



Boletín de la Sociedad Geológica Mexicana

ISSN: 1405-3322

Sociedad Geológica Mexicana A.C.

Garassino, Alessandro; Pasini, Giovanni; Clements, Don
A new spider crab (Brachyura, Epialtidae) from the Castle
Hayne Limestone Formation (Eocene), North Carolina, USA
Boletín de la Sociedad Geológica Mexicana, vol. 73, no. 3, 00006, 2021, September-December
Sociedad Geológica Mexicana A.C.

DOI: <https://doi.org/10.18268/BSGM2021v73n3a261220>

Available in: <https://www.redalyc.org/articulo.oa?id=94370811006>

- How to cite
- Complete issue
- More information about this article
- Journal's webpage in redalyc.org

redalyc.org

Scientific Information System Redalyc
Network of Scientific Journals from Latin America and the Caribbean, Spain and
Portugal

Project academic non-profit, developed under the open access initiative

A new spider crab (*Brachyura*, *Epialtidae*) from the Castle Hayne Limestone Formation (Eocene), North Carolina, USA

Un nuevo cangrejo araña (Brachyura, Epialtidae) de la Formación Caliza Castle Hayne (Eoceno), Carolina del Norte, EUA

Alessandro Garassino^{1,*}, Giovanni Pasini², Don Clements¹

¹North Carolina Museum of Natural Sciences, 11 West Jones Street, Raleigh, North Carolina 27601, USA.

²Via Alessandro Volta 16, 22070 Appiano Gentile (Como), Italy.

* Corresponding author: (A. Garassino) alegarassino@gmail.com

ABSTRACT

A new spider crab, *Eoinachoides bretoni* n. sp. (Epialtidae MacLeay, 1838) from the Comfort Member of the Castle Hayne Formation (Eocene) of Onslow County, North Carolina (USA), is herein described, representing the second spider crab recovered from this member. Although the new species does not enlarge the stratigraphical range for the genus which is currently restricted from the Eocene to Miocene, it is the first report in North America, extending the palaeogeographic distribution of *Eoinachoides*, limited currently in the fossil record of South America. In addition, an updated list of the species of the Castle Hayne Formation is herein provided.

Keywords: Crustacea, Decapoda, Majoidea, Paleogene, Castle Hayne Formation, taxonomy.

RESUMEN

Se describe un nuevo cangrejo araña, *Eoinachoides bretoni* n. sp. (Epialtidae MacLeay, 1838) del Miembro Comfort de la Formación Castle Hayne (Eoceno) en el Condado de Onslow, Carolina del Norte (EUA), representa el segundo cangrejo araña encontrado en este miembro. Aunque la nueva especie no extiende el alcance estratigráfico del género, restringido actualmente al Eoceno-Mioceno, es el primer reporte para Norteamérica, extendiendo la distribución paleobiogeográfica de *Eoinachoides*, limitada actualmente al registro fósil de Sudamérica. Se proporciona una lista actualizada de las especies de crustáceos de la Formación Castle Hayne.

Palabras clave: Crustacea, Decapoda, Majoidea, Paleogeno, Formación Castle Hayne, taxonomía.

How to cite this article:

Garassino, A., Pasini, G., Clements, D., 2021, A new spider crab (*Brachyura*, *Epialtidae*) from the Castle Hayne Limestone Formation (Eocene), North Carolina, USA: Boletín de la Sociedad Geológica Mexicana, 73 (3), A261220. <http://dx.doi.org/10.18268/BSGM2021v73n3a261220>

Manuscript received: November 5, 2020
Corrected manuscript received: December 1, 2020
Manuscript accepted: December 14, 2020

Peer Reviewing under the responsibility of Universidad Nacional Autónoma de México.

This is an open access article under the CC BY-NC-SA license (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

1. Introduction

The middle Eocene Castle Hayne Formation (North Carolina) has produced a rich decapod fauna including 13 families (excluding *incertae sedis*), 19 genera, and 23 species. Though Rathbun (1935) reported two decapods from this formation, there has been little interest in fossil crabs until recently. Bishop and Whitmore (1986) figured several fossils from the Castle Hayne Formation, providing preliminary assignments without descriptions. Later, Salva *et al.* (1995) introduced the rich decapod fauna and its palaeogeographic implications and Blow and Manning (1996) reported three new genera and eight new species from this formation. Feldmann *et al.* (1998) gave a new impulse to the knowledge of the decapod fauna of the Castle Hayne Formation, describing four new species and reporting one species previously recorded from the Santee Limestone of South Carolina by Blow and Manning (1996). The most recent contributions to the decapod fauna of the Castle Hayne Formation have been provided by Ossó and Clements (2016) and Davis *et al.* (2020) who described a new genus and a new species respectively, the latter representing the first report of a decapod crab from the Spring Garden Member of the Castle Hayne Formation (see Table 1).

The purpose of this paper is the description of a new spider crab, *Eoinachoides bretoni* n. sp. from the Comfort Member of the Castle Hayne Formation from which all decapod crabs known to date have been collected, except *Matutites collinsi* Davis, Garassino and Weaver, 2020, recovered from the Spring Garden Member of the same formation. It represents the second spider crab reported from the Comfort Member.

2. Geological setting

Eoinachoides bretoni n. sp. was collected from the Comfort Member of Ward *et al.* (1978) from Bartonian aged rocks of the Castle Hayne Formation in the north quarry at approximately 34° 50' 34.4"N x 77° 32' 45.3"W (Figure 1). Harris

and Zullo (1991) reported five sequences within the Castle Hayne ranging in age from Lutetian to Priabonian. Temporal placement of *Eoinachoides bretoni* n. sp is possible based upon Kier's echinoid biozones (Kier, 1980). Indeed, *E. bretoni* n. sp was found associated with Middle Biozone echinoids such as *Linthia harmatucki* Kier, 1980 and *Eurodia rugosa depressa* Kier, 1980. Kier's Middle Biozone correlates to sequence 2 and 3 of Harris and Zullo (1991) which is Bartonian. An excellent graphic correlating the lithosomes of Ward *et al.* (1978), the sequence stratigraphy of Harris and Zullo (1991) and Kier's echinoid biozones can be found in Ciampaglio *et al.* (2007).

Simms (2012: 42) reported nearly 100 ft. (ca. 30 m.) of Castle Hayne Formation at the Onslow Quarry. The overburden varies from 2 to 57 ft. (from ca. 0.6 m. ca. 17 m.) with much of the variable thickness a factor of the Castle Hayne formation's dissolution and sediment filled stream erosion features, as the modern landscape has almost no relief. The section where *E. bretoni* n. sp was discovered is in the upper product limestone at the new north quarry. In other areas with less overburden in nearby quarries, there have been younger Castle Hayne formation rocks that include Kier's late echinoid biozone above a sequence break that is Priabonian. The provenance of *E. bretoni* n. sp. does not include rocks of this age.

3. Systematic paleontology

Superfamily Majoidea Samouelle, 1819

Family Epialtidae MacLeay, 1838

Subfamily Epialtinae MacLeay, 1838

Genus *Eoinachoides* Van Straelen, 1933

Type species: *Eoinachoides senni* Van Straelen, 1933, by original designation [late Eocene (Priabonian) – Venezuela (South America)].

Other fossil species: *Eoinachoides latispinosa* Carriol, de Muizon and Secrétan, 1987, Miocene – Argentina, Peru, Venezuela (South America); *E. bretoni* n. sp., middle Eocene (Bartonian) – North Carolina (USA) (herein).

Table 1. Updated list of decapod crustaceans from the Castle Hayne Formation (after Blow and Manning, 1996; Feldmann *et al.*, 1998; Clements, 2014; Ossó and Clements, 2016; Davis *et al.*, 2020).

Family Diogenidae Ortmann, 1892 Genus <i>Paguristes</i> Dana, 1851 <i>Paguristes wheeleri</i> Blow and Manning, 1996
Family Dromiidae De Haan, 1833 Genus <i>Dromidia</i> Stimpson, 1858 <i>Dromidia bedetteae</i> Blow and Manning, 1996
Family Homolidae De Haan, 1839 Genus <i>Prohomola</i> Karasawa, 1992 <i>Prohomola katunai</i> ? Blow and Manning, 1996
Family Raninidae De Haan, 1839 Genus <i>Cyrtorina</i> Monod, 1956 <i>Cyrtorina fusselsi</i> Blow and Manning, 1996 Genus <i>Lophoranina</i> Fabiani, 1910 <i>Lophoranina raynorae</i> Blow and Manning, 1996
Family Calappidae De Haan, 1833 Genus <i>Calappilia</i> A. Milne-Edwards in De Bouillé, 1873 <i>Calappilia sitzi</i> Blow and Manning, 1996
Family Matutidae De Haan, 1841 Genus <i>Matutites</i> Blow and Manning, 1996 <i>Matutites collinsi</i> Davis, Garassino and Weaver, 2020 <i>M. miltonorum</i> Feldmann, Bice, Schweitzer Hopkins, Salva and Pickford, 1998
Family Majidae Samouelle, 1819 Genus <i>Wilsonimaia</i> Blow and Manning, 1996 <i>Wilsonimaia ethelae</i> Blow and Manning, 1996 <i>W. scheiderorum</i> Blow and Manning, 1996
Family Parthenopidae MacLeay, 1838 Genus <i>Acantholambrus</i> Blow and Manning, 1996 <i>Acantholambrus baumi</i> Blow and Manning, 1996
Family Cancridae Latreille, 1802 Genus <i>Sarahcarcinus</i> Blow and Manning, 1996 <i>Sarahcarcinus campbellorum</i> Blow and Manning, 1996 (= <i>Pororaria? granulosa</i> Feldmann, Bice, Schweitzer Hopkins, Salva and Pickford, 1998) Genus <i>Santeecarcinus</i> Blow and Manning, 1996 <i>Santeecarcinus harmatuki</i> Blow and Manning, 1996
Family Carpilidae Ortmann, 1893 Genus <i>Eocarpilius</i> Blow and Manning, 1996 <i>Eocarpilius blowi</i> Feldmann, Bice, Schweitzer Hopkins, Salva and Pickford, 1998 <i>E. carolinensis</i> Blow and Manning, 1996
Family Tumidocarcinidae Schweitzer, 2005 Genus <i>Lobonotus</i> A. Milne-Edwards, 1863 <i>Lobonotus sturgeonii</i> (Feldmann, Bice, Schweitzer Hopkins, Salva and Pickford, 1998)
Family Zanthopsidae Via Boada, 1959 Genus <i>Martinetta</i> Blow and Manning, 1997 <i>Martinetta palmeri</i> Blow and Manning, 1997 Genus <i>Neozanthopsis</i> Schweitzer, 2003 <i>Neozanthopsis carolinensis</i> (Rathbun, 1935)
Pilumnoidea Samouelle, 1819 Family <i>incertae sedis</i> Genus <i>Pilummede</i> Ossó and Clements, 2016 <i>Pilummede penderensis</i> Ossó and Clements, 2016 Family Pilumnidae Samouelle, 1819 Genus <i>Viacarcinus</i> Blow and Manning, 1996 <i>Viacarcinus druidi</i> Blow and Manning, 1996
Xanthoidea <i>incertae sedis</i> Genus <i>Titanocarcinus</i> A. Milne-Edwards, 1863 <i>Titanocarcinus euglyphos</i> Bittner, 1875
Family Oziidae Dana, 1851 Genus <i>Menippe</i> De Haan, 1833 <i>Menippe anomala</i> Rathbun, 1935 <i>M. burnsi</i> Rathbun, 1935

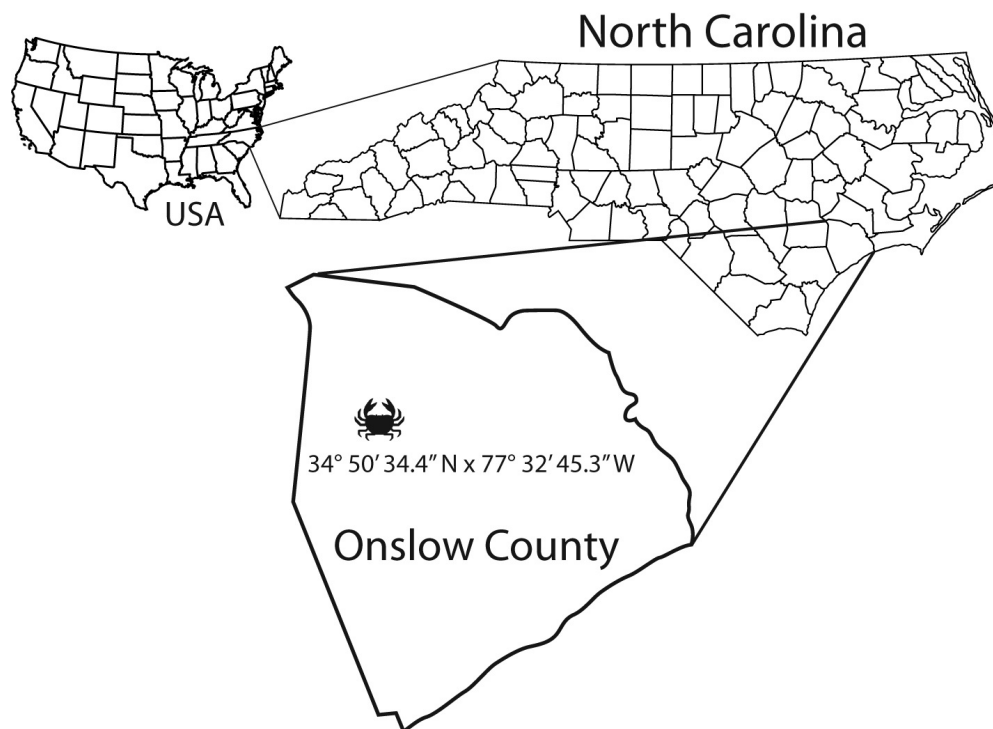


Figure 1 Map of the Onslow County (North Carolina, USA), reporting the coordinates of the fossiliferous locality.

Eoinachoides bretoni n. sp.

Figures 2A to 2D

Diagnosis: Pyriform carapace, slightly longer than wide; front slightly protruded forward, axially depressed, with a pair of lateral tuberculate ridges; protogastric region with one median tubercle; triangular-shaped mesogastric region with one distal tubercle; subpentagonal-shaped cardiac region with a pair of median tubercles; smooth depressed intestinal region; smooth orbital and hepatic regions; inflated subhepatic region with a transverse ridge of three aligned small tubercles; epibranchial region with one lateral tubercle; mesobranchial region with a median tubercle; gastric regions slightly tuberculate; hepatic, cardiac, and branchial regions covered with small tubercles uniformly arranged.

Etymology: after Gérard Breton (1944-2019) for his important contribution to the knowledge of the Cenozoic fossil crabs.

Type material: Holotype, NCSM 12629 (carapace length: 26 mm; maximum carapace

width at level of mesobranchial region: 23 mm). (NCSM = NC Museum of Natural Sciences, Raleigh, North Carolina, USA).

Type locality: Onslow quarry (= Richlands quarry), Onslow County, NC.

Stratigraphy: Eocene (Bartonian), Comfort Member of the Castle Hayne Formation.

Description: Pyriform carapace, slightly longer than wide, widest at level of mesobranchial regions; carapace regions with swellings; apparently short bifid rostrum slightly protruded forward, axially depressed; very narrow orbits; supraorbital cave poorly preserved, apparently without intercalated spine; slightly spiny anterolateral margin almost straight; slightly spiny posterolateral margin strongly convex; smooth, short posterior margin weakly convex medially; smooth epigastric region; protogastric region with one median large tubercle and a pair of small median tubercles, aligned to form a square-shaped structure; triangular-shaped mesogastric region with one distal tubercle; smooth metagastric region with two deep gastric pits; smooth depressed urogastric

region; pentagonal-shaped cardiac region with a pair of median tubercles; smooth depressed intestinal region; smooth orbital and hepatic regions; inflated subhepatic region with a transverse ridge of three aligned small tubercles; branchial regions strongly inflated; epibranchial region with one lateral tubercle; mesobranchial region with a median tubercle; smooth metabranchial region; deep, sinuous cervical groove; gastric regions slightly tuberculate; hepatic, cardiac, and branchial regions

covered with small tubercles uniformly arranged. Cephalic and thoracic appendages and ventral parts not preserved.

Discussion: Although the supraorbital cave is poorly preserved, based upon Schweitzer *et al.* (2020), the studied specimen has been tentatively assigned to *Eoinachoides* Van Straelen, 1933 in having carapace ovate, narrowed anteriorly and widened posteriorly, axial regions well defined, and cardiac region with a pair of tubercles. Based

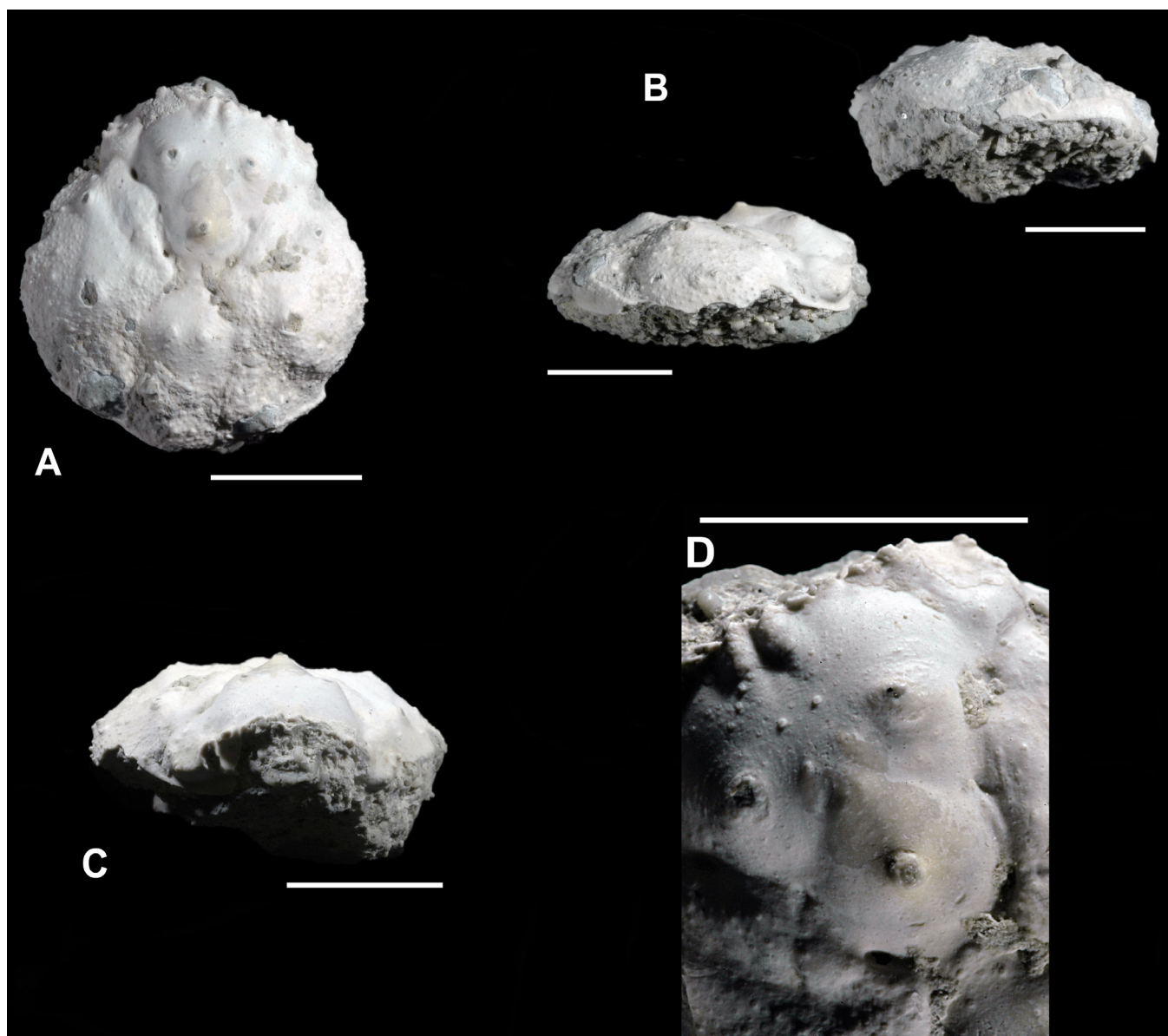


Figure 2 *Eoinachoides bretoni* n. sp., NCSM 12629. A) Dorsal view. B) Lateral views. C) Frontal view. D) Close-up of the frontal and gastric regions. Scale bar equals 1 cm. Photographs: R. Chandler.

upon Schweitzer *et al.* (2010) this genus includes just two species, *E. senni* Van Straelen, 1933 from the Eocene of Venezuela and *E. latispinosa* Carriol, de Muizon and Secrétan, 1987, from the Miocene of Argentina, Peru, and Venezuela (Feldmann and Schweitzer, 2004; Collins *et al.*, 2009; Aguilera *et al.*, 2010; Luque *et al.*, 2017).

Eoinachoides senni was described by Van Straelen (1933: 6, 7) from one complete carapace. The smooth protogastric regions distinguish this species from *E. bretoni* n. sp. having protogastric regions with one median tubercle.

Eoinachoides latispinosa was described by Carriol, de Muizon and Secrétan (1987: 8, 9) from one incomplete carapace. The smooth protogastric regions, the mesogastric region with three aligned tubercles, and the mesobranchial regions with a semi-circle row of four tubercles distinguish this species from *E. bretoni* n. sp. having protogastric regions with one median tubercle, mesobranchial region with one distal tubercle, and mesobranchial region with one median tubercle.

In conclusion, although the new species does not enlarge the stratigraphical range for the genus which is currently restricted from the Eocene to the Miocene, it represents the first report in North America, extending the palaeogeographic distribution of *Eoinachoides*, limited currently in the fossil record of South America.

Acknowledgements

We thank L. McCall, North Carolina, for donating the studied specimen to the North Carolina Museum of Natural Sciences (Raleigh); R. Chandler, North Carolina, for the photographs of the specimen; H. Karasawa, Mizunami Fossil Museum, Japan, for useful suggestions about the systematic assignment of the studied specimen; T. Nyborg, Loma Linda University, California, and O. González León, Facultad de Estudios Superiores Iztacala, Mexico, for careful review and criticism. Plant Manager Doug Fetsco and Danny Humphries generously allowed access to the

Martin Marietta Onslow quarry for our research. Without Martin Marietta quarry access across the Carolinas, very little would have been published on Castle Hayne and Santee Formation decapod crustaceans.

References

- Aguilera, O., Rodrigues de Aguilera, D., Vega, F.J., Sánchez-Villagra, M., 2010, Mesozoic and Cenozoic decapod crustaceans from Venezuela and related trace-fossil assemblages, in Sánchez-Villagra, M., Aguilera, O., Carlini, A.A. (eds.), *Urumaco and Venezuelan paleontology*: Bloomington, Indiana University Press. 103-128 pp.
- Bishop, G.A., Whitmore, J.L., 1986, The Paleogene crabs of North America: Occurrence, preservation, and distribution: SEPM Guidebook, Southeastern United States, Third Annual Midyear Meeting, 297-306.
- Bittner, A., 1875, Die Brachyuren des vicentinischen Tertiärgebirges: Denkschriften der Kaiserlichen Akademie der Wissenschaften in Wien, 34, 63-106.
- Blow, W.C., Manning, R.B., 1996, Preliminary descriptions of 25 new decapod crustaceans from the Middle Eocene of the Carolinas, U.S.A.: *Tulane Studies in Geology and Paleontology*, 29(1), 1-26.
- Blow, W.C., Manning, R.B., 1997, A new genus, *Martinetta*, and two new species of xanthoid crabs from the Middle Eocene Santee Limestone of South Carolina: *Tulane Studies in Geology and Paleontology*, 30(3), 171-190.
- Ciampaglio, C., Donovan, S.K., Weaver, P.G., 2007, A new bourgueticrinid (Crinoidea) from the Castle Hayne Formation (Eocene) of southeastern North Carolina, USA: *Swiss Journal of Geosciences*, 100(2), 243-249. <https://doi.org/10.1007/s00015-007-1221-5>
- Carriol, R.P., de Muizon, C., Secrétan, S., 1987, Les crustacés (Cirripedia et Decapoda) du Néogène de la Côte Péruvienne: *Annales de*

- Paléontologie (Vert.-Invert.), 73(3), 137-164.
- Clements, D.N., 2014, Cretaceous and Paleogene Decapods, in Richard Chandler (ed.) Fossil Invertebrates – Plants Volume I: North Carolina Fossil Club, USA, 300 p.
- Collins, J.S.H., Portell, R.W., Donovan, S.K., 2009, Decapod crustaceans from the Neogene of the Caribbean: diversity, distribution and prospectus: Scripta Geologica, 138, 55-111.
- Dana, J.D., 1851, Conspectus crustaceorum quae in orbis terrarum circumnavigatione, Carolo Wilkes e classe reipublicae foederatae duce, lexit et descripsit: Paguridea: Proceedings of the Academy of Natural Sciences of Philadelphia, 5(10), 267-272. <https://doi.org/10.5962/bhl.title.53615>
- Davis, D.J., Garassino, A., Weaver, P.G., 2020, *Matutites collinsi* n. sp. (Crustacea, Decapoda, Matutidae) from the Spring Garden Member of the Castle Hayne Formation in North Carolina (USA): Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen, 296(1-2), 67-71. <https://doi.org/10.1127/njgpa/2020/0870>
- De Bouillé, R., 1873, Paléontologie de Biarritz et de quelques autres localités des Basses-Pyrénées: Compte-Rendu Travaux Congrès Scientifique de France (39^e session à Pau), 427-450.
- De Haan, W., 1833–1849, Crustacea, in Siebold, P.F. v. (ed.), Fauna Japonica, sive descriptio animalium, quae in itinere per Japoniam, jussu et auspiciis superiorum, qui summum in India Batava imperium tenent, suscepto, annis 1823-1830 collegit, notis, observationibus a ad- umbrationibus illustravit. 243; Lugduni Batavorum (Arnz). <https://doi.org/10.5962/bhl.title.124951>
- Fabiani, R., 1910, I Crostacei terziari del Vicentino. Illustrazione di alcune specie e Catalogo generale delle forme finora segnalate nella Provincia: Bollettino del Museo Civico di Vicenza, 1(1), 29-45.
- Feldmann, R.M., Bice, K.L., Schweitzer Hopkins, C.E., Salva, E.W., Pickford, K., 1998, Decapod crustaceans from the Eocene Castle Hayne Limestone, North Carolina: paleoceanographic implications: The Paleontological Society Memoirs, 48, 1-28. <https://doi.org/10.1017/s0022336000059916>
- Feldmann, R.M., Schweitzer, C.E., 2004, Decapod crustaceans from the Lower Miocene of north-western Venezuela (Cerro La Cruz, Castillo Formation): Palaeontology, 71, 7-22.
- Harris, W.B., Zullo, V.A., 1991, Eocene and Oligocene stratigraphy of the outer Coastal Plain of North and South Carolina, in Horton, J.W., Zullo, V.A. (eds.), The geology of the Carolinas: Knoxville, Carolina Geological Society, 50th Anniversary Volume, and the University of Tennessee Press, 251-262.
- Karasawa, H., 1992, Fossil decapod crustaceans from the Manda Group (Middle Eocene), Kyushu, Japan: Transactions and Proceedings of the Palaeontological Society of Japan, 167, 1247-1258.
- Kier, P.M., 1980, Echinoids of the Middle Eocene Warley Hill Formation, Santee Limestone, and Castle Hayne Limestone of North and South Carolina: Smithsonian Contributions to Paleobiology, 39, 102 p. <https://doi.org/10.5479/si.00810266.39.1>
- Latreille, P.A., 1802, Histoire naturelle générale et particulière, des Crustacés et des Insectes. Ouvrage faisant suite aux Œuvres de Leclerc de Buffon, et partie du Cours complet d'Histoire naturelle rédigé par C.S. Sonnini, membre de plusieurs Sociétés savantes. Paris, Dufart. 5, 407 p. <https://doi.org/10.5962/bhl.title.15764>
- Luque, J., Schweitzer, C.E., Santana, W., Portell, R.W., Vega, F.J., Klompmaker, A.A., 2017, Checklist of fossil decapod crustaceans from tropical America. Part I: Anomura and Brachyura: Nauplius, 25, e2017025. <https://doi.org/10.1590/2358-2936e2017025>
- MacLeay, W.S., 1838, On the Brachyurous Decapod Crustacea. Brought from the Cape by Dr. Smith. Illustrations of the Zoology 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": together with a summary of African Zoology, and an inquiry into the geographical ranges of species in that quarter of the globe, published under the Authority of the Lords Commissioners of Her Majesty's Treasury, Invertebratae. IV (1849), 53-71.

Milne-Edwards, A., 1862-1865, Monographie des Crustacés fossiles de la famille Cancériens: Annales de Science Naturelle, Zoologie sér. 4, 18 (1862): 31-85; 20 (1863): 273-324; sér. 5, 1 (1864): 31-88; 3 (1865): 297-351.

Monod, T., 1956, Hippidea et Brachyura ouestafricains: Mémoires de l'Institut Français d'Afrique Noire, 45, 674 p.

Ortmann, A., 1892, Die Decapoden-Krebse des Strassburger Museum, mit besonderer Berücksichtigung der von Herrn Dr. Doederlein bei Japan und bei den Liu-Kiu-Inseln gesammelten und zur Zeit im Strassburger Museum aufbewahrten Formen. IV. Die Abtheilungen Galatheidea und Paguridea: Zoologische Jahrbüchern, Abtheilung für Systematik, Geographie und Biologie der Thiere, 6, 241-326. <https://doi.org/10.5962/bhl.part.26455>

Ortmann, A., 1893, Abtheilung: Brachyura (Brachyura genuina Boas), II. Unterabtheilung: Cancroidea, 2. Section: Cancrinea, 1. Gruppe: Cyclometopa. Die Decapoden-Krebse des Strassburger Museums, mit besonderer Berücksichtigung der von Herrn Dr. Döderlein bei Japan und bei den Liu-Kiu-Inseln gesammelten und zur Zeit im Strassburger Museum aufbewahrten Formen, VII Theil: Zoologische Jahrbücher, Abtheilung für Systematik, Geographie und Biologie der Thiere, 7, 411-495.

Ossó, A., Clements, D., 2016, A new genus and species: *Pilummede penderensis* (Decapoda: Brachyura) from the Castle Hayne Limestone

Formation (Eocene), Pender County, North Carolina (USA): Paleontología Mexicana, 5(2), 137-146.

Rathbun, M.J., 1935, Fossil Crustacea of the Atlantic and Gulf Coastal Plain: Geological Society of America, (special paper) 2, 1-160. <https://doi.org/10.1130/spe2-p1>

Salva, E.W., Schweitzer-Hopkins, C.E., Feldmann, R.M., 1995, Paleooceanography of decapod-rich rocks of the Castle Hayne Formation (Eocene) of North Carolina: Geological Society of America, Abstracts with Program, 27(6), A-368.

Samouelle, G., 1819, The entomologists' useful compendium; or an introduction to the knowledge of British insects, comprising the best means of obtaining and preserving them, and a description of the apparatus generally used; together with the genera of Linné, and modern methods of arranging the Classes Crustacea, Myriapoda, spiders, mites and insects, from their affinities and structure, according to the views of Dr. Leach. Also an explanation of the terms used in entomology; a calendar of the times of appearance and usual situations of near 3000 species of British Insects; with instructions for collecting and fitting up objects for the microscope. London, T. Boys. 496 p. <https://doi.org/10.5962/bhl.title.34177>

Schweitzer, C.E., 2003, Utility of proxy characters for classification of fossils: an example from the fossil Xanthoidea (Crustacea: Decapoda: Brachyura): Journal of Paleontology, 77, 1107-1128. [https://doi.org/10.1666/0022-3360\(2003\)077<1107:UOPCFC>2.0.CO;2](https://doi.org/10.1666/0022-3360(2003)077<1107:UOPCFC>2.0.CO;2)

Schweitzer, C.E., 2005, The genus *Xanthilites* Bell, 1858 and a new xanthoid family (Crustacea: Decapoda: Brachyura: Xanthoidea): new hypotheses on the origin of the Xanthoidea MacLeay, 1838: Journal of Paleontology, 79(2), 277-295. [https://doi.org/10.1666/0022-3360\(2005\)079<0277:TGXBA>2.0.CO;2](https://doi.org/10.1666/0022-3360(2005)079<0277:TGXBA>2.0.CO;2)

- Schweitzer, C.E., Feldmann, R.M., Garassino, A., Karasawa, H., Schweigert, G., 2010, Systematic list of fossil decapod crustacean species: Crustaceana Monographs, 10, 222 p.
- Schweitzer, C.E., Feldmann, R.M., Karasawa, H., 2020, Part R, Revised, Volume 1, Chapter 8T11: Systematic descriptions: Superfamily Majoidea: Treatise Online, 136, 1-31. <https://doi.org/10.1163/ej.9789004178915.i-222>
- Simms, C., 2012, Geology of the Castle Hayne Limestone in the Onslow Quarry, Richlands, NC: Thesis presented to the Faculty of the Department of Geological Sciences East Carolina University, In Partial Fulfillment of the Requirements for the Degree Master of Science in Geology, 144 p.
- Stimpson, W.S., 1858, Prodromus descriptionis animalium evertetbratorum, quae in Expeditione ad Oceanum Pacificum Septentrionalem, a Republica Federata missa, Cadwaladaro Ringgold et Johanne Rodgers ducibus, observavit et descripsit. Pars VII. Crustacea Anomura: Proceedings of the Academy of Natural Sciences of Philadelphia, 10, 225-252. <https://doi.org/10.5962/bhl.title.51447>
- Van Straelen, V., 1933, Sur des Crustacés Décapodes Cénozoïque du Venezuela: Bulletin du Musée royal d'Histoire naturelle de Belgique, 9(10), 1-11.
- Vía Boada, L., 1959, Decápodos fósiles del Eoceno español: Boletín del Instituto Geológico y Minero de España, 70, 1-72.
- Ward, L.W., Lawrence, D.R., Blackwelder, B.W., 1978, Stratigraphic revision of the middle Eocene, Oligocene and lower Miocene – Atlantic Coastal Plain of North Carolina: U.S. Geological Survey Bulletin, 1457, 23 p. <https://doi.org/10.3133/b1457f>