New ostracod species (*Cypridopsis schwartzi* n. sp.) from Texas

Okan Külköylüoğlu[1], Alaettin Tuncer[2], Joseph A. Veech[3]

[1] Department of Biology, Faculty of Arts and Science, Bolu Abant İzzet Baysal University, 14300, Turkey
[2] Department of Geological Engineering, Hacettepe University, Ankara, Turkey
[3] Department of Biology, Texas State University, San Marcos, Texas, USA

Introduction

Total of 39 taxa (19 species, 20 taxa) were collected from 59 different shallow aquatic bodies in Texas during April to June 2017. *Cypridopsis schwartzi* n. sp. is proposed as a new species collected from a cattle pond at Freeman Ranch near San Marcos, Texas. The species has several different characteristics from other bisexual forms, including carapace shape, presence of a curved- z3 seta on the second antenna, numbers of vibratory plate on the first thoracic leg, shape of hemipenis, numbers of whorls on the Zenker organ, and several other differences in the numbers and shapes of other parts of the chaetotaxy. Including *Cypridopsis schwartzi* n. sp., there are now 12 species in the genus *Cypridopsis*, and the new species is the fifth bisexual form for Texas. The new species was compared with other species of the genus in Texas and the taxonomic relationships are discussed.

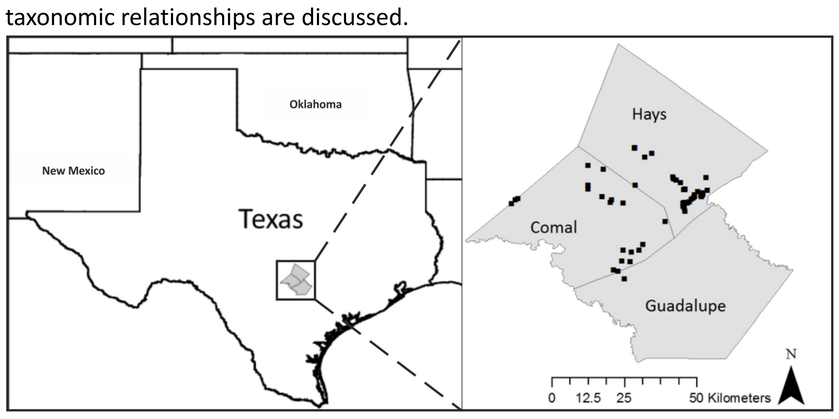

FIGURE 1.. Location of the three-county survey area in the central part of Texas, USA (top panel) and locations of the 54 sampling sites (squares in bottom panel)

Material&Method

The water samples were collected from 59 different shallow (ca. 100 cm of maximum depth) aquatic bodies of Texas (Figure 1) between 27 March and 14 June 2017 (see Table 1 for exceptions). In each sampling site, we measured values of several environmental variables including dissolved oxygen (DO, mg L−1), percent oxygen saturation (% DO), water and air temperatures (Tw, °C), electrical conductivity (EC, S cm−1), pH, atmospheric pressure (mmHg), altitude (m), geographic coordinates). We used YSI 650 MDS equipped with YSI 6929-V2 Multi-parameter Water Quality Sonde for the first four variables while pH values were measured with pH-meter (Oakton pH 310 series). Geographical information (altitude and latitude/longitude coordinates) were obtained from an iPhone 7 smartphone. All materials were kept in 70% ethanol in situ and brought to the laboratory where samples were filtered under tap water with four standard size sieves (1; 0.5; 0.25; 0.125 mm). Soon after, they were again kept in 70% ethanol for further analyses. Ostracod specimens were separated from the debris under a stereomicroscope (Nikon SMZ 1500). Species identification was done by dissecting adult individuals of each of the species under a light microscope (Olympus BX-51). Each specimen was stored in lactophenol solution and covered with a cover slide. We used a camera lucida attached to the light microscope for line drawings. Carapace and valves were photographed with Scanning Electron Microscope (SEM) at the Department of Geological Engineering, Hacettepe University. Species identification was achieved with taxonomic keys of several authors (e.g., Meisch 2000; Karanovic 2012). All samples are kept at the Limnology Laboratory of the Biology Department, Bolu Abant İzzet Baysal University, Bolu, Turkey, and available upon request.

Subclass Podocopa Sars, 1866

Order Podocopida Sars, 1866

Suborder Cypridocopina Baird, 1845

Subfamily Cypridopsinae Kaufmann, 1900

Tribe Cypridopsini Kaufmann, 1900

Genus Cypridopsis Brady, 1867

Type species: *Cypridopsis vidua* O.F. Müller, 1776

***Cypridopsis schwartzi* n. sp.**

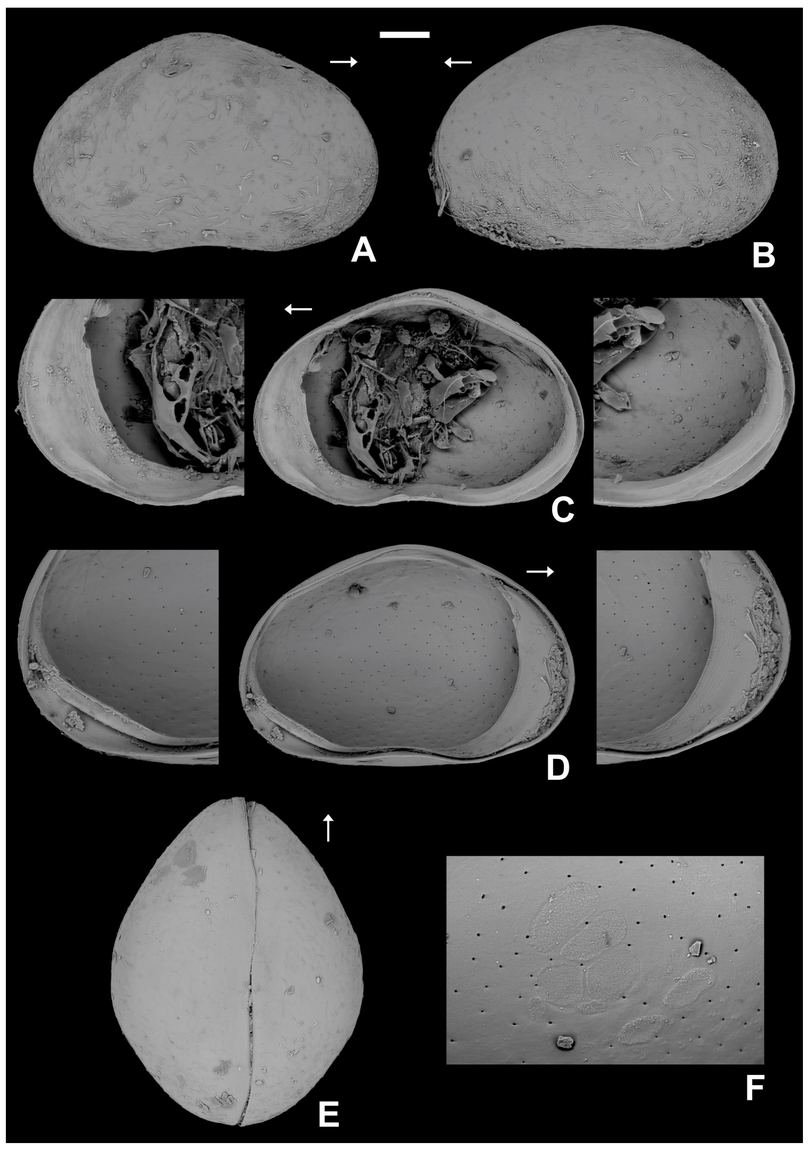

FIGURE 2. *Cypridopsis schwartzi* n. sp. Male. A) RV external view, B) LV external view, C) RV and D) LV internal view and details of anterior and posterior margins, E) Dorsal view, F) Muscle scars. Scale 100 µm for A-E, 10 µm for F

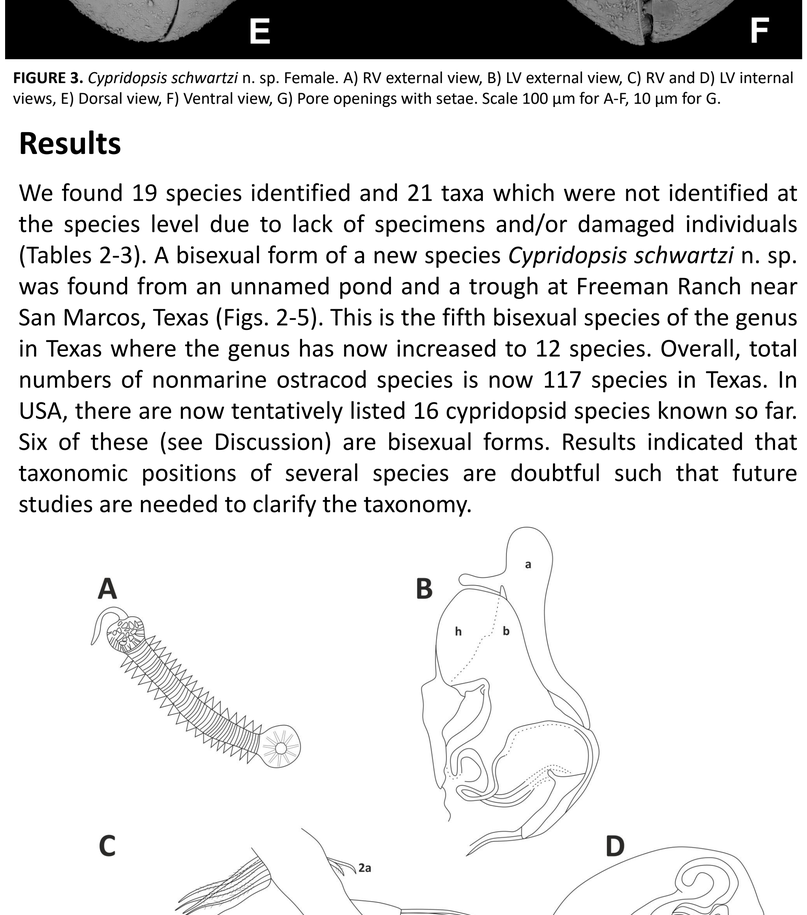

FIGURE 3. *Cypridopsis schwartzi* n. sp. Female. A) RV external view, B) LV external view, C) RV and D) LV internal views, E) Dorsal view, F) Ventral view, G) Pore openings with setae. Scale 100 µm for A-F, 10 µm for G.

Results

We found 19 species identified and 21 taxa which were not identified at the species level due to lack of specimens and/or damaged individuals (Tables 2-3). A bisexual form of a new species *Cypridopsis schwartzi* n. sp. was found from an unnamed pond and a trough at Freeman Ranch near San Marcos, Texas (Figs. 2-5). This is the fifth bisexual species of the genus in Texas where the genus has now increased to 12 species. Overall, total numbers of nonmarine ostracod species is now 117 species in Texas. In USA, there are now tentatively listed 16 cypridopsid species known so far. Six of these (see Discussion) are bisexual forms. Results indicated that taxonomic positions of several species are doubtful such that future studies are needed to clarify the taxonomy.

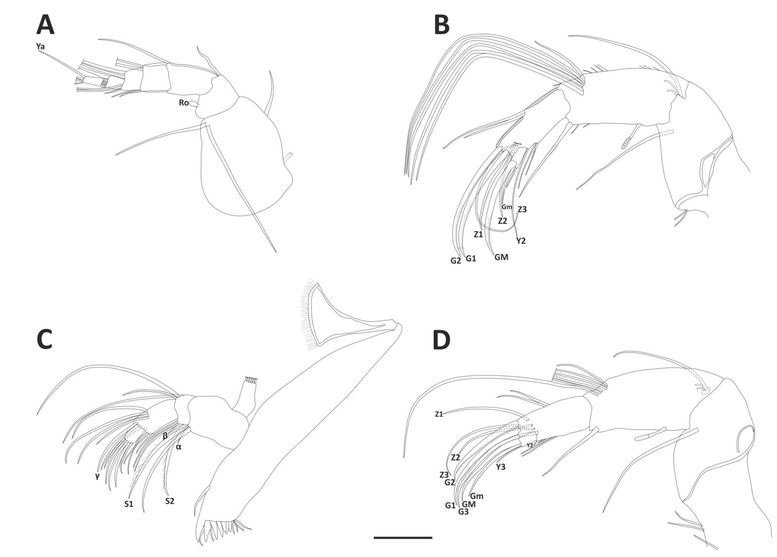

FIGURE 4. *Cypridopsis schwartzi* n. sp. Male: A) Antennule (A1), B) Antenna (A2), C) Mandible (Md), D) A2 of female. Scale: 100 µm.

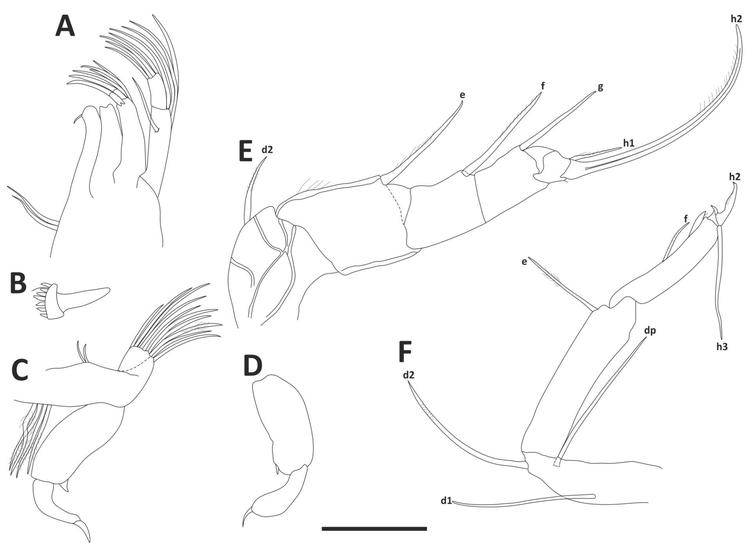

FIGURE 5. *Cypridopsis schwartzi* n. sp. Male: A) Maxillule (Mx1), B) Rake-like organ, C) Right clasping organ, D) Left clasping organ, E) T2, F) T3. Scale: 100 µm.

FIGURE 6. *Cypridopsis schwartzi* n. sp. A) Zenker's Organ, B) Hemipenis, C) T1 of female, D) Uropod and genital organ of female. Scale: 100 µm.

Discussion and Conclusion

As mentioned above for those earlier studies, the genus *Cypridopsis* needs an urgent revision because many species' taxonomic statuses are not clear. This is mostly because their descriptions and illustrations do not provide sufficient amount of information on the species or taxa. For example, several taxonomic keys (e.g., cf. Tressler 1959; Meisch 2000; Karanovic 2012) use carapace closure for ostracod species identification. Generally, LV overlaps RV in the genus but out of about 66-71 species, there may be at least 10 species whose RV overlaps LV (Meisch 2000). Interestingly, all these species were described between 1903 and 1968 (Sars 1903;Löffler 1968, respectively) are parthenogenetic and mostly distributed from countries in Afrotropical, Australasian, Palearctic, Pacific Oceanic Islands, and Asian regions. Hence, one can consider this information in future studies. Finally, as indicated above, *Cypridopsis schwartzi* n. sp. is different than all known species of the genus. Thus, we propose *Cypridopsis schwartzi* n. sp. as a new species from Texas. Including the new species, 12 species of the genus *Cypridopsis* can be tentatively listed in Texas. Six of which (but see discussion above) are bisexual forms. Accordingly, there are now about 117 non-marine ostracods reported from Texas. This increases the number of known cypridopsid species to 16 in the USA. Although results indicate that taxonomic positions of several species are doubtful, the state Texas has potentially high ostracod species diversity.

TABLE 1. Ecological data collected from 59 sites in and around Comal County, Texas. Abbreviations: Ta (air) and Tw (water) temperatures, EC (electrical conductivity), DO (dissolved oxygen), %DO (percent oxygen saturation), Comal Atmp (atmospheric pressure), Elev (elevation), Lat (latitude), Long (longitude). Empty cells indicate no ecological data. * Type locality of the new species. ** Location indicates the named water body that was sampled or other nearby landmark name. If no entry, then no nearby landmarks. Latitude and longitude coordinates give the exact location of sampling.

Date	Site	County	Location**	Habitat type	Ta	Tw	EC	pH	DO	%DO	Atmp	Elev	Lat	Long
2.05.2017	1	Hays	Wonder World Dr.	water body	25	29.9	462	8.6	10.3		749	857	29.8615	-97.958
2.05.2017	2	Hays	Unnamed pond	pond	25	29	548	8.1	12.1		749	851	29.8656	-97.952
2.05.2017	3	Hays	Unnamed pond	pond	26	25	854	8.3	7.22		748	811	29.8459	-97.969
2.05.2017	4	Hays	Unnamed pond	pond	26	27.4	358	8.3	8'8		748	730	29.8359	-97.966
2.05.2017	5	Hays	Unnamed pond	pond	26	31	443	8.5	14.1		748	850	29.8515	-97.973
2.05.2017	6	Hays	Unnamed pond	pond	27	28.3	259	8.2	7.88		748	886	29.8632	-97.968
2.05.2017	7	Hays	Unnamed pond	pond	29	30.9	170	9.1	6.98		746	852	29.9035	-97.967
2.05.2017	8	Hays	Unnamed pond	pond	29	29.9	293	8	6.73		746	851	29.903	-97.966
4.05.2017	9	Comal	Guadalupe River State Park	river	26	22.8	508	8.1	8.38		742	1040	29.8751	-98.484
4.05.2017	10	Comal	Guadalupe River State Park	mouth	24	21	735	8.1	7.74		739	1050	29.8716	-98.491
4.05.2017	11	Comal	Unnamed pond	pond	24	27.4	472	8	11.7		735	1270	29.8597	-98.503
4.05.2017	12	Comal	Unnamed pond	pond	24	24.3	165	7.6	7.68		745	860	29.714	-98.158
4.05.2017	13	Hays		ditch	25	24	707	7.4	9.96		750	610	29.8046	-98.029
6.05.2017	14	Hays	Nearby Fair Field	pond	16	22.8	228	8.2	707		750	600	29.8855	-97.917
6.05.2017	15	Hays	Unnamed pond	pond	16	16.6	715	7.8	11.1		751	620	29.8858	-97.911
6.05.2017	16	Hays	Unnamed pond	pond	17	21.2	791	7.3	5.15		750	530	29.8927	-97.911
6.05.2017	17	Hays		creek	17	23.3	454	7.7	8.36		751	590	29.9015	-97.898
6.05.2017	18	Hays	Blanco River	river	18	25.3	388	8.1	10.6		750	600	29.9407	-97.901
18.05.2017	19	Hays		ditch	25	26.2	606	7.8	7.84	94.6	745	600	29.8729	-97.947
18.05.2017	20	Hays		creek	25	24.1	768	8	1.93	22.3	746	590	29.8777	-97.941
18.05.2017	21	Hays		water body	26	25.4	679	7.7	3.52	42.9	745	580	29.8807	-97.936
18.05.2017	22	Hays		water body	26	25	563	7.7	5.4	65.4	745	580	29.8819	-97.915
18.05.2017	23	Hays	Freeman Ranch	mouth	28	24.8	565	8.1	7.4	89.3	738	870	29.937	-98.002
18.05.2017	24	Hays	Freeman Ranch	mouth	28	24.3	609	7.8	5.06	60.6	738	840	29.9319	-97.994
18.05.2017	25	Hays	Freeman Ranch	mouth	28	24.4	574	7.4	2.81	33.1	738	840	29.9318	-97.994
18.05.2017	26	Hays	Freeman Ranch	mouth	28	25.9	535	7.6	2.94	36.2	742	690	29.9317	-97.994
18.05.2017	27	Hays	Freeman Ranch	mouth	28	25.2	679	7.8	4.85	59.1	738	830	29.9237	-97.981
18.05.2017	28	Hays	Blue Hole Spring, Wimberley	spring fed creek	31	23.1	580	7.7	6.86	80.1	737	930	30.0036	-98.091
18.05.2017	29	Hays	Smith Creek	creek	31	22.2	625	7.3	5.15	59.31	734	960	30.0163	-98.068
18.05.2017	30	Hays		left of flowing water creek	32	31.7	761	7.9	8.37	114.1	743	570	29.8963	-97.926
18.05.2017	31	Hays	Theatre Pond, TSU campus	pond	32	33	390	8.4	10.8	148.2	743	590	29.8875	-97.938
29.05.2017	32	Comal	New Braunfels	man-made pond	22	25.5	414	8.8	7.33	89.8	749	660	29.7313	-98.097
29.05.2017	33	Comal	New Braunfels	small pool	23	23.1	820	7.2	4.93	57.2	751	660	29.7152	-98.109
29.05.2017	34	Comal	New Braunfels	Comal river	23	23.3	612	7.3	6.07	71.3	751	630	29.7085	-98.133
29.05.2017	35	Comal	New Braunfels	creek	22	23.5	1011	7.6	4.65	54.8	751	630	29.6807	-98.162
29.05.2017	36	Comal	New Braunfels	ditch	22	24.9	774	7.7	7.62	92.5	749	630	29.653	-98.189
29.05.2017	37	Comal	New Braunfels	pond	22	24.8	461	8.5	7.43	89.8	749	720	29.648	-98.174
29.05.2017	38	Guadalupe	Santa Clara Creek	creek	22	23.6	673	8	4.23	50	749	680	29.6258	-98.153
29.05.2017	39	Comal	New Braunfels	ditch	22	23.3	1446	8.1	8.14	95.6	750	660	29.6787	-98.136
9.06.2017	40	Hays	San Marcos	pond	23	27.2	164	8.6	4.1	51.3	747	630	29.8608	-97.973
9.06.2017	41	Comal	Guadalupe River, New Braunfels	river	23	17.5	439	8.8	9.2	96.4	744	855	29.8613	-98.158
9.06.2017	42	Comal	Canyon Lake	lake	24	26.2	392	7.4	8.89	110.1	743	760	29.8633	-98.197
9.06.2017	43	Comal	Canyon Lake-out flow	river	25	18	460	8.6	9.37	98.9	743	750	29.8707	-98.194
9.06.2017	44	Comal	Canyon Lake	lake	25	27.5	387	9.2	9.16	116.1	739	880	29.882	-98.224
9.06.2017	45	Comal	Canyon Lake	lake	25	27.9	396	9	8.78	112	738	1070	29.9054	-98.267
9.06.2017	46	Hays		limnocrene spring	25	22.1	749	7.5	4.91	56.3	737	930	29.9167	-98.266
9.06.2017	47	Hays		pond	25	23.8	583	7.9	2.68	31.6	734	1010	29.9174	-98.121
14.06.2017	48	Hays	Ringtail Ridge Pond	pond	27	26.9	412	7.6	2.89	37.6	746	690	29.9034	-97.967
14.06.2017	49	Hays	Jacob's Well	spring source	28	20.9	607	7.4	6.3	70.5	740	930	30.0345	-98.126
14.06.2017	50	Hays	Jacob's Well	small creek well	28	27.8	582	7.2	9.52	121.5	740	900	30.0346	-98.127
14.06.2017	51	Hays	Wood Creek	creek	28	21.7	617	7.9	6.1	69.4	740	910	30.0303	-98.122
14.06.2017	52	Comal		creek	29	30.4	590	7.4	8.88	118.6	735	1130	29.9767	-98.267
14.06.2017	53	Comal	John Knox Creek	creek	29	25.9	580	7.7	8	98.6	739	960	29.965	-98.219
04.21.2017	add1	Hays	Unnamed pond	pond										
17.03.2017	add2	Comal	Comal spring	spring										
30.03.2017	add3	Comal	John Knox Ranch	spring								963	29.965	98.2197
31.03.2017	add4	Comal	John Knox Ranch	creek								960	29.965	98.2198
18.05.2017	add5*	Hays	Freeman Ranch (TSU)	pond water								840	29.937	-98.002
27.03.2017	add6	East Sandia	West Texas	E Sandia spring		20.7	4289	7.2	6.74					

TABLE 2. Total of 40 ostracod taxa collected from 59 sites in Texas. Abbreviations: DS, *Darwinula stevensoni*; CH, *Cypridopsis* cf. *helvetica*; CV, *Cypridopsis vidua*; Cha, *Cypridopsis hartwigi*; C.n.sp., *Cypridopsis schwartzi* n. sp.; Cysp1, *Cypridopsis* sp. 1; Cysp2, *Cypridopsis* sp. 2; CW, *Cavernocypris* cf. *wardi*; BO, *Bradleycypris obliqua*; PG, *Physocypria gibbera*; Phsp1, *Physocypria* sp1. ; PP, *Physocypria pustulosa*; PD, *Physocypria* cf. *denticulata*; Cypsp1, *Cypria* sp. 1; PI, *Potamocypris* cf. *illinoiensis*; PV, *Potamocypris* cf. *variegata*; PS, *Potamocypris similis*; PSm, *Potamocypris smaragdina*; PPa, *Potamocypris* cf. *paludum*; PU, *Potamocypris unicaudata*; Pssp1, *Pseudocandona* sp. A; Casp1, *Candona* sp. 1; FC, *Fabaeformiscandona caudata*; PL, *Pseudocandona* cf. *lobipes*; CT, *Comalcandona tressleri*; SM, *Stenocypris malcolmsoni*; Pscsp1, *Psychrodromus* sp. 1; II, *Ilyocypris inermis*; IG, *Ilyocypris gibba*; IB, *Ilyocypris* cf. *bradyi*; Ilsp1, *Ilyocypris* sp. 1; PZ, *Prionocypris zenkeri*; HI, *Herpetocypris intermedia*; Lisp1, *Limnocythere* sp. 1; PR, *Paralimnocythere* cf. *relicta*; LS, *Limnocytherina sanctipatricii*; Hesp1, *Heterocypris* sp. 1; CT, *Cypridelis torosa*; Eusp1, *Eucypris* sp. 1; Unident, unidentified ostracod; a, adult; j, juvenile; c, carapace; Cs, carapaces; f, female; m, male; M, >100 individuals; v, valve.

Site	DS	CH	CV	Cha	C.n.sp.	Cysp1	Cysp2	CW	BO	PG	Phsp1	PP	PD	Cysp1	PI	PV	PS	PSm	Ppa	PU	Pusp1	Casp1	FC
1			1c									M						4a					
2			8a,c										M	Cs, v									
3			7a									7a,1c											
4			7a									M		2j							2a?		
5			13a,4j																				
6			M									M									4a,c		
7			1a,4c																				
8		1a,Cs													4a								
9	3a,1j	1a?																					
10				M				11a,j															
11			18a,c																				
12	1a		4da																		1m,1f,1j		
13			1a																				
14			4a,c																				
15			1a									11a											
16	8a																				2a?		
17	3a				2a	1a?								1a		1c							
18			3a,2c					11a,1c				6a,1j						6a,?			1M		
19			3a,3j,3c											13a,2j							1f		
20	1a	1a?	21a,3j									2a		5a,2j		1a					2a,2j		
21			4a,c									3a		9da,j									
22			3a,c																				
23																							
24					2m,3f,2a					33m,f,j											5f,c		
25					8a,Cs, v					15a,Cs											5a		
26					2a,Cs																2c		
27			5a,6j													1c							
28	11a,2j		4a,1c							8a													
29					2f,1c					2f											1c		
30	2f,2j		14f,2j,1c							4m,6f													
31			16f,2j,cs							2a		2a									1f		
32			3f																		5f,7m, 2j,2c		
33	1a,2j													1a							1a,1c		
34																							
35																					1c		
36																		6a					
37			4a,c																				
38			2f							18a, 5j,2c													
39											1a												
40			24a,3j,c							48a,1j,2c													
41	14a																				1a		
42	3a,1j		2f																				
43	10f		3f														4f				3f,1j		
44	3f,1j		6f,1j								2a												
45	1f											1f											
46		1a																					
47			2a,1j																				
48																							
49																							
50																							
51																							
52																							
53																							
add1	1a		2a,3c							2f													
add2	5a																						
add3																					43a,j		
add4	1a	4a										1c									1a		
add5					M					M													
add6																							

Site	PL	CT	SM	Pssp1	II	IG	IB	Ilsp1	PZ	HI	Lisp1	PR	LS	Hesp1	CT	Eusp1	Unident
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																1a,1j,1c	
9								2a,3a									
10																	
11						2a,6c											
13						1c		8a,16js		4a,2c		4a					
14																	
15						1a		1a,4j									
16																	
17							2a,4c										
18		1a,a			3a,1j							1da					
19												1a,1c,1j					
20										2a,?j						1j	
21										2a							
22										1a,1j							
23																	
24														Cs			
25														Cs			
26																	
27														1c			
28	1m,1f,4da,4a		1a,16a,j					9C,2j		2f,2j,2v		1c					
29		1a						2c		1j	1a,3c						
30	8m,6f,6j									1f							
31																	
32																	
29		1a						2c		1j	1a,3c						
33								2f,2j,1c									
30										1f							
35								6a									
36																	
37																	
38								6a									
39																	
40																	
41						2a				1j							
43																	
44																	
43					12a	2f,1c				6a,2j			6f				
44																	
45			6a														
46										M							
47																	
48																	
49																	
50																	
51																	
52																	
53																	
add1																	
add2																	
add3		4a, 1j															
add4								4v								1a, 1c	
add5																	
add6														1a1a			

TABLE 3. Sixteen species of the genus *Cypridopsis* reported from USA and their known distribution, types of sexual reproduction (Sex) (P, parthenogenetic; S, sexual reproduction), length of swimming setae on the second antenna (A2 setae), length of valves (RV, right valve; LV, left valve). Abbreviations: NA (North America), PAC (Pacific Oceanic Islands), PA (Palearctic). Type localities known in the USA: [1]Tennessee, [2]Texas, [3]Hawaii, [4]Louisiana. Note that data is not available for the empty cells. Dimensions in mm.

					Female		Male	
Sex	Species	Distribution	A2 setae	RV>/<LV	Lenght	Height	Width	Lenght	Height
P	*Cypridopsis arhiga* Cole 1965	NA[1]	short	LV>RV	0.53	0.27	0.27		
S	*Cypridopsis bisexualis* Cole 1966	NA[1]	long	LV>RV	0.60	0.35	0.32		
P	*Cypridopsis* cf. *herpestica* Cole 1965	NA[1,2]	short	LV>RV	0.57	0.32	0.40		
P	*Cypridopsis reptans* Cole 1965	NA[1]	short	LV>RV	0.62	0.31	0.30		
P	*Cypridopsis cypera* Tressler 1937	PAC[3]	long	LV>RV	0.70	0.36			
S	*Cypridopsis howei* Ferguson 1964	NA[2,4]	intermediate	?	0.58	0.39		similar	similar
S	*Cypridopsis echinatalva* Wise 1961	NA[2]	short	LV>RV	0.61	0.34		0.60	0.32
P	*Cypridopsis elongata* (Kaufmann 1900)	PA[2]	long	LV>RV	0.62	0.33	0.39		
P	*Cypridopsis hartwigi* G.W. Müller 1900	PA[2]	long	LV>RV	0.82	0.46			
P	*Cypridopsis lusatica* Schäfer 1943	PA[2]	intermediate	LV>RV	0.64	0.33	0.33		
S	*Cypridopsis musquizensis* Tressler 1954	NA[2]	long	?	0.70	0.44		0.62	0.41
S	*Cypridopsis schwartzi* n. sp.	This study[2]	long	LV>RV	0.70	0.46	0.48	0.68	0.44
S	*Cypridopsis phantomensis* Tressler 1954	NA[2]	long	?				0.68	0.44
P	*Cypridopsis potamis* Tressler 1954	NA[2]	long	LV>RV	0.60	0.40			
P	*Cypridopsis toyensis* Tressler 1954	NA[2]	intermediate	LV>RV	0.61	0.34			
P	*Cypridopsis vidua* (O.F. Müller 1776)	Cosmopolitan	long	LV>RV	0.60	0.32	0.34		

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