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NEW HOST AND DISTRIBUTION RECORDS FOR *LEIDYA BIMINI* PEARSE, 1951 IN THE GULF OF MEXICO, WITH COMMENTS ON RELATED TAXA AND A REDESCRIPTION OF *CARDIOCEPON PTEROIDES* NOBILI, 1906 (CRUSTACEA: ISOPODA: BOPYRIDAE: IONINAE)

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ABSTRACT Examination of grapsoid crabs, *Armases cinereum* (Bosc, 1802), in the Tampa Bay area revealed that 3.7% were infested with the bopyrid isopod *Leidya bimini* Pearse, 1951. These records represent a new host for the parasite and an extension of its range into the Gulf of Mexico. The relationships between the species of *Leidya* Cornalia and Panceri, 1861 and related genera have been difficult to ascertain, partly due to improper placement of some taxa within genera. The genera *Leidya*, *Megacepon* George, 1947, *Allokepon* Markham, 1982, and *Cardiocepon* Nobili, 1906 are discussed in terms of their species composition and phylogenetic relationships. Three species are placed in new combinations with genera: *Leidya sesarmae* Pearse, 1930 is tentatively placed in *Megacepon*, *Allokepon goetici* (Shiino, 1934) is transferred to *Megacepon*, and *Portunicepon tiariniae* Shiino, 1937 is transferred to *Allokepon*. The holotype of *Cardiocepon pteroides* Nobili, 1906 is redescribed and figured, and some errors in the original description are corrected.

INTRODUCTION

A collection of 191 specimens of the grapsoid crab *Armases cinereum* (Bosc, 1802) was made in the Tampa Bay area by Brian Mahon in 1998 during a survey of semiterrestrial crabs (Grapsidae and Ocypodidae) and seven of these were found to be parasitized by bopyrid isopods. Examination of the parasites showed them to be conspecific with *Leidya bimini* Pearse, 1951, a species originally described from the Bahamas on the grapsoid crab *Pachygrapsus transversus* (Gibbes, 1850). This bopyrid has subsequently been reported from Miami, Key West, and Galeta Island, Panama, on *P. transversus*, and from Miami on the grapsoid *Armases ricordi* (H. Milne Edwards, 1853) (Markham 1972). The 1998 collection from Tampa Bay represents a range extension of this bopyrid species into the Gulf of Mexico, and the first record of its occurrence on *Armases cinereum*. Remarks are provided on the other known species of *Leidya* Cornalia and Panceri, 1861, as well as species in the closely related genera *Megacepon* George, 1947, *Allokepon* Markham, 1982 and *Cardiocepon* Nobili, 1906. The holotype of *C. pteroides* Nobili, 1906 is redescribed and figured, and some errors in the original description are corrected.

All measurements are given in millimeters; host size is given as carapace width; parasite size is given as total length from anterior margin of head to posterior margin of pleotelson. Three pairs of bopyrid specimens and one lone female are deposited with hosts as vouchers in the American Museum of Natural History (AMNH)

and two pairs of specimens are in the collection of Brian Mahon. An additional pair of specimens was prepared for SEM but accidentally destroyed following examination. The holotype of *Cardiocepon pteroides* was borrowed from the Museo Civico di Storia Naturale "G. Doria," Genova, Italy (MCSN).

RESULTS

Family Bopyridae Rafinesque-Schmaltz, 1815 Subfamily Ioninae H. Milne Edwards, 1840 *Leidya* Cornalia and Panceri, 1861

Leidya Cornalia and Panceri 1861: 114.—Bourdon 1967: 115.—Bourdon and Bowman 1970: 422.—Bourdon and Stock 1979: 217.—Markham 1980: 628–629.—Bourdon 1981: 106–107.

Included species. *L. distorta* (Leidy, 1855) (type species by monotypy); *L. ucae* Pearse, 1930; *L. bimini* Pearse, 1951; *L. infelix* Markham, 2002.

Host families and genera. OCYPODIDAE: *Uca* (*L. distorta*: Bourdon and Bowman 1970, Roccatagliata and Torres Jordá 2002; *L. ucae*: Pearse 1930), *Ucides* (*L. distorta*: Lemos de Castro 1973); GRAPSIDAE: *Pachygrapsus* (*L. bimini*: Pearse 1951, Bourdon and Bowman 1970; *L. infelix*: Markham 2002; herein); ?*Cyclograpsus* (*L. bimini*: Bourdon and Bowman 1970); *Armases* (*L. bimini*: Markham 1972; herein).

Distribution. New Jersey, USA to Río de la Plata, Argentina (*L. distorta*); Bermuda, Bahamas, Jamaica, Florida, USA (Atlantic and Gulf coasts) (*L. bimini*);

California, USA and Baja California, Mexico (*L. infelix*); China (*L. ucae*).

Remarks. *Leidya infelix* from the west coast of North America has recently been described and appears to be the sister species to the clade containing *L. distorta* and *L. bimini*. Two Asian species have also been placed in this genus: *L. sesarmae* Pearse, 1930, and *L. ucae* Pearse, 1930, but neither of those species was well-described, the types of both taxa were until recently considered lost (Markham 1982), and neither species has been reported subsequently. Based on the rather poor descriptions and illustrations of Pearse (1930) it appears that *Leidya ucae*, described from a male and female pair, is a genuine *Leidya*; this has been confirmed through examination of the recently rediscovered types in the Smithsonian Institution (Markham, personal communication). The female *L. ucae*, although immature, shows the characteristic form of the pleopods for the genus and, if the “mental plate” illustrated by Pearse (1930: plate 1, figure 2) is indeed the first oostegite, this species possesses the important character state of an elongate first oostegite. In contrast, *L. sesarmae* was described based solely on the male, but does not appear to belong to this genus; the extremely elongate and tapered lateral margins of the pleon and the swollen and pronounced pleopods are unlike other species of *Leidya*. The shape of the pleonites and development of the pleopods suggests that *L. sesarmae* may be congeneric with *Portunicepon goetici* Shiino, 1934, although that species belongs in *Megacepon* (see below). *Leidya sesarmae* is hereby removed from the genus *Leidya* and tentatively placed in the genus *Megacepon*, although its definitive generic placement remains unclear in the absence of female specimens and the missing holotype.

It is interesting that, of the four currently recognized species of *Leidya*, two are grapsoid parasites and two are ocypodid parasites with one of each occurring in the Atlantic and the Pacific. The original host-preferences of this genus are enigmatic, raising the question of whether the ancestor of *Leidya* was an ocypodid parasite, with infestation of grapsoids being the derived state, or vice versa? Unfortunately, the two closely related genera to *Leidya*, *Megacepon*, and *Cardiocepon* are parasites of grapsoids and gecarcinids, respectively, and this does not add any insight into the question of original *Leidya* host preference.

Leidya bimini Pearse, 1951

Figure 1

Leidya bimini Pearse 1951: 368–369, figures 77a–i.—Bourdon and Bowman 1970: 419 (full synonymy), figures 6a–c.—Markham 1972: 190–192, figure 1.—Markham, 1979: 524.—Markham 1980: 628–629.—Bourdon 1981: 106.—Markham 1988: 56 (list).—McDermott 1991: 71–95.

Leidya distorta Richardson, 1908: 23–26, figures 1–5 (not *Leidya distorta* sensu Leidy, 1855).

Material. USA, Florida, Hillsborough County, coll. B. Mahon.—Davis Island, March 1998, host and parasites not measured (in right branchial chamber of host) (Mahon Collection).—Manatee River, 2 August 1998, host male 9.6 mm, female (w/epicarid larvae) 5.3 mm, male absent (in right branchial chamber of host) (AMNH 18464).—SW Gandy Bridge, 17 July 1998, host male 9.5 mm, female 4.5 mm, male 2.3 mm (in left branchial chamber of host) (AMNH 18465).—NW Gandy Bridge, 11 October 1998, host female 9.5 mm, female 5.0 mm, male 2.5 mm (in right branchial chamber of host) (destroyed during SEM; host AMNH 18466).—NW Gandy Bridge, 11 October 1998, host and parasites not measured (in right branchial chamber of host) (Mahon Collection).—NE Courtney Campbell Causeway, 4 June 1998, host female 8.5 mm, female (w/epicarid larvae) 5.0 mm, male 1.9 mm (in left branchial chamber of host) (AMNH 18467).—NE Courtney Campbell Causeway, 4 June 1998, host male 8.7 mm, female 5.3 mm, male 2.3 mm (in right branchial chamber of host) (AMNH 18468).

Remarks. All of the specimens examined herein conform to published descriptions of *Leidya bimini* (Pearse 1951, Bourdon and Bowman 1970, Markham 1972) in all important characters such as the structure of the female pleopods (Figure 1A), elongate shape of the first oostegite of the female, number and placement of the dorsal thoracic bosses on the female, long filiform “uropods” of the male (Figure 1B), and strong medioventral tubercles on pleonites I–V of the male (Figure 1B). Note that the SEM of the “uropods” (Figure 1B) shows no distinct segmentation line at the junction with the pleotelson; these structures may in fact be only hyper-elongated distolateral lobes of the pleotelson. The validity of *Leidya bimini* was demonstrated by Bourdon and Bowman (1970), who convincingly separated it from its western Atlantic congener *L. distorta* (Leidy, 1855). The adult isopod infestation prevalence for the Tampa Bay *L. bimini* was 3.7% (7 of 191 specimens), at the low end of the 1.3–16.2% reported from *Pachygrapsus transversus* (Gibbes) in Bermuda

Figure 1. *Leidyia bimini* Pearse, 1951. A) Female, 5.0 mm (destroyed); B) Male, 2.5 mm (destroyed), pleonites II-V and pleotelson. NW Gandy Bridge, Hillsborough County, Florida, USA, ex *Armases cinereum* (Bosc). MVT = midventral tubercle; P = pleopod; U = uropods.

by McDermott (1991). A collection of 39 specimens of *Armases ricordi* (H. Milne Edwards) from the same Tampa Bay stations contained no parasitized specimens (Mahon, pers. comm.), and attempts to find additional parasites on *A. cinereum* in March 2000 were unsuccessful (Mahon, personal communication).

Richardson (1908) stated that "the species found by Fritz Mueller in the branchial cavity of a Grapsoid *Pachygrapsus transversus* (Gibbes), from the coast of Brazil, is probably this species and genus [*L. distorta*], and not *Grapsicepon fritzii*, the nominal species of Giard and Bonnier [1887]." In fact, if the material of Müller (1871) is identical with *L. bimini* (*L. distorta* sensu Richardson), then *G. fritzii* Giard and Bonnier (1887) would be the same taxon as *L. bimini*, as pointed out by Markham (1979) in his synonymy list for *L. bimini*. However, *G. fritzii* is a nomen nudum from both Giard and Bonnier (1887: 63, 70) and Bonnier (1900: 266), and placement of this name into synonymy with *L. bimini* would not involve any change in the valid species name for the taxon. But while it is possible that *G. fritzii* and *L. bimini* are conspecific, it is equally possible that *G. fritzii* and *G. edwardsi* Bonnier, 1900, known from the grapsoid *Planes minutus* (Linnaeus) in Brazil, are actually the conspecific taxa in question. However, there have been no records of *L. bimini* from Brazil, nor any subsequent records of bopyrid parasites from Brazilian *Pachygrapsus*, and it is therefore best to treat *G. fritzii* as an indeterminable nomen nudum (herein) or perhaps a questionable synonym of *L. bimini* (Markham 1979).

Cardiocepon Nobili, 1906

Cardiocepon Nobili 1906: 1104–1106, figure 3.—Bourdon 1967: 115.—Bourdon and Bowman 1970: 422.—Bourdon and Stock 1979: 216–217.—Bourdon 1981: 105.—Markham 1980: 628–629.

Included species. *C. pteroides* Nobili, 1906 (type species by monotypy).

Host families and genera. GECARCINIDAE: *Cardisoma* (Nobili 1906).

Distribution. Ternate, Indonesia.

Remarks. The sole species in this genus possesses peculiarly shaped, ventrally directed, pleopodal endopodites; these have short, stout, almost hook-like digitations; the exopodites are similar in size and shape to the lateral plates. Bourdon's (1981) suspicion that the supposed biramous epimeral plates as described by Nobili (1906) are, in fact, uniramous is confirmed, but the genus is valid nevertheless. Although the female of this species is similar to *Megacepon*, its prominent

dorsal bosses on pleonites II and III, coupled with the distinctive shape of the pleopodal endopodites, require its continued status as a separate genus. Additionally, the first oostegite is of an extreme elongated and foliaceous form greatly exceeding that found in either *Leidya* and *Megacepon*. As this species has not been reported subsequent to the holotype, and the description of Nobili (1906) was incomplete and partly inaccurate, the holotype (now damaged) is redescribed below.

Cardiocepon pteroides Nobili, 1906

Figure 2

Cardiocepon pteroides Nobili 1906: 1104–1106, figure 3.—Bourdon and Stock 1979: 217.—Markham 1980: 629.—Bourdon 1981: 105.

Redescription. Female (Figures 2A–H), based on holotype. Body length approximately 22.9 mm (specimen broken), maximal width 10.6 mm, head length 2.7 mm, head width 5.0 mm. Pereon essentially straight. All body regions and pereonites distinctly segmented.

Head broad, weakly produced with anterior lamina flattened along distal margin; dorsal surface of head strongly bilobed with lobes directed latero-dorsally (Figure 2A). Eyes absent. Antenna of 3 articles; antennule of 5 articles. Maxilliped (Figure 2B) with low rounded spur; distal segment subovate with mesiodistal narrow, acute nonarticulating palp.

Pereon composed of 7 pereonites, broadest across pereonites III and IV, tapering anteriorly and posteriorly. Coxal plates largest on pereonites II–IV, markedly smaller on pereonites I and V–VII. First oostegite proximal lobe subquadrate, distal lobe extremely elongate, broadening distally and becoming more pronounced; rounded, internal ridge with pronounced digitations (Figure 2C). Oostegites completely enclosing brood pouch; posteriormost oostegite surface faintly tuberculate with fringe of setae on posterior margin. Pereopods II–IV of about same size; pereopods I, and V–VII much smaller (Figure 2D). Basis of all pereopods bearing pronounced rounded medial boss. First pair of pereopods surrounding head region; small gaps between pereopods V–VII. Pereonite VI with large triangular, posteriorly directed, medial boss strongly overreaching pereonite VII and extending over pleonite I; other pereonites without bosses.

Pleon with 5 distinct pleonites plus pleotelson; pleonites II and III each with prominent medial, posteroventrally directed and distally rounded, dorsal boss (Figure 2E). Pleonites I–V with biramous pleopods and uniramous lateral plates; exopodites and lateral

Figure 2. *Cardiocepon pteroides* Nobili, 1906. Holotype female, approximately 22.9 mm (MCSN): A) cephalon, dorsal view; B) right maxilliped, external; C) right oostegite I, internal; D) left pereopod VI; E) pleonites I–III, dorsal view; F) left pleopod and lateral plate I; G) endopod of pleopod II, ventral view; H) left uropod and pleopod V, ventral view. L = lateral plate; P = pleopod; PM = pleonite; U = uropod; numbers indicate pleon segment. Scale = 2.4 mm (F, G), 2.5 mm (D), 3.2 mm (A, B, E, H), 4.8 mm (C).

plates elongate and distally tapered with smooth dorsal surfaces, deep median furrow on ventral surfaces, and strongly digitate margins (Figures 2E, F); endopodites short, ventrally directed, with stout finger-like digitations (Figure 2G); lateral plates and pleopods on pleonites I–IV similar in size, reduced to less than 50% of length on pleonite V (Figure 2H); uropods uniramous, similar in size and shape to pleopodal exopodites I–IV (Figure 2H).

Megacepon George, 1947

Megacepon George 1947: 385.—Bourdon 1967: 116.—Bourdon and Bowman 1970: 422.—Bourdon and Stock 1979: 216–217.—Markham 1980: 628–629.—Bourdon 1981: 105–107.—Markham 1982: 361.

Included species. *M. sesarmae* (Pearse, 1930) n. comb.; *M. goetici* (Shiino, 1934) n. comb.; *M. choprai* George, 1947 (type species by monotypy); *M. pleopodatopus* Bourdon, 1981.

Host families and genera. GRAPSIDAE: *Chiromantes* (*M. choprai*: Shiino 1958; *M. sesarmae*: Pearse 1930); *Episesarma* (*M. choprai*: Markham 1980); *Goetice* (*M. goetici*: Shiino 1934, Shiino 1958, Markham 1982); *Muradium* (*M. choprai*: George 1947);

Perisesarma (*M. choprai*: Markham 1990); *Sesarma* (*M. choprai*: George 1947, Shiino 1958, Markham 1980, 1990; *M. sesarmae*: Pearse, 1930); *Varuna* (*M. pleopodatopus*: Bourdon 1981).

Distribution. India (*M. choprai*); Japan (*M. goetici*, *M. choprai*); Indonesia (*M. pleopodatopus*); Thailand (*M. choprai*); Hong Kong (*M. goetici*); China (*M. sesarmae*).

Remarks. Species in this genus possess an elongate first oostegite, a prominent mediodorsal boss on the first pleonite of the female, and a telson with moderately produced lateral lobes (not true uropods) on the male. The type species of *Megacepon* was redescribed by Shiino (1958, female) and Markham (1980, male), while Bourdon (1981) described a second species, although only conditionally assigning it to *Megacepon*. Bourdon and Bowman (1970) considered *Leidya sesarmae* and *M. choprai* as possibly conspecific, but the description of the male of *M. choprai* by Markham (1980) shows that they are not; they are, however, considered here to be congeneric. Bourdon and Stock (1979) described the taxon “? *Megacepon* sp. (aff. *Portunicepon goetici* Shiino, 1934),” which they suggested might be conspecific with *Portunicepon goetici*. This placement of *goetici* in *Megacepon* is supported by Markham’s (1982) illustration of the first oostegite, although Markham

(1982) incorrectly placed Shiino's species in *Allokepon* (all of which have females with short first oostegites and lacking mediodorsal bosses on pereonites II–IV, and males with short lateral lobes on the pleotelson); see also remarks below under *Allokepon*. Comparison of the descriptions and illustrations of Bourdon and Stock's (1979) "aff. *goetici*" specimens with those of *M. goetici* indicates that these are two distinct taxa, but likely not congeneric, as Bourdon and Stock's (1979) taxon has a large mediodorsal boss on pleonite II, rather than on pleonite I as is found in all other *Megacepon* species. Correct placement of Bourdon and Stock's (1979) taxon is deferred until the specimens can be reexamined; it may require a new genus. The description for "aff. *goetici*" given by Bourdon and Stock (1979: 214–216, figures 7–8), requires a correction in that the mediodorsal bosses on the pereonites of the female are strongly produced on segments V and VI, not IV to VI.

Allokepon Markham, 1982

Allokepon Markham 1982: 356–357.—Markham 1985: 38.—Markham 1989: 146 (juvenile characters).

Included species. *A. hendersoni* (Giard and Bonnier, 1888) (type species by original designation); *A. tiariniae* (Shiino, 1937) n. comb.; *A. monodi* (Bourdon, 1967); *A. sinensis* (Danforth, 1971).

Host families and genera. PORTUNIDAE: *Charybdis* (*A. hendersoni*: Bonnier, 1900); *Lissocarcinus* (*A. sinensis*: Danforth 1971, Markham 1982); *Portunus* (*A. sinensis*: Markham 1985, 1989); MAJIDAE: *Stenorhynchus* (*A. monodi*: Bourdon 1967, 1971); *Tiarinia* (*A. tiariniae*: Shiino 1937).

Distribution. India (*A. hendersoni*); Hong Kong, Thailand, and the Philippines (*A. sinensis*); Japan (*A. tiariniae*); Senegal and Dahomey (*A. monodi*).

Remarks. Markham (1982) erected this genus to contain four species originally placed in the genus *Portunicepon* Giard and Bonnier, 1887. These species were not congeneric with the type species of *Portunicepon* (which is a synonym of the type species of *Ergyne* Risso, 1816), and were assigned to their own genus, *Allokepon*, while *Portunicepon* was recognized as a synonym of *Ergyne*. Markham (1982) included one species (*A. goetici*) which has the unusual and clearly apomorphic elongate condition of the first oostegite. This species is herein removed to *Megacepon*, as it possesses all of the important characters of that genus (see above). Species of *Allokepon* possess a short first oostegite and prominent mediodorsal bosses on

pereonites VI and VII (lacking on pereonites I–V and all pleonites) of the females, although there is a specimen in the Paris Museum (MNHN) that appears referable to *A. tiariniae* but has large mediodorsal bosses on pereonites IV–VII; this specimen requires more study and is not otherwise discussed herein. Markham, in his 1982 redescription of the holotype of *A. sinensis*, indicated that the middorsal bosses occurred on pereonites V and VI, but Danforth (1971) described them on VI and VII. Markham (1982) excluded two species of "*Portunicepon*" from *Allokepon* but did not suggest proper generic placement for either. Based on literature descriptions and illustrations only, there appears to be no reason not to place *Portunicepon tiariniae* Shiino, 1937, in *Allokepon*, in spite of the peculiarly-shaped telson of the male. I agree, however, that *P. savignyi* (Stebbing, 1910), with its prominent mediodorsal bosses on pereonites V–VII (lacking on pereonites I–IV and all pleonites), does not belong in *Allokepon* nor apparently any other genus discussed herein; it may require its own genus. The same may also be true of *A. sinensis* sensu Markham (1985), which has mediodorsal bosses on pereonites VI and VII, as well as pleonites I and II. However, until the specimens can be reexamined, the current status should be maintained and *A. sinensis* sensu Markham (1985) is retained in *Allokepon* for the present, while "*Portunicepon*" *savignyi* is excluded (and remains unplaced).

PHYLOGENETIC RELATIONSHIPS

The peculiar elongate shape of the first oostegite is a synapomorphy shared by the Ioninae genera *Leidya*, *Megacepon* and *Cardiocepon* (see also Bourdon and Bowman 1970), the prominent mediodorsal boss in an unusual location on the first pleonite of the female is a synapomorphy for *Megacepon*, and the long "uropods" of males is a synapomorphy for *Leidya*. It is more difficult to find a synapomorphy for *Allokepon*, except perhaps the presence of mediodorsal bosses only on pereonites VI and VII (but this would exclude *A. sinensis* from the genus). Together these four genera appear to comprise a distinct clade, but further elucidation of the exact relationships between these genera and other Ioninae must await a comprehensive phylogenetic analysis based on type specimens of all taxa.

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