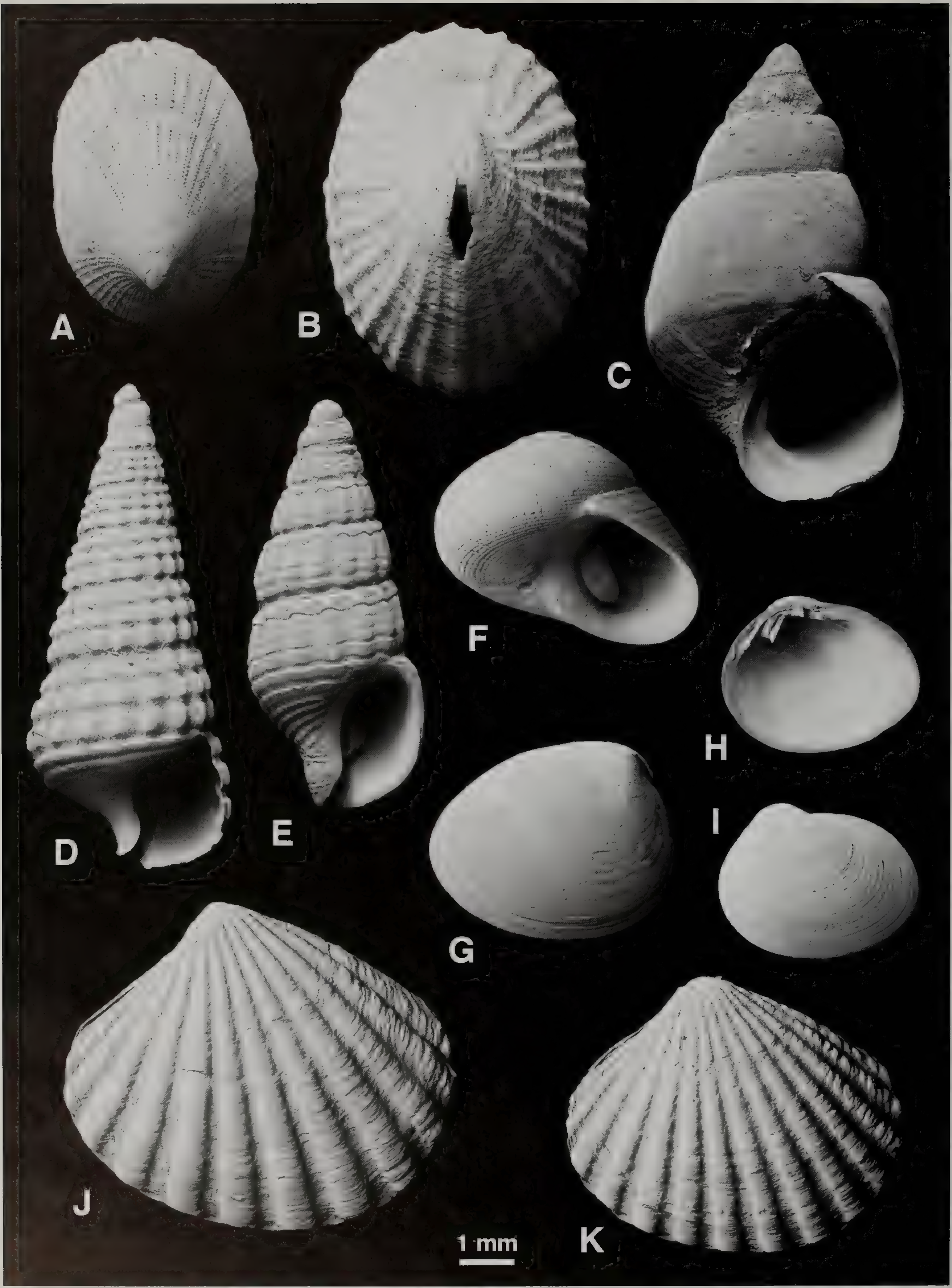
Tagelus (Tagelus) dombeii (Lamarck, 1818)

(Figure 5K)

Solen dombeii Lamarck, 1818: 454.
Tagelus dombeii – Soot-Ryen, 1959: 61–62. Osorio & Bahamonde, 1970: 204. Osorio, Atria & Mann, 1979: 32, fig. 37. Bernard, 1983: 48 (synonymy).
Tagelus (Tagelus) dombeii – Olsson, 1961: 351, pl. 62, figs 1, 1a, 5 (synonymy).

DESCRIPTION. Shell to 82 mm (to 90 mm, Olsson, 1961); narrowly elongate, dorsal and ventral margins almost parallel, ends rounded, valves gaping at either end, beaks central; sculpture smooth with fine concentric growth lines; hinge weak, 2 cardinal teeth in right valve, 1 in left; colour purple to brown with paler rays radiating from umbo, chalky white when eroded, covered by strong brown periostracum, often eroded at umbos, interior white to purple.

HABITAT. Dead shells common on sheltered beaches of silty sand. This is a deep-burrowing bivalve found in sand and silt (Urban, 1994, 1996). Its distribution is mainly intertidal, with records down to depths of 16 m (Soot-Ryen, 1959) and 37 m (Ramorino, 1968).


A
B
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1 mm
K

RECORDS. Stations 1, 6. Elsewhere El Lagartillo (Panama) to Golfo Corcovado (Olsson, 1961; Soot-Ryen, 1959), extended southward by the present record. Range: 8°N–46°S.

REMARKS. This is a commercial edible species; the 1997 catch was 4316 tonnes (SERNAP, 1998).

Family **VENERIDAE**

Venus antiqua King & Broderip, 1832

(Figure 5I)

Venus antiqua King & Broderip, 1832: 336. Fischer-Piette, 1975: 24–25 (synonymy).
Protothaca antiqua – Carcelles, 1950: 80, pl. 5, fig. 86.
Ameghinomya antiqua – Soot-Ryen, 1959: 54–55, pl. 3, figs 22, 23. Osorio & Bahamonde, 1970: 202. Dell, 1971: 175–176 (synonymy). Osorio, Atria & Mann, 1979: 29–30, fig. 32. Bernard, 1983: 51 (synonymy).
Protothaca antiqua antiqua – Herm, 1969: 123, pl. 10, figs 2–4, pl. 11, figs 1, 2.
Venus antiqua antiqua – Osorio, Frassinetti & Bustos, 1983: 49–56, figs 1–11 (synonymy).

DESCRIPTION. Shell to 76 mm; rounded, inflated; sculpture of numerous strong radial ribs, crossed by fine concentric lamellae, the lamellae more strongly raised on anterior and posterior slopes; lunule in front of beaks outlined by deeply incised line; hinge strong, three cardinal teeth in each valve; margin crenulated internally; pallial sinus small; colour cream to pale brown, sometimes marked by tessellated or fine radial chevron pattern in small shells, interior cream.

HABITAT. On silty sand at low water on sheltered beach; common embedded in gravel under stones in rock pools in low eulittoral on moderately sheltered rocky shore; abundant in gravel in shallow channel with strong tidal currents, 1.5 m depth at high tide; dredged from 7–15 m depth on bottoms of cobbles and silt; found living at salinities down to 15–20‰. This is a dominant member of intertidal and shallow subtidal soft-bottom communities in southern Chile, and is typically found shallowly buried in mixed silty and stony substrates (Urban, 1994) and in gravelly muddy sand (Clasing, Brey, Stead, Navarro & Asencio, 1994). It has been recorded down to depths of 18–25 m (Soot-Ryen, 1959; Dell, 1971) and 65 m (Ramorino, 1968).

RECORDS. Stations 1, 7, 14, 15, 22, 25, 26. Elsewhere Callao (Peru) to Tierra del Fuego (Soot-Ryen, 1959; Osorio *et al*., 1983). Range: 12–55°S.

REMARKS. This species shows variability in shell outline and degree of development of sculpture. It is an important edible species and is the major component of 'almejas' (including other large venerid bivalves), of which the 1997 harvest was 12475 tonnes, largely from Isla Chiloé (SERNAP, 1998). It is an abundant component of shell middens on Isla Traiguén and freshly dead shells indicate that collection for food continues on a small scale in the area. We do not advocate use of the subspecific epithet, since the description of the only 'subspecies' (*P. antiqua tongoyensis* Herm, 1969) does not conform to the requirements of either geographical or stratigraphic separation from the typical form. We follow Fischer-Piette (1975) in assigning this species to the genus *Venus*, and we confirm that the date of publication of the original description by King & Broderip is 1832.

Retrotapes exalbidus (Dillwyn, 1817)

(Figure 5J)

Venus exalbida Dillwyn, 1817: 170.
Samarangia exalbida – Carcelles, 1944: 287, pl. 12, figs 93, 94. Carcelles, 1950: 80, pl. 5, fig. 87.
Eurhomalea exalbida – Soot-Ryen, 1959: 59. Dell, 1964: 219 (synonymy). Osorio & Bahamonde, 1970: 203. Fischer-Piette & Vukadinovic, 1977: 106–107 (synonymy). Osorio, Atria & Mann, 1979: 30–31, fig. 34.
Retrotapes exalbida – del Río, 1997: 80–82, figs 22, 23, 41.

DESCRIPTION. Shell to 85 mm (to 106 mm, NHM); large, heavy venerid; sculptured by raised concentric lamellae, regularly-spaced 1–2 mm apart on young shells, becoming crowded on larger shells, lunule in front of beaks outlined by groove; internal margin smooth; hinge with 3 strong cardinal teeth in each valve; colour cream to brownish, interior white.

HABITAT. Two dead valves dredged from 10–15 m on bottoms of cobbles, gravel and coarse sand. It has been found living in the low intertidal zone in the Magellan Strait (Urban & Tesch, 1996), Carcelles (1950) gave a depth range of 5–115 m, and Dell (1964) recorded specimens from 147 m in the Falkland Islands.

RECORDS. Stations 7, 14. Elsewhere I. Chiloé to Cape Horn (Carcelles & Williamson, 1951; Fischer-Piette & Vukadinovic, 1977). Range: 42–56°S.

REMARKS. The shell outline and regularity of sculpture are both variable in this species (Carcelles, 1944; Dell, 1964). This species has recently been assigned to the new genus *Retrotapes* by del Río (1997); we note that since the Latin noun *tapes* is masculine, *Retrotapes* should take the same gender. It is an edible species, a component of 'almejas' (see *V. antiqua*).

Tawera gayi (Hupé, 1854)

(Figure 5H)

Venus gayi Hupé, 1854: 337, malacologia pl. 6, fig. 5a–c.
Clausinella gayi – Carcelles, 1944: 287, pl. 13, figs 97, 98. Carcelles, 1950: 80, pl. 5, fig. 88. Soot-Ryen, 1959: 58, pl. 3, figs 26, 27 (synonymy). Herm, 1969: 126, pl. 12, figs 7, 8.
Tawera gayi – Osorio & Bahamonde, 1970: 203. Dell, 1971: 175. Fischer-Piette & Vukadinovic, 1977: 39–40, fig. 8 (synonymy). Bernard, 1983: 53 (synonymy).

DESCRIPTION. Shell to 12 mm (to 39 mm, Carcelles, 1944); rounded outline; sculptured by fine concentric ridges, of which a few become irregular and anastomose on anterior and posterior slopes, lunule in front of beaks outlined by groove; inner margin crenulated; hinge with three strong cardinal teeth in each valve; colour cream to pale brown, interior white.

HABITAT. Two dead valves dredged from 10–15 m on bottoms of cobbles, gravel and coarse sand. Recorded from the tidal zone and

Fig. 7 Scanning electron micrographs of Gastropoda and Bivalvia. **A.** *Iothia coppingeri*. **B.** *Puncturella (Puncturella) conica*. **C.** *Nodilittorina araucana*. **D.** *Eumetula pulla*. **E.** *Glypteuthria meridionalis*. **F.** *Homalopoma cunninghami*. **G.** *Nucula (Nucula) pisum*. **H, I.** *Lasaea miliaris*. **J.** *Carditella tegulata*. **K.** *Carditopsis flabellum flabellum*. (All specimens from study area; NHM collection).

down to 40 m by Soot-Ryen (1959), 65 m (Ramorino, 1968), 5–10 m (Urban & Tesch, 1996) and to 219 m (Linse, 1997).

RECORDS. Stations 7, 14. Elsewhere Coquimbo to Tierra del Fuego (Fischer-Piette & Vukadinovic, 1977). Range: 30–56°S.

Family **HIATELLIDAE**

Hiatella solida (Sowerby, 1834)

(Figure 5L)

Saxicava solida Sowerby, 1834: 88–89.
Hiatella solida – Soot-Ryen, 1959: 67–68. Olsson, 1961: 425, pl. 77, fig. 6, 6a. Dell, 1964: 224–226 (synonymy). Osorio & Bahamonde, 1970: 206. Dell, 1971: 177–178. Marincovich, 1973: 14–15, fig. 22. Bernard, 1983: 59. Gordillo, 1995: 193–195, fig. 5.

DESCRIPTION. Shell 12 mm (to 46 mm, Dell, 1964); irregularly elongate rectangular, often distorted by nestling habit, sometimes with a strong keel running from umbo to postero-ventral margin, gaping posteriorly; sculpture of irregular growth lines; hinge often weak, ligament external; colour white with thin periostracum.

HABITAT. Single specimen in *Macrocystis* holdfast at 3–5 m depth. This species has been reported from a wide range of habitats. In the Beagle Channel, it is found attached by byssus on rocky shores, among *Mytilus* clusters, nestling in sand and gravel at low water and subtidally in *Macrocystis* holdfasts (Gordillo, 1995). On hard rock substrates it adopts a nestling habit in crevices, but on soft rock and on calcareous shells (e.g. of *Concholepas concholepas*) it becomes a shallow borer (Gallardo & Osorio, 1978). In the Falkland Islands it has been recorded from the sublittoral fringe to depths of over 350 m (Dell, 1964).

RECORDS. Station 22. Elsewhere the distribution is unclear owing to taxonomic uncertainty, but Soot-Ryen (1959) gives Ecuador to Cape Horn, and Olsson (1961) has a record from the Pearl Islands (Panama). Range: 8°N–56°S.

REMARKS. As discussed by Dell (1964) the taxonomy of this genus is confused, because of variation in shell outline and hinge development. Although he concluded that *H. antarctica* (Philippi, 1845) was a synonym of *H. solida*, others have maintained the two as distinct taxa (Osorio & Bahamonde, 1970; Bernard, 1983). During this study abundant fossil specimens (up to 36 mm), were found in the eroding clay cliff of a raised beach on the southwestern side of Isla Rojas.

Family **TEREDINIDAE**

Bankia (Bankia) martensi (Stempell, 1899)

(Figure 5N–P)

Teredo (Xylotrya) martensi Stempell, 1899: 240, pl. 12, figs 24–27.
Bankia martensi – Turner, 1966: 109, pl. 48, fig. D, pl. 61, figs A–C, pl. 62, figs A, B (synonymy).
Bankia (Bankia) martensi – Soot-Ryen, 1959: 70. Osorio & Bahamonde, 1970: 207. Osorio, Atria & Mann, 1979: 36, fig. 44. Bernard, 1983: 62.

DESCRIPTION. Animal to approx. 150 mm, shell to 8 mm, pallets to 35 mm; body elongate, worm-like, enclosed in calcareous tube bored into wood; shell (Fig. 5N) at anterior end, reduced, file-like surface, white with thin brown periostracum; pair of calcareous pallets protect siphons at posterior end; pallet (Fig. 5O) composed of central stalk with numerous cone-like elements with fringed border, each cone extending laterally as a point.

HABITAT. A wood-boring species, abundant in logs in the intertidal zone, recorded down to salinity of 20‰. Reported from the intertidal to a depth of 55 m (Soot-Ryen, 1959).

RECORDS. Stations 1, 7, 20, 25. Elsewhere Seno Reloncaví to Magellan Strait (Soot-Ryen, 1959). Range 41–54°S.

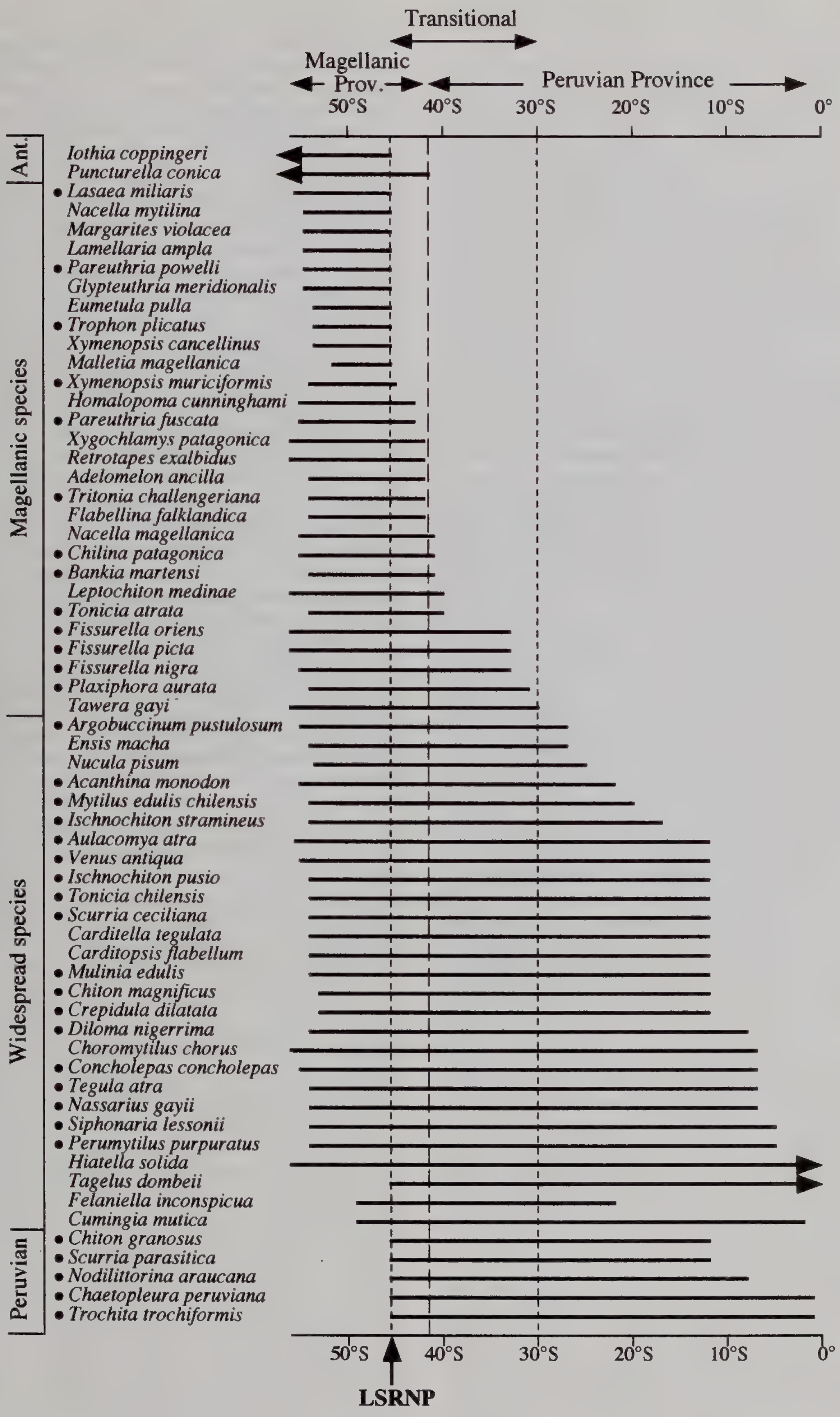
DISCUSSION

Ecology and distribution of molluscs in the study area

During our survey we recorded a total of 62 species of molluscs during shore collecting and dredging from depths of 5 to 15 m. For a region at this latitude (46°S) this is not a large number. In part, this paucity may be explained by the pronounced salinity gradient along the length of the fjord system. Within the Laguna San Rafael, subject to meltwater from the San Rafael Glacier, we recorded surface salinities of 14–15‰ (to 17‰, Davenport *et al.*, 1995), and found but three mollusc species. In the higher and more variable salinity regime of the Golfo Elefantes (surface salinity 15–21‰, at 15 m almost certainly greater) the records rose to 18 species. Only in the main Estero Elefantes were fully marine habitats present (27–33‰) and in such habitats our total was 56 species. The most euryhaline of the species was *Mytilus edulis chilensis*, occurring abundantly at almost all stations, down to a salinity of 5‰ (station 28). Other euryhaline species were those found on the shore (and therefore subject to the low surface water salinity) in the Golfo Elefantes: *Plaxiphora aurata*, *Nacella magellanica*, *Siphonaria lessonii*, *Perumytilus purpuratus*, *Aulacomya atra*, *Mulinia edulis* and *Bankia martensi*. The only species restricted to areas of low salinity were *Chilina patagonica* (5–15‰) and *Malletia magellanica* (14–21‰).

A striking aspect of this molluscan fauna was the dominance of mytilid bivalves in a range of intertidal and shallow sublittoral habitats. Most abundant was the euryhaline *Mytilus edulis chilensis*, forming dense beds in the mid to lower eulittoral on both exposed and sheltered shores, and on exposed shores providing a microhabitat for the limpets *Scurria parasitica* and *Siphonaria lessonii*. *Perumytilus purpuratus* generally occurred with *Mytilus edulis chilensis* on the upper shore, and was most common in sheltered sites with freshwater influence. *Aulacomya atra* also formed dense beds in the low eulittoral and sublittoral on wave-exposed coasts, and was probably common in the sublittoral of shelted sites (where

Fig. 8 Compilation of known geographical ranges for the molluscs recorded in our survey of the Laguna San Rafael, Golfo Elefantes and Estero Elefantes (see text for sources; 46°S latitude of survey area indicated as LSRNP). Superimposed are the biogeographical provincial boundaries of Brattström & Johanssen (1983). Antarctic species are those extending south of the Antarctic convergence; Magellanic species are those found only between Cape Horn and the northern limit of the transitional zone (56–30°S); Peruvian species are those found only within the Peruvian Province and transitional zone (2–46°S); widespread species are those found in both Magellanic and Peruvian Provinces and (in two cases) extending north of the equator. Arrows indicate ranges extending beyond the limits shown. Species occurring in the littoral zone and sublittoral fringe are indicated by dots. Note that *Xymenopsis cancellinus* is a junior synonym of *X. subnodosus*


Transitional
Magellanic Prov.
Peruvian Province
50°S
40°S
30°S
20°S
10°S
0°
Ant.
Magellanic species
Widespread species
Peruvian
Iothia coppingeri
Puncturella conica
• Lasaea miliaris
Nacella mytilina
Margarites violacea
Lamellaria ampla
• Pareuthria powelli
Glypteuthria meridionalis
Eumetula pulla
• Trophon plicatus
Xymenopsis cancellinus
Malletia magellanica
• Xymenopsis muriciformis
Homalopoma cunninghami
• Pareuthria fuscata
Xygochlamys patagonica
Retrotapes exalbidus
Adelomelon ancilla
• Tritonia challengeriana
Flabellina falklandica
Nacella magellanica
• Chilina patagonica
• Bankia martensi
Leptochiton medinae
• Tonicia atrata
• Fissurella oriens
• Fissurella picta
• Fissurella nigra
• Plaxiphora aurata
Tawera gayi
• Argobuccinum pustulosum
Ensis macha
Nucula pisum
• Acanthina monodon
• Mytilus edulis chilensis
• Ischnochiton stramineus
• Aulacomya atra
• Venus antiqua
• Ischnochiton pusio
• Tonicia chilensis
• Scurria ceciliana
Carditella tegulata
Carditopsis flabellum
• Mulinia edulis
• Chiton magnificus
• Crepidula dilatata
• Diloma nigerrima
Choromytilus chorus
• Concholepas concholepas
• Tegula atra
• Nassarius gayii
• Siphonaria lessonii
• Perumytilus purpuratus
Hiatella solida
Tagelus dombeii
Felaniella inconspicua
Cumingia mutica
• Chiton granosus
• Scurria parasitica
• Nodilittorina araucana
• Chaetopleura peruviana
• Trochita trochiformis
50°S
40°S
30°S
20°S
10°S
0°
LSRNP

dense *Macrocystis* beds made sampling difficult). The large mussel *Choromytilus chorus* was not found alive, but probably occurred in the shallow sublittoral.

The giant kelp *Macrocystis* provides a habitat for a characteristic association of molluscs in the Magellanic region. During our survey we found *Leptochiton medinae*, *Plaxiphora aurata*, *Fissurella oriens*, *Aulacomya atra* and *Hiatella solida* in the holdfasts, and a similar fauna has been recorded from holdfasts further south, in the Beagle Channel (Ojeda & Santelices, 1984; but also including *Pareuthria*, *Xymenopsis* and a cerithiopsid). However, on the kelp lamina we found molluscs to be very scarce, and only occasional specimens of *Nacella mytilina*, *Fissurella oriens* and *Flabellina falklandica* were encountered. In the Beagle Channel the kelp lamina supports a larger community of molluscs, of which the most characteristic are *Nacella mytilina*, *Margarella violacea*, *Chlamys vitrea* (King & Broderip, 1832) and *Gaimardia trapesina* (Lamarck, 1819) (King & Broderip, 1832; Castilla, 1985; Waloszek, 1984; D.G. Reid, pers. obs.).

During our survey we did not neglect to examine trawled sediment and washings from intertidal algae for the presence of small molluscs. Nevertheless, no small rissoiform gastropods were found. This is surprising in view of the 23 species, many of them intertidal, belonging to the families Eatoniellidae, Cingulopsidae and Rissoidae that were recorded from southern Chile and Tierra del Fuego by Ponder & Worsfold (1994). Possibly the low and fluctuating salinity of large parts of the Estero Elefantes fjord system might be connected with the apparent scarcity of small gastropod species in the shallow-water habitats that we examined.

Biogeographical affinities of the molluscs

Many different authors have discussed the marine biogeographical 'provinces' of the west coast of South America, basing their classifications on various taxonomic groups, ecological systems and depth ranges. Those who have referred specifically to molluscs include Dall (1909), Carcelles & Williamson (1951), Stuardo (1964), Dell (1971), Marincovich (1973) and Viviani (1979), and their conclusions have been summarized, and their data enlarged, by Brattström & Johanssen (1983). In general there is agreement that two provinces can be recognized to the south of the tropical zone; a northern warm-temperate Peruvian Province south of about 2–6°S, and a southern cold-temperate Magellanic Province from the southern tip of the continent northwards. The boundary between these two provinces has most often been placed at the northern end of Isla Chiloé (about 42°S), where numerous marine invertebrates show their distributional end points. Nevertheless, most authors have recognized that the division is not a sharp one, and that there is a broad area of overlap between species that are typical of each province, so that a transitional zone can be defined, lying between 30 and 46°S (Brattström & Johanssen, 1983). Regional classifications of this kind are susceptible to incomplete data and to problems of sampling. They are also necessarily somewhat artificial, since the geographical ranges of different taxa can be determined by various environmental and biological factors, and influenced by their different histories and dispersal capabilities. Nevertheless, they can provide a useful summary of distributional data.

In this context, our study area is of interest since it lies at the southern end of the transitional zone (46°S), and in a region of the Chilean coastline for which distributional data for molluscs is poor. Most previous studies of Chilean molluscs have concentrated upon the far south, the Magellan Strait and Tierra del Fuego, and on areas further to the north, including Isla Chiloé (see Introduction). Therefore, it is not surprising that of the 62 species we have recorded from the Laguna San Rafael and Estero Elefantes, 17 (27%) are extensions to the known ranges. In the Systematic Descriptions we have reviewed the published information on the geographical ranges of these 62 species, and these are tabulated in Figure 8, with the provincial boundaries of Brattström & Johanssen (1983) superimposed. Clearly, these data cannot be used in isolation to judge the validity of biogeographic boundaries, since the sampling of species is restricted to those occurring in one locality, and is not representative of the entire Chilean coastline. They do, however, add new information to the previous compilation and demonstrate the biogeographic affinities of the fauna we have studied.

In Figure 8 we have divided the species into four categories: Antarctic (extending south of the Antarctic convergence), Magellanic (from Cape Horn up to and including the transitional zone, 30–56°S), widespread (occurring both south and north of the transitional zone, including two species extending north of the equator) and Peruvian (occurring in the Peruvian Province up to and including the transitional zone, 1–46°S). The predominantly southern (Magellanic) character of the fauna is apparent, since 30 species (48%) are strictly Antarctic or Magellanic, and a further 26 of the widespread species (42%) extend also to the south of our study area. Only five of the species (8%) are strictly Peruvian. Furthermore, our records are the northernmost for 11 species, and the southernmost for only 6 species. In their compilation of the distributions of marine invertebrates along the western coast of South America, Brattström & Johanssen (1983) included 99 molluscan species; their list was biased towards the better known Peruvian species, supporting their assertion that the invertebrate fauna of Chile as a whole was predominantly northern in character and origin. These authors included only seven Magellanic molluscs with northern limits at or to the south of Isla Chiloé (42°S). To these our records add a further 15 species with northern limits between 42–46°S, thus emphasizing the importance of the southern component of the Chilean fauna, and of this region as a distributional boundary for many molluscs.

As pointed out by Brattström & Johanssen (1983) the biogeographical composition of the Chilean invertebrate fauna varies with depth, the southern (Magellanic) component becoming more pronounced in deeper water. Since the water is colder at depth, sublittoral Magellanicspecies penetrate further north into the transitional zone than strictly intertidal species. This trend is also evident in our data (Fig. 8). Of the 26 species found only in our samples dredged from 5–15 m, 65% were Magellanic and Antarctic, 35% widespread and none Peruvian. Of the remaining 36 species occurring in the eulittoral zone and sublittoral fringe, 39% were Magellanic, 47% widespread and 14% Peruvian.

Human exploitation of molluscs

Throughout much of the Chilean coastline the larger molluscs of intertidal and shallow subtidal habitats are heavily exploited for food by the local inhabitants (Osorio *et al.*, 1979; Moreno *et al.*, 1984; Duran *et al.*, 1987; SERNAP, 1998). Edible species found in the present survey were *Chiton granosus*, *Nacella magellanica*, *Fissurella nigra*, *F. oriens*, *F. picta*, *Tegula atra*, *Trochita trochiformis*, *Argobuccinum pustulosum ranelliforme*, *Concholepas concholepas*, *Mytilus edulis chilensis*, *Choromytilus chorus*, *Aulacomya atra*, *Zygochlamys patagonica*, *Mulinia edulis*, *Ensis macha*, *Tagelus dombeii*, *Venus antiqua* and *Retrotapes exalbidus*. Of these, only the bivalves and *Concholepas concholepas* are collected in commercial quantities elsewhere in Chile, and only the three large mytilids are cultivated. The exploitation of marine molluscs has a long history, for in precolonial times the indigenous people relied heavily upon them for food. Evidence of this was found on Isla Traiguén, where three extensive middens were examined (stations 4, 9, 10), the largest of which was about 100 m long and 5 m in depth. The age of these middens is unknown. They correspond to the ‘white middens’ described in the detailed survey of the archaeological sites of Isla Traiguén by Curry (in press), consisting largely of intact shells and fragments of *Aulacomya atra*, *Choromytilus chorus*, *Venus antiqua* and the large barnacle *Megabalanus psittacus*, together with a few shells of *Concholepas concholepas*, *Crepidula dilatata*, *Trochita trochiformis* and *Mulinia edulis*. Gathering of molluscs by local fishermen in the Estero Elefantes evidently continues, since we found collections of fresh shells of *Aulacomya atra*, *Choromytilus chorus*, *Concholepas concholepas* and *Venus antiqua* at several sites on the shore, although this appears to be on a small scale.

The exploitation of intertidal molluscs has implications not only for conservation, but also for the general ecology of rocky shores. At sites in central Chile, it has been demonstrated that where human interference is prevented there are marked changes in zonation and community structure. For example, *Fissurella* species become more common when no longer gathered for food, grazing down the previously abundant macroalgae such as *Iridaea*, and competing with another grazer, *Siphonaria lessonii* (Moreno *et al*., 1984; Godoy & Moreno, 1989; Duarte *et al*., 1996). The large mussel *Choromytilus chorus* is a prized species, so heavily exploited that it has disappeared from intertidal habitats in much of its range (Viviani, 1979), yet in a marine reserve an intertidal population soon became established (Moreno, 1995). The most valuable, and perhaps vulnerable, of the molluscs exploited in wild populations is *Concholepas concholepas*. When intertidal collection is prevented populations on the shore increase and include large adults that are elsewhere restricted to the sublittoral zone; furthermore, the dense beds of *Perumytilus purpuratus* and barnacles, both preyed upon by *Concholepas concholepas*, become dramatically depleted (Castilla & Durán, 1985; Moreno *et al*., 1986; Durán *et al*., 1987). Therefore, in areas of the Chilean coast with significant human impact the natural pattern of zonation is much altered. This emphasizes the importance of conservation of relatively untouched coastlines such as those of the Laguna San Rafael National Park and adjacent parts of the Chonos Archipelago.

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Remarks on the genera *Schizocuma* Băcescu, 1972 and *Styloptocuma* Băcescu & Muradian, 1974 (Crustacea, Cumacea)

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SYNOPSIS. Morphological data are presented to support the view that *Schizocuma* Băcescu, 1972 and *Styloptocuma* Băcescu & Muradian, 1974 are good genera. Both genera exhibited a mixture of characters found in *Cumella* and *Nannastacus*, but share more common with *Cumella*. *Schizocuma* and *Styloptocuma* appeared to have evolved in deeper waters, earlier than the rest of *Cumella* group, having separated from a common stem with the *Nannastacus* group.

INTRODUCTION

Schizocuma Băcescu and *Styloptocuma* Băcescu & Muradian are two deep-sea genera belonging to the family Nannastacidae. Currently available descriptions of the species in these genera are incomplete, lacking data on the mouthparts or one of the sexes. In the case of *Schizocuma vemae,* (known only from the holotype), the type material has been lost. Both *Schizocuma* and *Styloptocuma* have been subjects of systematic revisions by authors who have either totally or partially invalidated them (Jones 1984, Watling 1991), or considered them to be good genera (Băcescu 1992, Holthuis 1990).

This study is based entirely on material loaned to the author by the Department of Zoology of the Natural History Museum, London.

MATERIALS AND METHODS

The material examined consists of non type specimens of 8 species, 7 of which were described by Jones (1984); all were previously identified by him and included in the genus *Cumella*. These specimens were collected by different research vessels of Woods Hole Oceanographic Institute.

Cumella acuminatum Jones, 1984 1992:700:30
86 specimens (females and immature males); collecting data – Atlantis II 31, sta.156, 0° 46' S 29° 28' W, 3459 m, 14.2.1967.

Cumella antipai (Băcescu & Muradian, 1974) 1992:678:10
13 females, 3 males (2 adults and 1 immature); collecting data – Knorr 25, sta.293, 8° 58' N 50° 04.3' W, 1518 m, 27.2.1972.

Cumella bishopi Jones, 1984 1992:677:30
44 females, 38 males (22 adults and 16 immatures); collecting data – Knorr 25, sta.293, 8° 58' N 50° 04.3' W, 1518 m, 27.2.1972.

Cumella dayae Jones, 1984 1992:684:36
22 females, 17 males (5 adults and 12 immatures); collecting data – Atlantis II 60, sta. 245, 36° 35.7' S 53° 01' W, 2707 m, 14.3.1971.

Cumella echinata Jones, 1984 1992:685:20
18 females, 4 males; collecting data – Chain 106, sta. 313, 51° 32.2' N 12° 35.9' W, 1500 m, 17.8.1972.

Cumella formosa Jones, 1984 1992:676:4
3 females, 1 immature male, 1 manca; collecting data – Atlantis II 60, sta. 245, 36° 55.7' S 53° 61.4' W, 2707 m, 14.3.1971.

Cumella spinoculata Jones, 1984 1992:783:7
3 females, 2 males and 2 juv.; collecting data – Chain 106, sta. 313, 51° 32.2' N 12° 35.9' W, 1500 m, 17.8.1972.

Cumella vemae (Băcescu & Muradian, 1974) 1992:777:4
1 female, 2 immature males; collecting data – Atlantis II 31, sta.167, 7° 58' S 34° 17' W, 1007 m, 20.2.1967.

13 specimens in glycerine-alcohol on slides were dissected for this study. Measurements were taken with an ocular micrometer, and all the slides are deposited in the collections of the Natural History Museum, London.

SYSTEMATIC REMARKS

Genus *SCHIZOCUMA* Băcescu, 1972

Schizocuma Băcescu, 1972: 246.
Cumella Jones, 1984: 210–211.
Schizocuma Watling, 1991: 755.
Schizocuma Băcescu, 1992: 258–259.

TYPE SPECIES. *Schizocuma vemae* Băcescu, 1972.

DIAGNOSIS. Carapace short (one-fifth the length of pleon with uropods), without carinae, with long hairs in males and dorsal spines in females (also on the ocular lobe); antero-ventral corner rounded or subacute, antero- inferior edge slightly serrated. Median ocular lobe incompletely subdivided. Branchial siphons separated, located medially to dorsolaterally; pseudorostral lobes widely separated. Pleonites long and thin, their length increasing distally up to the fifth, which is 5.5 times longer than broad. Pleotelson short. Antenna 1 without tubercle on 2nd article of peduncle, subequal in length or longer than 3rd, accessory flagellum 2-articulated. Antenna 2 with short flagellum. Pars incisiva of mandible with 4 teeth, lacinia mobilis, thin, with 3 teeth, not exceeding pars incisiva, five long plumose lifting setae between lacinia mobilis and truncated, robust, pars molaris. Maxilla 1 with simple robust acuminate setae on

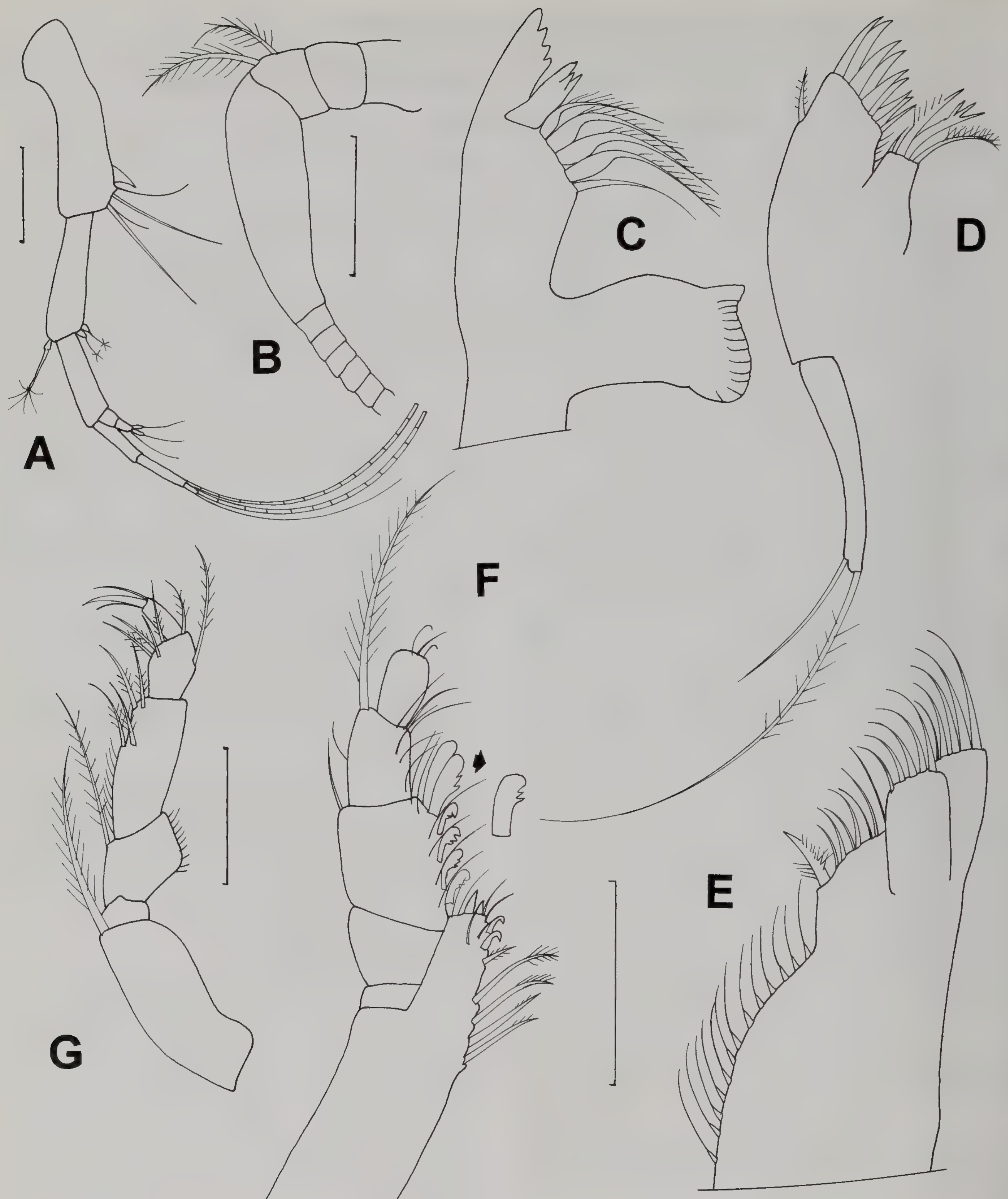

Fig. 1 *Schizocuma spinoculatum* (Jones, 1984) immature male A. antenna 1; B. antenna 2; C. mandible; D. maxilla 1; E. maxilla 2; F. maxilliped 1; G. maxillipd 2. Scale bars (in mm): A 0.1; B 0.2; C–F 0.1; G 0.1.

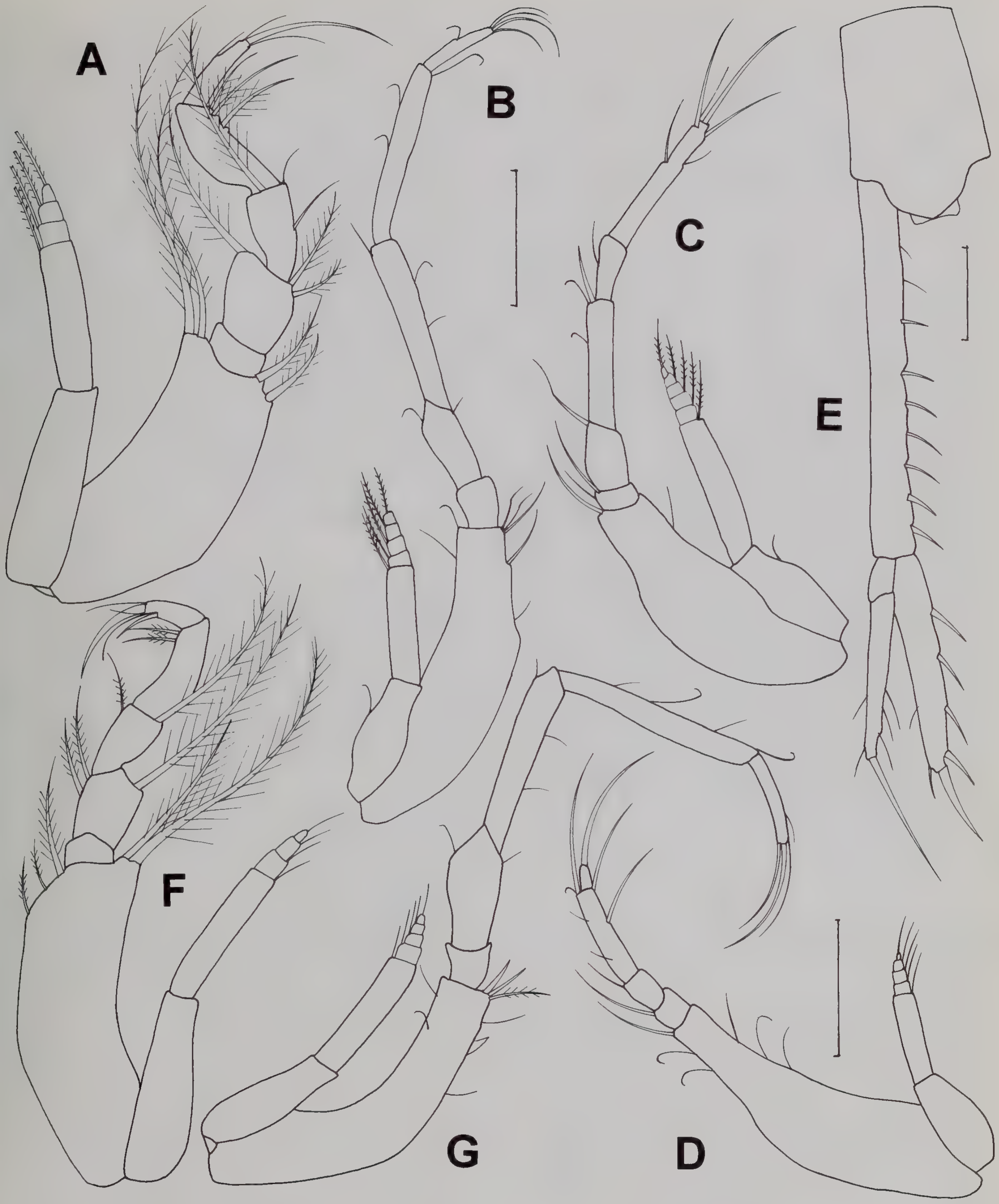

Fig. 2 *Schizocuma spinoculatum* (Jones, 1984) A–E. immature male; F, G. female A. maxilliped 3; B. pereopod 1; C. pereopod 2; D. pereopod 3; E. uropod; F. maxilliped 3; G. pereopod 1. Scale bars (in mm): A, E 0.1; B, C, F, G 0.2; D 0.2.

protopod, palp with 2 filaments. Maxilla 2 with two endites, fine simple setae on endites and outer margins of protopod. Basis of maxilliped 1 with an outer endite not exceeding merus, carpus with flattened hand-like setae on outer margin of carpus, rounded, enlarged dactylus. Basis of maxilliped 2, longest article, merus bulky, carpus longer than all articles excepting basis, with short plumose setae on outer margin, dactylus with an apical claw. Maxilliped 3 with short inner process. Exopods on maxilliped 3 and pereopods 1–2 in females and on maxilliped 3 and pereopods 1–4 in males. Uropod peduncle much longer than pleonite 6 and its rami, uropod exopod basal article normal, endopod as long as, or slightly longer than exopod.

GENDER. Neuter.

ADDITIONAL SPECIES. *Schizocuma calmani* (Stebbing, 1912), *S. molossa* (Zimmer, 1907), *S. spinoculatum* (Jones, 1984), *S. spinosum* (Jones, 1984).

REMARKS. Băcescu (1972) considered *Schizocuma* to be distinguishable from *Cumella* only by the separated siphons and slenderness and elongation of the body and appendages. Jones (1984) argued that there is a gradation in body and appendage form and there are not sufficient criteria to recognise *Schizocuma* as a separate genus. Watling (1991) added to the characters presented by Băcescu, including dorso-lateral pseudorostral lobes and unique ocular lobe, and considered *Schizocuma* as a valid genus. The study of the mandible and maxilliped 1 revealed that there are also distinctive characters that clearly separate *Schizocuma* from *Cumella*: pars incisiva of mandible with 4 teeth (versus 3 in *Cumella*), dactylus of maxilliped 1 rounded and enlarged versus acuminate and small in *Cumella*. These last characters and the separated pseudorostral lobes and siphons are more similar to the *Nannastacus* group (*Nannastacus*, *Scherocumella*, *Schizotrema*), but the others (unique eye lobe, peduncle of antenna 1 without tubercle, maxilliped 2 with slender plumose setae on propodus, uropods with long peduncles) are more like *Cumella*. Watling (1991) mentioned in the list of the additional species of this genus the species *Schizocuma divisa* (Jones, 1984). In my opinion this species belongs to the genus *Cumella* (as described by Jones) because of its non-separated siphons, fairly short pleon and a uropodal peduncle 1.5 longer than its rami (shorter than in *Schizocuma*).

Schizocuma spinoculatum (Jones, 1984)

Figs 1, 2

Cumella spinoculata Jones, 1984: 219–220.
Schizocuma spinoculata Watling, 1991: 755.
Schizocuma spinoculatum Băcescu, 1992: 258–259.

DESCRIPTION. To the original description I am adding add the following morphological data on the immature male (not mentioned by Jones). Antenna 1 (Fig. 1 A) with spine on 1st article of peduncle, 2nd article a little longer than 3rd, accessory flagellum 2-articulate. Antenna 2 (Fig. 1 B) characteristic for an older stage, with short flagellum, but most articles well developed. Mandible (Fig. 1 C), pars incisiva with 4 teeth, lacinia mobilis with 3 teeth, robust pars molaris with a tooth-like process on its distal outer corner. Maxilla 1 (Fig. 1 D), protopod with 9 acuminate setae, palp with 2 unequal filaments, the longest backwardly setulated in its proximal half. Maxilla 2 (Fig. 1 E) with simple setae on endites that exceed protopod and margins of protopod. Maxilliped 1 (Fig. 1 F), with endite of basis not exceeding extremity of merus, with strong plumose setae, acuminate setae and retinacula; flattened hand-like setae on outer margin of carpus, with rounded extremity; propodus a little longer than dactylus (propodus/dactylus= 1.4), rounded and enlarged dactylus with few apical setae. Maxilliped 2 (Fig. 1 G), basis a third of the entire maxilliped, bulky merus, carpus, the longest article excepting basis, propodus with plumose setae on outer distal corner, dactylus as long as his strong claw. Maxilliped 3 (Fig. 2 A), basis, stronger than in female, with a very short inner process. Pereopod 1 (Fig. 2 B), basis without spines as in female, carpus as long as propodus. Pereopod 2 (Fig. 2 C), with stronger basis, a stiff acuminate seta on outer distal corner of carpus (fine, simple setae in female), dactylus a little longer than in female (dactylus/propodus= 2.5). Pereopod 3 (Fig. 2 D), basis longer than half of pereopod, dactylus with long terminal seta. Uropod (Fig. 2 E), peduncle much longer than last pleonite (1.85) and its rami (1.80), exopod a little shorter than endopod, with a terminal seta, endopod with 4 short setae on inner margin and a terminal robust short one.

Jones (1984) description of the female is amended to include the following details: Maxilliped 3 (Fig. 2 F), basis with short inner process, merus also without any process, a little longer than dactylus, dactylus with an apical, strong, claw, longer than the article. Pereopod 1 (Fig. 2 G), basis shorter than half of the entire pereopod, 2 acuminate setae on distal outer corner, carpus shorter than propodus, dactylus with a claw longer than it. Pereopod 2 (Fig. 2 G), basis shorter than half of the entire pereopod, dactylus 2.4 times longer than propodus, with short simple terminal setae.

Schizocuma vemae Băcescu, 1972

Figs 3, 4

Schizocuma vemae, Băcescu, 1972: 246.
Cumella vemae, Jones, 1984: 214
Schizocuma vemae, Watling, 1991: 755
Schizocuma vemae, Băcescu, 1992: 258–259.

DESCRIPTION. To the description of the female in Jones (1984) the following additional observations: Carapace (Fig. 3 A) with one dorsal spine (up to 4 in Jones). Pereopod 1 (Fig. 3 B), basis shorter than half of entire pereopod, carpus a little shorter than propodus, dactylus shorter than its claw. Pereopod 2 (Fig. 3 C), basis shorter than half of entire pereopod, a stiff acuminate seta on outer distal corner of carpus as long as propodus, dactylus 4.3 times longer than propodus, with simple setae. Pereopod 3 (Fig. 3 D), with thin and long articles, basis as long as half of entire pereopod, carpus 3.2 times longer than propodus, dactylus with a long terminal seta. Uropod (Fig. 3 E), peduncle very long (4 times longer than last pleonite), peduncle/rami = 2.5; exopod as long as endopod, with a terminal seta, endopod with simple setae and subterminal acuminate seta on inner margin and a terminal, thin acuminate seta.

The description of an immature male by Băcescu (1972) was also incomplete. The following details are added: Antenna 1 (Fig. 3 F), peduncle articles long and thin, 2nd article longer than 3rd, accessory flagellum, 2-articulate, shorter than basal article of main flagellum. Antenna 2 (Fig. 3 G), characteristic of an immature male. Mandible (Fig. 3 H), pars incisiva with 4 teeth, lacinia mobilis with 3 teeth, robust, truncated pars molaris with a tooth-like process. Maxilla 1 (Fig. 4 A), protopod with 9 acuminate setae, palp with 2 unequal filaments, the longest one is backwardly setulated. Maxilla 2 (Fig. 4 B), as usual for the genus. Maxilliped 1 (Fig. 4 C), carpus with flattened hand-like setae with acute extremity, propodus 3.3 times longer than dactylus, dactylus with apical fine, small setae. Maxilliped 2 (Fig. 4 D), with robust articles, as is usual for the genus. Pereopod 3 (Fig. 4 E), carpus 2.5 times longer than propodus, dactylus with a long, curved acuminate seta. Pereopod 4 (Fig. 4 F), basis thinner, carpus longer than in the previous pair (3 times longer), dactylus

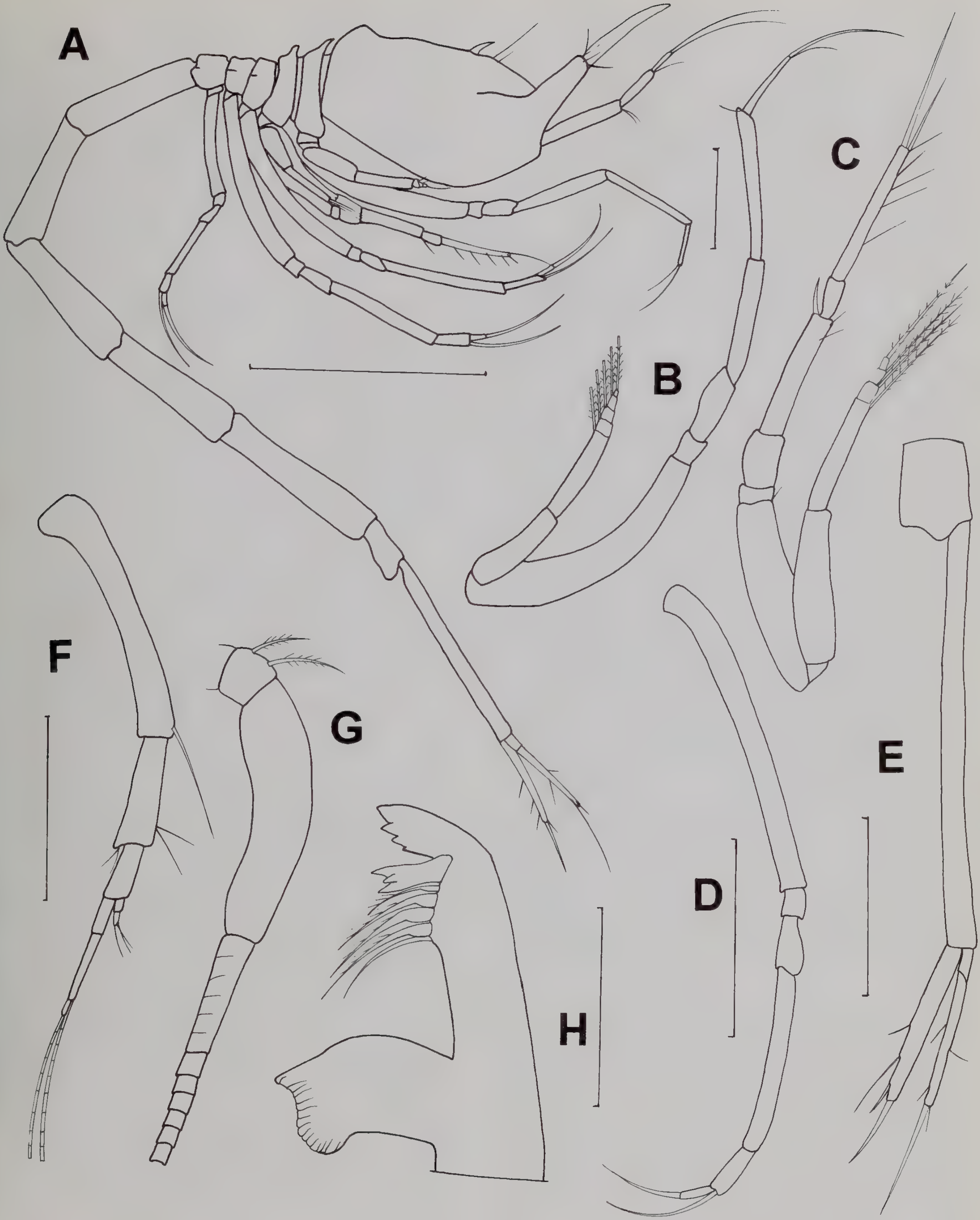

Fig. 3 *Schizocuma vemae* Băcescu, 1972 A–E. female; F–H. immature male A. body, lateral view; B. pereopod 1; C. pereopod 2; D. pereopod 3; E. uropod; F. antenna 1; G. antenna 2; H. mandible. Scale bars (in mm): A 1; B 0.25; C, D 0.3; E 0.3; F, G 0.2; H 0.1.

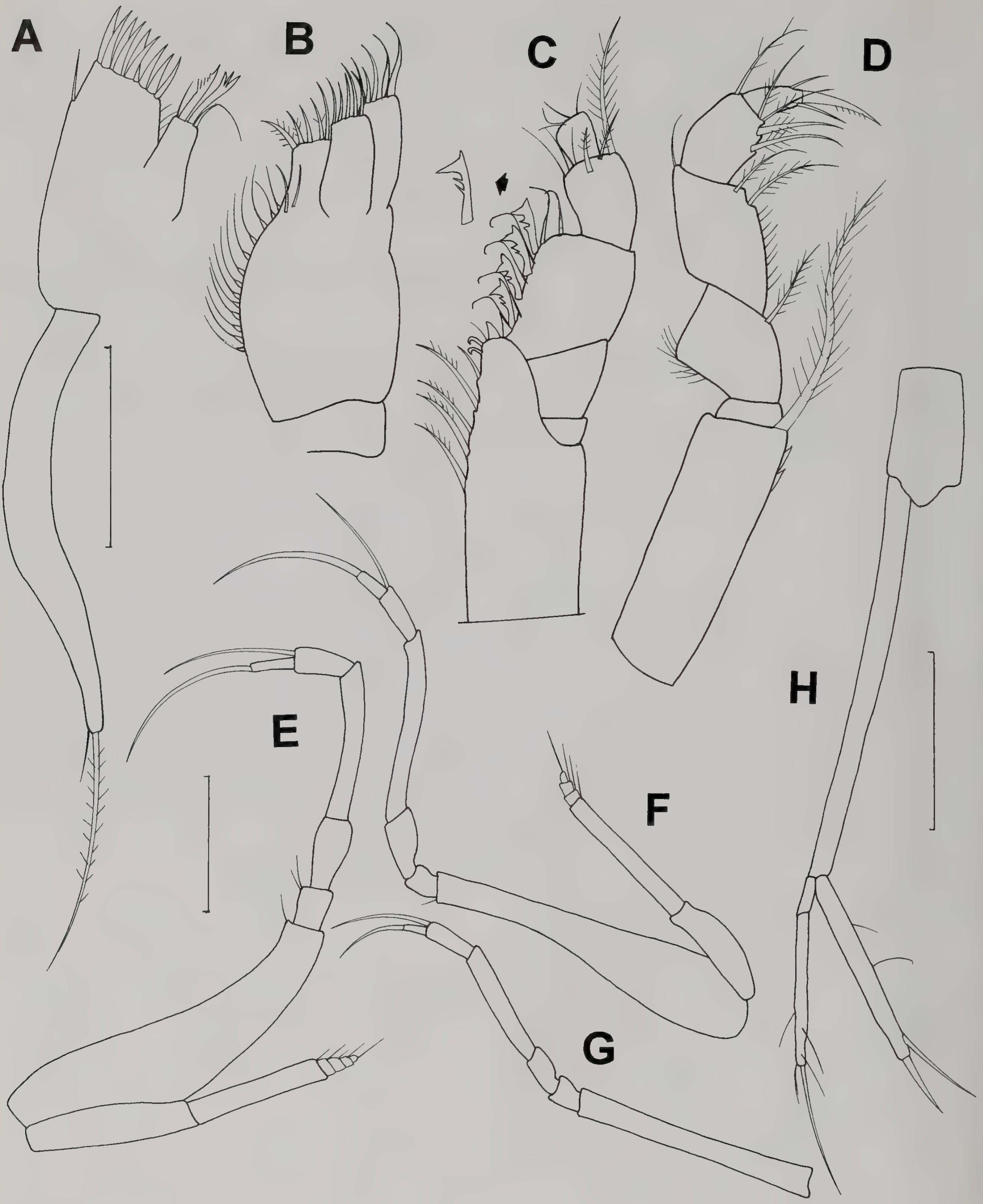

Fig. 4 *Schizocuma vemae* Băcescu, 1972 immature male A. maxilla 1; B. maxilla 2; C. maxilliped 1; D. maxilliped 2; E. pereopod 3; F. pereopod 4; G. pereopod 5; H. uropod. Scale bars (in mm): A – D 0.1; E – G 0.2; H 0.3.

also with a terminal, long, curved acuminate seta. Pereopod 5 (Fig. 4 G), basis as long as half of entire pereopod, carpus about 2 times longer than propodus. Uropod (Fig. 4 H), peduncle shorter than in female (2:1), 2 times longer than its rami, exopod as long as endopod, with a long terminal seta, endopod with a subterminal long simple seta and a terminal acuminate seta.

REMARKS. It does not seem possible to establish a neotype for the species because the specimens from the British collection, although from the same deep western Atlantic, are far (7° 58' S 34° 17' W) from the type locality (27° 7' N 77° 08' W).

Key for the identification of *Schizocuma* species

1	Spines on carapace and eye lobe	2
–	Spines on carapace or on eye lobe	4
2	Dorsal spines on the whole carapace	3
–	Dorsal spines only on the posterior part of carapace	*S. molossa* (Zimmer, 1913)
3	Double rows of spines on carapace	*S. spinosum* (Jones, 1984)
–	Single row of spines on carapace	*S. calmani* (Stebbing, 1912)
4	Spines only on eye lobe	*S. spinoculatum* (Jones, 1984)
–	Spines only on carapace	*S. vemae* Băcescu, 1972

Genus ***STYLOPTOCUMA*** Băcescu & Muradian, 1974

Styloptocuma Băcescu & Muradian, 1974: 74–75.
Cumella Ledoyer, 1983: 77.
Cumella Jones, 1984: 210–211.
Cumella (*Styloptocuma*) Watling, 1991: 752
Styloptocuma Băcescu, 1992: 262–265.
Styloptocuma Holthuis, 1992: 264.
Cumella Ledoyer, 1997: 869 – 876.

TYPE SPECIES. *S. antipai* Băcescu & Muradian, 1974.

DIAGNOSIS. Very elongate cumacean, with numerous spines on entire body or only on carapace, long upturned pseudorostrum, long, styliform eye lobe that could reach or even exceed the extremity of pseudorostrum, without any traces of visual elements. Antenna 1 with a very long basal peduncle article (longer than half of peduncle), second article with a tubercle, main flagellum with two long articles, accessory flagellum with two articles, shorter than the first article of main flagellum. Pars incisiva of mandible with 4 teeth, lacinia mobilis with 4 (rarely 3) teeth, long stiff setae between lacinia mobilis and robust pars molaris (without any tubercles). Maxilla 1 with robust acuminate setae on protopod, palp with 2 filaments. Maxilla 2 with endites, possibly with a row of fine, small setae between the outer margin of protopod and endites. Maxilliped 1 with basis never exceeding extremity of merus, carpus with hand-like setae on outer margin, long propodus and rounded dactylus. Maxilliped 2 with long and slender basis, propodus with two plumose setae on distal outer corner, dactylus with terminal setae. Maxilliped 3 without inner process of basis, propodus longest article excepting basis, dactylus with terminal claws or setae. Pereopods and uropods very slender. Number of exopods – 3 in female, 5 in male.

GENDER. Neuter.

ADDITIONAL SPECIES. *S. aculeatum* (Jones, 1984), *S. acuminatum* (Jones, 1984), *S. angustatum* (Jones, 1984), *S. concinnum* (Jones, 1984), *S. bishopi* (Jones, 1984), *S. cristatum* (Jones, 1984), *S. dayae* (Jones, 1984), *S. echinatum* (Jones, 1984), *S. egregium* (Hansen, 1920), *S. erectum* (Jones, 1984), *S. extans* (Jones, 1984), *S. formosum* (Jones, 1984), *S. gracillimum* (Calman, 1905), *S. inermis* (Ledoyer, 1997), *S. longisipho* (Jones, 1984), *S. subductum* (Jones, 1984).

REMARKS. Jones (1984) considered *Styloptocuma* to be a synonym of *Cumella* because there did not seem to be any characters that could be used to separate the genus (pseudorostrum, eye lobe, form of body, antennule, pereopods and uropods). The absence of mouthparts, especially maxilliped 1, from the descriptions, and no importance accorded to the tubercle on the antennule, also caused Ledoyer (1983, 1997) to adopt Jones' view. In his revision of some genera of nannastacids based on earlier descriptions, Watling 1991 concluded that *Styloptocuma* could be considered a subgenus of *Cumella*. Holthuis (1992) discussed only the designation of the type species of this genus and accepted the concept of *Styloptocuma* in Băcescu & Muradian (1974) without any further comment.

Styloptocuma possesses a mixture of characters that unite it with most of the *Cumella* group – non-separated pseudorostral lobes, a unique eye lobe, form of carapace, lacinia mobilis of mandible with 3 teeth, propodus of maxilliped 2 with setae, thin pereopods, long uropods; and to the *Nannastacus* group – antenna 1 with tubercle, mandible with 4 teeth on pars incisiva and lacinia mobilis, long, rounded dactylus of maxilliped 1. Maxilla 2 has features of both groups (the transeverse row of setules on the protopod is characteristic for the *Nannastacus* group; absent in *Cumella*). This genus seems to link these groups and therefore has a unique set of characters.

Styloptocuma acuminatum (Jones, 1984)

Figs 5,6

Cumella acuminata Jones, 1984: 220–221.
Cumella (Styloptocuma) acuminata Watling, 1991: 752.
Styloptocuma acuminatum Băcescu, 1992: 262.

DESCRIPTION. A brief description of the distinctive characters of the immature male not mentioned by Jones is given. Antenna 2 as in Fig. 5 B. Maxilliped 3 (Fig. 5 C) has a longer basis and dactylar claw than in the female. Pereopod 1 (Fig. 5 D) with an acuminate seta on outer distal corner of basis. Pereopod 2 (Fig. 5 E) with teeth on outer margin of basis and a shorter dactylus (shorter than carpus). Pereopods 3 and 4 (Fig. 5 F, G) with exopods, carpus longest article of pereopod excepting basis, dactylus with a long curved terminal seta. Pereopod 5 (Fig. 5 H) with the shortest basis of all pereopods, carpus shorter than in pairs 3 and 4. Uropod (Fig. 5 I) with peduncle 1.2 longer than the last pleonite and 1.8 times longer than its rami; subequal rami, exopod with a terminal short acuminate seta, endopod with 5 slender acuminate setae on inner margin and a short terminal robust acuminate seta.

To the description of female in Jones (1984) the following details are added: Antenna 1 (Fig. 5 J, K) with a tubercle on the 2nd article of the peduncle. Mandible (Fig. 5 L), pars incisiva with 4 teeth, lacinia mobilis with 4 teeth (one of them very small), truncated pars molaris. Maxilla 1 (Fig. 6 A) with robust acuminate setae on protopod and palp with 2 filaments, the longest being backwardly setulated in its proximal half. Maxilla 2 (Fig. 6 B) without a row of fine, small setae between endites and outer margin of protopod. Maxilliped 1 (Fig. 6 C) with a bifid robust acuminate seta on endite of basis, carpus with hand-like flattened setae with 6 denticles, dactylus smaller than propodus, enlarged, with excavated distal margin. Maxilliped 2 (Fig. 6 D), slender basis, carpus longest article excepting basis, propodus with plumose setae, dactylus with a curved claw. Maxilliped 3 (Fig. 6 E), basis without inner process, dactylus with terminal setae. Pereopod 3 (Fig. 6 H), with slender

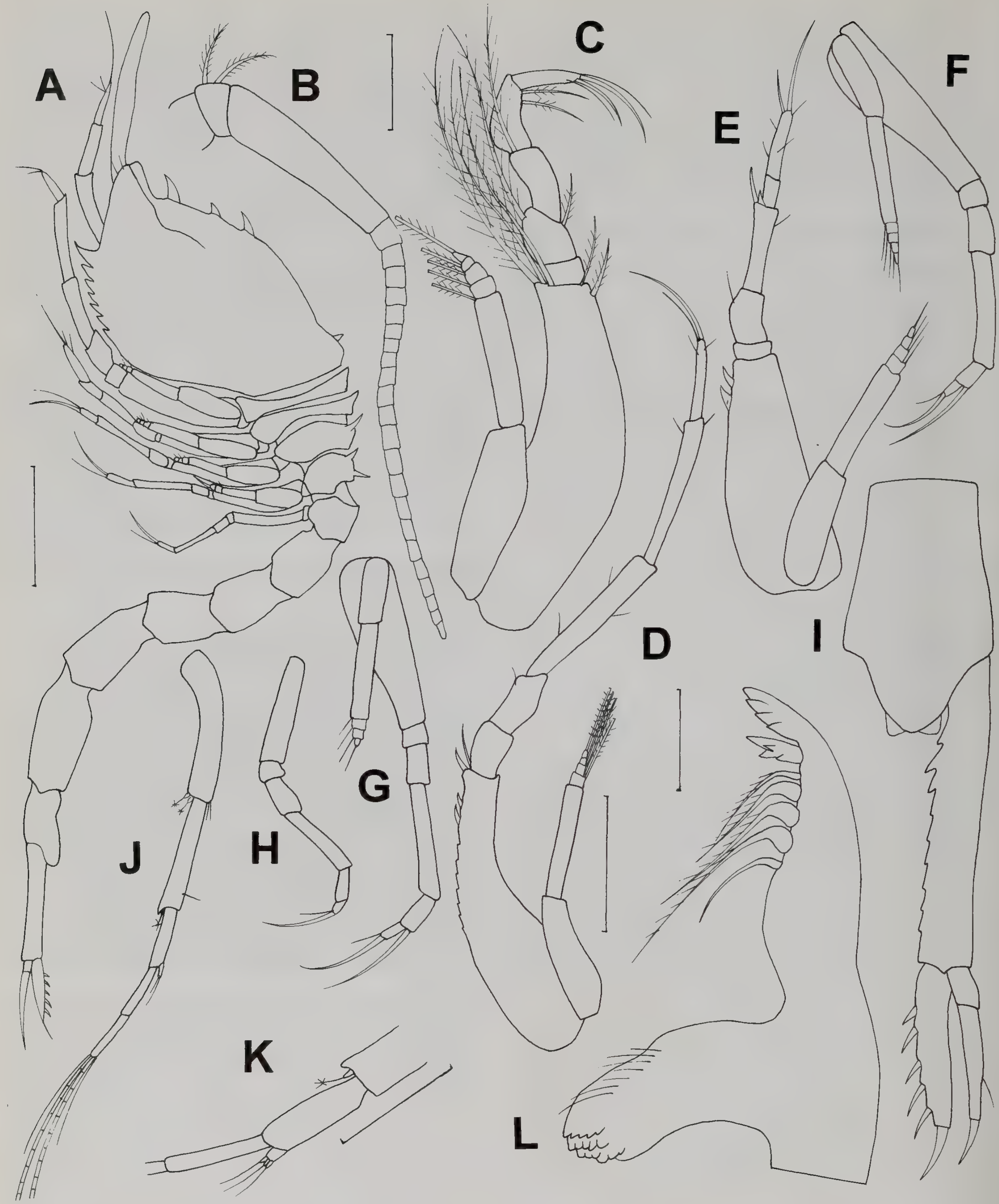

Fig. 5 *Styloptocuma acuminatum* (Jones, 1984) A–I. immature male; J – L. female A. body, lateral view; B. antenna 2; C. maxilliped 3; D. pereopod 1; E. pereopod 2; F. pereopod 3; G. pereopod 4; H. pereopod 5; I. uropod; J. antenna 1; K. antenna 1, detail; L. mandible. Scale bars (in mm): A 0.5; B, D–J 0.2; C 0.1; K 0.1; L 0.05.

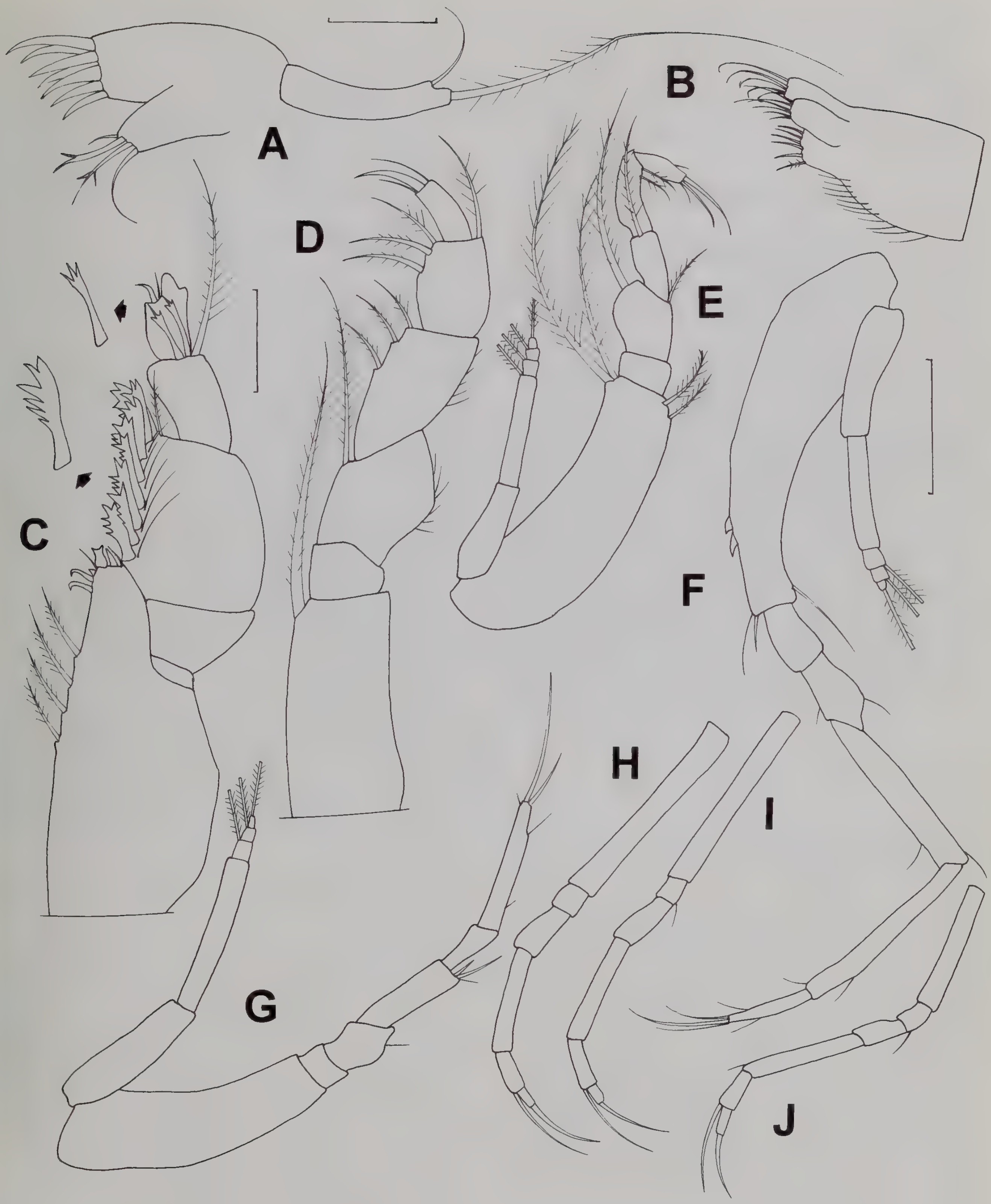

Fig. 6 *Styloptocuma acuminatum* (Jones, 1984) female A. maxilla 1; B. maxilla 2; C. maxilliped 1; D. maxilliped 2; E. maxilliped 3; F. pereopod 1; G. pereopod 2; H. pereopod 3; I. pereopod 4; J. pereopod 5. Scale bars (in mm): A 0.1; B – D 0.05; E – J 0.2.

articles, basis shorter than half of pereopod, carpus longest article of pereopod excepting basis, dactylus with a long curved apical seta. Pereopod 4 (Fig. 6 I), similar to the previous pair. Pereopod 5 (Fig. 6 J) with the smallest basis of all pereopods and with carpus longer than in the pairs 3 and 5.

REMARKS. Pereopod 1 (Fig. 6 F) has a basis with two teeth on outer margin (absent in description given in Jones 1984). Pereopod 2 (Fig. 6 G) has a shorter dactylus than is suggested in the original description.

Styloptocuma antipai Băcescu & Muradian, 1974

Fig. 7

Styloptocuma antipai Băcescu & Muradian, 1974: 74–75.
Cumella antipai Jones, 1984: 214.
Cumella (Styloptocuma) antipai Watling, 1991: 752
Styloptocuma antipai Băcescu, 1992: 262.

DESCRIPTION. The description of an immature male including the mouth appendages is given. Mandible (Fig. 7 A) as in *S. acuminatum.* Maxilla 1 (Fig. 7 B) with glabrous filaments. Maxilla 2 (Fig. 7 C) as in *S. acuminatum.* Maxilliped 1 (Fig. 7 D) with hand-like flattened setae on carpus (different form than in *S. acuminatum*), rounded and enlarged dactylus. Maxilliped 3 (Fig. 7 E) as in female described by Băcescu & Muradian (1974). Pereopod 1 (Fig. 7 F), with carpus as long as propodus instead of carpus shorter than propodus of female (as given in Băcescu & Muradian 1974 and Jones 1984). Pereopod 2 (Fig. 7 G), as in female, but with glabrous margins of basis and dactylus with a shorter terminal seta. Pereopod 3 (Fig. 7 H), basis half of pereopod, dactylus with a terminal strong curved claw. Pereopods 1–4 with exopods. Uropod (Fig. 7 I), peduncle 2 times longer than the last pleonite, 1.5 times longer than its rami, inner margin serrated; subequal rami, exopod with simple setae on both margins and a long terminal one, endopod with three acuminate setae on inner margin and a terminal robust acuminate seta a little shorter than on exopod.

Styloptocuma bishopi (Jones, 1984)

Figs 8, 9

Cumella bishopi Jones, 1984: 233.
Cumella (Styloptocuma) bishopi Watling, 1991: 752
Styloptocuma bishopi Băcescu, 1992: 263.

DESCRIPTION. A description of immature male is given. Antenna 1 (Fig. 8 A), 1st article of peduncle shorter than remaining articles, 2nd article with a tubercle with pedunculate setae. Mandible (Fig. 8 B), pars incisiva with 4 teeth, robust lacinia mobilis with 3 teeth, truncated pars molaris. Maxilla 1 (Fig. 8 C), as in *S. antipai*, with glabrous filaments. Maxilla 2 (Fig. 8 D), with a row of fine, small setae between endites and outer margin of protopod. Maxilliped 1 (Fig. 8 E), endite of basis with 2 spatulate setae, carpus with hand-like flattened setae with 6 denticles, rounded dactylus. Maxilliped 2 (Fig. 8 F), as usual for the genus. Maxilliped 3 (Fig. 8 G), basis and merus without teeth. Pereopod 1 (Fig. 8 H), as in female. Pereopod 2 (Fig. 8 I), as in female, with larger basis. Pereopod 3 (Fig. 9 A), basis half of pereopod, carpus 2 times longer than propodus. Pereopod 4 (Fig. 9 B), basis shorter than half of pereopod, carpus 3 times longer than propodus. Pereopod 5 (Fig. 9 C), slender articles, carpus 3.8 times longer than propodus.

The description in Jones (1984) is augmented with the following details: Pereopod 3 (Fig. 9 G), basis half of pereopod, with serrated outer margin, carpus/propodus = 1.6, dactylus with a short curved claw. Pereopod 4 (Fig. 9 H), basis shorter than half of pereopod, with a serrated outer margin, longer carpus (carpus/propodus = 2.5). Pereopod 5 (Fig. 9 I), basis shorter than half of pereopod, with serrated outer margin, carpus longer than in the pairs 3 and 4 (carpus /propodus= 2.8).

REMARKS. Differences noted in specimens examined for this study include: maxilliped 3 (Fig. 9 D) with a tooth on inner margin of merus, pereopod 1 (Fig. 9 E) with teeth also on the outer margin, carpus longer than propodus (versus carpus shorter than propodus), pereopod 2 (Fig. 9 F), with 2 stiff acuminate setae on outer distal corner of carpus (instead of simple setae).

Styloptocuma dayae (Jones, 1984)

Figs 10, 11

Cumella dayae Jones, 1984: 226–227.
Cumella (Styloptocuma) dayae Watling, 1991: 752.
Styloptocuma dayae Băcescu, 1992: 263

DESCRIPTION. The description of the female is supplemented with additional data on antenna 1, mouthpieces and maxillipeds 1, 2 and pereopods 3–5. Antenna 1 (Fig. 10 A), 2nd article of peduncle with a short tubercle. Mandible (Fig. 10 B), pars incisiva with 4 teeth (one of them is very short), strong lacinia mobilis with 3 teeth. Maxilla 1 (Fig. 10 C), protopod with robust acuminate setae and palp with 2 glabrous filaments. Maxilla 2 (Fig. 10 D), no row of fine, small setae between endites and outer margin of protopod. Maxilliped 1 (Fig. 10 E), carpus with hand-like flattened setae with 4 denticles, rounded and enlarged dactylus. Maxilliped 2 (Fig. 10 F), as usual for the genus. Pereopod 3 (Fig. 10 G), basis longer than half of pereopod, tiny dactylus with a long terminal seta. Pereopod 4 (Fig. 10 H), basis shorter than half of pereopod, carpus shorter than in the previous pair. Pereopod 5 (Fig. 10 I), basis shorter than half of pereopod, carpus longer than in pairs 3 and 4.

Some details on the structure of the immature male are also provided. Maxilliped 3 (Fig. 11 A), basis without the short process mentioned by Jones for the female. Pereopods 1 and 2 (Fig. 11 B, C), as in female. Pereopod 3 (Fig. 11 D), basis half of pereopod, carpus/propodus: 1.8, tiny dactylus with long terminal seta. Pereopod 4 (Fig. 11 E), basis shorter than half of pereopod, carpus/propodus: 1.7. Pereopod 5 (Fig. 11 F), basis shorter than carpus, carpus/propodus: 3.1.

Styloptocuma echinatum (Jones, 1984)

Figs 12, 13

Cumella echinata Jones, 1984: 223–224.
Cumella (Styloptocuma) echinata Watling, 1991: 752.
Styloptocuma echinatum Băcescu, 1992: 263.

DESCRIPTION. This species was incompletely described in Jones (1984), his description being based only the female. Additional details for immature males and females are included here. *Immature male* – Antenna 1 (Fig. 12 A), 1st article of peduncle twice longer than the rest of antenna, 2nd article with a tubercle. Mandible (Fig. 13 B), pars incisiva with 4 teeth, lacinia mobilis also with 4 teeth (one of them very short). Maxilla 1 (Fig. 13 C), palp with 2 glabrous filaments. Maxilla 2 (Fig. 13 D), long fine setae on outer margin of protopod, but not between its outer margin and endites. Maxilliped 1 (Fig. 13 E), carpus with hand-like flattened setae with 4 denticles, rounded and enlarged dactylus. Maxilliped 2 (Fig. 13 F), as usual for the genus. Maxilliped 3 (Fig. 13 G), basis without inner process, dactylus with 2 claws. Pereopod 1 (Fig. 13 H), basis with rows of

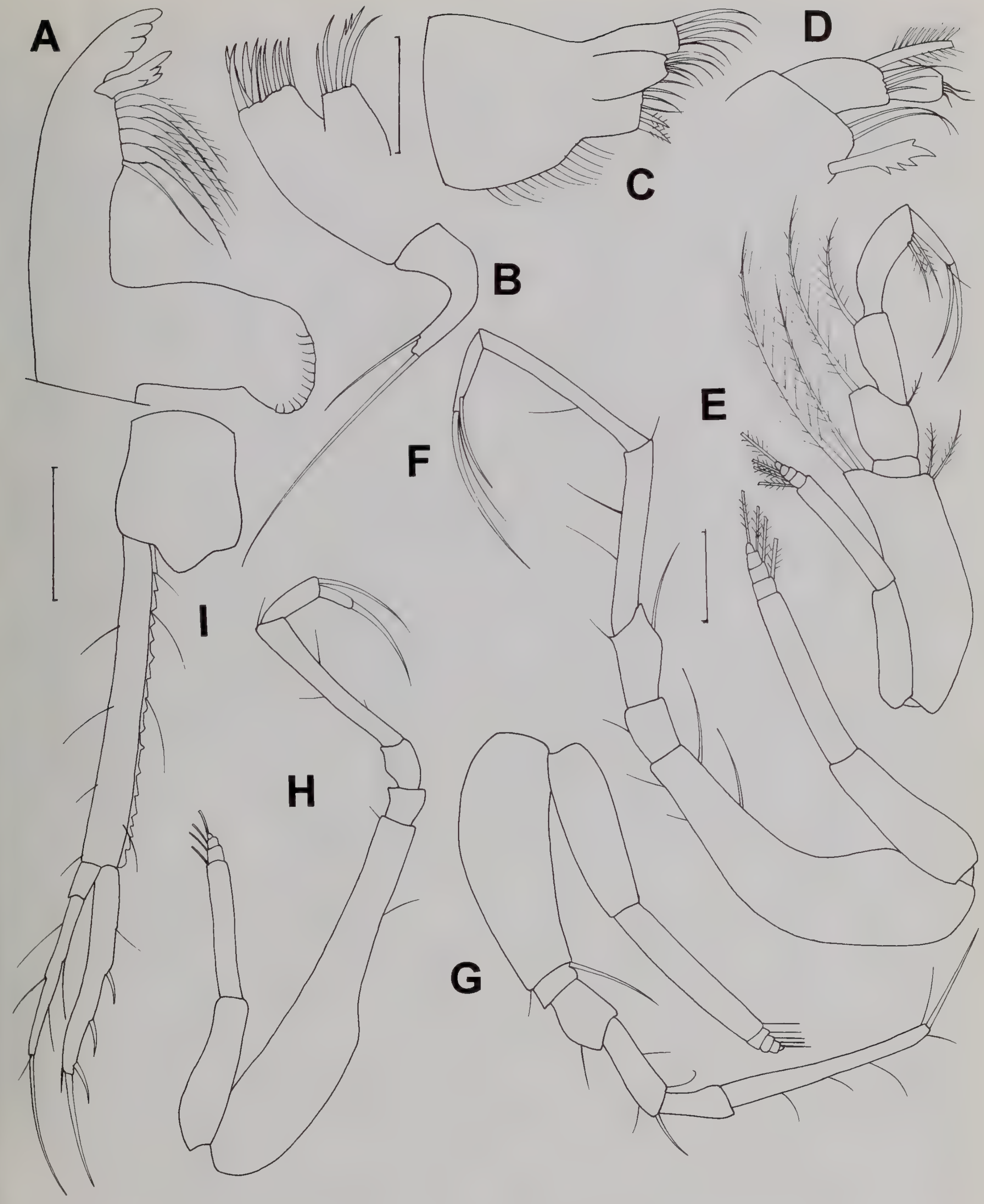

Fig. 7 *Styloptocuma antipai* Băcescu & Muradian, 1974 immature male A. mandible; B. maxilla 1; C. maxilla 2; D. tip of maxilliped 1; E. maxilliped 3; F. pereopod 1; G. pereopod 2; H. pereopod 3; I. uropod. Scale bars (in mm): A – D 0.05; E – H 0.1; I 0.2.

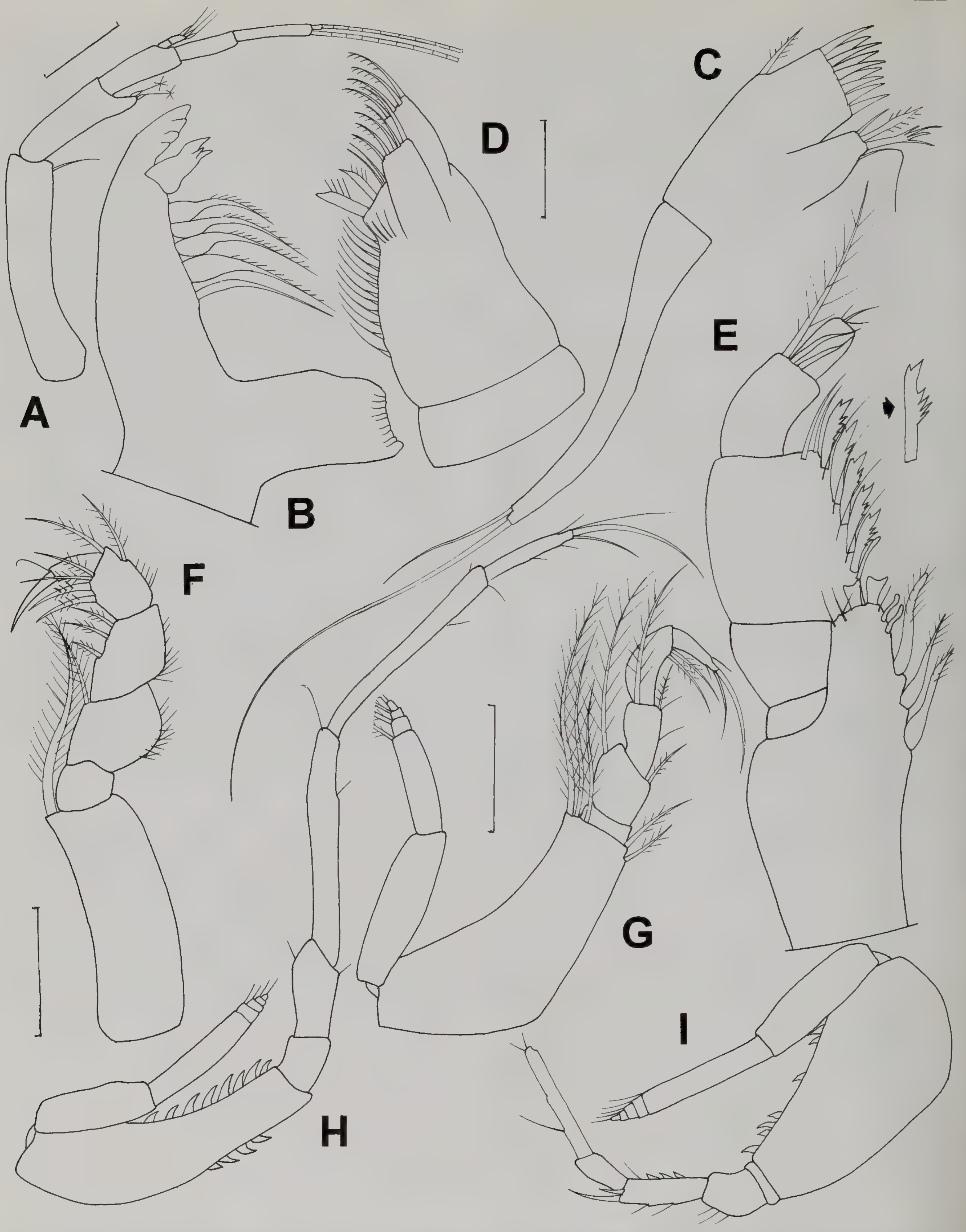

Fig. 8 *Styloptocuma bishopi* (Jones, 1984) immature male A. antenna 1; B. mandible; C. maxilla 1; D. maxilla 2; E. maxilliped 1; F. maxilliped 2; G. maxilliped 3; H. pereopod 1; I. pereopod 2. Scale bars (in mm): A 0.1; B – E 0.05; F 0.1; G – I 0.2.

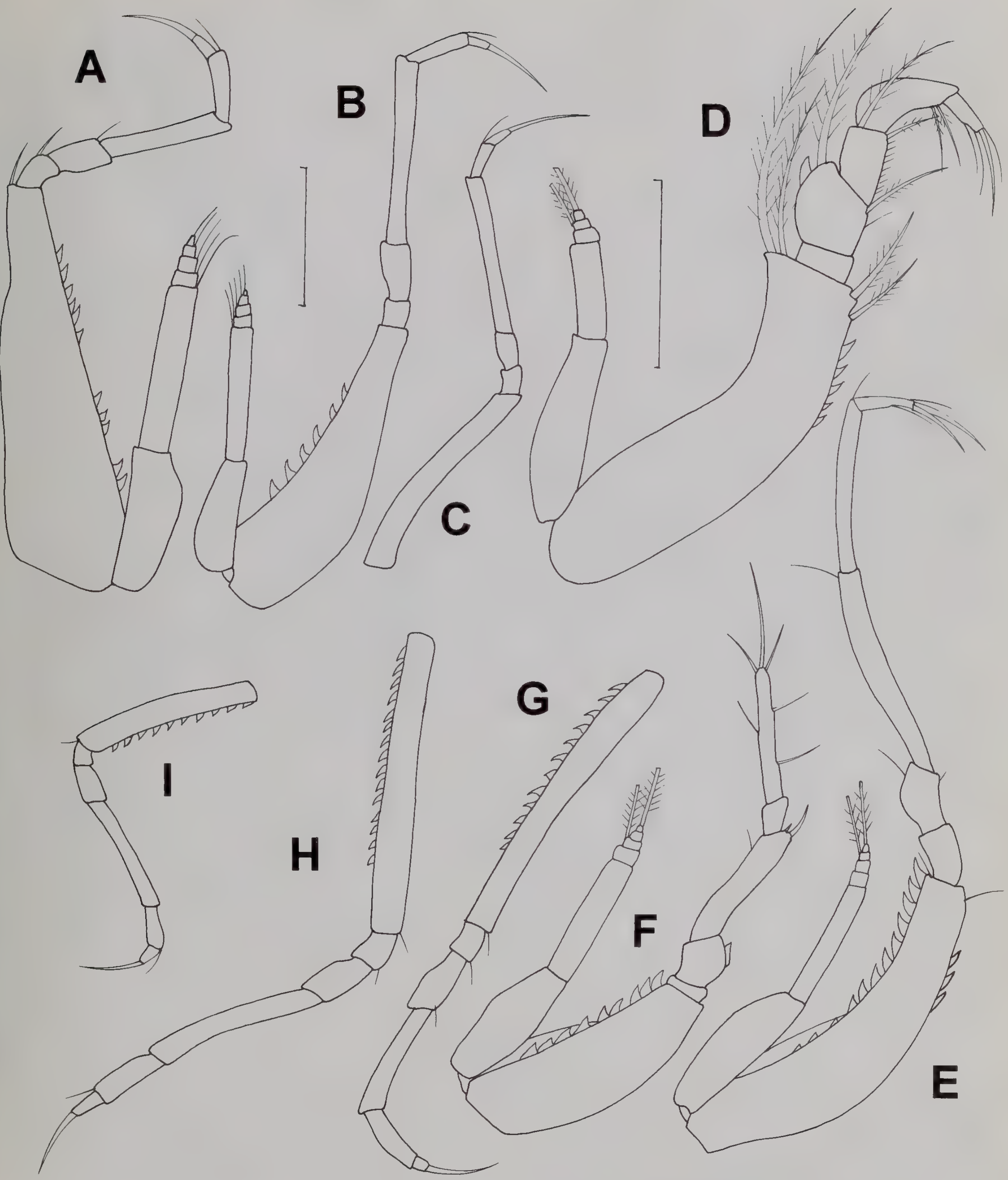

Fig. 9 *Styloptocuma bishopi* (Jones, 1984) A – C. immature male; D – I. female A. pereopod 3; B. pereopod 4; C. pereopod 5; D. maxilliped 3; E. pereopod 1; F. pereopod 2; G. pereopod 3. H. pereopod 4; I. pereopod 5. Scale bars (in mm): A – C, E, F – I 0.2; D 0.2.

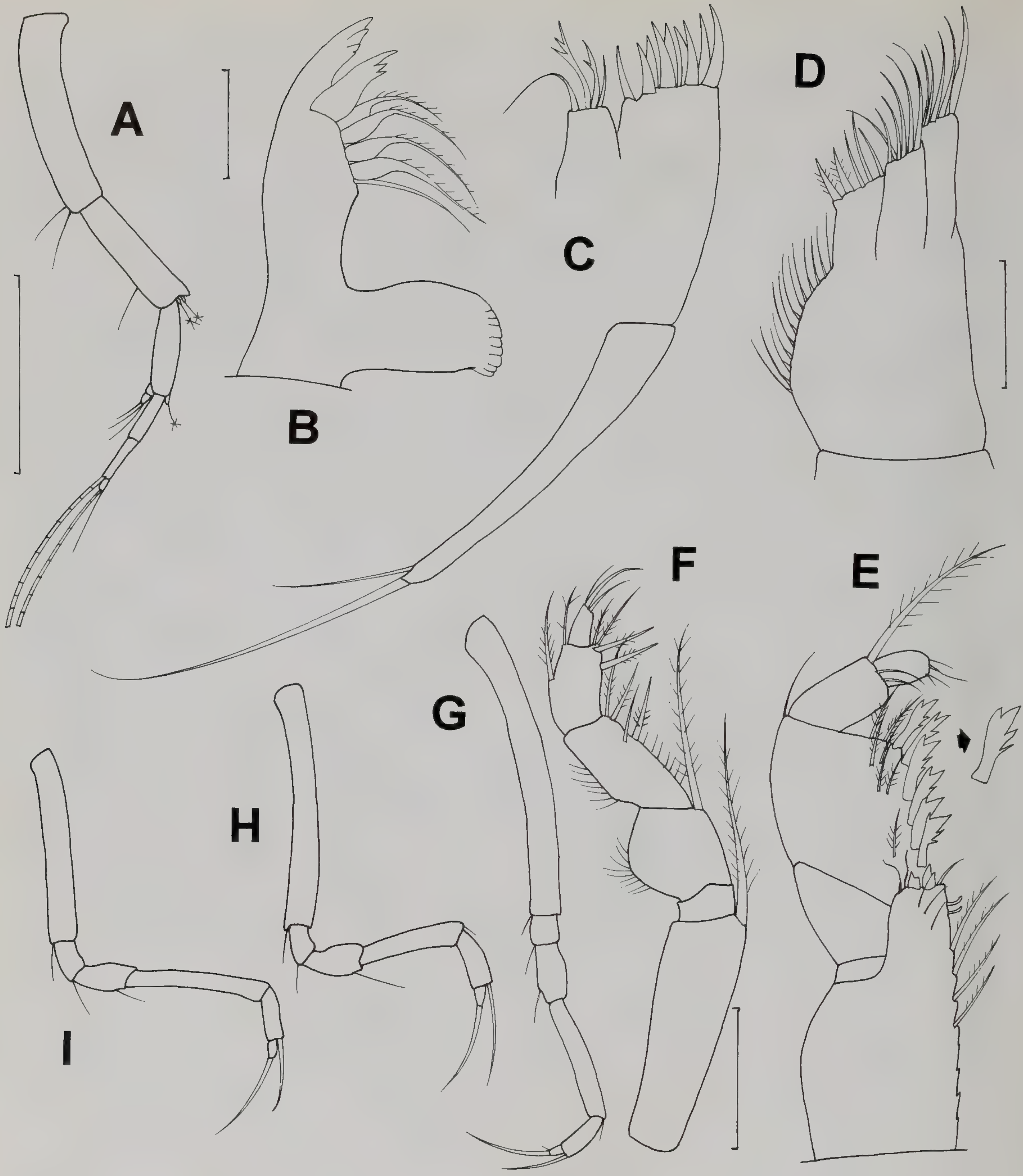

Fig. 10 *Styloptocuma dayae* (Jones, 1984) female A. antenna 1; B. mandible; C. maxilla 1; D. maxilla 2; E. maxilliped 1; F. maxilliped 2; G. pereopod 3; H. pereopod 4: I. pereopod 5. Scale bars (in mm): A 0.2; B, E 0.05; C, D 0.05; F 0.1.

teeth on both margins, very long and slender carpus and propodus, carpus a little longer than propodus. Pereopod 2 (Fig. 14 A), carpus with teeth on inner margin and with 2 stiff acuminate setae on outer distal corner, dactylus 3 times longer than propodus, with simple setae. Pereopod 3 (Fig. 14 B), basis longer than half of pereopod, carpus/propodus: 1.9, tiny dactylus with a long curved terminal seta. Pereopod 4 (Fig. 14 C), basis shorter than half of pereopod, carpus/propodus: 2.9, dactylus as in previous pair. Pereopod 5 (Fig. 14 D), basis shorter than half of pereopod, carpus/propodus: 1.6, same type of dactylus.

Female – Maxilliped 3 (Fig. 14 E), as in male. Pereopod 1 (Fg. 14 F), teeth only on outer margin of basis, carpus shorter than propodus. Pereopod 2 (Fig. 14 G), as in male. Pereopods 3–5 (Fig. 14 H–J),

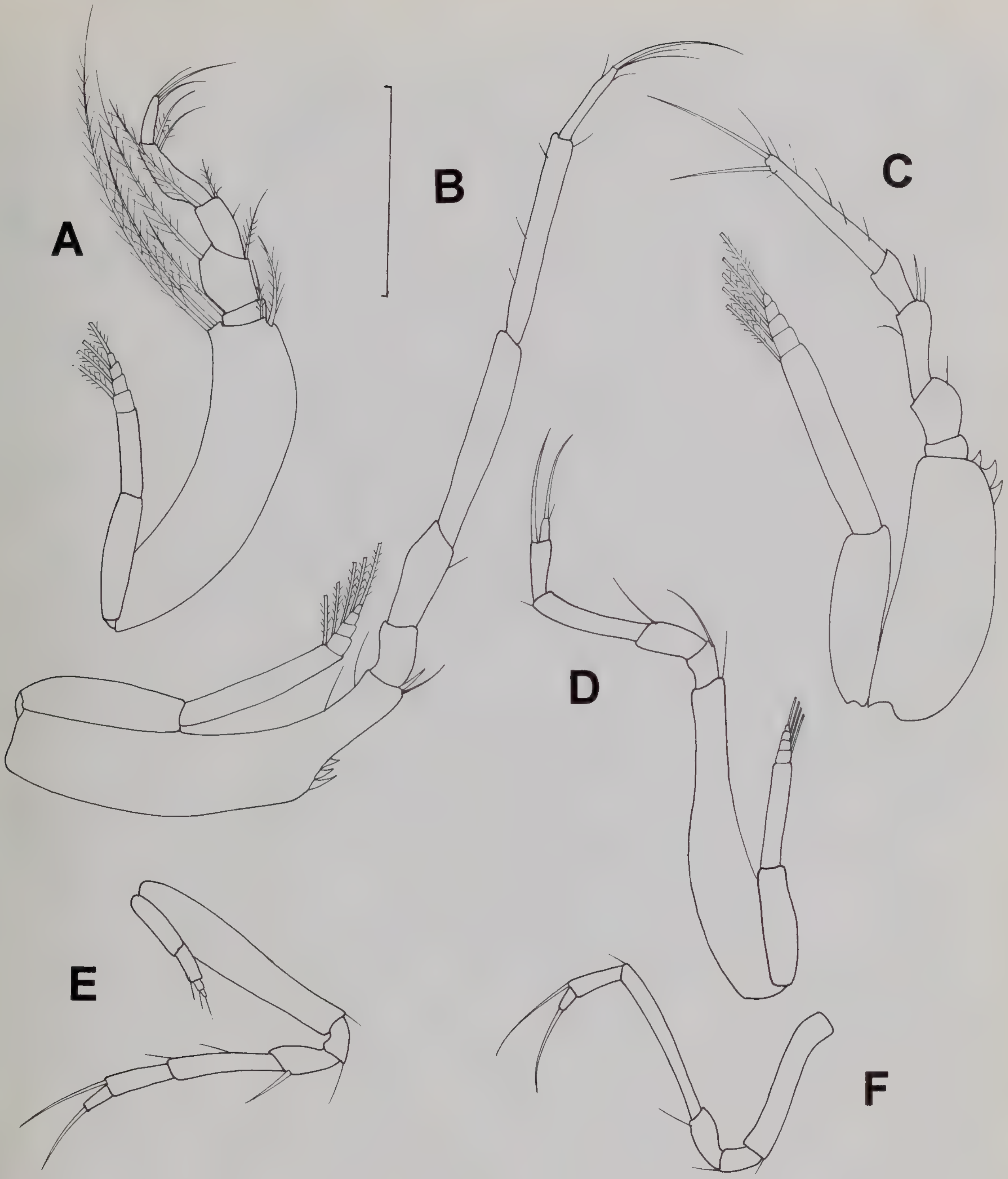

Fig. 11 *Styloptocuma dayae* (Jones, 1984) immature male A. maxilliped 3; B. pereopod 1; C. pereopod 2; D. pereopod 3; E. pereopod 4; F. pereopod 5. Scale bar (in mm): A – F 0.3.

very elongated and slender, with the same ratio between articles as in male.

Styloptocuma formosum (Jones, 1984)

Figs 14, 15

Cumella formosa Jones, 1984: 231–233.
Cumella (Styloptocuma) formosa Watling, 1991: 752.
Styloptocuma formosum Băcescu, 1992: 264.

DESCRIPTION. To the description of the adult female in Jones (1984) the following details are added: Antenna 2 (Fig. 14 B), with

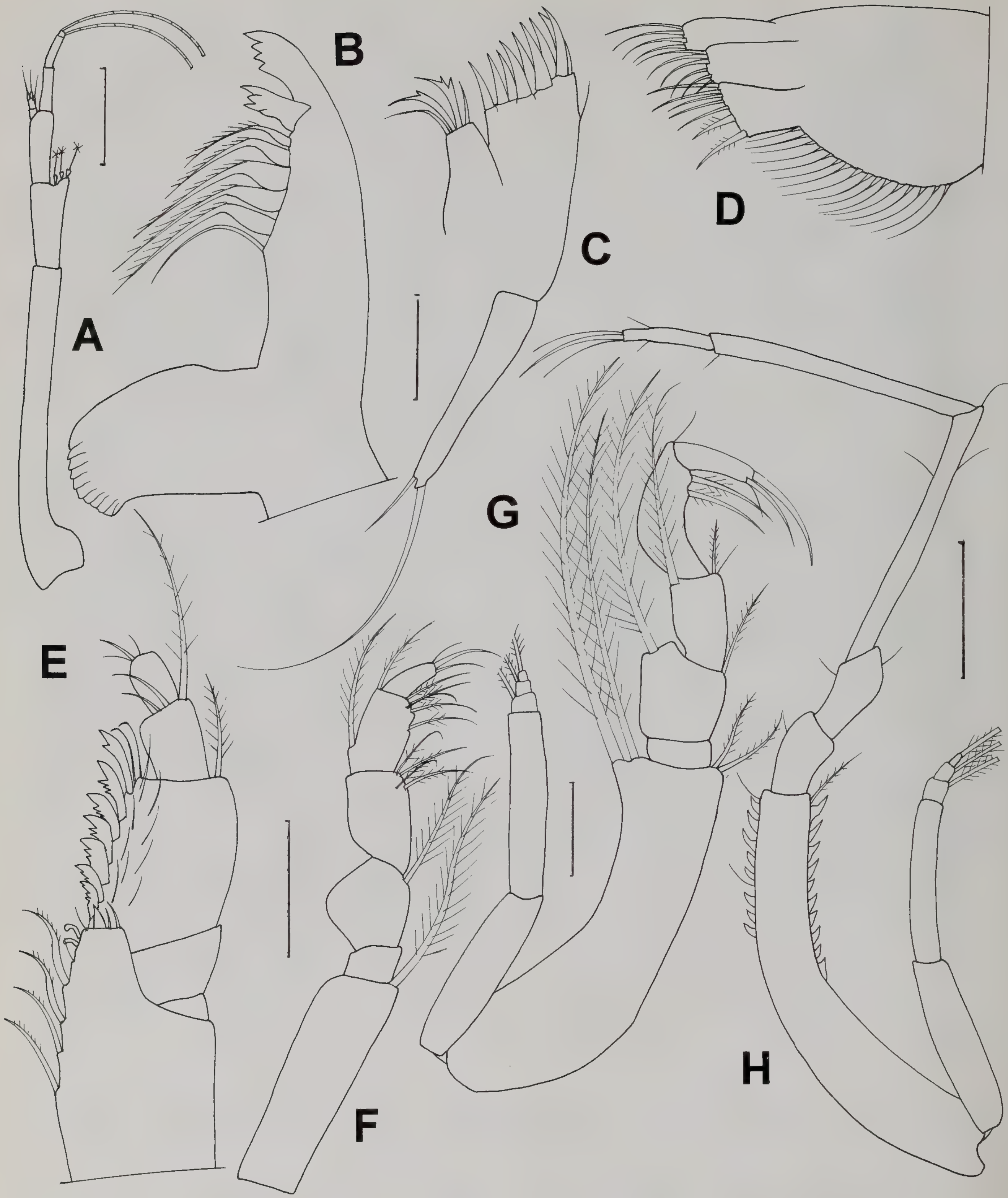

Fig. 12 *Styloptocuma echinatum* (Jones, 1984) immature male A. antenna 1; B. mandible; C. maxilla 1; D. maxilla 2; E. maxilliped 1; F. maxilliped 2; G. maxilliped 3; H. pereopod 1. Scale bars (in mm): A 0.1; B – E 0.05; F 0.1; G 0.1; H 0.2.

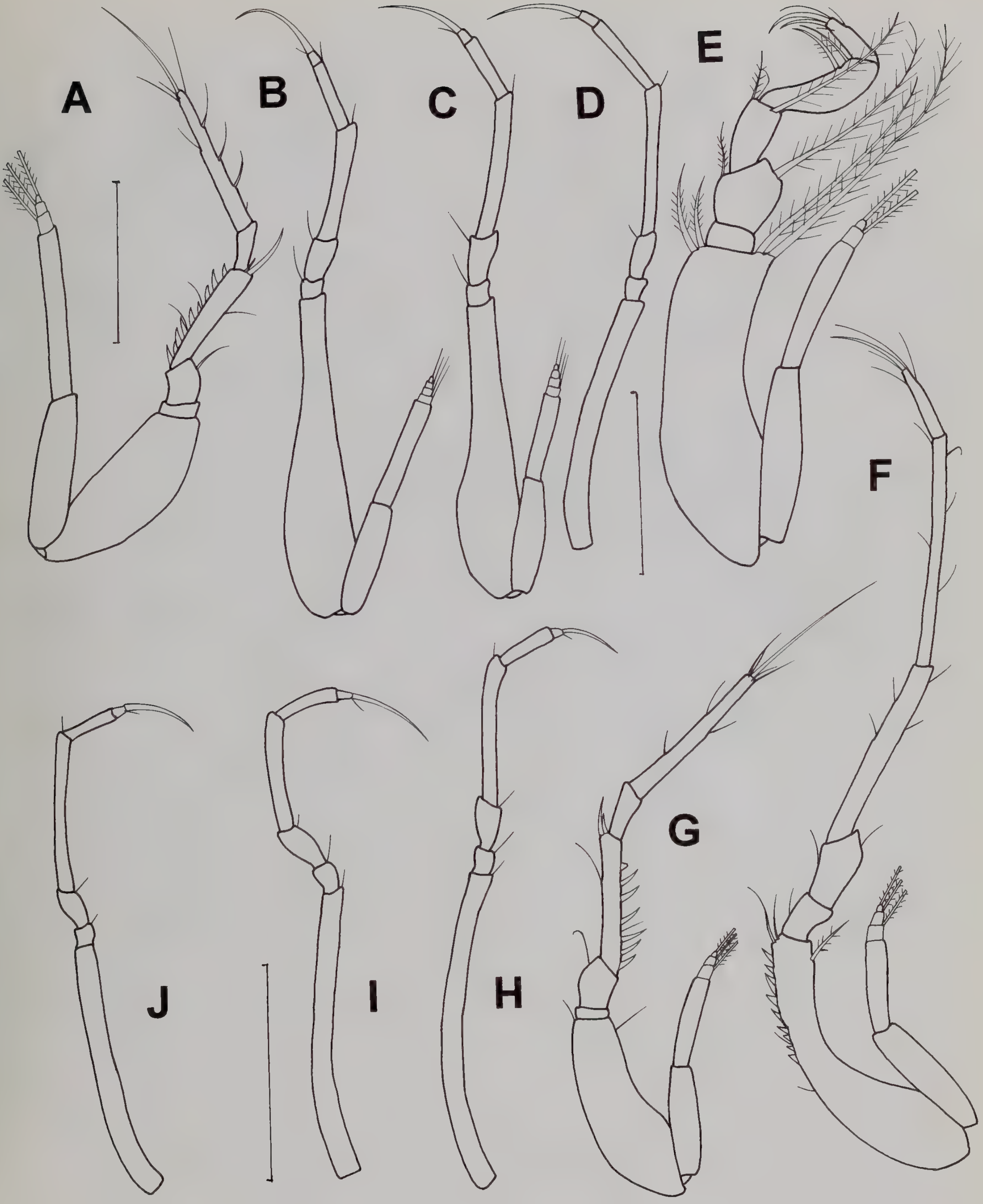

Fig. 13 *Styloptocuma echinatum* (Jones, 1984) A – D. immature male; E–J. female A. pereopod 2; B. pereopod 3; C. pereopod 4; D. pereopod 5; E. maxilliped 3; F. pereopod 1; G. pereopod 2; H. pereopod 3; I. pereopod 4; J. pereopod 5. Scale bars (in mm): A – D 0.3; E 0.5; F – J 0.5.

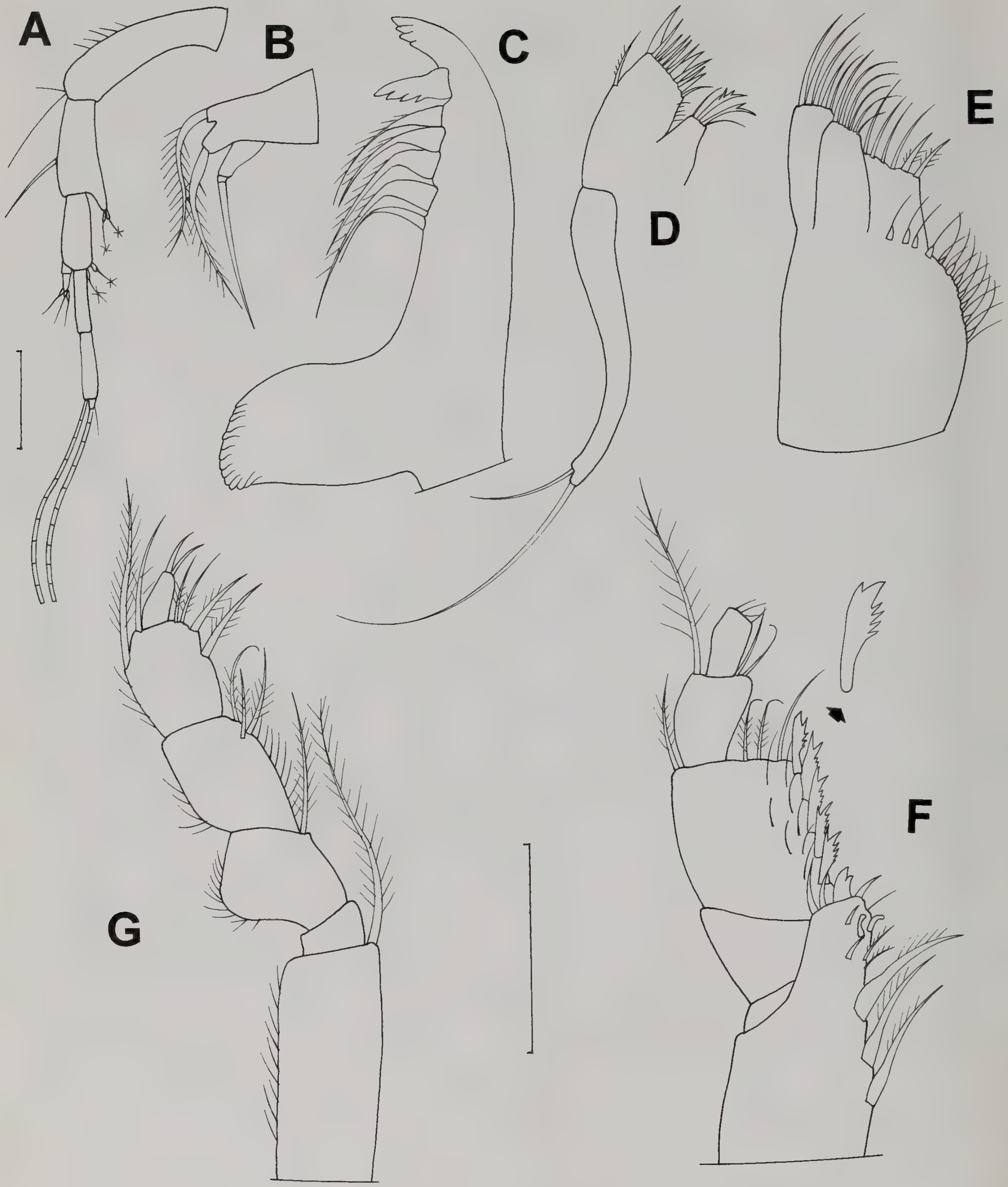

Fig. 14 *Styloptocuma formosum* (Jones, 1984) female A. antenna 1; B. antenna 2; C. mandible; D. maxilla 1; E. maxilla 2; F. maxilliped 1; G. maxilliped 2. Scale bars (in mm): A, B 0.1; C – G 0.1.

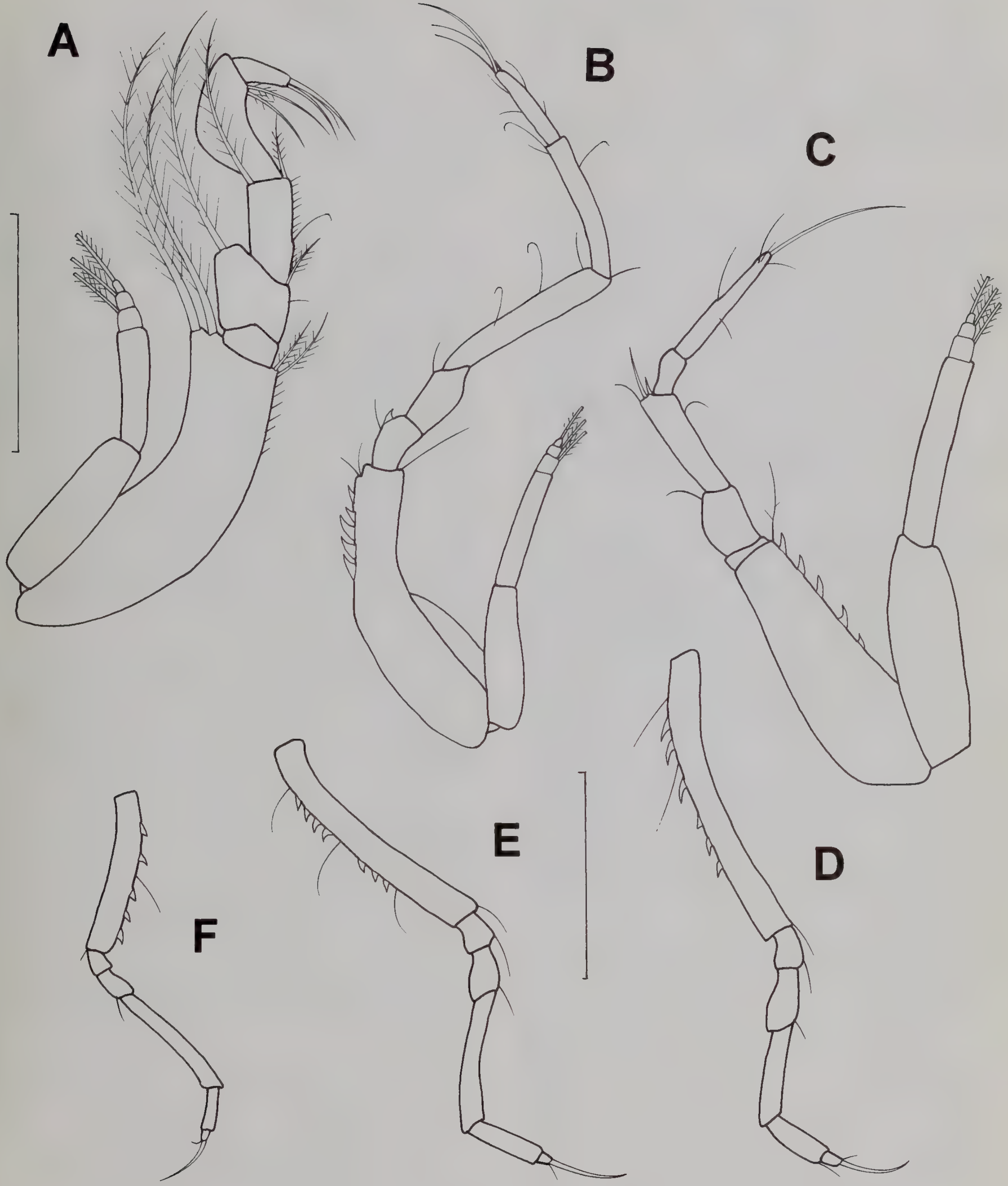

Fig. 15 *Styloptocuma formosum* (Jones, 1984) female A. maxilliped 3; B. pereopod 1; C. pereopod 2; D. pereopod 3; E. pereopod 4; F. pereopod 5. Scale bars (in mm): A 0.25; B – F 0.3.

2 articles and 2 plumose and one simple setae. Mandible (Fig. 14 C), pars incisiva and lacinia mobilis with 4 teeth . Maxilla 1 (Fig. 14 D), palp with 2 glabrous filaments. Maxilla 2 (Fig. 14 E), a row of fine, small setae between outer margin of protopod and endites. Maxilliped 1 (Fig. 14 F), carpus with hand-like flattened setae with 6 denticles, more fully developed and rounded dactylus. Maxilliped 2 (Fig. 14 G), with robust articles, propodus with plumose setae. Maxilliped 3 (Fig. 15 A), basis with a very short inner process, setules on outer margins of basis and carpus. Pereopods 3–5 (Fig. 15 D–F), basis with teeth on inner margin, 3rd pair with longer basis, 5th one with longer carpus, short dactylus with long curved terminal seta.

REMARKS. Antenna 1 (Fig. 14 A) as described in Jones (1984). Pereopod 1 (Fig. 15 B) has teeth on outer margin and 2nd pair (Fig. 15 C) has teeth on inner margin (versus glabrous in Jones).

Key for the identification of *Styloptocuma* species

1 Eye lobe not exceeding pseudorostrum 2

– Eye lobe exceeding pseudorostrum 14

2 Pseudorostrum passes beyond the level of the anterior corner 3

– Pseudorostrum not or scarcely passing beyond the level of the anterior corner 5

3 Rows of spines on lateral sides of pleon 4

– Without spines on lateral sides of pleon .... *S. aculeatum* (Jones, 1984)

4 Spines on pseudorostrum, pereopods and uropods .... *S. echinatum* (Jones, 1984)

– No spines on pseudorostrum, pereopods and uropod .... *S. erectum* (Jones, 1984)

5 Rows of spines on lateral sides of pleon 6

– Without spines on lateral sides of pleon 9

6 Carapace with dorsal spines 7

– Carapace without dorsal spines .... *S. extans* (Jones, 1984)

7 Eye lobe reaching end of pseudorostrum 8

– Eye lobe not reaching end of pseudorostrum .... *S. concinnum* (Jones, 1984)

8 Eye lobe with an apical spine .... *S. cristatum* (Jones, 1984)

– Eye lobe without apical spine .... *S. formosum* (Jones, 1984)

9 Carapace with dorsal spines 10

– Carapace without spines 13

10 Carapace with double rows of dorsal spines .... *S. subductum* (Jones, 1984)

– Carapace with a single row of spines 11

11 Uropodal peduncle 2 × longer than 6th pleonite 12

– Uropodal peduncle less than 2 × longer than 6th pleonite .... *S. acuminatum* (Jones, 1984)

12 Carapace and uropods with many spines .... *S. dayae* (Jones, 1984)

– Carapace and uropods with fewer spines .... *S. gracillimum* (Calman, 1905)

13 Uropodal peduncle 2 × longer than 6th pleonit .... *S. angustatum* (Jones, 1984)

– Uropodal peduncle less than 2 × longer than 6th pleonite .... *S. inermis* (Ledoyer, 1997)

14 Pseudorostrum long 15

– Pseudorostrum short .... *S. longisipho* (Jones, 1984)

15 Two dorsal rows of spines on carapace 16

– One dorsal row of of spines on carapace .... *S. egregium* (Hansen, 1920)

16 Body and uropods densely spinose, pereopods less serrated .... *S. antipai* Băcescu & Muradian, 1974

– Body and uropods with fewer, shorter spines, pereopods more serrated .... *S. bishopi* (Jones, 1984)

PHYLOGENETIC REMARKS

Both *Schizocuma* and *Styloptocuma* with mixed characters seem to be earlier separated from the branch of *Cumella* group than the other genera (*Almyracuma* Jones & Burbanck, 1959, *Atlantocuma* Băcescu & Muradian, 1974, *Claudicuma* Roccatagliata, 1981, *Cumella* Sars, 1865, *Cumellopsis* Calman, 1905, *Elasocumella* Watling, 1991, *Platycuma* Calman, 1905) and evolved in specific ways in the deep sea preserving more characters common with *Nannastacus* group (*Nannastacus* Bate, 1865, *Scherocumella* Watling, 1991, *Schizotrema* Calman, 1911), characters absent to the other deep sea mentioned genera of the *Cumella* group. *Styloptocuma* seems to be closer to *Nannastacus* within the group of *Cumella* than *Schizocuma*.

ACKNOWLEDGEMENTS. I am grateful to Miranda Lowe from the Department of Zoology, The Natural History Museum, London, for the loan of the studied material; to the late Acad. Mihai Băcescu for the valuable references and discussions; to the late Norman Jones for suggestions regarding this study and for suggesting a suitable institution for depositing the materials studied by him; and to Aurora Dinu who inked the drawings.

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A new species of *Sigambra* (Polychaeta, Pilargidae) from the abyssal plains of the NE Atlantic

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INTRODUCTION

During an intensive study of the benthic communities of the NE Atlantic abyssal plains (Rice *et al.* 1994), a new species of *Sigambra* was identified. It was conspicuous in being one of the more abundant species and certainly the dominant predator. The species was widespread, being recorded from study sites from the Cap Verde Abyssal Plain in the south to the Porcupine Abyssal Plain in the north.

MATERIAL AND METHODS

All specimens were collected using a modified United States Naval Electronics Laboratory. spade box corer (SBC). Samples from the Porcupine, Madeira and Cape Verde Abyssal Plains were sectioned horizontally into 0–1 cm, 1–3 cm and 3–5 cm layers and processed through a number of sieves – 1, 0.5 and 0.3 mm. Samples from the Tagus Abyssal Plain were taken with a vegematically modified box corer and only the inner nine subcores were processed through a 0.3 mm sieve.

MATERIAL STUDIED

Specimens have been deposited in a number of taxonomic institutions and corresponding registration numbers are given below. Abbreviations: AM – The Australian Museum, Sydney; LA – Los Angeles County Museum of Natural History; MNHN – Museum National d'Histoire Naturelle, Paris; BMNH – The Natural History Museum, London; NMNH – National Museum of Natural History, Smithsonian Institution; NMS – The National Museums of Scotland; NMW – The National Museum of Wales; ZH Zoologisches Institut und. Museum, Hamburg; ZMUC – Zoological Museum, Copenhagen.

Holotype: Porcupine Abyssal Plain *Challenger II* Criuse 111: 53201#29 48°51.5' N 16°29.6' W, 4844 m, sediment layer 1–3 cm 0.5mm sieve, 14/4/1994 (BMNH 2000. 1852).

Paratypes: Porcupine Abyssal Plain the following samples centred on 48°50' N 16°30' W in 4850 m:

Discovery Cruise 185: 11908#18: 1–3cm 0.3 mm sieve 1 ind. 28/8/1989.

Challenger II Cruise 79: 52701#5: 1–3 cm, 0.3mm sieve 4 ind.; 1–3cm 0.5mm sieve 2 ind (NMSz: 2000.214).16/5/1991.
52701#9: 1–3 cm 0.5mm 1 ind (ZMH). 17/5/1991.
52701#25: 1–3 cm 0.3mm sieve 1 ind.(MNHN-POLY 53); 0–1 cm 0.5 mm sieve 1 ind (NMW.Z: 2000.070).; 3–5 cm 0.5mm sieve 2 ind (NMNH 186794). 20/5/1991;
52701#29: 1–3 cm 0.3 mm sieve 1 ind. (AM); 1 ind. (ZMUC-POL-1013 21/5/1991.
52701#47 1–3 cm 0.3 mm sieve 1 ind. (LA) 21/5/1991.
Challenger Cruise 111: 53201#23 1–3 cm 0.3 mm 1 ind. 13/4/1994; 53201#26 1–3 cm 0.3 mm sieve 1 ind., 1–3 cm 0.5 mm sieve 2 ind., 3–5 cm 0.3 mm 1 ind. 14/4/1994;
53201 # 29 1–3 cm 0.25 mm sieve 1 ind., 1–3 cm 0.5 mm sieve 1 ind., 3–5 cm 1 mm sieve ind. 14/4/1994;
53205#2 0.3 mm 0–1 cm sieve 1 ind., 3–5 cm 0.5 mm sieve 1 ind., 18/4/94.

Tagus Abyssal Plain centred on 38°N 11°W 5035 m: *Discovery* Cruise 186: SBC365 3 ind. 26/9/1989; SBC366 1 ind. 26/9/1989; SBC367 5 ind. 26/9/1989; SBC368 5 ind., SBC369 2 ind. 27/9/1989; SBC371 2 ind. 28/9/1989.

Madeira Abyssal Plain centred on 31°10' N 21°10' W 4985m: *Discovery* Cruise 194: 12174#35: 1–3 cm 0.3 mm sieve 2 ind.: 1–3 cm 0.5 mm sieve 1 ind.; 3–5 cm 0.5 mm sieve 3 ind. 21/8/1990.
12174#43: 1–3 cm 0.3 mm 1 ind. 22/8/1990.
12174#53: 1–3 cm 0.3 mm sieve 2 ind. 23/8/1990
12174 #60: 1–3 cm 0.3 mm sieve 1 ind. 24/8/1990.
12174#80 0–1 cm 0.3 mm sieve 1 ind.; 5–10 cm 0.5 mm sieve 1 ind. 28/8/90.

Cape Verde Abyssal Plain centred on 20°N 30°W 4500–4600 m: *Discovery* Cruise 204: 12600#32 0–1 cm 0.3 mm sieve 1 ind. 6/10/1994.

In addition the following material was examined: *Sigambra bidentata* Britaev & Saphronova, 1981 Natural History Museum Polychaete Collection Z1986:178–183 (5 paratypes), *Vityaz* Stn 7488 38° 41'N:133° 45'E 1550 m Sea of Japan. *Sigambra gracilis* Britaev & Saphronova, 1981 ZR1986.184–185 (2 paratypes), Vostok Bay, Sea of Japan. *Sigambra phuketensis* Licher and Westheide, 1997 Z1993. 15–16 (2 Paratypes), Bang Tao, W. Phuket Island, Thailand.

TAXONOMIC ACCOUNT

Family **PILARGIDAE**
Genus ***SIGAMBRA*** O.F.Müller, 1858

Species ***S. magnuncus*** sp. nov.

(Figs 1–5)

DESCRIPTION

Holotype: Length 3.7 mm for 33 chaetigers, greatest width of body 0.3 mm.

Paratypes: Range from length 0.5 mm for 13 chaetigers to 10.5 mm for 50 chaetigers, number of segments depends on size of individual. (Fig. 5).

Body unpigmented; slightly flattened anteriorly, but becoming more rounded posteriorly; anterior chaetigers widest.

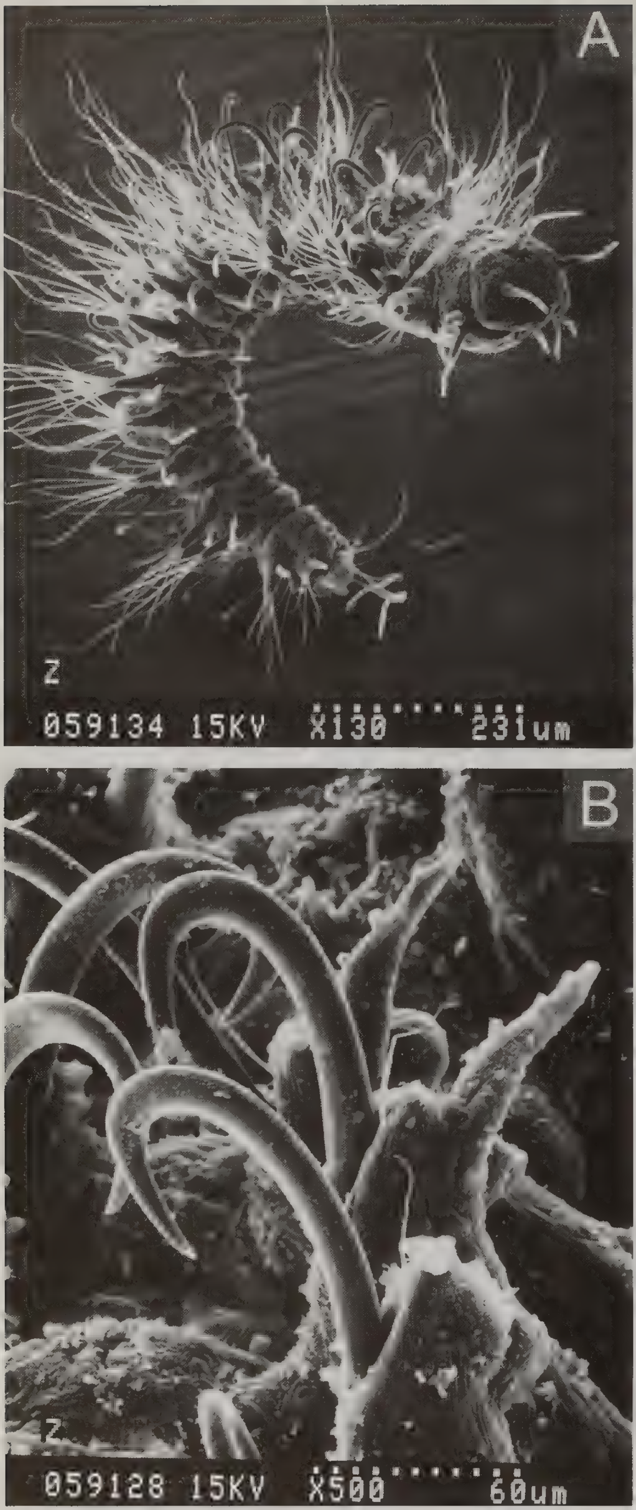

Fig. 1 SEMs of *Sigambra magnuncus* (MAP *Discovery Investigations* 12174#60 0.5 mm sieve, 1–3 cm) A. General view of individual. B. View of notopodia, note the small capillary chaeta in each notopodium

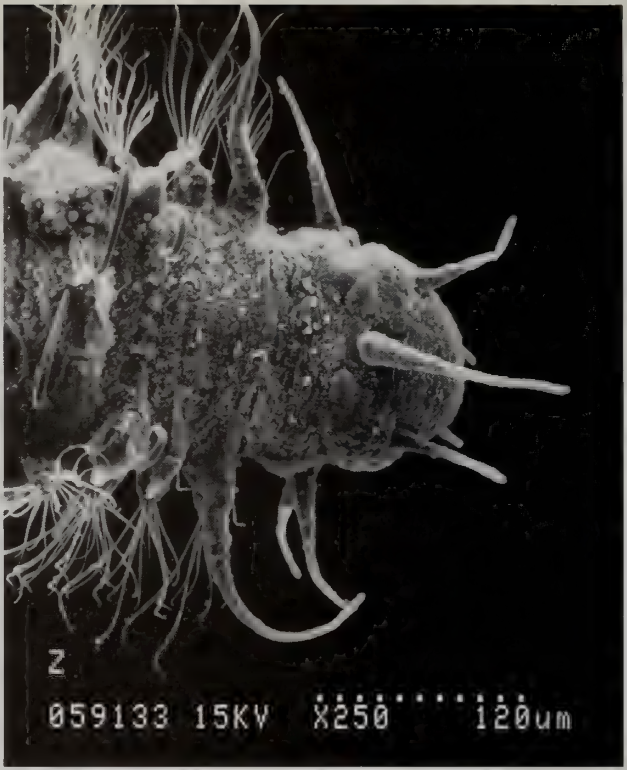

Fig. 2 SEMs of *Sigambra magnuncus* (MAP *Discovery Investigations* 12174#80 0.5mm sieve, 1–3 cm) Dorsal view of anterior region.

Prostomium rounded, slightly indented laterally at insertion of palps and prostomium. Palps biarticulate with relatively long palpostyles; palpophores fused distally over half their length. Three antennae, median antenna longest, situated slightly posterior to laterals in smaller specimens, but more level with them in larger individuals. A pair of cushion like nuchal organs, situated on either side of the median antennae. Eyes absent. Pharynx without jaws, armed with eight equal size, slightly pointed papillae.

Peristomium approximately twice as long as first chaetiger. Two pairs of long tapering tentacular cirri, dorsal cirri longer than ventral, and slightly shorter than median antennae. A row of low cushion-like papillae (sense organs) extending across dorsal surface of peristomium (may only be visible under high magnification).

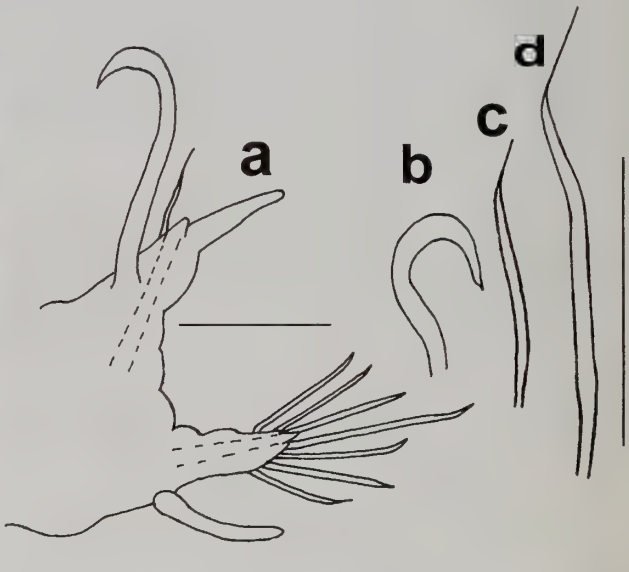

Fig. 3 **a** Parapodium from mid region, anterior view. **b** notopodial hook, **c** & **d** neurocapillaries. Scale bars = 0.1 mm.

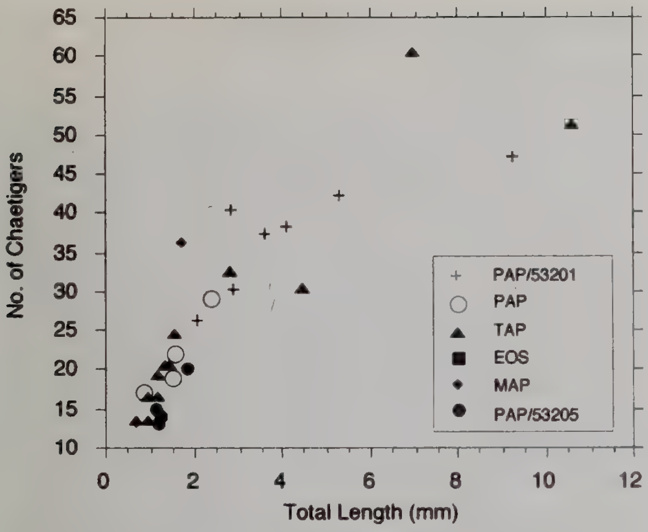

Fig. 4 Graph showing the relationship between size and number of chaetigers. Individuals from different sample sites are identified. PAP–Porcupine Abyssal Plain, MAP – Madeira Abyssal Plain, TAP – Tagus Abyssal Plain, EOS – Cap Verde Abyssal Plain.

Parapodia biramous; anterior parapodia laterally orientated, becoming more dorsal in median and posterior chaetigers. A row of cushion-like papillae extending across dorsal surface between notopodia on each chaetiger.

Notopodia pointed, with straight, blunt-tipped internal aciculae. Dorsal cirri of chaetiger 1 long, thin and tapering; nearly equal in length to median antenna; subsequent dorsal cirri initially shorter with wider bases, but in posterior chaetigers becoming more slender longer and projecting dorsally. Large hooks emergent on chaetiger 3 (Fig. 1b, 2, 3b) until one or two chaetigers from pygidium; in posterior chaetigers hooks meeting in midline. Short, delicate capillaries projecting from most notopodia, just one in anterior chaetigers (Fig. 1b, 3a), usually becoming two in posterior segments.

Neuropodial lobes pointed, with blunt-tipped, straight aciculae (Fig 3a); initially orientated laterally but become more vertical and dorsal in posterior chaetigers. Ventral cirri absent on chaetiger 2; on other chaetigers thin and tapering, equal to or shorter than neuropodia, equal to or slightly longer than dorsal cirri. Neurochaetae simple capillaries, slightly expanded at the base just free of the podia, tips quickly taper into a prolonged point (Fig. 3 c,d).

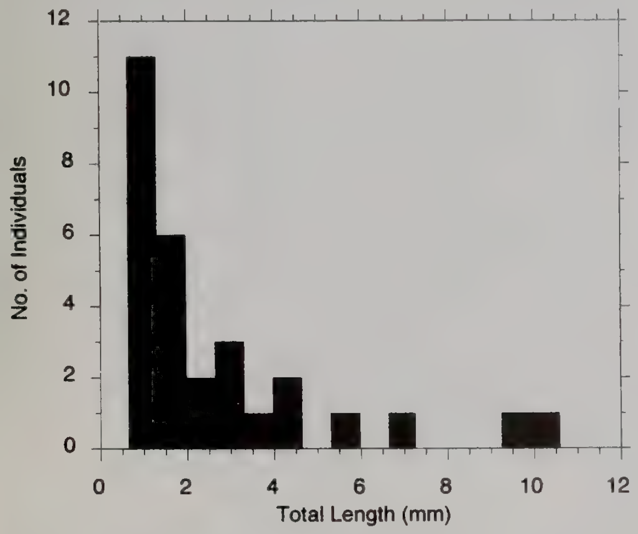

Fig. 5 Histogram showing the range of sizes of *S.magnuncus* collected in the NE Atlantic.

Pygidium with two tapering cirri. Anus dorsal.

DISTRIBUTION. *S. magnuncus* has been recorded from the abyssal plains of the NE Atlantic at depths from 4000 m to 5085 m.

ETYMOLOGY. The name of this species derives from the large conspicuous hooks on the notopodia (Latin *magnus* – large *uncus* – hook).

DISCUSSION

Taxonomic Affinities

Licher & Westheide (1994) suggested that the Pilargidae was not a separate family and that species in the family belonged in the Hesionidae. This hypothesis has been rejected by Pleijel (1998) and Pleijel and Dahlgren (1998) on the basis that Licher & Westheide's (1994) original study was not rooted in an appropriate outgroup. Subsequent analysis by Pleijel and Dahlgren (1998) indicated that the Pilargidae and Hesionidae were different and non-overlapping groups. We, therefore, retain the family Pilargidae.

Including *S. magnuncus*, there are 17 described species of *Sigambra* (Licher and Westheide, 1997). Based on examination of *Sigambra* material in the NHM and the revision of Licher & Westheide (1997), *S. magnuncus* shares certain features with *S. ocellata* (Hartmann-Schröder, 1959), *S. bidentata* Britaev & Saphronova, 1981 and *S. qingdaoensis* Licher & Westheide, 1997, namely the ventral cirrus is missing on chaetiger 2 and there are eight papillae in the pharynx (Licher & Westheide, 1997). The relative proportions of the dorsal and ventral cirri suggest similarities with *S. ocellata*, however, in *S. magnuncus* the notopodial hooks start on chaetiger 3 rather than chaetiger 6 as in *S. ocellata*. In *S. bidentata* and *S. qingdaoensis* the notopodial hooks can start from chaetigers 3, similar to *S. magnuncus*, but in addition to differences in cirral length, *S. magnuncus* differs from *S. bidentata* in not having bidentate neurochaetae. *S. magnuncus* differs from *S. qingdaoensis* in having one capillary notochaeta in anterior chaetigers, becoming two in posterior chaetigers, whereas in *S. qingdaoensis* there are always two notopodial capillaries. Finally, the notopodial hooks in *S. magnuncus* are much larger than in comparable sized individuals of the other species.

Growth and abundance

S. magnuncus was most common in samples from the Porcupine and Tagus abyssal plains with densities of 4 to 32 individuals per m^2, while lower numbers were found in the Madeira and Cap Verde samples. This was partly due to lower overall densities of polychaetes at these latter sites (Paterson *et al.* 1998), but their distribution suggests that this species is more common in northern abyssal areas. Also analysis of the distribution within the sediment suggests that this species is found within the sediment rather than on the surface.

There is a good range of sizes within the collection, allowing allometric changes to be noted. Notopodial hooks in smaller specimens appear to be extremely large, but in larger specimens these hooks are proportionately smaller. This suggests that hooks are produced at a set size, not affected by growth. The hooks always occur first on chaetiger 3.

Size of specimens ranges from 0.5 to 10.5 mm, although most individuals were between 0.75 to 4.5 mm long (Fig. 5). The relationship between length of specimen and number of chaetigers is given in Fig. 4. The graph indicates that initially as individuals increase in length so the numbers of chaetigers increases linearly, however, at the upper size there is wide variation in numbers of chaetigers, suggesting that there may be an upper limit to chaetiger number.

Growth in *Sigambra grubii* Muller, 1858 also appears to show a linear relationship between length and number of chaetigers over a similar size range as *S. magnuncus* (Salazar-Vallejo, 1990). However, there was more variation in the relationship between size and the chaetiger on which the first hook appeared.

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