Bulletin of the Mizunami Fossil Museum, no. 44 (2018), p. 1–8, 5 figs.
© 2018, Mizunami Fossil Museum

Libinia marylandicus Palmer, 1935: discovery of a forgotten specimen from the Maryland Miocene, USA, and re-evaluation of *Libinia* spp. from the Maryland Miocene

Rodney M. Feldmann*, Carrie E. Schweitzer, and David J. Bohaska*****

*Department of Geology, Kent State University, Kent, OH 44242, USA <rfeldman@kent.edu>
**Department of Geology, Kent State University at Stark, North Canton, OH 44720, USA <cschweit@kent.edu>
***Department of Paleobiology, U. S. National Museum of Natural History, Smithsonian Institution, Washington, DC 20560, USA
< bohaskad@si.edu >

Abstract

Recognition of the holotype and three additional specimens of *Libinia marylandicus* Palmer, 1935, which was published obscurely and never illustrated, permits elaborating on the original description and comparing it to *Libinia amplissimus* Feldmann and Schweitzer, 2016. The rediscovery confirms that four distinctly different species of *Libinia*, including two extant species, are known from the Miocene St. Marys Formation in Maryland.

Key words: Decapoda, Brachyura, Epialtidae, Miocene, Maryland, USA

Introduction

Occasionally, new species are described that fall into obscurity. One such is the spider crab, *Libinia marylandicus* Palmer, 1935. It was described briefly in the Bulletin of The Natural History Society of Maryland. The specimen was never illustrated, but was deposited in the Department of Paleontology of that society with a catalogue number of M300C. Other than the original description, the only other mentions of the species were in a University of Maryland Libraries bibliography (Donohue, 1967) and the Newsletter of the Natural History Society of Maryland (Young, 2014). The latter noted the species as one of two new species published in the society's bulletin. Thus, the species and the sole specimen documenting it passed into obscurity until recently rediscovered.

The original description was preliminary, and Elra Palmer, also the collector of the specimen, intended a more detailed description (Palmer, 1935). He apparently borrowed and further prepared the specimen as discussed below. The specimen was at his home at the time of his death. Through the efforts of his widow, Callie Palmer, and The Natural History Society of Maryland members Arnold Norden and Ralph E. Eshelman and officers Joseph McSharry and Charles A. Davis, the specimen was returned to the Society and transferred to the Smithsonian Institution. Included with the donation were three partial specimens (USNM 630039–630041) of *Callinectes*, also cited in Palmer (1935), two from the St. Marys Formation and one from the Pleistocene. Dan Levin of the Smithsonian's Department of Paleobiology retrieved all four specimens from a processing area and catalogued them.

In 2014, Mr. John Nance delivered a specimen to us of a very large spider crab that had been collected from the Miocene St. Marys Formation and had been prepared by him. Subsequent study documented the unique character of the specimen, and it was named *Libinia amplissimus* Feldmann and Schweitzer, 2016. Stimulated by this publication, one of us (DJB) contacted (RMF) to say that the holotype of *Libinia marylandicus* had just surfaced and was in the process of being accessioned into the type collection. Prompted by this discovery, we borrowed the specimen and determined that it was clearly a species of *Libinia* and that it was strikingly different from *L. amplissimus*.

Continued search of the collections of the Natural History Museum yielded more specimens from the St. Marys Formation referable to *Libinia*. Two are readily referable to *L. marylandicus*; one is tentatively referred to that species; one is assignable to *L. dubia* H. Milne Edwards, 1834; and one has been identified as *L. emarginata* Leach, 1815. Yet another specimen of *L. dubia* may well be assigned to the St. Marys Formation, although it was originally considered to be Pleistocene in age. These specimens have been re-examined and incorporated into this study to identify and illustrate all the species of that

genus currently known from Miocene rocks in Maryland. Thus, the purpose of this work is to more completely describe *L. marylandicus*, to illustrate it for the first time, and to discuss the other species of *Libinia* known from the St. Marys Formation.

Material and localities

Abbreviations:
CCM-I, Invertebrate collection of the Calvert County Museum
UI, University of Iowa, Department of Earth and Environmental Sciences
USNM, United States National Museum, Smithsonian Institution

Studied specimens:
Libinia marylandicus Palmer, 1935
USNM 630038: Holotype, *Libinia marylandicus* Palmer. Collected November, 1933, by Elra Palmer. "Masson Eyrie" is on the label received with the specimen, but the locality is better known as Langleys Bluff. The bluff is on the Chesapeake Bay shore of St. Marys County, Maryland, about 5.5 miles south from Cedar Point, south of the Patuxent Naval Air Station. Langleys Bluff is best known as a marine Pleistocene site, but has Miocene St. Marys Formation at the base (Blake, 1953). Palmer mentioned five mollusks, "characteristic" of the St. Marys Formation associated with the holotype. Of these, *Dallarca idonea* (Conrad, 1832, as *Arca*), and *Nassarius peralta* (Conrad, 1868, as *Nassa*) (fide Ward and Andrews, 2008) are restricted to the St. Marys Formation. *Turritella plebeia* Say, 1824, occurs in all three Maryland Miocene formations, and often occurs in large numbers in the St. Marys Formation. *Panope goldfussi* (Wagner, 1839, as *Panopea*) (fide Vokes, 1957) occurs in all three Miocene formations. *Lunatia heros* (Say, 1822, as *Natica*) is common in the St. Marys Formation and is extant.

The mollusks mentioned above appear not to have been saved. Different species in or related to the genera *Dallarca, Nassarius*, and *Lunatia* are listed as occurring in the Pleistocene of Langleys Bluff by Blake (1953). Palmer stated that the holotype was collected in situ "in the bluish clay of the St. Marys Formation," but Blake (page 10) described the St. Marys Formation at Langleys as "bluish, sandy, marine clay" and his section (p. 11) shows a "greenish-blue clay" immediately above it as Pleistocene age. Blake also noted (p. 7) that St. Marys Formation mollusks are reworked into the Pleistocene portion of the section.

Elra Palmer was an experienced fossil collector and naturalist, and given that *Libinia marylandicus* is an extinct species, his attribution to the Miocene is probably correct. The stratigraphy is moderately complex, however, and collection of additional *in situ* specimens would be desirable.

Ward and Andrews (2008, p. 46) placed the St. Marys Formation exposed at Langleys Bluff in the Little Cove Point Member, but stated that the mollusks there appear intermediate between that member and the next higher Windmill Point Member of the St. Marys Formation.
University of Iowa 31815. Collected by Walter L. Manger in 1966, "South of Governors Run", from a talus slope. Personal communication with Walter Manger (to DJB, 20 May, 2016) indicated the collecting site as, "south of Governors Run, north of Flag Ponds." The specimen was collected from talus, so it was unlikely to have been transported from the locality, but the stratigraphic position is uncertain. In that stretch, upper Calvert Formation, Choptank Foprmation, and high on the cliff, the St. Marys Formation crop out. The Calvert Formation dips below sea level to the south, and the St. Marys in exposed high on the cliff; hence, talus from it is often weathered, although it is largely unexamined due to inaccessibility.

This specimen was identified as a large majid, probably *Libinia*, by F. D. Holland, Jr., University of North Dakota, and subsequently donated to the University of Iowa by Manger.
USNM 636368: Collected by Pamela C. Platt from float at Langley Bluff. Collected either 21 October, 2002 or 27 September, 2003. No other information is available.
USNM 639959: Collected on the bay at Tuppett's Landing, St. Marys County. Tuppett's Landing may be an old name for the site commonly referred to as Langley Bluff. No other information is available.

Libinia amplissimus Feldmann and Schweitzer, 2016
CMM-I-3817: Holotype, *Libinia amplissimus* Feldmann and Schweitzer. Collected by Bill Counterman in Bed "E" (Ward and Andrews, 2008), Little Cove Member of the St. Marys Formation, north from Driftwood Beach, Calvert County.

Libinia emarginata Leach, 1815
USNM 559391: Collected by Lauck W. Ward, December, 1968, from a slump block of the Conoy Member (= Bed 20) of the St. Marys Formation (the Conoy Member was originally placed within the Choptank Formation) at the then Baltimore Gas and Electric Company nuclear power plant construction site. The specimen was collected as part of the Calvert Cliffs Project, and the specimen was transferred to the Smithsonian from the Maryland Science Center of the Maryland Academy of Sciences by Pete Yancone. This specimen was illustrated by Ward and Andrews (2008, pl. 13).

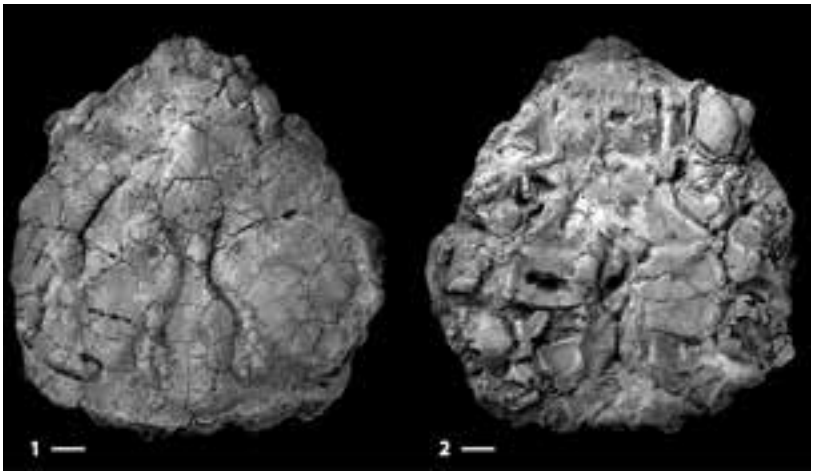


Fig. 1. ***Libinia marylandicus* Palmer, 1938,** holotype, USNM 630038. 1, dorsal carapace; 2, ventral surface of male. Scales bars = 1 cm.

Libinia dubia H. Milne Edwards, 1834

USNM 639958: Collected on the bay at Tuppett's Landing, St. Marys County. Tuppett's Landing may be an old name for the site commonly referred to as Langley Bluff. No other information is available.

USNM 642020: Collected by S. F. Blake, as Blake 2476, at Wailes Bluff, St. Marys County and originally determined to be from the Talbot (Pimlico) beds of Pleistocene age. The specimen was identified by Henry B. Roberts.

Systematic Paleontology

Infraorder Brachyura Linnaeus, 1758
Section Eubrachyura de Saint Laurent, 1980
Superfamily Majoidea Samouelle, 1819
Family Epialtidae MacLeay, 1838
Libinia Leach, 1815 [in 1814–1817]

Type species: *Libinia emarginata* Leach, 1815 [in 1814–1817], by monotypy.

Included species: See Ng *et al*. (2008) and Schweitzer *et al*. (2010).

Diagnosis: See Feldmann and Schweitzer (2016).

Libinia marylandicus Palmer, 1935

(Figs. 1–3)

Diagnosis: Large, weakly vaulted, with short, bifid, downturned rostrum; posterolateral and posterior margins smoothly rounded; metagastric and urogatric regions constricted.

Original description: "The specimen designated as *Libinia marylandicus* is not complete. It consists of a much compressed carapace. The shape is triangular orbiculate. The dorsal surface is broken up into many plates; however, the intestinal, cardiac, urogastric, and metagastric regions are clearly distinguishable. The urogastric region and the posterior end of the metagastric region is narrowly constricted. The rostrum is lacking and the pre- and postorbital spines are indistinguishable. Tubercles are easily noted near the margin of the mesobranchial region.

The ventral surface is partly obscure, being covered with hard matrix. The ambulatory legs as well as the chelipeds are lacking, but the coxae of all the legs can clearly be distinguished. The basis, ischium, and a portion of the merus of the left cheliped are the most complete leg remains of this specimen. The apron is lacking, and the anterior portion of the seventh segment of the sternum, as well as the region around the maxillipeds, is covered with matrix. Only a portion of the right sub-hepatic region is exposed.

The measurements of the type specimen in centimeters are:

Length of carapace ---------- 10.1 cm.
Width of carapace in widest part ---------- 10.5 cm.
Exorbital width ---------- 2.5 cm." (Palmer, 1935, p. 7)

Emendation to description: Carapace large for genus, subtriangular to chordate in outline; measurements taken on holotype, USNM 630038; length excluding rostrum, 10.0 cm, maximum width measured posterior to midlength, 10.5 cm. Surface tumid, axial regions well defined. Rostrum and orbital regions incomplete, fronto-orbital region about 1.9 cm wide. Rostrum appears to be bifid, downturned. Anterolateral margin long, straight. Posterolateral margin smoothly convex. Posterior margin broad, about 6.3 cm wide, smoothly and weakly convex, with narrow rim.

Mesogastric region pyriform, about 1.8 cm wide at widest point, tapering anteriorly to terminate at a distance of about 2.1 cm from broken rostral margin and tapering posteriorly to about 1.0 cm where the cervical groove crosses midline. Other cephalic regions not clearly differentiated. Cervical groove linear, approaches midline at about 40° angle, curving to cross midline in concave-forward arc.

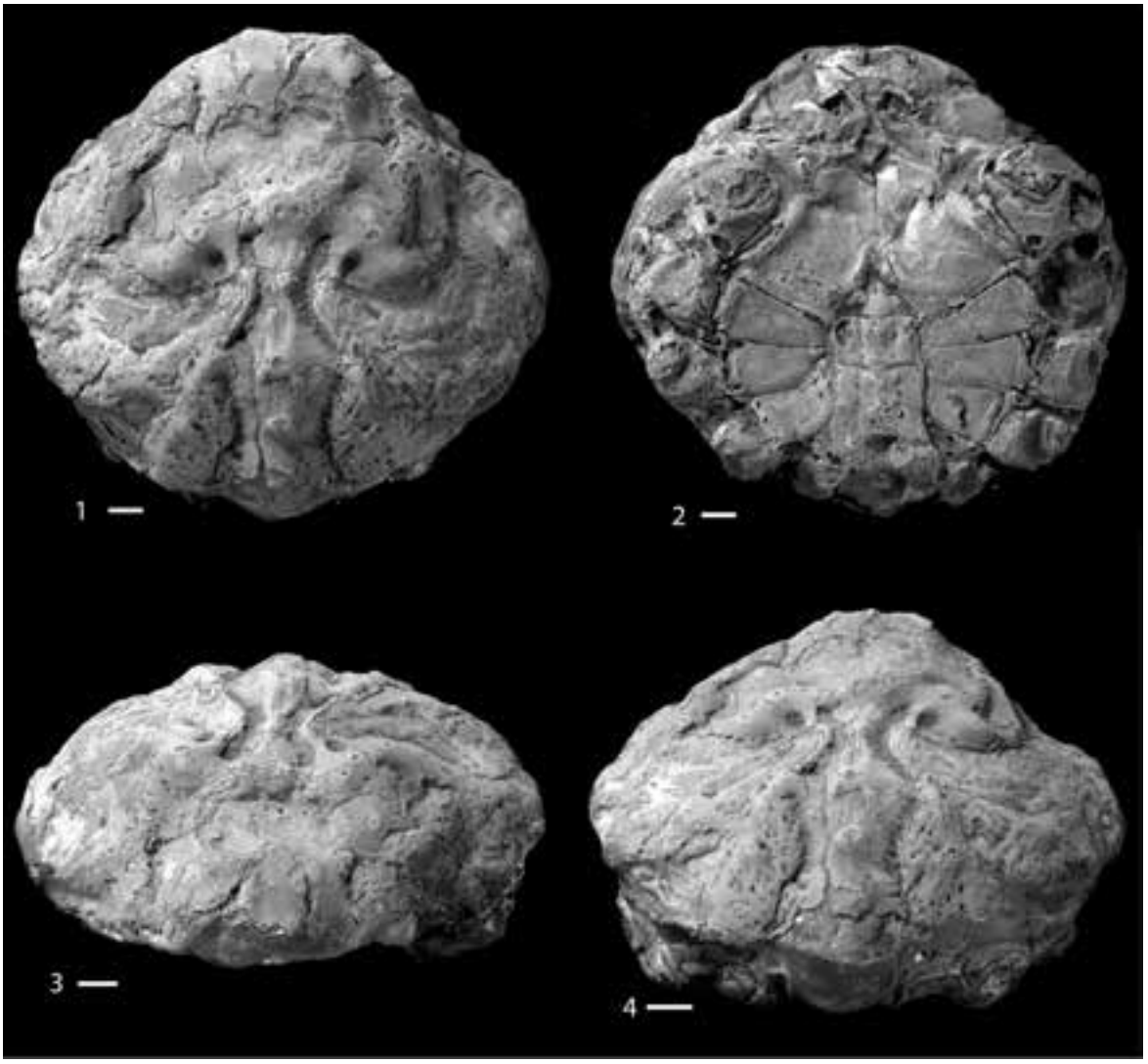


Fig. 2. ***Libinia marylandicus* Palmer, 1938,** UI 31815. 1, dorsal carapace; 2, ventral surface of male with pleon; 3, inclined frontal view; 4, inclined posterior view. Scale bars = 1 cm.

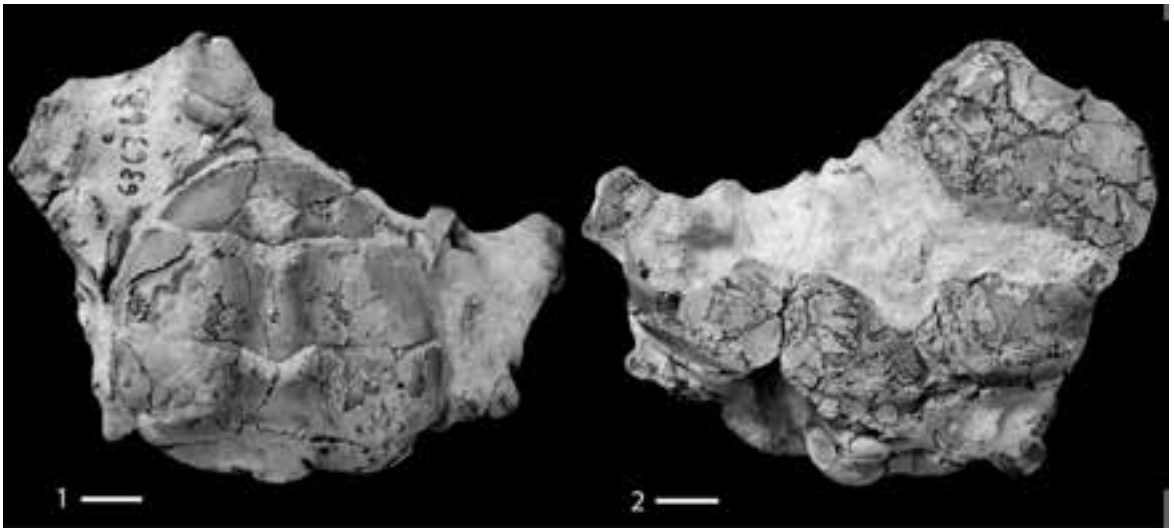


Fig. 3. ***Libinia marylandicus* Palmer, 1938,** USNM 636368. 1, female pleon; 2, posterior remains of dorsal carapace. Scale bars = 1 cm.

Metagastric region longer than wide with prominent swelling posteriorly. Urogastric region depressed, broadening posteriorly. Cardiac region elongate pentagonal, about 1.8 cm wide anterior to midlength, bearing two axial swellings. Intestinal region transversely ovoid with prominent swelling. Branchiocardiac groove a deeply impressed sinuous curve bounding metagastric, urogastric, and cardiac regions, becoming less distinct around intestinal region. Branchial regions large, inflated, apparently undifferentiated.

Ventral surface on holotype exposes rectangular buccal frame, about 3.0 cm wide and 1.6 cm long, bounded by narrow, well defined rim of smooth, depressed pterygostomial region and circular male sternum. Sternites 1–3 fused, triangular, wider than long, rimmed, with notch in sternal margin separating sternites 3 and 4. Sternite 4 lateral margins weakly convex axially, broadening posteriorly to small episternal projections. Sternites 5–7 similar in outline, broadening laterally, bearing small episternal projections, decreasing in width from sternite 5–7. Sternites separated by well defined, complete sutures. Surfaces smooth and medially depressed. Sternite 8 small. Axial depression of sternum deep, about 1.6 cm wide and tapering anteriorly to just anterior to midlength of sternite 4. Coxae and broken bases of pereiopods 1–5 present. Circular male gonopore exposed near distal end of right coxa 5.

Male pleon with large, transversely arched, wider than long, rectangular somite 1. Somites 2–5 decreasing in length posteriorly, rectangular, with smooth, arched tergal surface and flattened pleura with straight margins. Somite 6 similar to somite 5, but longer. Telson small, triangular, extends to posterior 1/3 of sternite 4.

Female pleon broadly elliptical, covering entire sternum, broadest at somite 5, tapering proximally to narrow, poorly preserved somite 1 and distally to smoothly rounded telson. Terga elevated axially; elevation broadest at somite 5 and becoming narrower and lower onto telson. Terga separated from broadly and smoothly arched pleura by longitudinal depressions. Somite 6 longest; somite 5 slightly shorter; remaining somites poorly preserved, but appear to decrease in length proximally.

Locality and stratigraphic position: The holotype, U. S. National Museum of Natural History, USNM 630038, and additional specimens USNM 636368, and USNM 639959 were collected from the St. Marys Formation, Calvert and St. Marys counties, Maryland. It is inferred that UI 31815 was also collected from the St. Marys Formation, but it may have come from the older Choptank Formation.

Discussion: The holotype of *Libinia marylandicus* is a dorsal carapace and ventral surface preserving the buccal frame, nearly complete male sternum, and basal elements of the pereiopods. Although the carapace has been heavily fractured, the regions are well delineated, but the rostral terminations are missing. The cuticle of both dorsal and ventral surfaces has been replaced by a bluish-black mineral that appears to be apatite, a replacement mineral commonly observed in decapod fossils. When originally described, Palmer noted that the ventral surface was obscured by durable matrix. Subsequent to that, the venter was prepared in its entirety, probably by Palmer, to reveal the form of the buccal frame, the sternum, the male genital openings, and the basal segments of the pereiopods. Another specimen, UI 31815, referred to this species with certainty is a large male, length >124.6 mm, width 137.6 mm, exhibits a sternum like that of the holotype. It also has a complete male pleon. One other specimen, USNM 636368, is a female with a fragmentary dorsal carapace and nearly complete female pleon. Because of the partial preservation of the carapace, assignment of the specimen to *L. marylandicus* is tentative. The conformation of the left posterolateral margin and part of the posterior margin is consistent with the form of that region on more complete specimens; thus, we tentatively assign the specimen to *L. marylandicus*. The pleons of females in the other species are not preserved for comparison.

Libinia amplissimus Feldmann and Schweitzer, 2016

Diagnosis: See Feldmann and Schweitzer (2016, p. 23).

Discussion: Although the specimen upon which this species was described is badly fragmented, it was carefully reassembled by John Nance and exhibits all the essential characters to document its unique morphology. In contrast to the other species of *Libinia* known from the St. Marys Formation, *L. amplissimus* is very large, has a chordate outline, short and apparently bifid rostrum, muted carapace regions, and bears extremely long, robust, first pereiopods.

Libinia emarginata Leach, 1815

(Fig. 4)

Diagnosis: See Williams (1984, p 318).

Discussion: The sole specimen collected by Lauck Ward from the Conoy Member of the St. Marys Formation conforms closely to the description and diagnostic characters of extant members of the species. Presence of about nine nodes or spines on the axial region and the pyriform outline of the carapace along with a relatively short, bifid rostrum support placement of the Miocene specimen in this species. To date, this is the only representative of the species in the Maryland Miocene.

Libinia emarginata, along with *L. dubia*, from the St. Marys Formation at Langleys Bluff are relatively small

compared to *L. marylandicus* and *L. amplissimus*. This introduces the possibility that the former represent juvenile forms of the latter species. However, comparison of the conformation of the axial regions as well as the development of nodes and spines supports placement of the smaller forms into extant species and the latter, larger forms into extinct species. This relationship can only be tested by collection of intermediate-sized specimens to define an ontogenetic sequence.

Libinia dubia H. Milne Edwards, 1834

(Fig. 5)

Diagnosis: See Williams (1984, p.316).

Discussion: A single, partial specimen, USNM 639958, from the St. Marys Formation can be assigned to *Libinia dubia*. Features that support this placement include a bifid rostrum that is much longer than that seen on *L. emarginata*, a somewhat more projected frontal region, and a reduced number of spines on the axial regions. Unfortunately, the specimen is partial; the branchial regions are largely missing, so that the overall proportions and the carapace outline cannot be determined. Partial elements of the pereiopods are also present, but are not particularly diagnostic. Nonetheless, the features that are present are supportive of this placement.

A second specimen originally described from the Pimlico beds at Wailes Bluff, St. Marys County, was placed in *L. dubia* along with a specimen that was preserved in quite a different way. One of the specimens was a carapace that was free from the enclosing sediment so that both interior and exterior of the carapace could be seen (Easton, 1940). This type of delicate preservation is common in Pleistocene or modern sediments; thus, the specimen is Pleistocene in age in all probability. However, the other specimen, USNM 642020, is a carapace filled with sediment reminiscent of the St. Marys Formation, is fractured, and parts of the cuticle are missing (Blake, 1953). The preservational style is so much like that seen on USNM 639958 that it leaves little doubt that this much more complete specimen is Miocene in age.

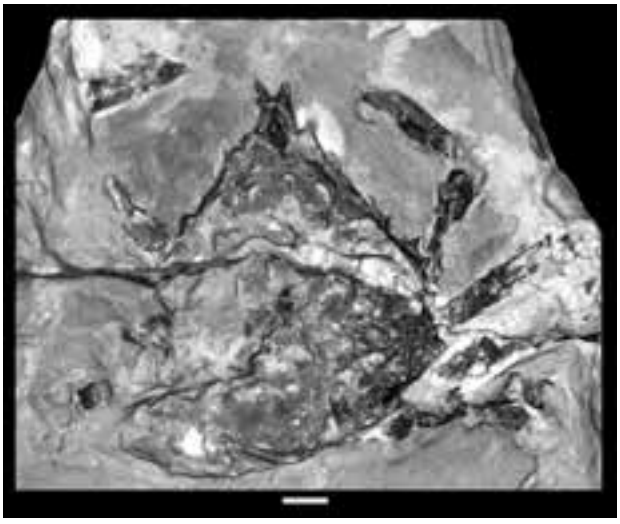


Fig. 4. ***Libinia emarginata* Leach, 1815,** USNM 559391. Dorsal view, unwhitened. Scale bar = 1 cm.



Fig. 5. ***Libinia dubia* H. Milne Edwards, 1834.** 1, 2, dorsal and right lateral view of USNM 639958; 3, dorsal view of USNM 642020. Scale bars = 1 cm.

Discussion

With the addition of *Libinia emarginata* and *L. dubia*, discussed below, four species of *Libinia* have now been described from the St. Marys Formation in Maryland. One of the two specimens of *L. dubia* was originally collected from deposits at Wailes Bluff, Maryland, and was determined to be Pleistocene in age. The material was identified by Mary Jane Rathbun (Easton, 1940; Blake, 1953). A second specimen, identified as *L. dubia*, USNM 642020, (Fig. 5.3) was identified by Henry B. Roberts. Comparison of the preservational style of the Rathbun specimen (Easton, 1940, p. 519) and that identified by Roberts confirms that the two are substantially different and that the Roberts specimen much more closely resembles the type of preservation expected in the St. Marys Formation. Thus, we conclude that *Libinia dubia* occurs in the Miocene St. Marys Formation as well as in the Pleistocene Pamlico beds. *Libinia dubia* is currently found along the East Coast and Gulf Coast of the United States, a range it shares with *L. emarginata* (Williams, 1984).

Comparison of the two St. Marys species, *Libinia marylandicus* and *L. amplissimus*, with the extant species from the same region confirms that the two are distinct.

Libinia marylandicus has an outline that is smoothly rounded along the posterior and posterolateral margins and shows no evidence of having a particularly elongate rostrum. These features are similar to those seen on *L. emarginata*. The outline of *L. amplissimus* exhibits a posterior margin that is drawn out and the rostrum, although the termination is missing, appears to be elongate. This shape is reminiscent of that of *L. dubia*. The nature of the outlines of these two fossil species is significant because the fragmentation of the carapace seen on both *L. marylandicus* and *L. amplissimus* does not significantly alter the outlines. The two species also differ in the regional development on the carapace. The axial features on the former are very pronounced whereas those of *L. amplissimus* are reduced to the point that distinguishing them is difficult. Although this basis for comparison is somewhat more susceptible to preservational bias, all indications are that the difference in axial regional development is real. Thus, the two specimens are representative of two different species.

Determining the relative age of *Libinia marylandicus* and *L. amplissimus* from the St. Marys Formation is problematic. Both have been recorded as being from the Little Cove Member. The molluscan assemblage reported by Ward and Andrews (2008) places the stratigraphic position of *L. marylandicus* above that of *L. amplissimus*. However, it is clear that occurrence in the same member of the St. Marys Formation suggests that they were not separated by a large time interval. As revealed in the modern fauna (Williams, 1984), multiple species of *Libinia* in the same fauna is not unusual.

Acknowledgements

The loan of the holotype and additional specimens of *Libinia marylandicus* was facilitated by D. Levin, from the USNM. John Nance, Calvert Marine Museum, Solomons, Maryland, offered valuable information on the stratigraphic position of the specimen. Holly Little, Smithsonian Institution, Washington, D. C. provided the photograph in Figure 4.

References

Blake, S. F. 1953. The Pleistocene fauna of Wailes Bluff and Langleys Bluff, Maryland. Smithsonian Miscellaneous collections 121(12): 1–32.

Conrad, T. A. 1832. Fossil shells of the Tertiary formations of North America. Philadelphia, 56 p.

Conrad, T. A. 1868. Descriptions of new genera and species of Miocene shells, with notes on other fossil and recent species. American Journal of Conchology 8: 257–270.

Donohue, M. D. 1967. Fossil finds in Maryland: A retrospective bibliography. University of Maryland Libraries, College Park, Maryland. vi +231 pages.

Easton, W. H. 1940. A Pleistocene occurrence of *Libinia dubia*, a brachyuran. Journal of Paleontology 14(5): 519–520.

Feldmann, R. M., and C. E. Schweitzer. 2016. Giant spider crab from the St. Marys Formation (Miocene) in Calvert County, Maryland, USA. Bulletin of the Mizunami Fossil Museum 42: 23–28.

Leach, W. E. 1815 [in 1814–1817]. The zoological miscellany: being descriptions of new, or interesting, animals 1–3: 150 pls.

Linnaeus, C. von. 1758. Systema Naturae per Tegna tria Naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis (ed.10) 1: 1–824. Laurentii Salvii, Holmiae [=Stockholm].

MacLeay, W. S. 1838. On the brachyurous decapod Crustacea brought from the Cape by Dr. Smith. In: A. Smith, Illustrations of the Annulosa of South Africa; consisting chiefly of figures and descriptions of the objects of natural history collected during an expedition into the interior of South Africa, in the years 1834, 1835, and 1836; fitted out by "The Cape of Good Hope Association for Exploring Central Africa..": 53–71, 2 pls.

Milne Edwards, H. 1834 [in 1834–1840]. Histoire naturelle des Crustacés, comprenant l'anatomie, la physiologie et, la classification de ces animaux 1: xxxv +1–468.

Ng, P. K. L., D. Guinot, and P. J. F. Davie. 2008. Systema Brachyurorum: Part I. An annotated checklist of extant brachyuran crabs of the world. The Raffles Bulletin of Zoology, Supplement 17: 1–286.

Palmer, E. M. 1935. Preliminary report on a possible new species of fossil crab from the Miocene of Maryland. The Natural History Society of Maryland Bulletin 6: 7–8.

Saint Laurent, M. de. 1980 Sur la classification et la phylogénie des Crustacés Décapodes Brachyoures. I. Podotremata Guniot, 1977, et Eubrachyura sect. nov. Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, Paris, series D 290: 1265–1268.

Samouelle, G. 1819. The entomologist's useful compendium, or an introduction to the British insects, etc. 1–496.

Say, T. 1822. Description of univalve terrestrial and fluviatile shells of the United States. Journal of the Academy of Natural Sciences of Philadelphia 2: 370–381.

Say, T. 1824. An account of some of the fossil shells of

Maryland. Journal of the Academy of Natural Sciences of Philadelphia 4: 124–155.

Schweitzer, C. E., R. M. Feldmann, A. Garassino, H. Karasawa, and G. Schweigert. 2010. Systematic list of fossil decapod crustacean species. Crustaceana Monography 10: 1–222.

Vokes, H. E. 1957. Miocene fossils of Maryland. Maryland Department of Geology, Mines, and Water Resources, Bulletin 20: vii +1–85.

Wagner, W. 1839. Description of five new fossils of the older Pliocene formation of Maryland and North Carolina. Journal of the Academy of Sciences of Philadelphia 8: 51–53.

Ward, L. W., and G. W. Andrews. 2008. Stratigraphy of the Calvert, Choptank, and St. Marys Formations (Miocene) in the Chesapeake Bay area, Maryland and Virginia. Virginia Museum of Natural History, Memoir 9: 1–60, 16 pls.

Williams, A. B. 1984. Shrimps, Lobsters, and Crabs of the Atlantic Coast of the Eastern United States, Maine to Florida. Smithsonian Institution Press, Washington, D. C.: 550 p.

Young, A. 2014. 85 Facts about The Natural History Society of Maryland.The Natural History Society of Maryland Newsletter, Fall 2014: 1–10.

Manuscript accepted on April 24, 2017