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Diversity of Hyperiid Amphipods (Crustacea: Peracarida) in the Western Caribbean Sea: News from the Deep

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Rebeca Gasca (2009) Diversity of hyperiid amphipods (Crustacea: Peracarida) in the western Caribbean Sea: news from the deep. *Zoological Studies* **48**(1): 63-70. Previous surveys of hyperiid amphipods from the western Caribbean were largely restricted to the epipelagic layer (0-200 m in depth). The need for deeper sampling in the area has been recognized in some work; presumably, this strategy would significantly increase knowledge of the local and regional diversity of this and other zooplankton taxa. Hyperiid amphipods collected at an expanded sampling range (0-940 m) in Mexican waters of the northwestern (NW) Caribbean, were taxonomically analyzed. Samples were collected during 2 cruises (2002 and 2006), using different sampling gear on each one. In total, 92 hyperiid species were found; 32 species had not hitherto been recorded in the area, thus increasing (from 60 to 92, 50%) the number of species currently known in this part of the Caribbean. Some of these species were recorded for the first time in the NW Caribbean or in Mexican territorial waters. A greater relative increase was observed among the Physosomata, a group known to contain mainly meso- and bathypelagic forms. A revised, expanded checklist of the hyperiids of the NW Caribbean is also provided; this area is now among the best studied in the NW tropical Atlantic, which in turn still has a low number of records compared to other regions of the world. These results confirm that 1) significant increases of local and regional lists of hyperiids may be expected from more sampling efforts in deeper layers, and 2) this and other groups of tropical oceanic zooplankton deserve further study in this environment. http://zoolstud.sinica.edu.tw/Journals/48.1/63.pdf

Key words: Marine biogeography, Zooplankton, Mesopelagic, Tropics, Biodiversity.

Zooplankton represent an important community in terms of their contribution to marine biodiversity with many groups, including holopelagic crustaceans, being more diverse in deeper layers (Angel 1998). In the northwestern (NW) tropical Atlantic (NWTA), as in other tropical areas, the planktonic fauna has mainly been surveyed in the upper layers (0-200 m), but little is known about the composition of zooplankton dwelling at greater depths. The extension of this environment is at least 1 order of magnitude greater than that of the epipelagic layers; hence, the current knowledge of the diversity of most zooplankton groups in these regions is limited to a thin layer that represents only about 10% of the water column (Suárez-Morales and Gasca 1996). This enormous environment, possibly harboring a largely undiscovered fauna remains practically unknown.

Hyperiid amphipods are one of the crustacean zooplankton groups that have received recent attention because of their potential diversity in deeper layers of the world's oceans (Gasca and Haddock 2004, Gasca 2005). This group, known to contain more than 250 species, includes mainly epipelagic forms with reduced migrational patterns, but many are deep-living forms (Vinogradov et al. 1996, Vinogradov 1999). In the NWTA, the western Caribbean is an area in which some groups of the epizooplankton, including hyperiid amphipods, are relatively well known. However,

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the fauna from deeper layers remains unstudied. Up to 60 hyperiid species are known to occur in this area, but successive surveys have predicted that this number could be significantly increased by sampling efforts in deeper waters (Gasca and Shih 2001 2003, Gasca and Suárez-Morales 2004). Only recently was this kind of sampling possible in the NW sector of the Caribbean Sea. The results of the analysis of hyperiids found in these new samples from intermediate and deep waters of this sector of the Caribbean were analyzed and compared with previous accounts in the same region and in other tropical areas of the world. A revised, updated list of species of hyperiids known from this area is also presented including relevant data about the new records.

MATERIALS AND METHODS

Zooplankton samples were collected during 2 oceanographic surveys carried out in the oceanic waters off the Mexican coast of the western Caribbean Sea (Fig. 1). The 1st cruise (CARIBE-2002B) was operated by the Mexican Ministry of the Navy on board the *R/V Antares* on 1-27 June 2002. Twenty zooplankton samples were obtained by oblique tows at different depths between the surface and 600 m. A standard CalCOFI net with a mouth diameter of 0.74 m, filtering mesh of 0.33 mm, and provisioned with a digital flowmeter, was used to obtain the samples. Samples were fixed and preserved in a buffered formalin solution. The 2nd cruise, carried out 14 Mar.- 4 Apr. 2006, was operated by the National Oceanic and Atmospheric

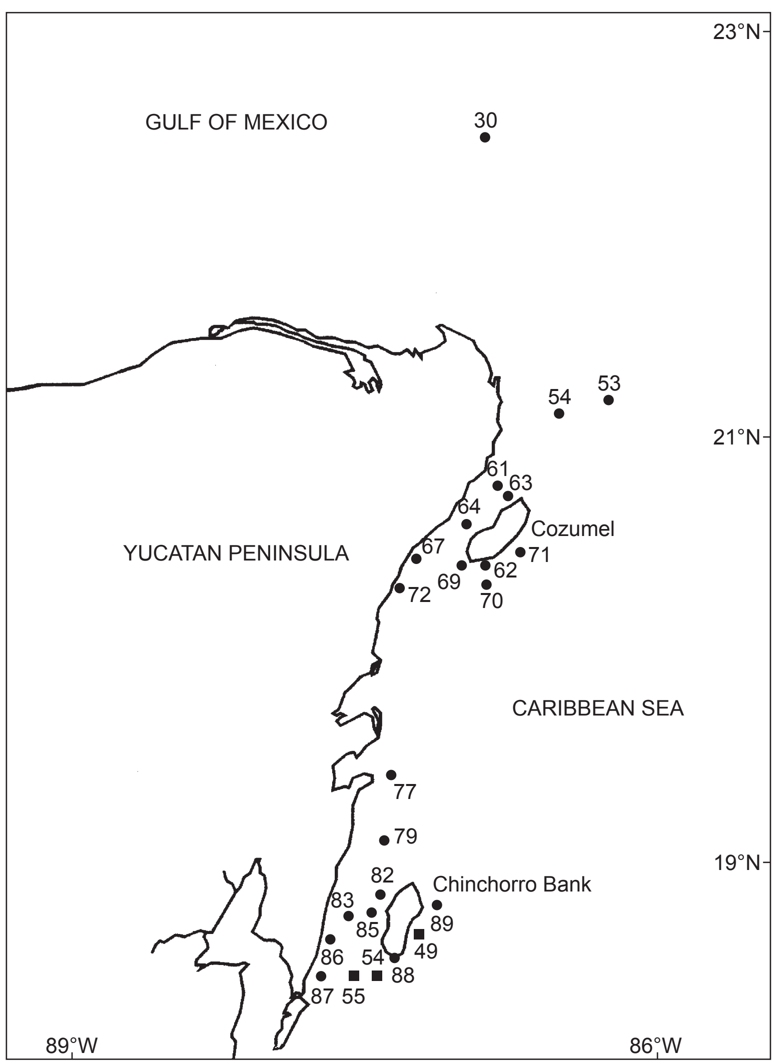

Fig. 1. Surveyed area with zooplankton sampling sites in Mexican waters of the northwestern Caribbean. The circles indicate the sites visited diring the CARIBE 2002B cruise and squares correspond to the *Gordon Gunther* cruise.

Administration (NOAA) Southeast Fisheries Science Center (SFSC) on board the *R/V Gordon Gunther*. Six zooplankton samples were collected at 3 oceanic sites off the Mexican Caribbean. The sampling gear used was a MOCNESS net (1 m per side with a filtering mesh of 0.3 mm); it was hauled at different depths between the surface and 941 m. Samples were fixed in 4% formalin and preserved in a solution of 95% seawater, 4.5% propylene-glycol, and 0.5% propylene-phenoxytol. Hyperiid amphipods were sorted from the original samples and kept in this solution. Work by Vinogradov et al. (1996) was followed for the basic taxonomic arrangement of hyperiids and for the identification and classification of most genera. Species of particularly complex genera such as *Lycaea*, *Phronima*, and *Oxycephalus* were identified following Harbison and Madin (1976), Shih (1991), and Zeidler (1999), respectively. Recent revisions by Zeidler (2003a 2004a b) were used for the superfamilies Vibilioidea, Lycaeopsoidea, and Phronimoidea. Some species mentioned in the literature under a different name were included in this account with the new, accepted nomen.

RESULTS AND DISCUSSION

The taxonomic analysis of the hyperiid amphipods from the surveyed area yielded 92 species belonging to both the hyperiid infraorders of Physosomata and Physocephalata. The 1st group was represented by 3 families, 4 genera, and 15 species; the 2nd one included 15 families, 34 genera, and 77 species. A complete list of species recorded in this survey, including 32 that had not previously been recorded in the western Caribbean, is presented in table 1.

The 11 new records of the Physosomata, a group of deep-living forms (Vinogradov 1999), include the first report of the family Lanceolidae in the Caribbean; the only species collected, *Lanceola sayana*, is known to dwell in deep waters (1000-3000 m), but it can also be collected in surface layers because of its ample vertical migration range. In the NWTA it was previously recorded from the Sargasso Sea (Gasca 2007). Another interesting record is that of *Mimonectes gaussi*, the only member of the family Mimonectidae recorded in the survey area and in the NWTA (see Gasca 2007, LeCroy et al. in press); this species is known to occur at depths of more than 500 m (Vinogradov 1999).

The family Scinidae is the most diverse of the Physosomata; the group is mainly comprised of deep-living forms, but many species are frequently recorded from epipelagic layers. In the western Caribbean, there are only 4 records of species of *Scina*, namely, *S. nana*, *S. stenopus*, *S. tullbergi*, and *S. wagleri atlantis* (Gasca and Suárez-Morales 2004), all with an ample vertical distribution. In this survey, the number of species recorded in the area increased to 12 by the addition of several interesting species/records of this genus. Some

Table 1. Revised list of species of hyperiid amphipods recorded from the northwestern Caribbean including those that are new records in the area (*) and species not previously found in Mexican territorial waters of the Atlantic and Pacific Oceans (**)

Class Crustacea	Family Scinidae Stebbing, 1888
Subclass Malacostraca	*Scina borealis* (G.O. Sars, 1882) *
Superorder Peracarida	*Scina crassicornis* (Fabricius, 1775) *
Order Amphipoda	*Scina curvidactyla* Chevreux, 1914 *
Suborder Hyperiidea	*Scina damasi* Pirlot, 1929 *
Infraorder Physosomata	*Scina excisa* Wagler, 1926 **
Superfamily Lanceoloidea	*Scina langhansi* Wagler, 1926 *
Family Lanceolidae Bovallius, 1887	*Scina lepisma* (Chun, 1889) *
Lanceola sayana Bovallius, 1885 *	*Scina nana* Wagler, 1926
Superfamily Scinoidea	*Scina stebbingi* Chevreux, 1919 **
Family Mimonectidae Bovallius, 1885	*Scina stenopus* Stebbing, 1895
Mimonectes gaussi (Woltereck, 1904) *	*Scina tullbergi* (Bovallius, 1885)

Table 1. (Cont.)

Scina wagleri atlantis Thurston, 1976	*Eupronoe maculata* Claus, 1879
Acanthoscina acanthodes (Stebbing, 1895) *	*Eupronoe minuta* Claus, 1879
Infraorder Physocephalata	*Eupronoe laticarpa* Stephensen, 1925 *
Superfamily Cystisomatoidea Zeidler, 2003[b]	*Eupronoe intermedia* Stebbing, 1888
Family Cystisomatidae Willemöes-Suhm, 1875	*Parapronoe crustulum* Claus, 1879 *
Cystisoma longipes (Bovallius, 1886) **	*Parapronoe elongata* Semenova, 1981 **
Superfamily Vibilioidea	*Parapronoe parva* Claus, 1879
Family Vibiliidae Dana, 1852	*Paralycaea gracilis* Claus, 1879
Vibilia australis Stebbing, 1888 *	*Paralycaea hoylei* Stebbing, 1888
Vibilia borealis Bate and Westwood, 1868 **	Family Lycaeidae Claus, 1879
Vibilia chuni Behning and Woltereck, 1912	*Lycaea pulex* Marion, 1874
Vibilia gibbosa Bovallius, 1887	*Lycaea pauli* Stebbing, 1888
Vibilia jeangerardi Lucas, 1845 **	*Lycaea bovalloides* Stephensen, 1925 *
Vibilia propinqua Stebbing, 1888	*Lycaea bovalli* Chevreux, 1900 *
Vibilia stebbingi Behning and Woltereck, 1912	*Lycaea pachypoda* (Claus, 1879) *
Vibilia viatrix Bovallius, 1887	*Lycaea bajensis* Shoemaker, 1925 *
Family Paraphronimidae Bovallius, 1887	*Lycaea vincentii* Stebbing, 1888 *
Paraphronima gracilis Claus, 1879 *	*Simorhynchotus antennarius* (Claus, 1871)
Paraphronima crassipes Claus, 1879	Family Tryphanidae Bovallius, 1887
Family Phronimidae Dana, 1852	*Tryphana malmi* Boeck, 1870 *
Phronima sedentaria (Forskål, 1775)	Family Brachyscelidae Stephensen, 1923
Phronima atlantica Guérin-Méneville, 1836	*Brachyscelus crusculum* Bate, 1861
Phronima solitaria Guérin-Méneville, 1844 *	*Brachyscelus globiceps* (Claus, 1879)
Phronima curvipes Vosseler, 1901 *	*Brachyscelus rapacoides* Stephensen, 1925
Phronima pacifica Streets, 1877	Family Oxycephalidae Bate, 1861
Phronima colletti Bovallius, 1887 *	*Oxycephalus clausi* Bovallius, 1887
Phronimella cf. *elongata* (Claus, 1862)	*Streetsia steenstrupi* (Bovallius, 1887)
Family Phrosinidae Dana, 1852	*Streetsia porcella* (Claus, 1879)
Phrosina semilunata Risso, 1822	*Leptocotis tenuirostris* (Claus, 1871)
Anchylomera blossevillei Milne-Edwards, 1830	*Glossocephalus milneedwardsi* Bovallius, 1887
Primno latreillei Stebbing, 1888	*Rhabdosoma whitei* Bate, 1862 *
Primno evansi Sheader, 1986[a]	*Rhabdosoma minor* Fage, 1954
Family Lestrigonidae Zeidler, 2004	Family Platyscelidae Bate, 1862
Lestrigonus bengalensis Giles, 1887	*Platyscelus serratulus* Stebbing, 1888
Lestrigonus schizogeneios (Stebbing, 1888)	*Platyscelus crustulatus* (Claus, 1879)
Lestrigonus latissimus (Bovallius, 1889)	*Platyscelus ovoides* (Risso, 1816) *
Lestrigonus macrophthalmus (Vosseler, 1901) *	*Hemityphis tenuimanus* Claus, 1879
Phronimopsis spinifera Claus, 1879	*Paratyphis maculatus* Claus, 1879
Themistella fusca (Dana, 1852) *	*Paratyphis parvus* Claus, 1887
Hyperioides longipes Chevreux, 1900	*Paratyphis spinosus* Spandl, 1924
Hyperietta vosseleri (Stebbing, 1904)	*Paratyphis promontori* Stebbing, 1888
Hyperietta stephenseni Bowman, 1973	*Tetrathyrus forcipatus* Claus, 1879
Family Dairellidae Bovalllius, 1887	*Amphithyrus bispinosus* Claus, 1879
Dairella californica (Bovallius, 1885)[b]	*Amphithyrus muratus* Volkov, 1982
Superfamily Lycaeopsoidea	*Amphithyrus glaber* Spandl, 1924
Family Lycaepsoidae Chevreux, 1913	*Amphithyrus sculpturatus* Claus, 1879
Lycaeopsis themistoides Claus, 1879	Family Parascelidae Bovallius, 1887
Lycaeopsis zamboangae (Stebbing, 1888)	*Thyropus sphaeroma* (Claus, 1879)
Superfamily Platysceloidea	*Parascelus edwardsi* Claus, 1879[c]
Family Pronoidae Dana, 1853	

[a]Also recorded as *Primno brevidens*. [b]Also recorded as *Dairella latissima*. [c]Also recorded as *P. typhoides*.

of these species are strong migrators that have been found at depths between 20 and 1000 m (i.e., *S. borealis*, *S. crassicornis*, *S. curvidactyla*, *S. langhansi*, and *S. stebbingi*) (Thurston 1976, Zeidler 1990, Vinogradov 1999), and others are known to occur at deeper layers only, e.g., *S. lepisma* (200-1000 m) and *S. excisa* (200-500 m) (Vinogradov 1999). Another scinid, *Acanthoscina acanthodes* also inhabits mesopelagic depths (200-500 m) and is a circumtropical species (Vinogradov 1999). Overall, the 11 new records of species of Physosomata significantly increase (by 3-fold) the previous account of only 4 records from the western Caribbean (Table 1, Fig. 2).

The infraorder Physocephalata is highly diverse; it contains species that dwell mainly in upper layers of the sea and have relatively reduced vertical migrational patterns (Vinogradov 1999). The Cystisomatidae comprises only 6 species of the genus *Cystisoma*; these forms are among the largest hyperiids known, with an unusually large head (Zeidler 2003b). The finding of *C. longipes* represents the first record of the genus in the NW Caribbean; this uncommon circumoceanic species dwells in mesopelagic waters at depths of 200-1000 m (Vinogradov 1999).

Within the taxonomically complex family Vibiliidae, previous records from the western Caribbean included only 5 species (Gasca and Shih 2001 2003); 3 more species are added herein. These species (*Vibilia australis*, *V. borealis*, and *V. jeangerardi*) are commonly found in the Atlantic and are regarded as circumtropical forms (Vinogradov 1999, Zeidler 2003a). The latter 2 species have not previously been recorded from the NWTA (Gasca 2003 2004 2007, LeCroy et al. in press).

The family Paraphronimidae was known from only 1 species (*Paraphronima crassipes*) in the Mexican Caribbean (Gasca and Shih 2001 2003, Gasca and Suárez-Morales 2004); the record of *Pph. gracilis*, with a vertical migration ranging from the surface down to 500 m in tropical and temperate latitudes (Zeidler 2003a), represents the 2nd finding of the genus in the area. The 3 new records within the Phronimidae (*Phronima solitaria*, *Phr. curvipes*, and *Phr. colleti*) are all previously known from depths ranging from the surface to 300 m; the number of species within the family increased to 7 in the western Caribbean.

The Lestrigonidae is another taxonomically complex and diverse group. In the western Caribbean, this family was known from 10 species (Gasca and Suárez-Morales 2004). The 2 species that represent new records (*Lestrigonus macrophthalmus* and *Themistella fusca*) are epipelagic forms dwelling in the upper 100 m (Vinogradov 1999); both were previously reported in other areas of the NWTA (Gasca 2003 2007, LeCroy et al. in press).

Previous Caribbean records of the family Pronoidae included 9 species; 3 more species are added here, one of *Eupronoe* and two of *Parapronoe*. Among these, the record of 1 female

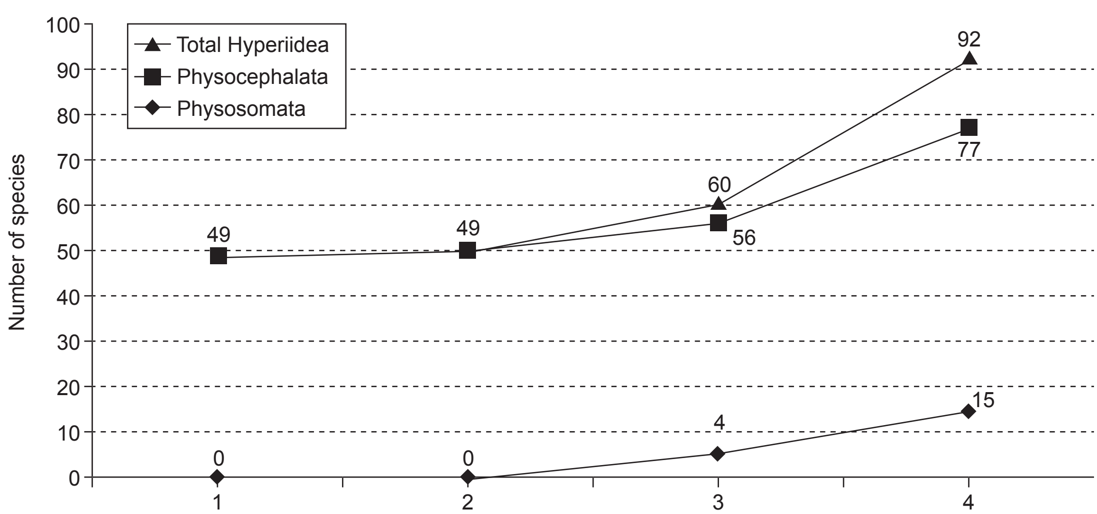

Fig. 2. Analysis of historical progression of records of Hyperiidea from the western Caribbean including total hyperiids and the infraorders Physosomata and Physocephalata. **1**, Gasca and Shih (2001); **2**, Gasca and Shih (2003); **3**, Gasca and Suárez-Morales (2004); **4**, this survey.

specimen of *E. laticarpa* in the surveyed area is noteworthy because it is regarded as a rare species (Vinogradov et al. 1996). The specimen has the characteristic pereopod II, with a massive distal process (Vinogradov et al. 1996). In the NWTA it has been recorded only once, from the Sargasso Sea (Gasca 2007). Another interesting record is represented by *Parapronoe* cf. *elongata*, a species known only from the Tasman Sea (Semenova 1981, Vinogradov et al. 1996, Zeidler 1998) and seas around China (Shih and Chen 1995). The only specimen found was a juvenile male (5 mm long), with a short telson as in *Ppr. elongata* and other diagnostic characters which agree with Semenova's (1981) description, but the length of the UII is not twice as long as it is wide. This morphometric difference could be within the intraspecific range of variation of *Ppr. elongata*, or it could suggest that this specimen represents an undescribed species. It is tentatively reported herein as *Ppr.* cf. *elongata* until more material is available for examination.

Records of the family Lycaeidae in this survey are significant because only 3 species are known to occur in the western Caribbean area (*Lycaea pulex*, *L. pauli*, and *Symorhynchotus antennarius*) (Gasca and Shih 2001 2003), and 5 species are added here, all of them of the genus *Lycaea*. Four of these species (i.e., *L. vincentii*, *L. bajensis*, *L. bovallii*, and *L. bovalloides*) are part of the *Lycaea pulex* complex defined by Harbison and Madin (1976) and Vinogradov (1999); these species have a complex taxonomic history, and their distributional patterns are therefore obscure (Vinogradov 1999). Members of this group of species have been recorded from the Gulf of Mexico and Sargasso Sea (Gasca 2007, LeCroy et al. in press).

The finding of *Tryphana malmi* represents the only record of the monotypic family Tryphanidae in the western Caribbean; it has been recorded in the Gulf of Mexico (LeCroy et al. in press) and Sargasso Sea (Gasca 2007). This species is known as an epipelagic form with an antiequatorial distribution (Vinogradov et al. 1996).

Families Oxycephalidae and Platyscelidae are among the best-known groups of the Physocephalata in the western Caribbean area (Gasca and Shih 2001 2003) and only 2 new records are added; 1 species for each family, *Rhabdosoma whitei* and *Platyscelus ovoides*, respectively. Both have been recorded in the upper 200 m and have circumtropical distributions (Vinogradov et al. 1996).

Overall, the number of species of hyperiids recorded in the western Caribbean has risen from 60 to 92; this is an increase of more than 50% over previous accounts. The finding of 21 new records of Physocephalata during this survey resulted in a substantial increase in the number of species known from the western Caribbean area, from 56 to 77. The infraorder Physosomata, predominantly deep-living, is now represented in the western Caribbean by 15 species, including the 11 new records added herein (Fig. 2).

The greater numerical increase among the Physocephalata is attributed to 1) the diversity of the group in epipelagic layers and 2) the sampling method, which comprised the entire water column. The relative increase (3 fold) of new records is noticeably greater among the Physosomata because of the expanded vertical sampling range that allowed collection of many strictly mesopelagic forms. Currently, the Physosomata represent approximately 38% of the known species of the suborder Hyperiidea; in this study, this group comprised only 16% of the species recorded in the western Caribbean; hence, it is presumed that the deeper layers of this basin (with an average depth of 2500 m) still deserve further study. This assumption agrees with the results of Shih and Chen (1995), who pointed out that the limited number of species of Physosomata recorded from the seas around China is related to the shallowness of the regional seas (averaging < 400 m) and the insufficient samples from deep waters. Further, Gasca (2007) reported a 2 fold increase of species of *Scina* from the Sargasso Sea from samples obtained at 400 m. Thus, the diversity of this group of hyperiids is probably underestimated in this region.

Previous surveys of hyperiid amphipods in the western Caribbean (Gasca and Suárez-Morales 2004, Gasca and Shih 2001 2003) were based on an accumulated set of 110 samples from the upper 200 m. Despite the increased sampling efforts, the number of species recorded from the area has not significantly increased in recent years (Fig. 2); only 60 species were recorded in this set of samples. As predicted in previous surveys, analysis of only 26 samples from deeper waters yielded a significant increase (50%) in the number of hyperiid records.

The number of new records reported herein (32) was not equal when the 2 different types of sampling gear used during this survey were compared; the CalCOFI net captured 62 species, of which 18 were new records. Of these, 7 were of the Physosomata and 11 were of the Physocephalata. The total number of species obtained with the MOCNESS net in 2006 was higher (87) than in 2002, as was the number of new records, 11 of the Physosomata and 21 of the Physocephalata. This is noteworthy because the 2002 sampling effort with the CalCOFI net was greater (20 samples) than in 2006, during which only 6 samples were obtained. The MOCNESS net, with a greater mouth surface (1 vs. 0.4 m^2 of the CalCOFI net) and deployed to greater depths than the CalCOFI net, proved to be more efficient in sampling both epipelagic (Physocephalata) and mesopelagic (Physosomata) hyperiids in the area. These results agree with those obtained by Gasca (2007), who found significantly higher hyperiid diversity in samples collected with the larger of the 2 nets deployed in the same depth range (0-400 m) in the Sargasso Sea. When comparing the net efficiency of the standard 1-m-diameter net versus a Bongo net, Ohman and Lavaniegos (2002) reported little detectable differences in the collection of hyperiid amphipods, but their analysis was limited to the upper 210 m, largely dominated by epipelagic physocephalate hyperiids.

The 6 new records for Mexican territorial waters (Table 1) increase the national account of hyperiid species from 168 (Gasca 2003 2004, LeCroy et al. in press, Gasca and Franco-Gordo 2008) to 174. The western Caribbean is now among the best-studied areas in the NWTA region; approximately 51% of the known hyperiid species from the Atlantic Ocean (178) (Vinogradov et al. 1996) have now been recorded in the survey area. Overall, the known species richness of hyperiid amphipods from the western Caribbean is now comparable to that from other adjacent tropical areas, such as the Gulf of Mexico (100 species; Gasca 2003 2004, LeCroy et al. in press), and the Sargasso Sea (89 species; Gasca 2007), but it is still far from the number of records known from the Mexican Pacific (150 species; Gasca and Franco-Gordo 2008, Gasca 2009). At a regional scale and even considering recent advances, the NWTA still deserves further study; a comparison to current accounts of the hyperiid fauna from other regions of the world seems to confirm this. The 117 species recorded in the seas around China is a figure only partially comparable because of the reduced number of physosomate hyperiids that have been known to occur in that region (Shih and Chen 1995). The 147 species recorded from the southwestern Atlantic (Vinogradov 1999) and the approximately 150 from the Eastern Tropical Pacific (Shih and Hendrycks 2003, Gasca 2009) include a greater proportion of records from mesopelagic depths. The study of the hyperiid fauna of these large, poorly known areas of the NWTA, particularly from samples obtained at deeper layers (> 300 m), are likely to continue yielding additional relevant information on the regional diversity of hyperiid amphipods.

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