

Explanation of Figures 30 to 38

Figures 30–38. *Choristella ponderi* McLean, sp. nov. Figures 30–32. Holotype, AMS C.151524, off Sydney, New South Wales, Australia. Height 3.2 mm. Apertural, spire, and umbilical views. Figure 33. AMS C.155463, off Fraser Island, Queensland, Australia. Height 3.5 mm. Figure 34. SEM view of operculum of paratype, AMS C.151524. Scale bar = 1 mm. Figure 35. SEM view of jaw of paratype, AMS C.151524. Scale bar = 200 μ m. Figure 36. SEM view of early whorls, showing protoconch and first teleoconch whorl. SEM photo by B. Marshall. AMS C.82431, off Caloundra, Queensland. Scale bar = 100 μ m. Figure 37. SEM view of critical point dried body, showing cephalic tentacles, oral lappets, and foot with pedal gland, paratype, AMS C.151524. Figure 38. SEM view of radula, paratype, AMS C.151524. Scale bar = 25 μ m.

Sta. 15, 7 July 1984, 3 dry specimens. AMS C.155460, off Frazer Island, Queensland (24°57.9'S, 153°37.3'E), 210 m, R/V *Kimbla* Sta. 27, 15 December 1977, 1 small dead specimen. AMS C.155463, S end Fraser Island Queensland (27°57'08"S, 153°51'03"E), 201 m, R/V *Kimbla* Sta. Q13, 10 November 1976, 1 dry specimen (Figure 33). AMS C.150125, N of Coolongatta, Queensland (28°07'S, 153°50'E), 146 m, R/V *Kapala* Sta. K78-17-14, 18 August 1978, 1 small specimen. AMS C.82431, E of Caloundra, Queensland, 91–110 m (50–60 fm), T. A. Garrard Coll., 1 specimen (Figure 37, protoconch). AMS C.150127, off Kiama, N.S.W. (34°46'S, 151°13'E), 387–552 m, in egg case, R/V *Kapala* Sta. K86-09-03, 15 April 1986, 2 small specimens, dry shells and wet bodies separate.

Remarks: This species is characterized by its small size, low spire, and relatively few whorls. There are a sufficient number of records to be certain that the specimens are mature. In its small size and low spire it is most similar to *Choristella leptalea* Bush, a species too poorly known to allow full comparison.

Choristella ponderi is broadly distributed on the east coast of Australia. Records are known from Queensland (23°08'S) to New South Wales (34°56'S).

Etymology: The name honors Winston Ponder, of the Australian Museum, Sydney.

Choristella hickmanae McLean, sp. nov.

(Figures 39–45)

Choristella n. sp.: HICKMAN, 1983:86, fig. 29 [radula].

Description: Shell (Figures 39–43) large for genus (maximum diameter 9 mm), spire height relatively low (height-width ratio of holotype 0.72). Shell wall extremely thin, maximum thickness of broken lip 0.1 mm. Surface dull, yellowish white, periostracum not evident, surface finely pitted. Protoconch and earliest teleoconch whorl missing. Remaining whorls 3.5, rounded, smooth; suture deeply impressed. Umbilicus broad, deep, not obstructed by reflection of inner lip. Spiral sculpture represented only by single narrow ridge deep within umbilicus; axial sculpture lacking, growth increments not apparent. Peristome complete, area of contact with previous whorl minimal. Operculum (Figure 39) pale brown, nucleus slightly excentric, final 3 whorls evenly expanding in multispiral pattern.

Dimensions. Height 6.5 mm, width 9.0 mm (estimated dimension of holotype prior to breakage); height 7 mm, diameter 10 mm (estimated dimension of sectioned paratype).

External anatomy. Figure 44 shows the left (umbilical view) side of a paratype specimen prior to sectioning. Four epipodial tentacles are shown adjacent to the operculum.

Radula (Figure 45). The radula agrees with the generic description in its overall morphology. The rachidian tooth

has a weakly projecting shaft, but a small, clearly distinct, overhanging cusp.

Type locality: Northern Cascadia Abyssal Plain, at base of continental slope, 95 nautical miles (172 km) west of Strait of Juan de Fuca, Washington (48°38.1'N, 126°58.0'W), 2176 m, gray silty clay. CAREY (1981) described the bottom conditions for the Cascadia Abyssal Plain.

Type material: 3 specimens from type locality, all with damaged shells, collected with beam trawl by A. Carey, Oregon State University (BMT-DWD Sta. 9), 11 September 1971. Holotype, LACM 2249 (Figures 42, 43) body used for light microscope preparation of radula. Two paratypes, LACM 2250, one sectioned, shell destroyed, photograph of shell and body prior to sectioning (Figures 39–41), one paratype specimen with badly damaged shell used for SEM preparation of radula by C. Hickman (Figure 45).

Remarks: *Choristella hickmanae* is a relatively low-spined species comparable to *C. leptalea* and *C. ponderi*, but is larger than either species (9 mm maximum dimension, compared to 4.0 mm for *C. leptalea* and 4.7 mm for *C. ponderi*). Each species has 3.5 whorls. The umbilicus of *C. hickmanae* is broader than that of *C. leptalea* and *C. ponderi*, in which the peristome is slightly reflected over the umbilicus.

The fine pitting on the surface of the shell is probably a result of etching due to the original preservation in formalin.

There is no record of association of the type lot with shark or skate egg cases, but the extremely thin shell and damaged condition of all specimens suggest that protection within an elasmobranch egg case would be essential to this species.

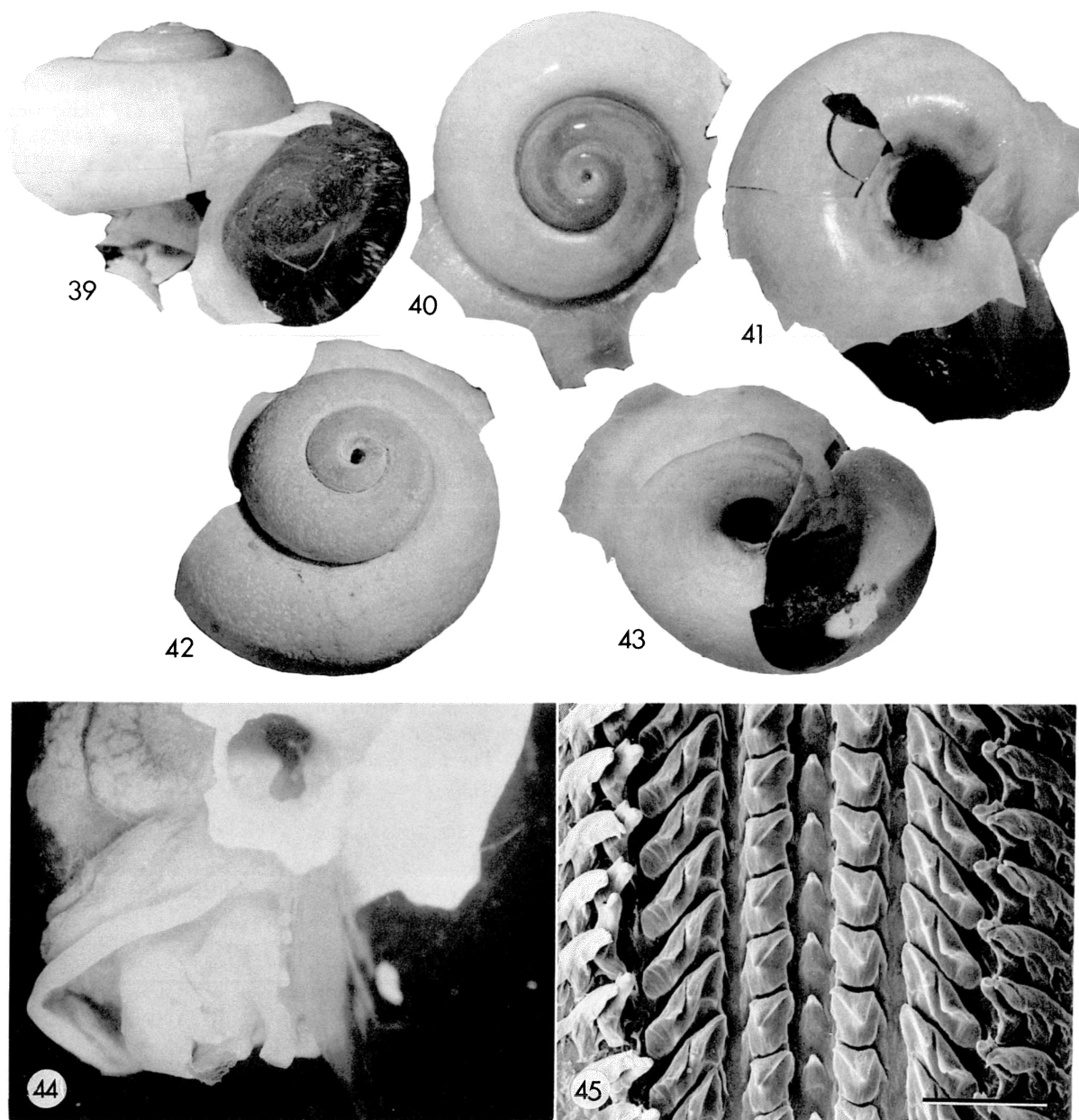
Etymology: This species is named after Carole S. Hickman, University of California, Berkeley.

Further Records of *Choristella* spp.

Four additional lots of *Choristella* species from the MNHNP collection were received on loan from P. Bouchet subsequent to the initial submission of this paper. All represent immature specimens and I refrain from describing further new taxa from this material because mature examples are unknown. These lots are listed here:

MNHN uncataloged, Mozambique Channel (11°44'S, 47°35'E), 3716 m. R/V *Suroit*, BENTHEDI Expedition, Sat. 87, 3 April 1977. Five specimens, maximum diameter 2.0 mm. Specimens of 1.0 mm in diameter show a basal carination.

MNHN uncataloged, Norfolk Ridge (23°03'S, 167°19'E), 503 m. R/V *N. O. Vauban*, SMIB 3 Expedition, Sta. DW22, 24 May 1987. Two specimens, maximum



Explanation of Figures 39 to 45

Figures 39–45. *Choristella hickmanae* McLean, sp. nov. Figures 39–41, 44. Paratype specimen prior to sectioning, Northern Cascadia Abyssal Plain off Washington, LACM 2250. Height 6.5 mm (estimate). Figures 42, 43. Holotype, same locality, LACM 2249. Diameter of broken shell 8.0 mm. Figure 45. SEM view of radula of paratype, LACM 2250. Scale bar = 50 μ m.

diameter 2.0 mm. Shell profile low, not showing basal carination. Radula and jaw examined with SEM, typical for *Choristella*.

MNHN uncataloged, Tanimbar Islands, Indonesia (08°42'S, 131°54'E), 356–368 m. R/V *Baruna Jaya 1*, KARUBAR expedition, Sta. CP69, 2 November 1991. Six specimens, maximum diameter 3.5 mm. Shell profile of

medium height; small specimens not showing basal carination. Radula and jaw examined with SEM, typical for *Choristella*.

MNHN uncataloged, Kai Islands, Indonesia (06°08'S, 132°45'E), 390–502 m, R/V *Baruna Jaya 1*, KARUBAR expedition, Sta. CP35, 27 October 1991. One specimen, maximum diameter 4.0 mm, similar to preceding lot.

Bichoristes McLean, gen. nov.

Type species: *Bichoristes wareni* McLean, sp. nov.

As the genus is monotypic, the generic diagnosis and remarks are combined in the species treatment below.

Bichoristes wareni McLean, sp. nov.

(Figures 46–53)

Description: Shell (Figures 46–48) minute (maximum diameter 3.2 mm), thin, periostracum unknown, whorls 3.2, quadrangular in section, growth form planispiral with two acutely angled, projecting carinations at outer edge, one above and the other below position of protoconch; upper carina projecting slightly more than lower carina. Suture at position of upper carination of previous whorl, not channeled; whorl extending above suture, forming rounded angulation, base defined at position of broadest possible umbilicus by sharp angulation. Spiral sculpture lacking except for these four carinations. Axial sculpture of exceedingly fine growth increments, prosocline on upper surface of whorl, greatest curvature close to suture, opisthocline on outer surface between the two keels, prosocline on base, greatest curvature close to umbilical keel. Aperture quadrangular, peristome complete; mature upper lip, outer lip, and lower lip slightly flared. Protoconch (Figure 49) diameter 200 μ m, tip bulbous, surface smooth, visible equally in spire and umbilical views, similarly recessed in both views. Operculum (Figure 50) thin, multispiral, about 10 whorls visible.

Dimensions. Height 1.4 mm, diameter 3.2 mm (holotype); height 1.2 mm, diameter 3.0 mm (paratype).

External anatomy. Unknown.

Jaw (Figure 51). Typical for family.

Radula. (Figures 52, 53). Rachidian tooth relatively large, with triangular shaft and prominent overhanging cusp; base of shaft with lateral nubs and one central nub. First lateral tooth massive, with two cusps, the innermost small and blunt like that of rachidian, the outermost acutely triangular and with long overhang; shaft base articulating with tooth below, inner edge of shaft articulating with rachidian. Second lateral tooth largest in row, with single large acutely pointed overhanging cusp, its upper profile descending away from rachidian, shaft long and deeply excavated for accommodation of outer lateral teeth. Third lateral tooth with long shaft and pointed cusp that projects over the deeply excavated shaft of second lateral tooth. Fourth lateral tooth small, fused with and emerging from shaft of third. Fifth lateral tooth vestigial, a small flap at the base of the shaft of the third lateral tooth.

Type locality: Norfolk Ridge, S of New Caledonia (24°55'S, 162°22'E), 505–515 m.

Type material: Holotype MNHN uncataloged, from type locality, R/V *Jean Charcot*, BIOCAL Expedition Sta. DW66, 3 September 1985. The body of the specimen was

extracted through a hole filed in the shell by A. Warén, who examined the operculum, radula, and jaw with SEM and provided the prints used here. One paratype, MNHN uncataloged, Norfolk Ridge (23°03'S, 167°19'E), 503 m, R/V *N. O. Vauban*, SMIB 3 Expedition Sta. DW22, 24 May 1987.

Remarks: The discovery of a planispirally coiled member of the Choristellidae was unanticipated. Although the shell morphology seems to be completely different from that of other choristellids, there are a number of shared characters: (1) shell is extremely thin; (2) protoconch surface is smooth; (3) teleoconch whorls do not exceed 3.5; (4) contact with the previous whorl is limited to the thin layer that makes the peristome complete where it fuses with the parietal wall, and (5) the umbilicus is as broad as is physically possible, the inner basal keel of *Bichoristes* corresponding to the sharp umbilical ridge of *Choristella*. *Bichoristes* adds the outer two keels; these delimit the area of contact for the next whorl, and the result is a planispiral growth form.

The radula has the basic choristellid plan, differing from that of *Choristella* in having the first rather than second lateral tooth the bicuspid tooth. Other distinctions are the nubs at the base of the shaft of the rachidian and the fusion of the fourth lateral tooth with the third.

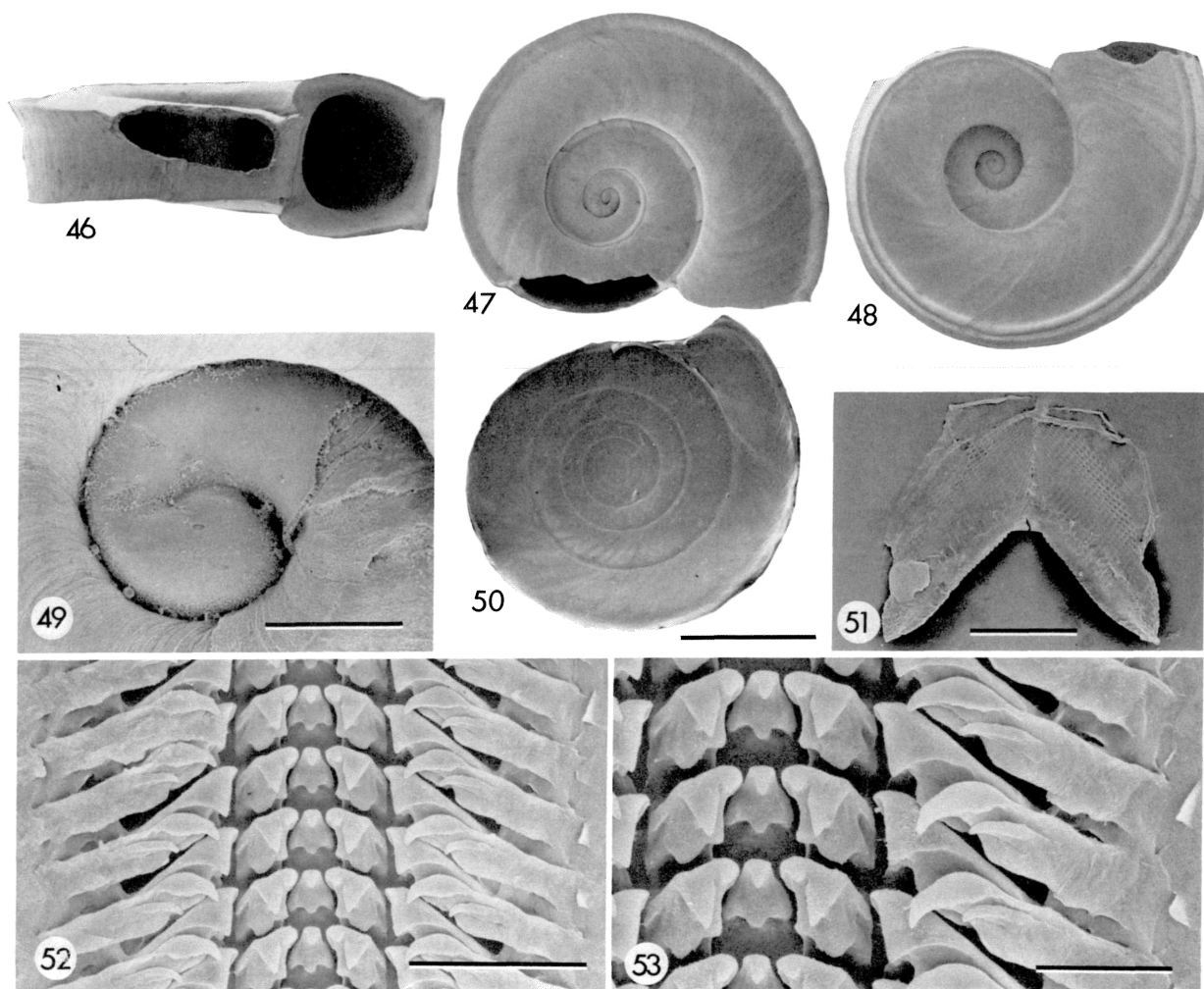
The sculptured shell of *Bichoristes* has to be interpreted as either derived or primitive in the family. I interpret *Bichoristes* as derived from the low-spired shell form typified by *Choristella ponderi* by the not so extreme modifications to the sculpture noted above. Its jaw and radula are so like those of other choristellids that it is difficult to conceive of a differing life mode. Functionally, its quadrangular shell morphology provides structural support. The narrow planispiral shell form would enable access to the deep crevices at both ends of the elasmobranch egg case, where a planispiral shell could be expected to penetrate further than the helically coiled shell form of *Choristella*.

Etymology: The name honors Anders Warén, of the Swedish Museum of Natural History, Stockholm, who recognized the familial affinity of the species among material in the MNHN collection.

DISCUSSION

Choristellidae and Addisoniidae share many characters of internal anatomy (HASZPRUNAR, 1988c, 1992) and a similar habitat and feeding specialization on the spent egg cases of elasmobranchs. Members of both families are thin-shelled, affording little protection from predators; instead, protection is provided by the thick walls of the egg cases within which they live.

The radula in the Choristellidae and Addisoniidae is relatively large and is provided with robust teeth that are capable of gouging into the walls of the egg cases to provide a direct source of food. Marshall (personal communication) reports that the inner wall of egg cases that contained



Explanation of Figures 46 to 53

Figures 46–53. *Bichoristes wareni* McLean, sp. nov. All are SEM views of holotype specimen, MNHN, Norfolk Ridge. Diameter 3.2 mm. Figures 46–48. Apertural, spire, and umbilical views. Figure 49. Protoconch. Scale bar = 100 μ m. Figure 50. Operculum. Scale bar = 400 μ m. Figure 51. Jaw. Scale bar = 100 μ m. Figure 52. Radula. Scale bar = 20 μ m. Figure 53. Radula. Scale bar = 10 μ m.

Choristella marshalli were eaten by the limpets. McLEAN (1985) illustrated radular grazing marks made on the inner wall of an egg case by *Addisonia brophyi* McLean, 1985.

The radula in other cocculiniform families is relatively small with weakly developed teeth in the central field; most of these families also differ in having marginal teeth that are used for sweeping. MARSHALL (1986) has emphasized that the diet in these families is likely the bacteria that are associated with the decomposition of the biogenic substrates, rather than the direct food source provided by the substrate.

There is no indication that members of either the Choristellidae or Addisoniidae occur in the capsules of developing elasmobranchs. The thin-shelled mollusks would be exposed to predators during penetration of the egg case. Thus

it is incorrect to say that these mollusks are parasitic. Dispersal of these mollusks would necessarily be possible only during the larval stage, at which time the larvae would settle on and enter a spent capsule through the opening from which the young elasmobranch had emerged.

Sizes of the egg cases available in the benthos places limits on the maximum size attained by choristellid and addisoniid species. The maximum size of 10 mm in choristellids could only be exceeded if the elasmobranch capsule were unusually large.

The distribution of each species must depend upon the availability of egg cases of sharks and skates. As noted earlier (McLEAN, 1985), egg cases are produced by three elasmobranch families, the cat sharks (family Scyliorhinidae), with about 85 species in the world, the bullhead or

horn sharks (family Heterodontidae) and the skates (family Rajidae) (ESCHMEYER *et al.*, 1983). COX (1963) and ESCHMEYER *et al.* (1983) illustrated the egg cases of the species in these families known from California. If a worldwide study of capsule producing elasmobranchs were available, it would be possible to predict the likelihood of associated species of choristellids and addisoniids. Because too few records are currently known, it is unknown whether choristellid species are host specific.

WOURMS (1977) reviewed the literature on elasmobranch egg-case structure and formation. Egg cases are composed of layers of the structural protein collagen, which exhibits unique chemical and physical properties when deployed in the egg cases. Shark embryos develop within the egg cases for up to nine months, during which there is little evidence of deterioration of the egg cases. The duration of spent egg cases in the benthos is unknown, nor am I aware of their being used as food by other organisms, but the cases undoubtedly persist in the benthos for a number of years. The egg cases should therefore provide a persistent and reliable food source.

SUMMARY

Additions to knowledge of the Choristellidae that result from this study are:

(1) Family-level shell characters are minute to small size, extremely thin shell, complete peristome, deep suture (except *Bichoristes*), umbilical ridge, smooth bulbous protoconch, and maximum of 3.5 teleoconch whorls.

(2) The radula is unique to the family. Its resemblance to that of the Cocculinellidae is superficial.

(3) The bulbous protoconch tip is unlike the compressed, laterally pinched protoconch tip of Pseudococculinidae and Cocculinellidae. Protoconch characters may yet confirm the affinity to Addisoniidae suggested by anatomical characters (HASZPRUNAR, 1992), but have not helped because the protoconch of Addisoniidae is deciduous and remains unknown.

(4) Taxa based on shell characters can readily be excluded from the genus if they do not meet all these criteria. In the Appendix, 10 species-level taxa that have previously been assigned to the family are excluded. Skeneiform genera with a sharp umbilical ridge may be excluded by lacking the deep suture.

(5) Specific characters in *Choristella* are relative size, relative proportions of height to width, and whether the multispiral operculum looks multispiral or appears to be paucispiral as a result of having only three whorls. External anatomy is too poorly known to be useful at this time.

(6) The new genus *Bichoristes* has a uniquely bicarinate and planispiral shell, although the radula is close to that of *Choristella*. Most of the shell characters diagnostic for *Choristella*, including thin shell, 3.5 whorls, smooth protoconch, and umbilical ridge, are present.

(7) Although most species are allopatric, one sympatric pair is known: *Choristella tenera* and *C. leptalea*.

(8) No species is known to be free living and unassociated with the spent egg cases of elasmobranchs.

(9) Shell size is limited by the size of available egg capsules.

(10) The family is broadly distributed, having been found in the most extensively sampled regions of the world in temperate zones at continental shelf to abyssal depths.

ACKNOWLEDGMENTS

Treatment of new species included here would not have been possible had not Philippe Bouchet of the Museum d'Histoire Naturelle, Paris, Bruce Marshall of the National Museum of New Zealand, and Winston Ponder of the Australian Museum, Sydney, turned over to me the undescribed choristellid species they had recognized in their museum collections, as well as some scanning work that had been done. SEM micrographs of the radula of *Choristella hickmanae* were provided by Carole Hickman. All illustrations for *Bichoristes wareni* were provided by Anders Warén, who also provided two views used for *Choristella nofronii*. Bruce Marshall provided the radular illustrations for *Trenchia agulhasae* used in the Appendix. I thank staff members of the Natural History Museum, London, and the U.S. National Museum of Natural History for the loan of pertinent type specimens. I thank Philippe Bouchet, Gerhard Haszprunar, Bruce Marshall, and Anders Warén, and the anonymous reviewers for reading the manuscript and offering helpful suggestions.

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APPENDIX—TAXA EXCLUDED FROM CHORISTELLIDAE

A number of taxa have been incorrectly allocated to the family Choristellidae (originally assigned to the "Choristidae"). The following taxa have not been shown to have the choristellid radular plan and lack some or all of the diagnostic shell characters (small size, extremely thin shell, complete peristome, deep suture, and sharp carination descending into the umbilicus). Some of the misallocated taxa are naticids, but many are potential members of the family Skeneidae (superfamily Trochacea). Skeneidae and families of similar appearance have been poorly understood but have received recent attention from MARSHALL (1988), HICKMAN & MCLEAN (1990), and WARÉN (1991, 1992). It is beyond the scope of this paper to allocate the following taxa, although some suggestions are made.

1. *Choristes elegans* Carpenter, 1872 (Figure 54)

Choristes elegans Carpenter in DAWSON, 1872:392, pl. 7, figs. 13, 13a; VERRILL, 1882:542, p. 58, fig. 28 ["I have figured a young fossil specimen for convenient comparison"]; RICHARDS, 1962:79, pl. 17, fig. 15 ["Montreal, Pleistocene"]; CLARKE, 1961:360 [in list of species under *Choristes*]; MARINCOVICH, 1977:338 [as valid genus and species of Naticidae]; BOUCHET & WARÉN, 1979, fig. 47 [syntype]. Type locality: Pleistocene, St. Lawrence River Estuary, Montreal, Quebec. **Lectotype (here designated):** USNM 188948; 2 paralectotypes: USNM 56385.

Carpenter was uncertain as to the familial relationships of the Pleistocene fossil he described as *Choristes elegans*: "It is hard to pronounce satisfactorily on its relationships. In its thin, coated shell it resembles *Velutina*; the striae and loose whirls recall *Naticina*; the straight pillar lip reminds us of *Fossarus*; while the umbilicus and rounded base, with entire mouth, best accord with the *Natica* group."

Although MARINCOVICH (1977) used *Choristes* for eastern Pacific naticid species, he cited only the original illustration of the type species; it is not clear whether he examined specimens. He did not cite the illustration of RICHARDS (1962:79, pl. 17, fig. 15), who figured a specimen identified as *Choristes elegans* from the Montreal Pleistocene and placed it in Choristidae without comment. BOUCHET & WARÉN (1979) figured a syntype without citing a catalog number. There are three shells in the USNM collection labeled *Choristes elegans* Carpenter, "Postpliocene, Montreal, Dawson." A **lectotype** (USNM 188948, height 20.1 mm, Figure 54) and two **paralectotypes** (USNM 56385, heights 16.7 mm and 17.2 mm) are

here designated. The lectotype (Figure 54) shows irregular spiral sculpture and the inner lip detached from the parietal wall. Carpenter noted the "smooth epidermis lining the umbilical chambers, conspicuously preserved, even in these fossil specimens, between the closest part of the parietal region."

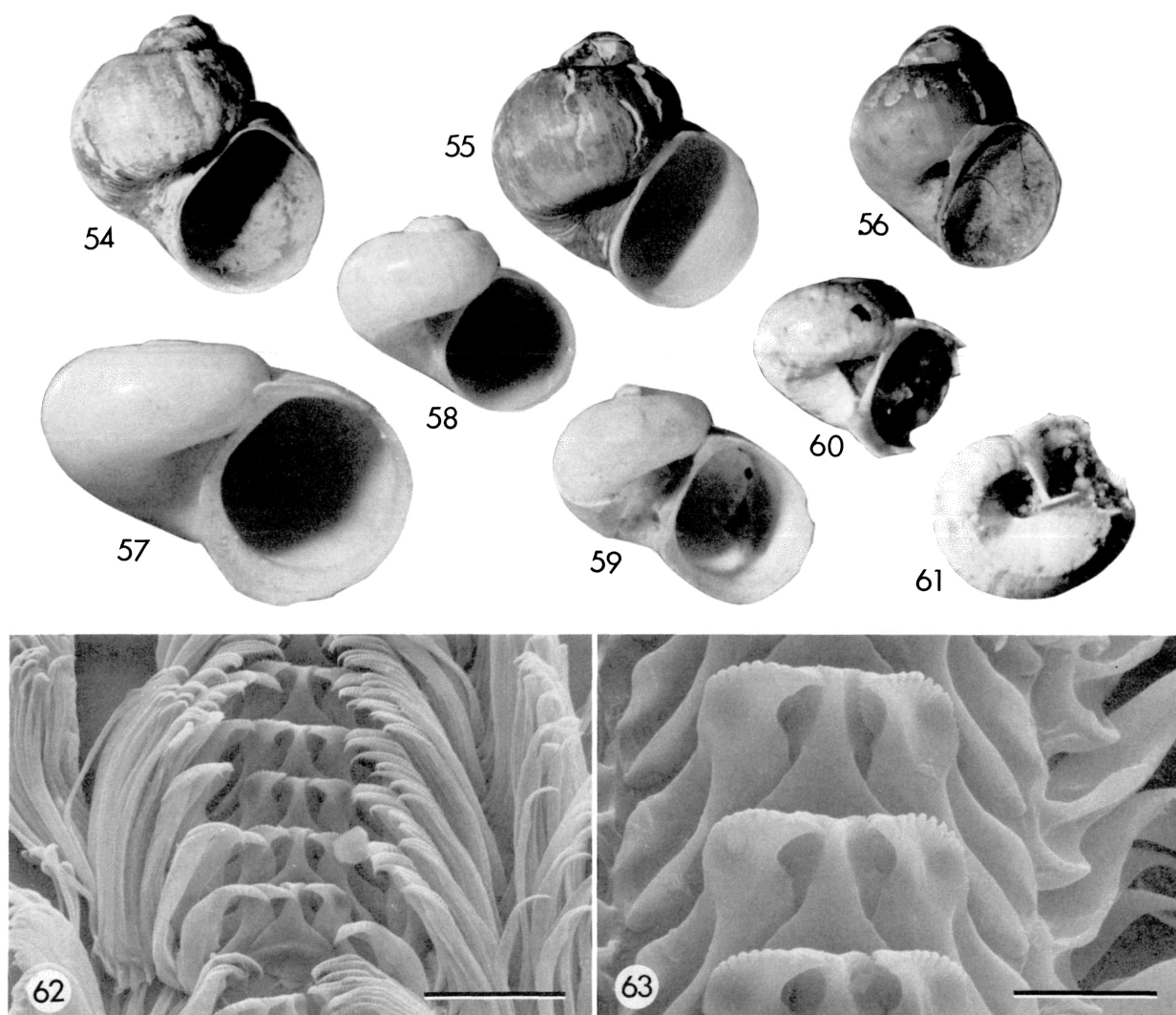
The type material of *Choristes elegans* is here identified as a variation of the naticid *Amauropsis islandica* (Gmelin, 1791), a morphologically variable species that is broadly distributed in shallow to moderate depths in the North Atlantic and Arctic Oceans. In his redescription of *A. islandica*, MARINCOVICH (1977:217, pl. 17, figs. 1-4, pl. 22, fig. 1) described the umbilicus as "open, extremely narrow and slitlike, usually concealed by periostracum of inner lip margin." This description of the periostracum agrees with that of Carpenter for *Choristes elegans*. The three specimens have broader umbilici than most specimens of *A. islandica*, but such a shell form may possibly correlate with the lowered salinity in the estuary of the St. Lawrence River.

MARINCOVICH (1977:338) was the first subsequent author to correctly assign *Choristes* to the Naticidae. GOLOKOV & STAROBOGATOV's (1975) assignment to the Naticidae on radular characters cannot be credited because it could only have been based on published illustrations of the radula of "*Choristes*" *tenera* (which is not a naticid). However, Marincovich did not note the fact that *Choristes elegans* would have to be considered extinct if recognized as a valid species; he did not compare it to *Amauropsis islandica* and he did not conclude that *Choristes tenera* Verrill should be assigned elsewhere, despite noting that the radular dentition of that species differed from that of two Recent naticids he assigned to *Choristes*. Instead, he stated that "another radular mount should be made to confirm the radular dentition reported by VERRILL (1882)."

KABAT (1989, 1991) was aware that Choristellidae Bouchet & Warén, 1979, solved the nomenclatural problem for the choristellids, but pointed out that Choristidae Verrill, 1882 (Naticacea) presented a problem of homonymy for the well-known insect family Choristidae Esben-Petersen, 1915 (nominotypical genus *Chorista* Klug, 1836). Kabat proposed that Choristidae Verrill be emended to Choristeidae Verrill, to conserve Choristidae Esben-Petersen and to retain Choristeidae in the event that it might prove to have utility in the Naticacea. Kabat (personal communication) now agrees with the synonymization of *Choristes* with *Amauropsis*.

2. *Choristes carpenteri* Dall, 1896 (Figures 55, 56)

Choristes carpenteri DALL, 1896:10; DALL, 1908:328, pl. 3, fig. 4; KEEN, 1971:388, fig. 424 [copy fig. of DALL, 1908]; CLARKE, 1961:360 [in list of *Choristes* species]; MARINCOVICH, 1977:340, pl. 31, figs. 8, 9, text fig. 11b [radula]. Type locality: Gulf of Panama, 2693 m. Holotype: USNM 123039.



Explanation of Figures 54 to 63

Figures 54–63. Type specimens of taxa incorrectly referred to Choristellidae. Name combinations as originally proposed. Figure 54. Lectotype, *Choristes elegans* Carpenter, 1862. USNM 56385. Pleistocene, St. Lawrence River Estuary, Montreal, Quebec. Height 20.1 mm. Figure 55. Holotype, *Choristes carpenteri* Dall, 1896. USNM 123039. Gulf of Panama, 2693 m. Height 21.0 mm. Figure 56. *Choristes carpenteri*, second reported specimen, USNM 123038. Gulf of Panama, 2690 m. Figure 57. Holotype, *Cyclostrema pompholyx* Dall, 1889. USNM 214279. Gulf of Mexico, 1472 m. Diameter 4.1 mm. Figure 58. Holotype, *Choristes agulhasae* Clarke, 1961. MCZ 224955. Cape Basin off South Africa, 4585 m. Height 2.0 mm. Figure 59. Holotype, *Choristes agulhasae argentinae* Clarke, 1961. Argentine Basin, 5130 m. MCZ 224956. Height 2.3 mm. Figures 60, 61. Syntype, *Cithna naticiformis* Jeffreys, 1883. BMNH 85.11.5.1615–1617. Porcupine Expedition of 1870, Sta. 17a, off Portugal, 1353 m. Height 1.8 mm. Specimen is still attached to cardboard mount. Figures 62, 63. SEM views of radula from holotype of *Choristes agulhasae* Clarke, 1961, courtesy B. Marshall. See text for generic assignment to *Trenchia* Knudsen, 1964. Scale bar of Figure 62 = 100 μm , of Figure 63 = 40 μm .

Despite the fact that *Choristes* was based on a shallow-water type species, MARINCOVICH (1977) retained the genus for two abyssal, eastern Pacific naticid species, *Choristes carpenteri* Dall, 1896, and *C. coani* Marinovich, 1975, invoking a unique radular definition (“moncuspsate rachidian, one moncuspsate lateral, and two moncuspsate

marginal teeth per half row”). Now that *Choristes* is relegated to the synonymy of *Amauropsis*, these two species are in need of generic reassignment in Naticidae. Affinity to *Amauropsis* is ruled out, as its type species has a tricuspsate rachidian tooth.

The holotype of *Choristes carpenteri* (USNM 123039,

from USFC Sta. 3382), is 21 mm in height, which is sufficiently large to remove it from consideration as a member of the Choristellidae. No mention of an operculum was made in the original account and the specimen appears not to have been collected alive. This specimen has the apical area worn. It is illustrated here for the first time (Figure 55).

In his subsequent account DALL (1908) mentioned a second specimen, from USFC Sta. 3361, 2690 m, Gulf of Panama. This must have been the specimen to which he referred in reporting that "the animal agrees in general appearance with that of *Choristes elegans* var. *tenera* Verrill, as described by Verrill." This specimen, USNM 123038, from USFC Sta. 3361 (Figure 56) is also marked "type"; it measures 15.0 mm in length. It exhibits a characteristic sculptural pattern of naticids in having collabral ridges on the upper part of the whorl near the suture. This specimen has the operculum and a dried body, but the body does not have the epipodial tentacles that may be seen on the dried bodies of *Choristella tenera*. Clearly and inexplicably Dall erred in reporting that the animal agreed with Verrill's species. Although MARINCOVICH purported to figure the holotype (1977:fig. 8), he actually figured this second specimen mentioned by Dall (USNM 123038), and incorrectly gave the length at 20.5 mm, rather than 15.0 mm.

3. *Choristes coani* Marincovich, 1975

Choristes coani MARINCOVICH, 1975:169, figs. 2, 6, 7; MARINCOVICH, 1977:341, pl. 31, figs. 10-12, text fig. 11c [radula]. Type locality: off Central Oregon, 2830 m. Holotype: USNM 741014.

This was described by Marincovich in the family Naticidae. Like the preceding species, it is in need of generic reassignment.

4. *Cyclostrema pompholyx* Dall, 1889 (Figure 57)

Cyclostrema pompholyx DALL, 1889:394, pl. 28, fig. 9; BUSH, 1897:139; TURNER, 1978:17, figs. 11, 12. Type locality: Gulf of Mexico, 1472 m. Holotype: USNM 214279.

Choristes pompholyx: CLARKE, 1961:360 [in list of *Choristes* species].

DALL (1889) originally stated: "I am in doubt as to the generic place of this species, so simple in its characters and without the soft parts. I had thought of putting it under *Choristes* or with *Vitrinella*, and finally in placing it here [*Cyclostrema*] feel by no means satisfied that the choice is a correct one." BUSH (1897) noted that Dall's species "may prove to be another species of *Choristes*," accounting for CLARKE (1961) having placed it in *Choristes*.

The shell is sturdy with a broadly inflated lip. It lacks the umbilical ridge of *Choristella*. There is no evidence to support the allocation of this species to the family Choristellidae.

5. *Choristes agulhasae* Clarke, 1961 (Figure 58)

Choristes agulhasae CLARKE, 1961:361, pl. 3, fig. 1. Type locality: Cape Basin (corrected from Agulhas Basin), SW of Cape Town, South Africa, 4585 m. Holotype: MCZ 224955.

No evidence was advanced to support the assignment of this species to the family, although there is an umbilical carination similar to that of *Choristella*. The radula (Figures 62, 63, SEM photos by Bruce Marshall) is rhipidoglossate, unlike that of Choristellidae. Marshall (personal communication) has identified it as that of *Trenchia* Knudsen, 1964 (family Skeneidae), characterized by the elongate and laterally excavated base of the first lateral tooth.

6. *Choristes agulhasae argentinae* Clarke, 1961 (Figure 59)

Choristes agulhasae argentinae CLARKE, 1961:361, pl. 3, figs. 2, 3. Type locality: Argentine Basin, ESE of Buenos Aires, Argentina, 5130 m. Holotype: MCZ 224956.

The holotype (Figure 59) is a single empty shell, larger than that of the preceding taxon. No evidence supports assignment to Choristellidae. It may be regarded as a possible member of *Trenchia*.

7. *Cithna naticiformis* Jeffreys, 1883 (Figures 60, 61)

Cithna naticiformis JEFFREYS, 1883:112, pl. 20, fig. 11; WARÉN, 1980:21; GUBBIOLI & NOFRONI, 1986:204, figs. Type locality: Porcupine Expedition of 1870, Sta. 17a, off Cape Mondego, Portugal, 1353 m. Syntypes: 3 shells, BMNH 85.11.5.1615-1617.

GUBBIOLI & NOFRONI (1986) incorrectly used this name for *Choristella nofronii* described here, as detailed in the remarks that follow the new species description. A syntype specimen is illustrated here (Figures 60, 61). Although radular material is not available, it is also a possible species of *Trenchia* on evidence from shell characters.

8. *Cyclostrema valvatooides* Jeffreys, 1883

Cyclostrema valvatooides JEFFREYS, 1883:92; WARÉN, 1980:19; GUBBIOLI & NOFRONI, 1986:205. Type locality: Porcupine Expedition, 1870, Sta. 17a, off Cape Mondego, Portugal, 1353 m. Holotype: BMNH 85.11.5.1593.

GUBBIOLI & NOFRONI (1986) also suggested that this name might apply to *Choristes nofronii* described here. I have examined the holotype, which is in bad condition due to chemical exfoliation; it lacks the umbilical carination of *Choristella*.

9. *Choristes mollis* Okutani, 1964

Choristes mollis OKUTANI, 1964:389. Type locality: off Miyake Island, Japan, 1230–1350 m.

No evidence supported the original placement in *Choristes*. The granular sculpture, and of most importance, the incomplete peristome as illustrated by Okutani are not characters of the family. The operculum is figured as multispiral with more whorls than in species of *Choristella*. Reassignment may be possible if the radula is intact in the holotype. Marshall (personal communication) suggests that it be compared to *Granigyra* Dall, 1889 (family Skeneidae).

10. *Choristes nipponica* Okutani, 1964

Choristes nipponica OKUTANI, 1964:388, pl. 6, fig. 2. Type locality; Sagami Bay, Japan, 1360–1385 m.

No evidence was given to support the assignment of this taxon to *Choristes*. The “shining shell,” sutural shelf rather than channeled suture, produced basal lip, and incomplete peristome are not characters of *Choristella*. The operculum is illustrated as multispiral. Assignment on radular characters may be possible.