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The genus *Erechthias* Meyrick of Ascension Island, including discovery of a new brachypterous species (Lepidoptera, Tineidae)

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Abstract

One previously named and two new species of the tineid genus *Erechthias* Meyrick are described and illustrated from the small, remote, mid-Atlantic Ascension Island. With these additions the Lepidoptera fauna of Ascension now totals 38 known species. Little is known regarding the biology of the two new species of *Erechthias*, and none of the species has been reared from larvae from Ascension. *Erechthias minuscula* (Walsingham) is a widespread, largely pantropical species first described from the West Indies. Larvae of *E. minuscula* are known to be scavengers on a wide variety of dead plant material. *Erechthias ascensionae*, new species, is one of two species of *Erechthias* now known to be endemic to the island. The other endemic species, *Erechthias grayi*, new species, is further remarkable in having wing reduction occurring in both sexes. It is one of the few species of Lepidoptera known where this extreme of brachyptery involving both sexes has evolved. The larvae of *E. grayi* are believed to be lichenivorous, and larval cases suspected to represent this species are illustrated.

Keywords

Brachyptery, distribution, genital morphology, larval case

Introduction

Ascension is a small, remote, tropical, volcanic island located in the middle of the Atlantic Ocean (Fig. 1), on the Mid-Atlantic Ridge. At 7°57'S and 14°22'W, it is some 1500 km from Africa and 2000 km from South America. The nearest land is St Helena, another small, volcanic island, 1300 km to the south-east. Ascension Island comprises about 98 sq km of volcanic deposit, with a maximum elevation above sea level of 860 m.

According to Chase and Manning (1972) Ascension Island arose during either the Pliocene or Pleistocene. The most recent phase of volcanism may have occurred less than 1000 years ago (Packard 1983). The oldest rocks above sea level date to only about one million years ago, and Ashmole and Ashmole (2000) estimate this to be the age of the island. This appears to be the comparatively short time frame within which evolutionary processes have been able to work on the island's colonists. A detailed treatment of the geology of Ascension is provided by Weaver (1999).

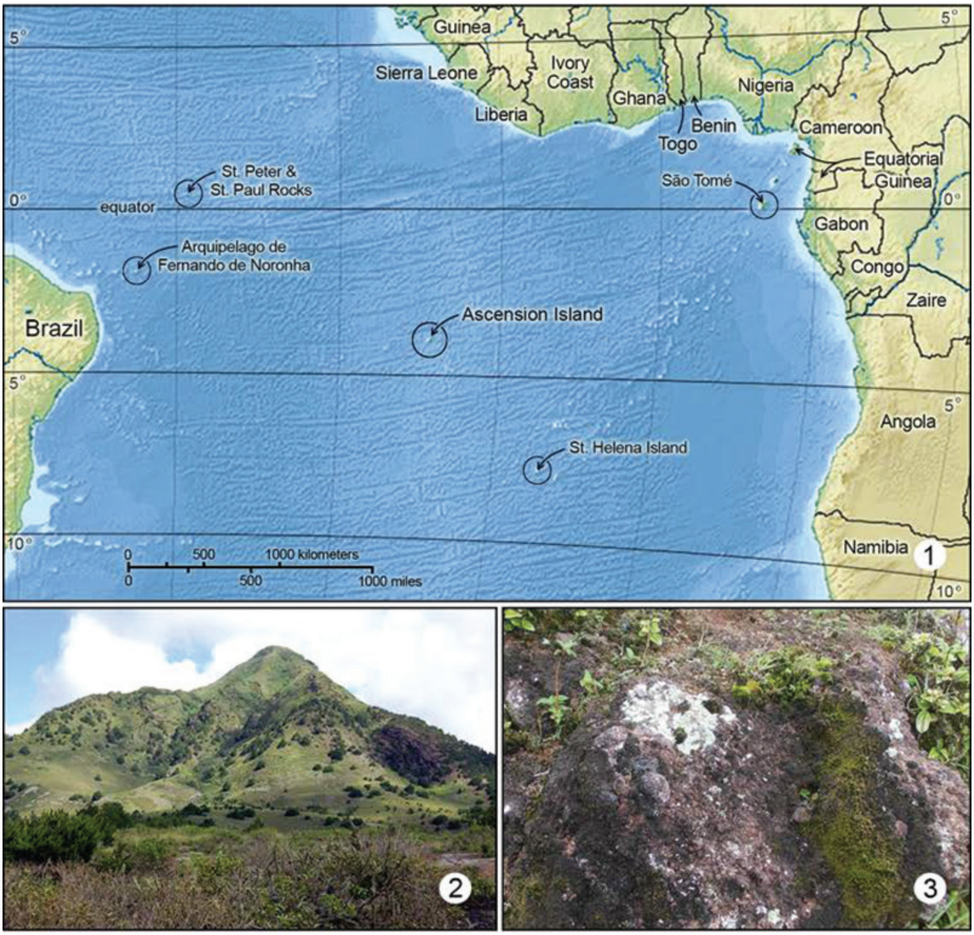
The island of Ascension was discovered on Ascension Day in 1501 by the Portuguese explorer and sea captain João da Nova, but there was no settled population for another three centuries, probably because of the lack of permanent fresh water. Settlement began in 1815 when the British established a garrison to prevent the French navy using the island in any attempt to free Napoleon Bonaparte from St Helena, where he had been exiled after the Battle of Waterloo. Napoleon never escaped and died on St. Helena in 1821.

The climate is tropical but the oceanic position of the island and the influence of the south-east trade winds are huge modifying influences. Although Green Mountain (Fig. 2) rises to a mere 860 m, it is cool, damp, windy, and frequently shrouded in mist and capped with cloud. It is indeed green compared with most of the island, where the vegetation is sparse and near-desert conditions prevail. However, the vegetation we see today across the island has been highly modified by deliberate and accidental introductions, and the impact of introduced animals such as goats, sheep and donkeys. Surviving areas of near natural vegetation are mostly difficult to access.

For this brief introduction, we have principally relied on information from Duffey (1964), Robinson and Kirke (1990), Disney (1991) and Ashmole and Ashmole (2000).

Robinson and Kirke (1990), who reviewed the Lepidoptera fauna of Ascension Island, concluded that it was 'remarkable only for its impoverishment, consisting of a small range of pantropical and pest species'. They recorded a total of 37 species, and with the possible exception of two species of Tineidae, a *Eudarcia* sp. and an *Erechthias* sp., they found no endemism. Most of the Lepidoptera they studied appeared to have originated from the Afrotropical and Mediterranean regions, either by introduction or immigration.

Erechthias is the largest, most diverse genus within the tineid subfamily Erechthiinae. Approximately 120 described species of *Erechthias* have been reported, with almost as many still undescribed (Robinson and Nielsen 1993). The great majority of the species are Old World in distribution. In the present study we describe and il-



Figures 1–3. 1 Map of mid Atlantic Ocean. Ascension Island habitats: **2** Green Mountain **3** Typical habitat of *Erechthias grayi*; Lichen covered rocks on Green Mountain.

lustrate the one previously named (*E. minuscula*) and one unnamed (*E. ascensionae*) species of *Erechthias* that Robinson (2009) reported from Ascension Island. *Erechthias minuscula* (Walsingham) is a widespread, largely pantropical species first described from the West Indies. *Erechthias ascensionae*, new species, is one of two species of *Erechthias* known to be endemic to the island. As Robinson (2009) had suspected, this species appears morphologically most similar to *Erechthias dracaenura* (Meyrick), described from one of the nearest islands to Ascension, São Tomé, which is located off the western coast of central Africa in the Gulf of Guinea. We also report the discovery of a brachypterous species, *Erechthias grayi*, new species, which is further remarkable in having wing reduction occurring in both sexes. This species was mentioned by Robinson (2009) in his brief review of the Ascension Island Tineidae, but he was uncertain of its generic and subfamily affinities.

Material

Specimens examined in this study are deposited in the following institutions.

BMNH Natural History Museum, formerly British Museum (Natural History), London, United Kingdom.

USNM Collections of the former United States National Museum, now deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA.

Methods

Specimen preparation

Genitalic dissections were cleared by heating in 10% KOH for ~ 30 minutes, and subsequently cleaned and stained with either 2% chlorazol black E or mercurochrome solutions. The genitalia were then mounted on slides using Canada balsam or euparal mounting media. Genitalic terminology follows Klots (1970).

Systematic account

***Erechthias* Meyrick**
http://species-id.net/wiki/Erechthias

Erechthias Meyrick, 1880: 252, 261. Type species: *Erechthias charadrota* Meyrick 1880: 268 by subsequent designation by Meyrick 1915: 233. [New Zealand].

Ereunetis Meyrick, 1880: 252, 258. Type species: *Ereunetis iuloptera* Meyrick 1880: 258, 260, by subsequent designation by Walsingham 1914: 347. [Australia].

Decadarchis Meyrick, 1886: 290. Type species: *Decadarchis melanastra* Meyrick 1886: 291, by monotypy. [Fiji].

Hactacma Meyrick, 1915: 233. Type species: *Erechthias chasmatias* Meyrick 1880: 263, 264, by original designation. [New Zealand].

Nesoxena Meyrick, 1929: 506. Type species: *Nesoxena strangulata* Meyrick 1929: 507. [Tuamotu Archipelago].

Amphisyncentris Meyrick, 1933: 412. Type species: *Amphisyncentris glyphidaula* Meyrick 1933: 412, by monotypy. [Fiji].

Gonglyodes Turner, 1933: 180. Type species: *Gonglyodes centroscia* Turner 1933: 180, by monotypy. [Australia].

Caryolestis Meyrick, 1934: 109. Type species: *Caryolestis praedatrix* Meyrick 1934: 110, by monotypy. [Tahiti].

Triadogona Meyrick, 1937: 153. Type species: *Triadogona amphileucota* Meyrick 1937: 153, by monotypy. [Fiji].

Anemerarcha Meyrick, 1937: 154. Type species: *Anemerarcha entomaula* Meyrick 1937: 154, by monotypy. [Fiji].

Empaesta Bradley, 1956: 163. Type species: *Tinea capnitis* Turner 1918: 288, by original designation. [Norfolk Island].

Tinexotaxa Gozmány, 1968: 306. Type species: *Tinexotaxa travestita* Gozmány 1968: 306, by original designation. [Sierra Leone].

Acrocenotes Diakonoff, [1968]: 259, 262. Type species: *Acrocenotes niphochrysa* Diakonoff [1968]: 257, 262, by original designation. [Philippines].

Neodecadarchis Zimmermann, 1978: 264, 341. Type species: *Ereunetis flavistriata* Walsingham 1907: 716, by original designation. [Hawaii].

Lepidobregma Zimmermann, 1978: 264, 351. Type species: *Ereunetis minuscula* Walsingham 1897: 155, by original designation. [West Indies].

Pantheus Zimmermann, 1978: 264, 353. Type species: *Ereunetis pencillata* Swezey, 1909: 13, by original designation. [Hawaii].

Adult. *Head* (Figs 12–15): Frons with scales moderately broad, either mostly appressed or partially raised, sometimes with weak scale tufts arising from ventro-lateral margin; pilifers present, with numerous, short bristles; vertex with prominent occipital and lateral tufts and scales more slender; Eye of medium size; frons broad; interocular index (Davis 1975) 0.7–1.2. Antenna extending ~ 0.7–1.0× length of forewing; scape with prominent pectin of ~10–14 bristles (Fig. 13); intercalary sclerite well sclerotized; flagellomeres with a single annulus of appressed, narrow scales; antennal cilia short in both sexes. Maxillary palpus as long as or usually slightly longer than labial palpus, 5-segmented, with length ratio of segments from base: 1.0: 0.5: 1.7–2.75: 5.5–8.7: 2-3.6. Haustellum moderately developed, ~ 0.6–1.0× length of labial palpus. Labial palpus well developed, length ratios from base: 1.0: 1.3–2.5: 1.0–1.4; segment 2 sometimes broad at base, with a prominent ventral brush of elongate, slender scales; a series of 5-16 long whitish to black bristles arising mostly laterally; 1-3 long, lateral bristles also usually present on basal segment.

Thorax: Wings (Figs 16–18) relatively narrow; forewing L/W index: 0.23–0.27; hindwing L/W index: 0.24–0.32. Forewing with Sc and R present in all species, Rs usually with 3–4 branches, reduced to one branch in *Erechthias grayi*; Rs4 and M1 rarely stalked; accessory cell usually absent, sometimes with a trace of chorda; M with 2 branches (M1 and M2+3), with M fused with Cu in *E. grayi*; base of M usually absent or vestigial in cell; Cu with 2 branches (fused with M in *E. grayi*); CuP usually weak; A3 vestigial; retinaculum in male on underside of subcoasta; triangular, with a rolled apex. Hindwing with Sc and R fused; Rs usually present but incomplete, unbranched; M usually 3-branched, sometimes with M1and 2 fused; Cu 2-branced; A3 usually present; frenulum with single large spine in male, 1-3 spines in female. Legs unmodified; foretibia with epiphysis arising near distal third of tibia; midtibia with a single pair of spurs of unequal length arising near apex; hindtibia with 2 pairs of spurs of unequal lengths arising near basal third of tibia and near apex.

Abdomen: Apodemes slender, slightly convergent, or short, basally broad and nearly triangular. Segment A8 with male coremata present or absent; female corethrogyne absent.

Male genitalia: Segment A10 mostly membranous, often setose and melanized laterally; apex of uncus variably bilobed. Tegumen a narrow dorsal ring, poorly differentiated from vinculum; vinculum with a well developed, usually broadly rounded, triangular saccus. Valva usually simple, rarely with lobes or processes, usually broad, and often with a dense concentration of thick, costal spines; costal apodemes usually well developed. Gnathos absent. Juxta highly modified, forming sclerotized pouch of variable depth between bases of valvae and articulating with costal apodemes of valvae. Aedeagus typically in the form of a simple cylinder, with a slightly swollen base in some species; vesica sometimes lined with minute spicules, or with 1–2 much larger, spine-like cornuti.

Female genitalia: Ovipositor short to moderately long, 0.05–0.50× length of abdomen; posterior ventral apophyses not developed; posterior (dorsal) apophyses 1.5–2.7× length of anterior apophyses. Eighth tergite often narrowly rectangular, with a few terminal setae; eighth sternum connected to anterior apophyses by ventral rami. Bursa copulatrix 0.5–1.9× length of abdomen. Antrum relatively slender, often narrowly funnel-shaped or sometimes in the form of an incomplete ring; junction with ductus seminalis immediately anterior to antrum. Ductus bursae slender, with or without coarse microtrichia lining interior. Corpus bursae membranous, ovate to pyriform, often with a single small signum with the more slender, rodlike end projecting free from exterior wall of corpus bursae; signum sometimes can be stellate, blade-shaped, in the shape of a small ridged plate, or absent.

Key to species of *Erechthias* occurring on Ascension Island

1	Adult brachypterous; forewing less than 2 mm long; hindwing nearly absent, less than 0.2 mm long (Fig. 18) .... ***grayi***
–	Adult fully winged; forewing more than 3 mm long; hindwing not reduced ... **2**
2	Apex of forewing not turned sharply upwards; color pale whitish cream heavily irrorated with dark brown scales (Fig. 5) .... ***ascensionae***
–	Apex of forewing sharply upturned; color pale whitish cream, variably irrorated or streaked with medium to dark brown scales (Fig. 4) .... ***minuscula***

Erechthias minuscula **(Walsingham)**

http://species-id.net/wiki/Erechthias_minuscula

Figs 4, 12–14, 16, 19–23

Ereunetis minuscula Walsingham, 1897: 155; 1907: 716.- Swezey 1909: 12.- Busck 1911: 80.- Swezey 1912:155.- Walsingham 1914 [1909–1915]: 347.- Wolcott

1923: 205.- Swezey 1929: 281.- Forbes 1930: 147.- Wolcott 1936: 501.- Swezey 1940: 458.- Wolcott 1948: 739.- Beardsley 1961: 354.

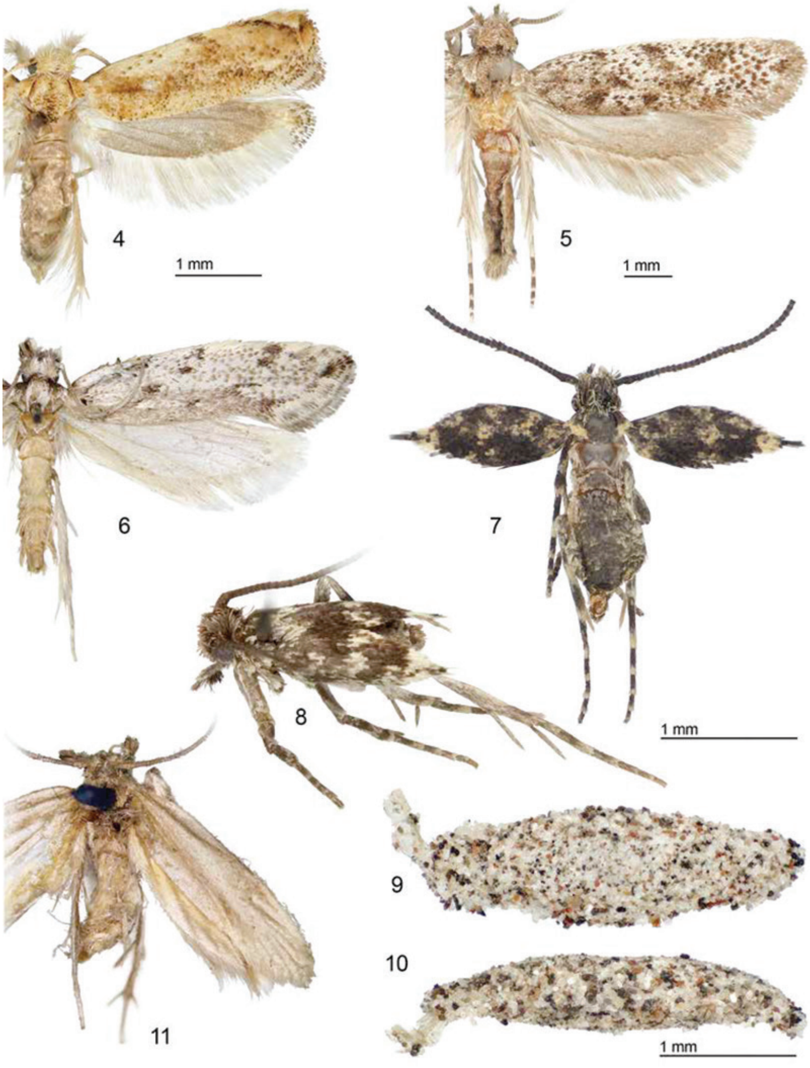
Decadarchis minuscula (Walsingham).- Meyrick 1929: 505.- Harris 1937: 486.- Ghesquière 1940: 86.- Vesey-Fitzgerald 1941: 158.- Lepesme 1947: 318.- Viette 1949: 316.- Swezey 1942: 215.- Davis 1953: 85.- Swezey 1952: 378.- Diakonoff 1968: 265, 308.- Clarke 1971: 211; 1986: 361.- Zimmermann 1978: 352.

Lepidobregma minuscula (Walsingham).- Zimmermann 1978: 352.- Davis 1983: 5.- Robinson and Nielsen 1993: 289.

Erechthias minuscula (Walsingham).- Davis 1984: 21.- Robinson and Kirke 1990: 133.- Robinson 2009: 20–25, 51, fig. 36.- Robinson and Nielsen 1993: 295, 310.- Heppner 2003: 236.

Adult (Fig. 4). *Head*: Scales of frons shiny whitish cream, moderately broad with 3-4-dentate apices, flatly appressed to frons with apices directed dorsad; a pair of scale tufts consisting of very slender, elongate scales arising from lower corners of frons. Vertex with a prominent pair of lateral, occipital tufts composed of very elongate, piliform, pale cream scales with minutely bidentate scales. Labial palpus with apical segment mostly smoothly scaled; scales of segment 2 flat, strongly appressed dorsally, shiny white to whitish cream; venter of segment 2 with a dense brush of long, slender, erect, whitish (rarely suffused with dark brown) scales with minutely bidentate apices, and a lateral series of ~ 13–16 long, whitish bristles sometimes with dark apices. Antenna ~ 2/3 as long as forewing; scales smoothly appressed, uniformly pale cream except for scales with dark brown apices along anterior edge and sometimes venter of flagellum; scape mostly pale cream irrorated with dark brown scales along anterior edge; pectin well developed, consisting of a longitudinal row of 12–14 long dark setae; scales of scape and pedicel moderately broad; flagellum with a single row of more slender scales completely encircling each segment; short cilia usually not evident but often visible between scales.

Thorax: Forewing length 3.5–4.0 mm (wing apex not extended) – 5.0 mm (wing apex fully extended). Dorsum and tegula pale cream, usually with suffusion of light brown medially; apices of light brown scales often with dark brown apices giving a mottle appearance to dorsum; thorax whitish cream ventrally. Forewing predominantly pale whitish cream, variably irrorated or streaked with medium to dark brown scales; a medium to dark brown, variously interrupted streak usually extending from wing base almost to tornus (completely lacking in some specimens); costal margin often with small concentrations of dark brown scales present near base of forewing, near distal 2/3, distal 4/5 and at apex; those markings near apex sometimes forming short striae; a pale whitish cream patch of scales along margin between spot at distal 4/5 and apex; apex of forewing bent abruptly dorsad; fringe white to pale cream, variably banded at apex with 1–2 slender bands of dark brown scales; most of ventral surfaces of fore and hindwings (except for whitish cream fringes) medium to dark brown. Hindwing uniformly pale grayish brown; fringe mostly concolorous except for 2-3 narrow bands of dark brown scales around apex. Frenulum a single long spine in male and female.

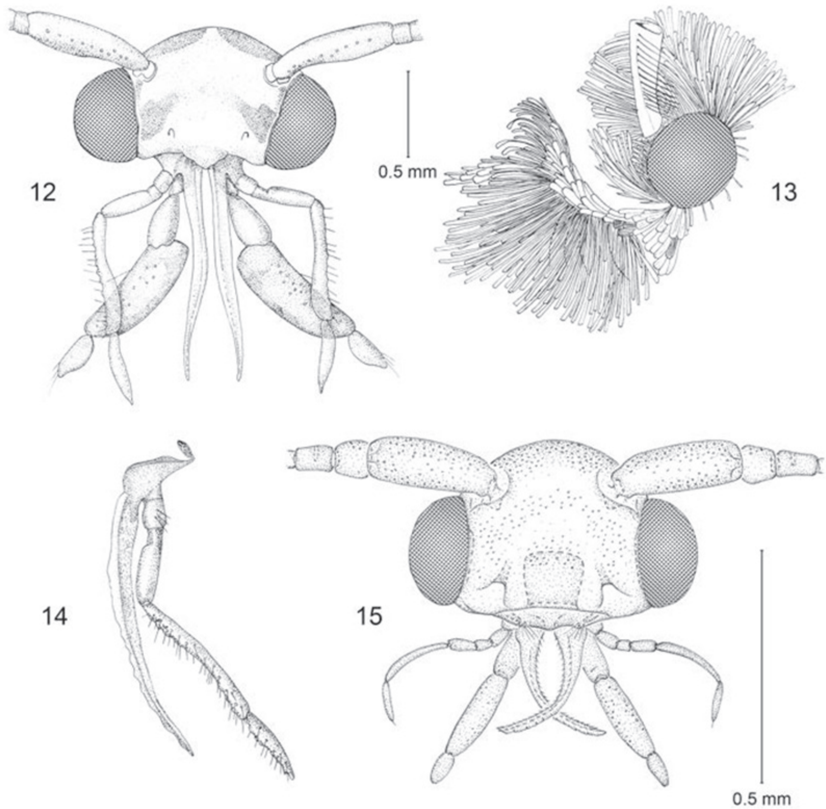


Figures 4–11. Adults and larval cases **4** ♂, *Erechthias minuscula*, (forewing length 4 mm), Florida, USA **5** ♂, *Erechthias ascensionae*, (forewing length 6.8 mm), Ascension Island **6** ♂, *E. dracaenura* (forewing length 8 mm), São Tomé **7, 8** ♂, *E. grayi* (forewing length 1.7 mm), Ascension Island **9** (dorsal) **10** (lateral) Larval cases *E.* sp. *grayi* ? (length 4.2 mm), Ascension Island **11** ♂, *E. darwini* (forewing length 6 mm), St. Paul's Rocks.

Fore and midlegs mostly pale to dark brown dorsally and pale cream ventrally with pale to dark brown banding on tibia and tarsomeres; hind leg generally paler, almost entirely pale cream in color.

Abdomen: Mostly pale golden brown dorsally, whitish cream ventrally. Eighth segment without coremata.

Male genitalia (Figs 19–21): Segment 10 mostly membranous, moderately sclerotized to form 2 elongate lateral lobes, with caudal margin superficially bifid. Tegu-



Figures 12–15. Adult head structure. **12–14** *Erechthias minuscula* **12** (anterior view) **13** (lateral view) **14** (maxilla) **15** *Erechthias grayi* (anterior view).

men a relatively narrow dorsal ring. Vinculum slender, narrowly V-shaped, elongate, ~ 0.8× the length of valva. Valva simple; cucullus broad with broadly rounded apex; costal margin densely setose, with setae concentrated near base of costa and less so at apex of valva. Juxta well developed as an elongate U-shaped pouch. Aedeagus a slender, simple cylinder, ~ 1.6× length of valva; vesica lined with numerous, minute spicules and with a single large, apical cornutus, sometimes closely accompanied with a shorter cornutus ~ half the length of the larger one.

Female genitalia (Fig. 22, 23): Eighth sternite weakly sclerotized; ostium opening near anterior margin, with a pair of moderately short setae on either side of ostium. Antrum reduced, triangular; length ~ equal to maximum width. Ductus bursae very slender and elongate; length ~ 1.7× that of posterior apophyses, ductus gradually enlarging to relatively small, ovate corpus bursae; walls of corpus bursae membranous except for a very small, elongate, triangular signum; distal, more slender half of signum projecting beyond wall of corpus bursae.

Lectotype. ♂ (present designation), WEST INDIES: Type H.T.; St. Thomas, Danish West Indies, 17 March 1894, Hedemann 7084; BM genitalia slide No. 4177;

Walsingham Collection 1910-427; *Ereunetis minuscula* Wlsm., P.Z.S. p. 155 (1897), Type ♂; (BMNH).

Material examined. ASCENSION ISLAND: Green Mountain: 4 ♂, 17–26 June 1988, C.M.StG Kirke, BM 1988-311, ♂ slide 29708, (BMNH).

Distribution. (Fig. 1). *Erechthias minuscula* is probably pantropical in distribution, and occurs widely in South America, the West Indies into southern Florida, USA. Robinson and Nielsen (1993) also report it from Australia.

Biology. Larvae of *E. minuscula* are scavengers on a wide variety of dead plant material and have been reported feeding on or within dead tree trunks, stems, seed pods, fruits, flowers, and leaves (Heppner 2003: 236).

Erechthias ascensionae **sp. n.**

http://zoobank.org/2FEB95B4-F5DA-4C6D-B10A-A602725E862F
http://species-id.net/wiki/Erechthias_ascensionae
Figs 5, 17, 24, 25

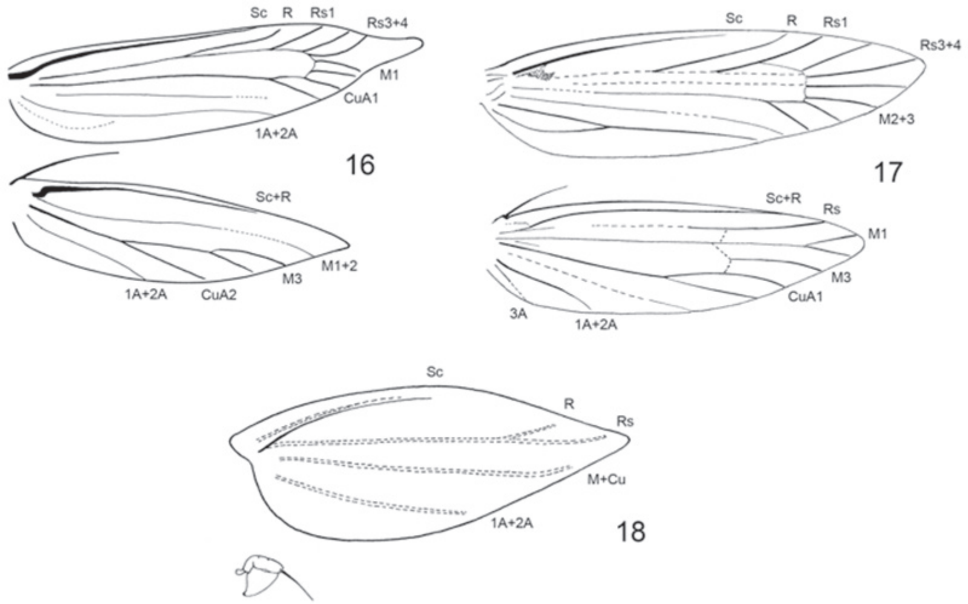
Ereunetis species.- Robinson and Kirke 1990: 133.- Robinson 2009: 51.

Diagnosis. Female unknown.

Adult (Fig. 5). *Head*: Scales very slender with bidentate apices; scales of frons partially raised and directed forward, light brown strongly irrorated with dull white; scales of vertex erect or mostly so, especially over occipital tufts, and mostly directed forward; color similar to frons with most scales with dull white apices,. Labial palpus with scales slightly appressed dorsally, mostly dull white with light brown bases to scales; venter of labial palpus with a dense brush of long, slender, erect, brown scales usually with white apices, and a lateral series of ~ 5-7 long, dark bristles; 2–3 bristles also arising laterally from basal segment. Antenna nearly as long as forewing; scales smoothly appressed, dark brown dorsally, paler, more white ventrally; scape dark brown irrorated with white scales and with a row of white scales bordering distal margin; scales of scape and pedicel moderately broad; flagellum without cilia and with a single row of more slender scales completely encircling each segment.

Thorax: Forewing (Fig. 17) length 5–6 mm. Dorsum and tegula similar to head in color but with broader scales; thorax mostly pale cream ventrally. Forewing predominantly pale whitish cream, irrorated with scattered dark brown scales; 2–3 small patches of dark brown scales usually present on basal half of forewing along costal and dorsal margins and 2 patches within discal cell; fringe mostly light brown irrorated with dull white. Hindwing and fringe uniformly pale grayish brown; frenulum a single stout spine in male, not examined in female; M1 and 2 stalked ~ 0.6 their length. Fore and midlegs mostly light grayish brown dorsally and whitish cream ventrally with prominent dark brown banding on tibia and tarsomeres; hindleg generally paler in color.

Abdomen: Pale grayish brown dorsally, whitish cream ventrally. Eighth segment without coremata.



Figures 16–18. Wing venation **16** *Erechthias minuscula* **17** *Erechthias ascensionae* **18** *Erechthias grayi*.

Male genitalia (Figs 24, 25): Segment 10 mostly sclerotized, fused to tegumen; uncus lobes minute, with caudal margin bifid. Tegumen a relatively narrow dorsal ring, with extended medium lobe fused to uncus. Vinculum broad, U-shaped, anterior margin broadly rounded, ~ 0.7× the length of valva. Valva simple; cucullus broad with rounded apex; costal margin densely setose. Juxta well developed as an elongate U-shaped pouch. Aedeagus slender, nearly as long as valva; vesica with numerous, minute spiculiform cornuti; base of aedeagus relatively deeply divided.

Female unknown.

Etymology. The species name is derived from the genitive case of the type locality (Ascension).

Holotype. ♂, ASCENSION ISLAND: [Specific locality unknown] 4 Sept. 1958, E.A.G. Duffey, B.M. 1958-760, digital image captured, (BMNH).

Paratypes. ASCENSION ISLAND: Same data as holotype: 6 ♂, BMNH genitalia slide ♂, 5854, BMNH wing slide 30835, (BMNH, NMNH).

Distribution (Fig. 1). Ascension Island.

Biology. Unknown; larvae are most likely plant detritvores or lichenivorous.

Remarks. The species nearest to *E ascensionae*, both morphologically and geographically, is *Erechthias dracaenura* (Meyrick), which is known only from São Tomé, an island located off the western coast of central Africa in the Gulf of Guinea (Fig. 1). The forewing patterns of both species are similar (Figs 5, 6) in possessing a whitish background color irrorated with isolated brown scales and marked with 6–8 scattered, moderately large, darker brown to black spots. The forewings of *E. dracaenura* generally appear more whitish and less heavily marked than those of *ascensionae*. The male genitalia of *E. ascensionae* (Figs 24–25) differ from that of *dracaenura* (Figs 26–27) in the apex of cucullus being more slender and in possessing a more elongate, tapered uncus.

Erechthias grayi **sp. n.**
http://zoobank.org/06C8414F-FC41-4DD7-BAB9-CCA4F5B3BC83
http://species-id.net/wiki/Erechthias_grayi
Figs 7–10, 18, 28–31

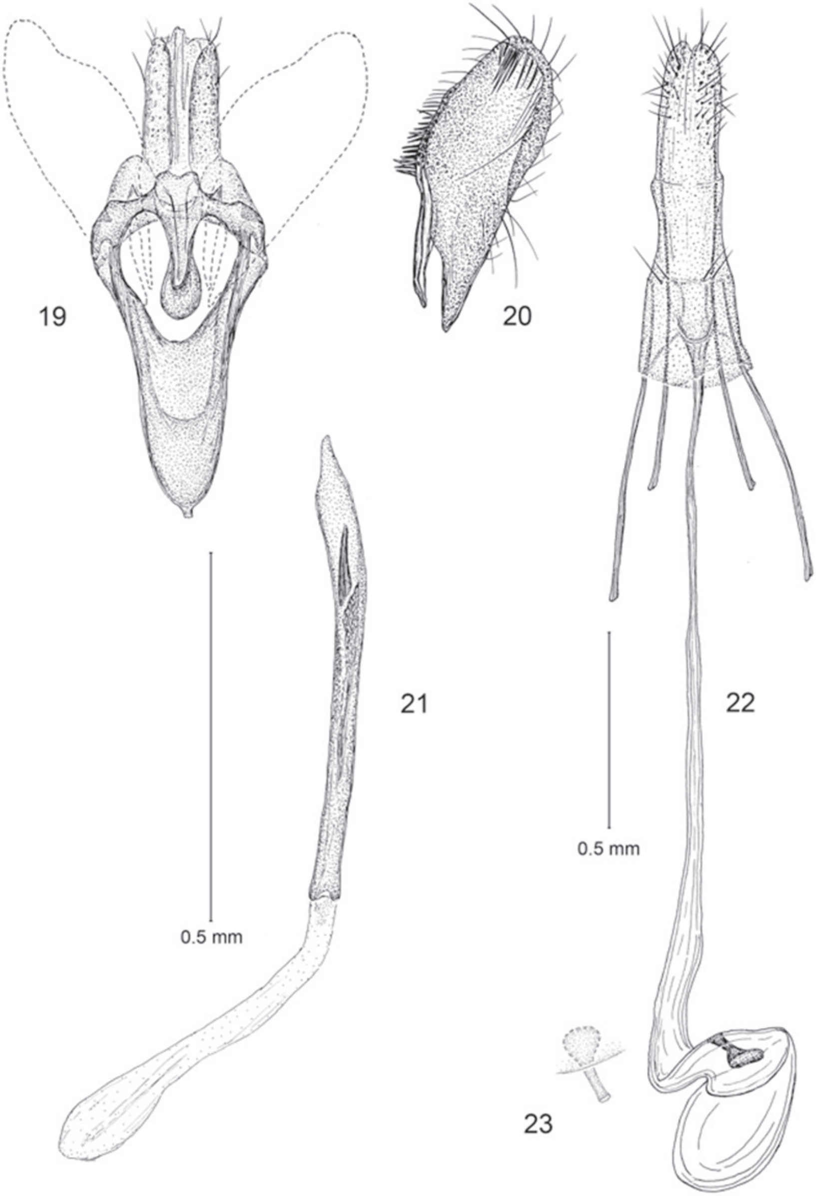
Diagnosis. Adult (Figs 7, 8). *Head*: Scales generally slender with bidentate apices; scales of frons smooth, appressed, directed dorsad, pale brown to gray on lower frons becoming dull white to pale gray at top of frons; scales of vertex erect or mostly so, especially over occipital tufts, fuscous, some with grayish white apices. Labial palpus with scales flattened and appressed dorsally, mostly dark grayish brown with scattered paler scales; venter of second segment with a dark brush of long, slender, erect scales and a lateral series of ~ 6-8 long, dark bristles; 1–2 bristles also arising laterally from basal segment. Maxillary palpus elongate, 5-segmented, approximately as long as labial palpus. Antenna ~ 1.6× the length of forewing; scales smoothly appressed, dark fuscous; scales of scape and pedicel moderately broad; flagellum without cilia and with a single row of more slender scales completely encircling each segment.

Thorax: Forewing brachypterous (Fig. 18), length 1.4–1.8 mm. Dorsum of thorax dark fuscous dorsally, with a few dull white scales at caudal margins of tegula and mesonotum; mostly grayish white ventrally. Forewing similar to dorsum in color, dark fuscous with an irregular scattering of dull white scales at base of wing and mostly crossing wing beyond middle; a slightly larger concentration of dull white scales at apex and extending a short distance along costa; fringe almost completely lacking, restricted to apex. Hindwing minute (Fig. 18), slightly variable in size, without scales; length ~ 0.15 mm; a single stout frenulum present in male ~ equal to length of hindwing (frenulum not examined in female); fringe absent. Fore and midlegs fuscous, lightly irrorated with pale grayish white scales; apices of tibia and tarsomeres ringed with grayish white; hindleg generally paler in color.

Abdomen: Dark fuscous dorsally, mostly grayish white ventrally. Eighth segment without coremata.

Male genitalia (Figs 28, 29): Segment 10 mostly membranous; uncus lobes indistinct, broadly rounded. Tegumen consisting of a relatively narrow dorsal ring. Vinculum broad, V-shaped, gradually tapering anteriorly with an acute anterior apex; vinculum ~ 0.7× the length of valva. Valva simple; cucullus broadly triangular with narrowly rounded apex; costal margin densely setose. Juxta well developed as an elongate U-shaped pouch. Aedeagus slender, ~ 1.3× length of valva; vesica with numerous, minute, spicular cornuti; base of aedeagus moderately flared, not divided.

Female genitalia (Figs 30, 31): Eighth sternite weakly sclerotized; ostium opening near anterior margin; an irregular cluster of ~ 5 pairs of long setae encircling caudal



Figures 19–23. *Erechthias minuscula*, genitalia **19** Male, ventral view **20** Valva, mesal view **21** Aedeagus, ventral view **22** Female, ventral view **23** Detail of signum in Fig. **22**.

margin of eighth segment. Antrum slender, length ~ 3× maximum width. Ductus bursae slender, elongate, slightly longer than anterior apophysis, gradually enlarging to moderately large, ovate corpus bursae; walls of corpus bursae membranous except for very small, elongate signum; distal, more slender half of signum projecting beyond wall of corpus bursae.

Etymology. The species name is a patronym for Alan Gray, a botanist who assisted Howard Mendel with the collection of this species on Ascension Island.

Holotype. ♂, ASCENSION ISLAND: Green Mountain, 743 m, Elliot's Path, (Windy Corner), GPS 7.57S. 14.21W: 6 Aug. 2003, H. Mendel, BMNH(E) 2003-137, digital image captured (BMNH).

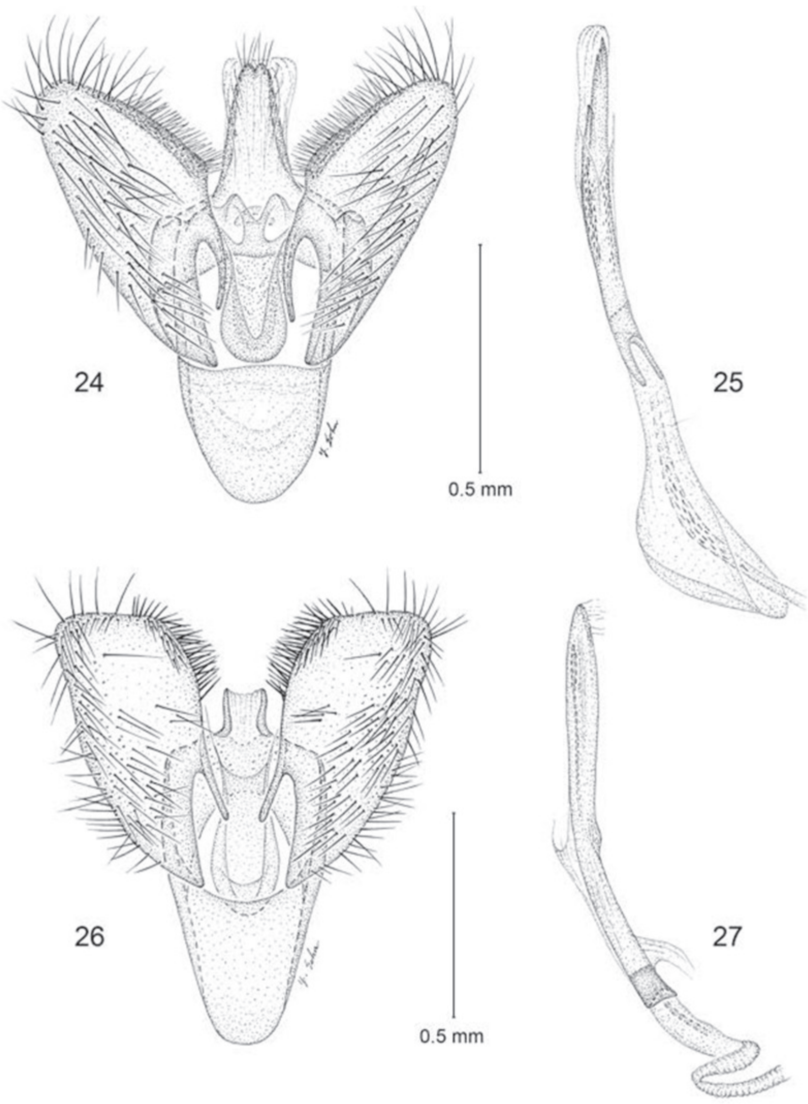
Paratypes. ASCENSION ISLAND: same locality as holotype: 11 ♂, 1 ♀, 13 Dec. 2005, H. Mendel, BMNH slide 33642♀, BMNH(E) 2006-13; 4 ♂, 21 Nov. 2012, H. Mendel and A. Gray, USNM slide 34532♂. ASCENSION ISLAND: White Horse Hill [Little White Hill], S. E. Bay: 2 ♂, 23 Aug. 2012; [pitfall trap]; Ms L. White, USNM slide 34533♂. White Horse Rock [Little White Hill, S. E. Bay]: 2 ♂, 29 May 2013; running over lichen covered rock; pooter; leg. A. Wakeham-Dawson; digital image captured. (BMNH, USNM).

Distribution (Fig. 1). Ascension Island. *Erechthias grayi* was at first thought to be confined to the higher elevations of Green Mountain where it was found on several occasions at altitudes around 743 m, in a very moist area frequently shrouded in cloud. Recent captures at Little White Hill, an extremely arid area at altitudes below 200 m show that *E. grayi* is tolerant of a wide range of conditions. What the two areas do have in common is that the vegetation and habitat are comparatively undisturbed. Probably, *E grayi* would have been more widespread on Ascension prior to human habitation and the disturbances accompanying human settlement.

Biology. Because adults have been collected in close association with lichen covered rocks, it is likely the larvae are lichenivorous, a frequently used food source in this group of moths. Several (13) small (3.5–4.2 mm long) mature larval cases, some with pupal exuviae attached (Figs 9, 10), were collected under lichen covered rocks at White Horse Hill, on the same day that an adult was collected there by A. Wakeham-Dawson. It is likely that these are the larval cases of *E. grayi*, but larval rearings will need to be conducted to confirm this. The cases are mostly white, speckled with small grains of sand and minute, dark fragments from the rocky substrate.

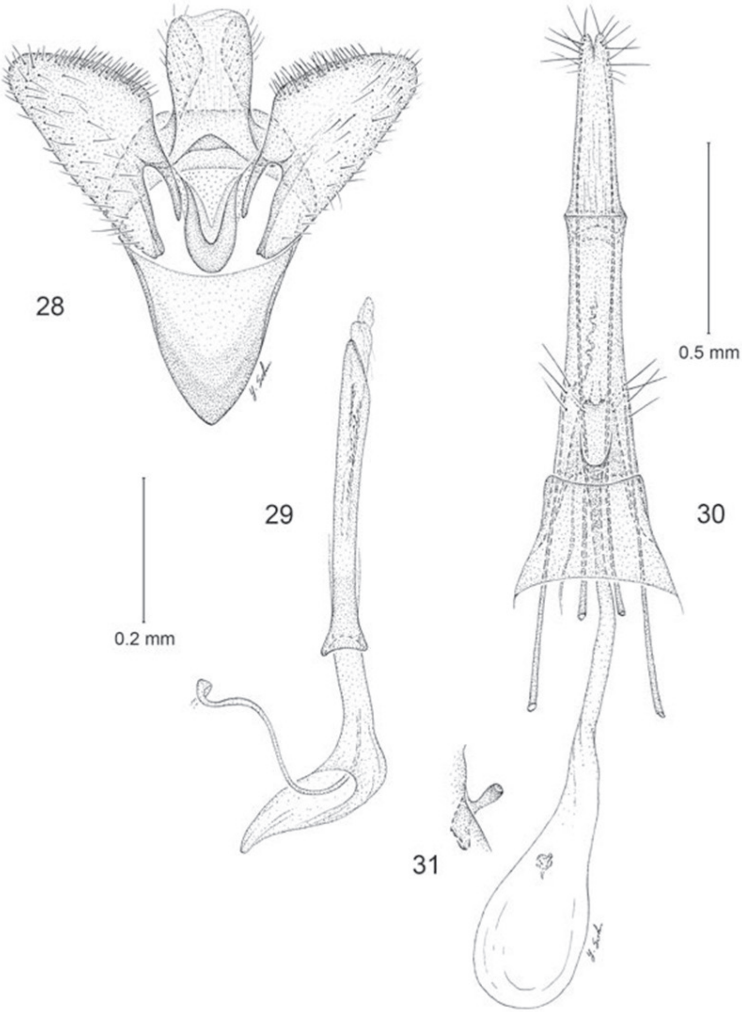
The behavior of the moths in the field was unusual. They would cling firmly to the bare rock, lichens (Fig. 3), and small plants in exposed situations and were only seen to move when disturbed, and then reluctantly. They would hop a few inches in a very bug-like (Heteroptera) manner and were most easily collected using an aspirator (pooter). Wakeham-Dawson (see paratype data) observed adults running over a lichen covered rock at White Horse Hill.

Remarks. *Erechthias grayi* is the only species within this large genus known to possess brachypterous adults, and thus is the most distinctive moth within *Erechthias.* The male and female genitalia of *E grayi* are most similar to those of *E. darwini* Robinson (1983), one of the few species of Lepidoptera known to inhabit St. Paul's Rocks (Pedro e São Paulo, Fig. 1), located slightly over 1000 miles northeast of Ascension Island. The male saccus of *E grayi* is more triangular and the female signum is more slender than those of *E. darwini.* Most significantly, the adults of *E. darwini* (Fig. 11) are fully winged and capable of flight. However, considering their genitalic similarities and geographical proximity, it is possible that *grayi* may have shared relatively recent common ancestry with *darwini*.



Figures 24–27. Male genitalia **24–25** *Erechthias ascensionae*, ventral view **25** Aedeagus, lateral view **26–27** *Erechthias dracaenura*, ventral view **27** Aedeagus, lateral view.

Reportedly, some form of wing reduction has occurred in either 25 (Sattler 1991) or as many as 35 families (Heppner 1991) of Lepidoptera. The two family totals quoted probably differ because Sattler did not include species displaying only slight wing dimorphism, and also because of some differences in the family classification followed by each author. Because of rather obvious reasons involving different selective pressures and flight requirements that exist between the sexes, wing reduction has rarely evolved in male Lepidoptera. Most species that have developed wing reduction in both sexes occur on small oceanic islands or in restricted coastal habitats (Sattler 1991,



Figures 28–31. *Erechthias grayi*, genitalia **28** Male, ventral view (1 mm) **29** Aedeagus**,** ventral view **30** Female, ventral view **31** Detail of signum in Fig. **30**.

Heppner 1991, 2010, Wagner and Liebherr 1992). Although several ecological and environmental factors can lead to a loss of flight among insects, the effect of continuous strong winds such as occur on isolated islands have long been considered a primary reason for wing reductions, particularly in Lepidoptera males (Sattler 1991, Wagner and Liebherr 1992). Previously, eight species representing five genera of Tineidae had been reported to exhibit some form of wing reduction, with four species (including three species of *Pringleophaga* Enderlein and one of *Proerodesma* Meyrick) being brachypterous in both sexes (Sattler 1991). No member of the large genus *Erechthias* had been reported as brachypterous prior to this report.

Acknowledgements

HM had the good fortune to visit Ascension on three occasions, and the new *Erechthias* was collected each time. The first trip (August 2003) was greatly assisted by Dr Alan Gray, who was commissioned to carry out an environmental impact assessment on a proposed development at the US airbase there. The second trip (December 2005) consisted of a few days in transit *en route* to St Helena on a project (Mendel et al. 2008) funded under the Overseas Territories Environment Programme (OTEP) run jointly by DFID (Department for International Development) and the Foreign and Commonwealth Office; their support is gratefully acknowledged. The third visit (November 2012), again organised by Dr Alan Gray, was also a project funded by OTEP. The logistical help and goodwill of Ascension Island Government (AIG) Conservation Department personnel (Stedson Stroud, Jolene Sim, Natasha Williams, Liza White, Catherine Supple, Sam Weber and Nicola Weber,) are gratefully acknowledged. Thanks to Liza White and Dr Andrew Wakeham-Dawson for allowing us to study additional material they collected.

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DATA PAPER

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Harvestmen of the BOS Arthropod Collection of the University of Oviedo (Spain) (Arachnida, Opiliones)

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Abstract

There are significant gaps in accessible knowledge about the distribution and phenology of Iberian harvestmen (Arachnida: Opiliones). Harvestmen accessible datasets in Iberian Peninsula are unknown, an only two other datasets available in GBIF are composed exclusively of harvestmen records. Moreover, only a few harvestmen data from Iberian Peninsula are available in GBIF network (or in any network that allows public retrieval or use these data). This paper describes the data associated with the Opiliones kept in the BOS Arthropod Collection of the University of Oviedo, Spain (hosted in the Department of Biología de Organismos y Sistemas), filling some of those gaps. The specimens were mainly collected from the northern third of the Iberian Peninsula. The earliest specimen deposited in the collection, dating back to the early 20th century, belongs to the P. Franganillo Collection. The dataset documents the collection of 16,455 specimens, preserved in 3,772 vials. Approximately 38% of the specimens belong to the family Sclerosomatidae, and 26% to Phalangidae; six other families with fewer specimens are also included. Data quality control was incorporated at several steps of digitisation process to facilitate reuse and improve accuracy. The complete dataset is also provided in Darwin Core Archive format, allowing public retrieval, use and combination with other biological, biodiversity of geographical variables datasets.

Keywords

Opiliones, Arthropoda, Iberian Peninsula, entomological collections, biodiversity collections, distribution, datasets, Spain, Portugal

General description

Purpose: Existing knowledge on the distribution of harvestmen in the Iberian Peninsula is still very fragmented (Prieto 2003). There are biodiversity collections with more data on Iberian harvestmen, both in terms of numbers of specimens and of localities; these records are partly published for some genera (e.g., Prieto 2004, Prieto and Fernández 2007, Merino-Sáinz et al. 2013a). However, there is no dataset that allows public retrieval or use these data. Thus, only 48 records of Iberian harvestmen are available in GBIF [http://data.gbif.org, accessed on 03 July 2013: Museum of Comparative Zoology Harvard University 43 records; Museum of Zoology University of Navarra MZNA 3 records; Senckenberg Collection Arachnology SMF 2 records]. Only two other datasets in GBIF are composed exclusively of harvestmen records: the Opiliones dataset of the UK National Biodiversity Network (http://data.gbif.org/datasets/resource/854, based on Sankey 1988 and Hillyard 2005), which includes 25,486 records, and the Harvestmen (Opiliones) of Ireland dataset of the National Biodiversity Data Centre (http://data.gbif.org/datasets/resource/10810), with 2,109 records (there are apparently additional 13,800 harvestmen records in GBIF from several datasets comprising more taxonomic groups) (Figure 1).

The purpose of this paper is to document a dataset corresponding to Opiliones specimens deposited in the BOS Arthropod Collection (subcollection of Opiliones: BOS-Opi) of the University of Oviedo, Spain, comprising 16,455 specimens in 3,772 vials (each vial containing specimens with the same species/locality/date/capture method information, i.e., a single record). As a result of this, the BOS-Opi dataset makes a significant contribution of primary data about Iberian harvestmen for ecological, faunistic and conservation studies. With the publication of this dataset, we aim to (1) providing a dataset with phenological and distribution data on harvestmen from the northern third of the Iberian Peninsula, and (2) describing the Opiliones subcollection of the BOS Arthropod Collection.

Additional information: A list of publications citing harvestmen contained in this dataset (BOS-Opi) is provided in point 2 of the reference section.

Project details

Project title: Informatización de la Colección de Artrópodos BOS de la Universidad de Oviedo / Digitisation of the BOS Arthropod Collection of University of Oviedo

Personnel digitisation: Torralba-Burrial A

Administrative contact: Anadón A

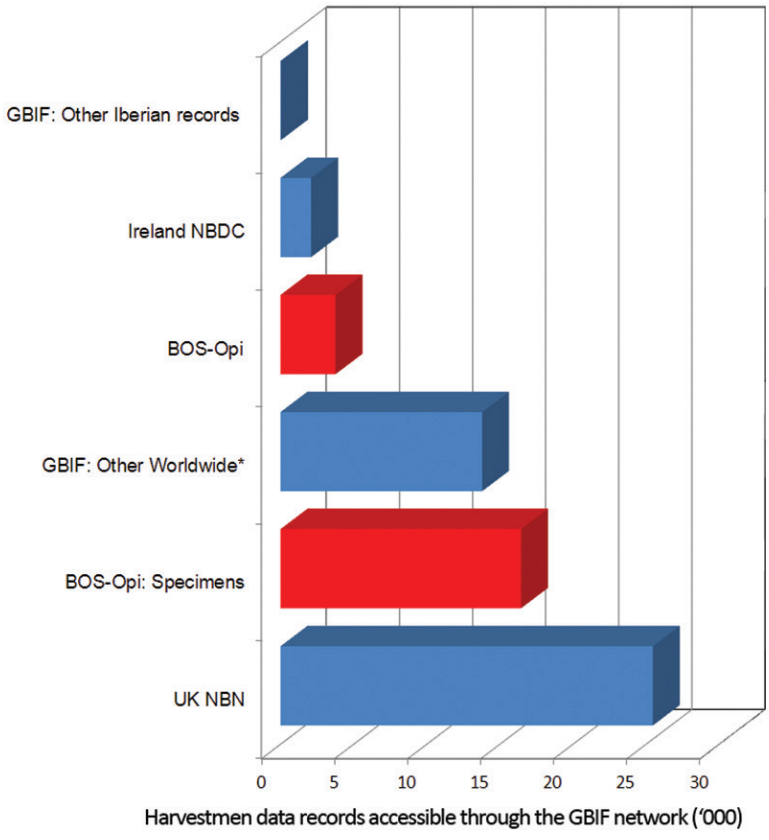

Figure 1. BOS-Opi contributes significantly to the publicly accessible Harvestmen data records through the GBIF network.

BOS-Opi determination specialist: Merino Sáinz I

BOS-Opi collectors: Collectors who have deposited more than 50 specimens include Merino Sáinz I, Anadón A, Fernández-Álvarez F.A., Torralba-Burrial A, Ocharan Larrondo FJ, Melero Cimas VX, Monteserín Real S, Ocharan Ibarra R, Rosa García R, and Vázquez Felechosa MT

Curator of *P. Franganillo Collection*: Lastra C

Funding: Digitisation of this biological collection was supported by the Spanish National R+D+i Plan (MICINN, Spanish Government, grant ref. PTA2010-4108-I) and PCTI Asturias (Asturias Regional Government, ref. COF11-38) through a contract for ATB.

Almost 73% of the specimens were collected as part of the PhD Thesis by Merino Sáinz (2012), which was supported by a Severo Ochoa pre-doctoral grant (ref. BP08039, FICYC, Asturias Regional Government). The project entitled "Cataloging Biodiversity of Muniellos Biosphere Reserve" was supported by the Asturias Regional Government (ref. SV-PA-00-01, SV-PA-01-06, SV-PA-02-08 and SV-PA-03-13).

Study area description: Harvestmen specimens deposited in BOS Arthropod Collection are from the northern third of the Iberian Peninsula (Figure 2). Most of this zone belongs to the Atlantic bioregion (from the Cantabrian Mountains to the Cantabrian Sea), with the Mediterranean bioregion in the south (the biogeographic regions are based on vegetation types as described by Rivas-Martínez et al. (2004) and European Union Habitats Directive 92/43/CEE). The Atlantic/Eurosiberian bioregion (from which the majority of specimens were collected) is a more humid zone with less summer drought compared to the Mediterranean bioregion (Rivas-Martínez 1987, AEMET and IM 2011). The climatic and habitat conditions also vary within this bioregion depending on the orography and geology (calcareous/siliceous) of the area (Rivas-Martínez 1987, AEMET and IM 2011). Oak and beech forests are the main potential vegetation in the area, but significant anthropogenic modifications have reconfigured the landscape throughout much of the territory (e.g., Díaz González and Prieto 1994). Harvestmen communities, as components of soil biodiversity, have an important role to play in the assessment of the mosaic of agricultural landscapes from the northern part of the Iberian Peninsula (e.g., Rosa García et al. 2010, 2011, Merino Sáinz 2012, Merino-Sáinz et al. 2013b).

Design description: The digitisation process of this dataset (BOS-Opi) was carried out according to the workflow put in place for the Odonata subcollection (BOS-Odo) (Torralba-Burrial and Ocharan 2013). Prior to digitisation, the preservation status of each specimen is evaluated and enhanced, and then a taxonomic identification with suitable literature is made (or reviewed when pre-existing) by a specialist. For reasons of optimizing storage of specimens in the collection, harvestmen specimens collected from same species, locality, date and capture method (i.e., a "record") are kept in the same vial. Digitisation of biodiversity data and retrospective georeferencing are then carried out. Best practices as suggested by Chapman (2005a) and Chapman and Wieczorek (2006) are followed for the georeferencing processes. Digital cartography (the gazetteer IBERPIX v2) was used for georeferencing. All data associated to specimens is managed with ZOORBAR software. The dataset is exported to DarwinCore v1.2 format and uploaded to the IPT of the GBIF Spanish node (http://www.gbif.es:8080/ipt). DarwinCore elements included in the dataset structure are listed in the dataset description section. Data quality controls of geographic, taxonomic and additional data associated with the harvestmen specimens were performed at several steps of digitisation process as an essential part of this Information Management Chain (Chapman 2005a, 2005b), as detailed in Torralba-Burrial and Ocharan (2013); these are explained in the quality controls section below.

Currently, dataset is being used to study phenological and life history differences of harvestmen species between areas in north Iberian Peninsula with different geographical/habitat features, species distribution and importance of opportunistic data in fill knowledge gaps when standardised sampling data are not available or are incomplete. Moreover, this dataset is considered as a dynamic catalogue of the harvestmen of BOS Arthropod Collection, allowing free access of citizens, researches, environmental companies and government managements to biodiversity data kept in this Collection.

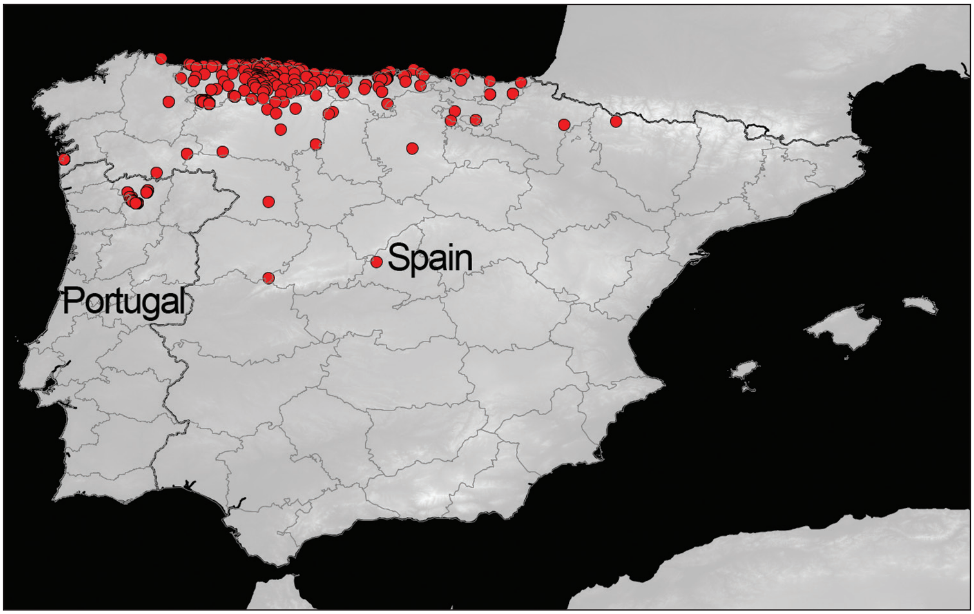

Figure 2. BOS-Opi facilitates access to harvestmen specimen data collected from northern region of Iberian Peninsula.

Taxonomic coverage

General taxonomic coverage description: All specimens were identified to species when preservation status, sex and life cycle phase permitted it. Sixty-two species were recorded from the northern third of the Iberian Peninsula (Merino Sáinz & Anadón 2008), 23 of which are included in this dataset (most of the absent species are from cave and subterranean habitats, difficult to found without specific samples). There are ten harvestmen families recorded from the Iberian Peninsula, and eight of these are represented in this dataset. Only Dicranolasmatidae (suborder Palpatores) and Phalangodidae (suborder Laniatores) are missing. As depicted in Figure 3, the family with the largest number of specimens in the collection is Sclerosomatidae (38.82%, consisting of the genera *Leiobunum*, *Homalenotus* and *Gyas*), followed by Phalangiidae (26.0%: *Odiellus*, *Phalangium*, *Paroligolophus*, *Oligolophus*, *Dicranopalpus*, *Megabunus* and *Mitopus*), Trogulidae (14.7%: *Trogulus* and *Anelasmocephalus*), Nemastomatidae (14.0%: *Nemastomella* and *Nemastoma*). Other families represent less of 5% of the records (Figure 3).

No types are hosted among the Opiliones of the BOS Arthropod Collection. However, this collection does include the historic *Collection of Arachnids P. Franganillo*, with 17 specimens (in ten vials with BOS-Opi codes 3758-3767, five missing since the cataloguing of the collection by Lastra 1974) from the early 20th Century. Pelegrin Franganillo published many new species of arachnids during the first quarter of the century, with very short (if any) descriptions and without figures. In four publications Franganillo (1913, 1917, 1925, 1926) cited, described or commented on Iberian har-

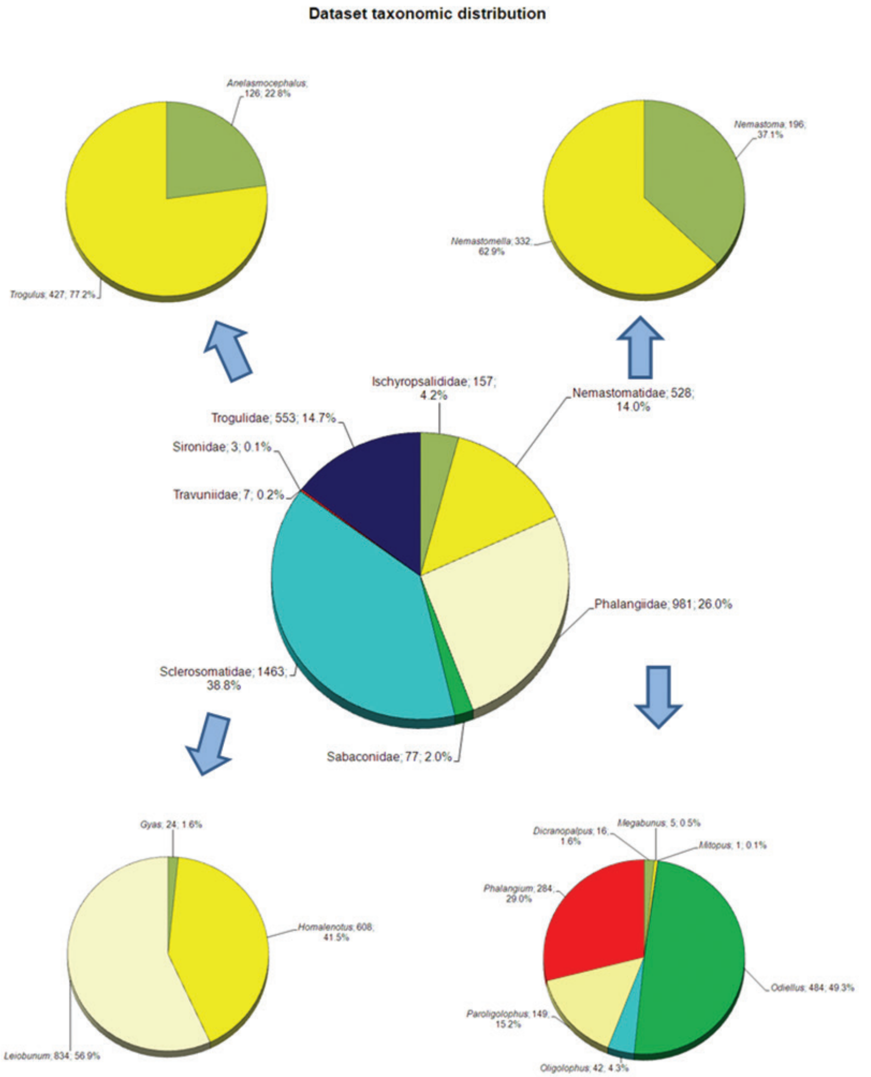

Figure 3. Taxonomic coverage of the BOS-Opi dataset.

vestmen. The location of the collection was unknown since the death of Franganillo (in 1955 at La Habana, Cuba) and no comparison with type specimens was possible. For these reasons, most of the names given by Franganillo are considered as *nomina dubia* both in Araneae (e.g., Urones 1996, Duncan et al. 2010, Crews 2011) and in Opiliones (e.g., Prieto 2003), are synonymized (e.g., Kraus and Kraus 1988, Alayón García 2002, Polotow and Brescovit 2009, Miller et al. 2012), or his records were discarded when other cross-checking sources were not available (e.g., Cardoso and Morano 2010). In 1972, part of the Spanish collection of P. Franganillo was found in a garret of the "La Inmaculada School" (where Franganillo was a teacher) and J.M. Patac de las Traviesas donated it to Oviedo University (see Lastra 1975). The preservation status was very deficient: specimens were dried and locality/determination labels were missing, but almost all vials had a collection number, and assignation and reconstruction of the collection catalogue (without localities or type assignation) was possible for the vials present (Lastra 1974). A study of this collection reveals misidentifications of other species in Araneae (Méndez 1998). In Opiliones, species described by Franganillo are considered *nomina dubia* (Prieto 2003), and most of his records of other species have been discarded (Mello-Leitao 1936, Prieto 2003). Identifications of the harvestmen specimens of the Franganillo collection at the University of Oviedo show previous misidentifications (*Oligolophus vittiger* Simon is an *Odiellus* sp., two specimens of *Phalangium parietinum* de Geer are really *Gyas titanus* Simon), current identifications more accurate (three specimens of *Liobunum* sp. belong to *Leiobunum blackwalli* Meade) and other specimens show a correct identification by Franganillo (*Phalangium opilio* Linnaeus).

Taxonomic ranks

Kingdom: Animalia
Phylum: Arthropoda
Class: Arachnida
Order: Opiliones
Family: Ischyropsalididae, Nemastomatidae, Phalangiidae, Sabaconidae, Sclerosomatidae, Sironidae, Travuniidae, Trogulidae.
Common names: Animals, Arthropods, Arachnids, Harvestmen.

Spatial coverage

General spatial coverage

All specimens are from the northern part of the Iberian Peninsula (Figure 2). Most of them are from Asturias province (89.58% of records with "species/locality/date"), with other specimens originating from Cantabria (6.86%), Tras-os-Montes (1.20%), Pontevedra (0.88%) and other provinces (León, Burgos, Álava, Guipúzcoa, Vizcaya, Lugo, Palencia, Ourense, Zamora, Huesca, Salamanca, Navarra and Madrid).

Coordinates

40°18'N and 43°42'N Latitude; 8°54'W and 0°30'W Longitude.

Temporal coverage (specimens' data range)

1900–2012

Temporal coverage (collection formation)

1977-present

Natural collections description

Parent collection identifier: Colección de Artrópodos BOS
Collection name: Colección de Artrópodos BOS de la Universidad de Oviedo: Opiliones (BOS-Opi)
Collection identifier: http://data.gbif.org/datasets/resource/15038
Specimen preservation method: Ethanol 70°
Curatorial unit: 3772 with an uncertainty of 0 (Vials (records))
Curatorial unit: 16455 with an uncertainty of 0 (Specimens)

Methods

Method description: The digitisation process of the Opiliones subcollection (BOS-Opi) was realised in accordance with the published workflow of the Odonata subcollection (BOS-Odo) (see Torralba-Burrial and Ocharan 2013).

Pre-digitisation phase: The preservation status of harvestmen specimens was reviewed prior to digitisation. Vials were changed when necessary and refilled with preservation liquid (ethanol 70°). Specimens were identified or identifications were reviewed when they were already noted. Identification labels were added when labels were lacking or otherwise incomplete. Specimens' vials were sorted alphabetically by family/genus/species names in trays, and hosted in metallic cabinets in a cold chamber.

Digitisation phase: A database with DarwinCorev1.2 standard fields and other fields specific to different research projects was developed using MS EXCEL software. All biodiversity data available on the specimens' labels (i.e., specimen code, species identification and name of determiner, sex, number of specimens in the vial, locality, date, habitat, collector, collection method, research project and observations) were included in the database.

Other geographic data (municipality, GPS coordinates, altitude, etc.) from specimen labels or from associated publications were added to the database when available. If coordinates were not present on the specimen labels or in primary publications, retrospective georeferencing (see Chapman and Wieczorek 2006) was carried out using digital cartography tools (mainly the public gazetteer IBERPIX v2, compiled by the

Spanish National Geographic Institute, http://www.ign.es/iberpix2/visor). Localities were sorted geographically for batch retrospective georeferencing, starting with larger batches (Chapman and Wieczorek 2006). Coordinates were stored in MGRS format, and IBERPIX v2 was used to calculate the uncertainty radius of the place georeferenced.

The database was converted and imported to, and managed with, ZOORBAR v2.1.1 software (Pando et al. 1996–2012).

Creation of the dataset: The dataset was exported as a file in DarwinCorev1.2 format and geographic coordinates were carried out with ZOORBAR v2.1.1 software. DarwinCore elements included in dataset structure are listed in the dataset description section. Data format, georeferenced coordinates and absence of ASCII anomalous characters were checked with DARWIN_TEST v.3.2 software (http://www.gbif.es/darwin_test/Darwin_test.php). Erroneous data were corrected and data cleaning was repeated to enhance the data quality (see details in the section on quality control).

The dataset was transformed to a DarwinCore Archive format with metadata to ensure rapid discovery of this biodiversity resource and future publishing as a citable academic paper (see Chavan and Penev 2011). The dataset was uploaded to the Integrated Publishing Toolkit (IPT v2.0.4) Platform of the Spanish node of the Global Biodiversity Information Facility (GBIF) (http://www.gbif.es:8080/ipt). Links to these data were also provided on the BOS Arthropod Collection website (http://www.unioviedo.es/BOS/Zoologia/artropodos). The offline version of the dataset includes the identification history of each specimen (4149 items), collection method, research project, and notes on materials derived from the specimens (e.g., publications). This information is available on request.

Study extent description: Specimens are mainly from the northern third of the Iberian Peninsula (see geographic coverage section). The earliest specimens are from the 20th century (belonging to the P. Franganillo collection), but the general collection starts in 1977. However, only 9.73% of the items were collected prior to the year 2000, while 75.93% were collected between 2009 and 2012. The BOS-Opi dataset includes the record distributions by month (cumulative number of records in Figure 4), in several cases stemming from repeated sampling in each locality; this information is useful for studies of the life cycles of harvestmen from the region (e.g. Merino Sáinz 2012) and for making comparisons with other regions.

Sampling description: Material deposited in the Opiliones subcollection of the BOS Arthropod Collection has been collected in three ways:

1) specimens from the PhD dissertation by Merino Sáinz (2012) carried out at the University of Oviedo (72.99% of items);

2) specimens from the project "Cataloguing of the Biodiversity from the Biosphere Reserve of Muniellos" (SW of Asturias province) (Ocharan Larrondo et al. 2003) (13.10%);

3) specimens from other sources: collections from students in Biology and Forestry Engineering programs at the University of Oviedo, other research projects, practical courses, etc. (13.92%).

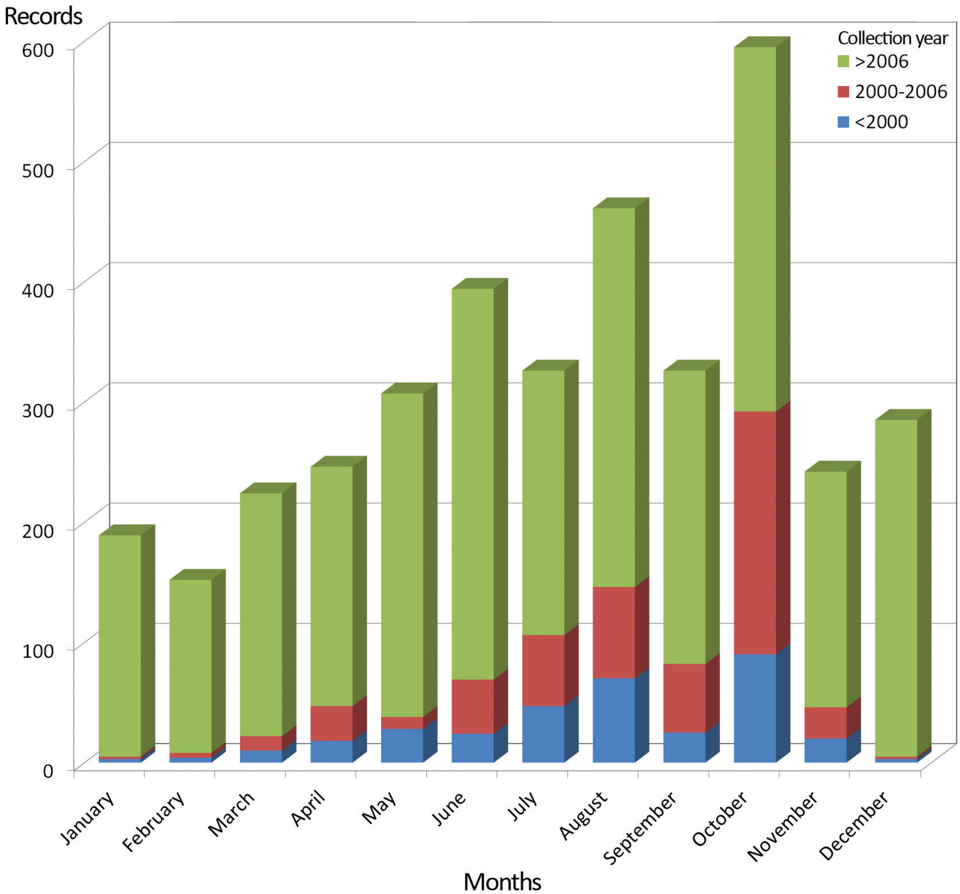

Figure 4. Cumulative monthly distribution of the records of BOS-Opi dataset.

Most of the specimens were collected with pitfall traps (85.15%). Ethylene glycol was used as a fixation and preservation liquid in the pitfalls (proven effective in various environments and for taxonomic groups including arachnids; Schmidt et al. 2006, Jud and Schmidt-Entling 2008, Cheli and Corley 2010). Sodium polyphosphate was added to reduce surface tension and to facilitate the capture of arthropods. Direct (hand) collection of specimens and sweep netting yielded 14.26% and 4.32% of the specimens, respectively. Other methods combined (vegetation beating over an upturned umbrella, Berlese funnel, light trap, Malaise trap, sieve) yielded a much lower number of specimens (1.2%) (see Barrientos 2004, Merino Sáinz 2012 for descriptions).

Quality control description: Validation and cleaning of geographic, taxonomic and additional data associated with the harvestmen specimens was incorporated at several steps of the process as an essential component of the digitisation project (see

Chapman 2005a,b). Workflow was similar to the one described by Torralba-Burrial and Ocharan (2013). Specimens were identified or else their identification revised by an expert (I. Merino-Sáinz). Scientific names were checked with a taxonomic thesaurus incorporated in the database software (according to current trends in harvestmen nomenclature: Prieto 2003, 2008). Possible mistakes in geographic coordinates (format, localities within country/provincial boundaries), in the format or coherence of dates, or in ASCII anomalous characters were checked using automated routines with DARWIN_TEST (v3.2) software.

Datasets

Dataset description

Object name: Darwin Core Archive BOS Arthropod Collection of University of Oviedo (Spain): Opiliones
Character encoding: UTF-8
Format name: Darwin Core Archive format
Format version: 1.0
Distribution: http://www.gbif.es:8080/ipt/archive.do?r=bos-opi
Publication date of data: 2013-07-04
Update police: Annually when necessary to transmit data of new specimens kept at BOS Collection.
Language: Spanish
Licenses of use: This dataset [BOS Arthropod Collection of University of Oviedo (Spain): Opiliones (BOS-Opi)] is made available under the Open Data Commons Attribution License: http://www.opendatacommons.org/licenses/by/1.0/.
DarwinCore elements: The DarwinCore elements (http://purl.org/dc/terms/) included in the dataset published through the GBIF network describe the specimens' data to several levels. These elements are: Record data: type (basisofrecord), DateLastModified, InstitutionCode, CollectionCode, CatalogNumber, Collector, IndividualCount, Sex, YearCollected, MonthCollected, DayCollected, Notes (with info about habitat in most of cases); Geographic data: Country, StateProvince, Locality (including municipality when available), MinimumElevation (meters), MaximunElevatium (meters), Latitude (decimalLatitude), Longitude (decimalLongitude), CoordinatePrecision (meters); Taxonomic data: Kingdom (Animalia all records), Phylum (Arthropoda all records), Class (Arachnida all records), Order (Opiliones all records), Family, Genus, Species (specificEpithet), ScientificNameAuthor (authorship of taxa name), ScientificName, Identified by, Yearidentified, Type status. Moreover, some DarwinCore elements were mapped to fixed values in the IPT as described in this data-paper: language, rights, rightsHolder, bibliographicCitation, references, datasetID, datasetName, ownerInstitutionCode.

External datasets

Dataset description

Object name: BOS Arthropod Collection of University of Oviedo (Spain): Opiliones
Character encoding: iso-8859-1
Format name: Darwin Core Archive
Format version: 1.0
Distribution: http://data.gbif.org/datasets/resource/15038
Metadata language: English
Date of metadata creation: 2013-06-12
Hierarchy level: Dataset

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Francisco Pando (Spanish GBIF node - CSIC) reviewed the manuscript and provided helpful comments. Other members of Spanish GBIF node, especially Katia Cezón, help in the database migration process to Zoorbar environment. Vishwas Chavan and anonymous reviewers enhanced the paper with their suggestions.

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DATA PAPER

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Ross Sea Mollusca from the Latitudinal Gradient Program: R/V *Italica* 2004 Rauschert dredge samples

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Resource citation: Italian National Antarctic Museum (2013-). Ross Sea Mollusca from the Latitudinal Gradient Program: Italica 2004 Rauschert dredge samples, 505 incidence records. Contributed by Ghiglione C, Alvaro MC, Griffiths H, Linse K, Schiaparelli S. Online at http://ipt.biodiversity.aq/manage/resource-registerResource.do, Version 1.0 (last updated on 2013-08-01), GBIF key: http://gbrds.gbif.org/browse/agent?uuid=6c808b65-184a-4ec2-a658-d55d5e1f9ba5. Data paper ID: doi: 10.3897/zookeys.341.6031

Abstract

Information regarding the molluscs in this dataset is based on the Rauschert dredge samples collected during the Latitudinal Gradient Program (LGP) on board the R/V "*Italica*" in the Ross Sea (Antarctica) in the austral summer 2004. A total of 18 epibenthic dredge deployments/samplings have been performed at four different locations at depths ranging from 84 to 515m by using a Rauschert dredge with a mesh size of 500µm. In total 8,359 specimens have been collected belonging to a total of 161 species. Considering this dataset in terms of occurrences, it corresponds to 505 discrete distributional records (incidence data). Of these, in order of abundance, 5,965 specimens were Gastropoda (accounting for 113 species), 1,323 were Bivalvia (accounting for 36 species), 949 were Aplacophora (accounting for 7 species), 74 specimens were Scaphopoda (3 species), 38 were Monoplacophora (1 species) and, finally, 10 specimens were Polyplacophora (1 species). This data set represents the first large-scale survey of benthic micro-molluscs for the area and provides important information about the distribution of several species, which have been seldom or never recorded before in the Ross Sea. All vouchers are permanently stored at the Italian National Antarctic Museum (MNA), Section of Genoa, enabling future comparison and crosschecking. This material is also currently under study, from a molecular point of view, by the barcoding project "BAMBi" (PNRA 2010/A1.10).

Keywords
Antarctica, Ross Sea, Mollusca, Gastropoda, Bivalvia, Monoplacophora, Aplacophora, Polyplacophora, Scaphopoda, Italica 2004, Rauschert dredge, Latitudinal Gradient Program

Purpose

This dataset is about the mollusc samples obtained in the framework of the 2004 voyage of the RV "*Italica*", under the Latitudinal Gradient Program (LGP), by deploying a fine-mesh dredge (Rauschert dredge). This collection is now part of the Italian National Antarctic Museum (MNA, Section of Genova) and is published with the aim of increasing the knowledge of the distribution of mollusc species in the Ross Sea. The dataset is also the first Italian contribution to ANTABIF based on materials stored at the MNA.

Project details

Project title: Latitudinal Gradient Program (LGP) R/V "Italica" voyage 2004 - Mollusca.

Curator and Promoter: Stefano Schiaparelli.

Personnel: Claudio Ghiglione, Maria Chiara Alvaro, Huw J. Griffiths, Katrin Linse.

Funding: This study is part of the Project 2002/8.6 ("The coastal ecosystem of Victoria Land Coast: distribution and structure along a latitudinal gradient") and of the Project 2010/A1.10 (Barcoding of Antarctic Marine Biodiversity, BAMBi) funded by the Italian National Antarctic Research Program (PNRA). Vouchers are maintained at the Italian National Antarctic Museum (MNA), Section of Genoa.

Study area description: This dataset lists the species that have been collected by deploying for the first time a Rauschert dredge in the Ross Sea (Rehm et al. 2006). Samples were obtained during the Austral summer 2004 in the framework of the 19th PNRA Antarctic expedition, on board the R/V "*Italica*". The study area was the continental shelf along the latitudinal transect comprised between Cape Adare (~71°S) and Terra Nova Bay (~75°S) (Fig. 2). The Rauschert dredge was deployed in its 'standard' structure, i.e. having a mesh size of 500µm and with an opening of 0.5 m (Lörz et al. 1999). The dredge has been towed at a mean velocity of 1 knot to collect benthic samples at eighteen stations, comprised between 84 and 515m of depth. More details about sampling stations are reported in Rehm et al. (2006).

Design description: In the past decade, the Ross Sea has been the area studied by the Latitudinal Gradient Program (LGP; www.lgp.aq) which aimed at: i) understanding the complex ecosystems that exist along the Victoria Land coast; and ii) determining the effects of environmental change on these ecosystems; iii) maximising the transfer of information and ideas, by utilising joint logistic facilities. To achieve these targets, two temporally parallel research voyages took place during the Austral summer 2004: one on board the Italian R/V "*Italica*" and one on board the R/V "*Tangaroa*" ("BioRoss" voyage, TAN0402) organized, respectively, by NIWA (National Institute of Water and Atmospheric Research, Wellington) and PNRA (Antarctic National Research Project).

In the field, samples were collected by using a Rauschert dredge with a mesh size of 500µm (Lörz et al. 1999). Samples were fixed on board in precooled Ethanol in order to have material suitable for genetic studies. Sorting and classification was performed at the Italian National Antarctic Museum (MNA), Section of Genoa, where all the samples were acquired as permanent vouchers. The digital and SEM images of the mollusc species studied will be made available through the ANTABIF Antarctic Field Guide Project (http://afg.biodiversity.aq/about). The LGP contributed to the SCAR biology programme Evolution and Biodiversity in the Antarctic (EBA) and now to the SCAR programme State of the Antarctic Ecosystem (AntEco). The dataflow is illustrated in Figure 1.

Methods

Method step description

The material was collected during the R/V "*Italica*" 2004 LGP Expedition by Dr. Peter Rehm (see Rehm et al. 2006) under the framework of the PNRA Project 2002/8.6. In the specific, the Rauschert samples were preserved immediately in pre-cooled 90% ethanol and kept in -25°C for later DNA extraction. Sorting of molluscs was performed at the Italian National Antarctic Museum. Taxonomic identification was performed at the Italian Antarctic National Museum (MNA, Section of Genoa) and at the British Antarctic Survey (BAS) laboratories. All living specimens were sorted under a stereomicroscope and, whenever possible, classified down to the specific level. More minute species were photographed at ESEM (Leo Stereoscan 440) facility at DISTAV. Dead shells have not been taken into account in the present study.

The present molluscs dataset has been formatted in order to fulfil the standards (Darwin Core) required by the OBIS scheme (http://iobis.org/data/schema-and-metadata) according the SCAR-MarBIN Data Toolkit (available at http://www.scarmarbin.be/documents/SM-FATv1.zip). The dataset was uploaded in the ANTOBIS database (the geospatial component of SCAR-MarBIN) and added to SOMBASE (Southern Ocean Mollusc Database, www.antarctica.ac.uk/sombase). SOMBASE generated initial core data system upon which SCAR's Marine Biodiversity Information Network (SCAR-MarBIN) was built. Taxonomy was matched against the Register of Antarctic Marine Species, using the Taxon Match tool (http://www.scarmarbin.be/rams.php?p=match). Data from both the R/V "*Italica*" and the R/V "*Tangaroa*" ("BioRoss", TAN0402) voyages were published in Schiaparelli et al. (2006). A detailed analysis of the distribution of mollusc species sampled by the Rauschert dredge as well as the illustration of all new records for the Ross Sea is in Ghiglione et al. (submitted). The dataflow is illustrated in Figure 1.

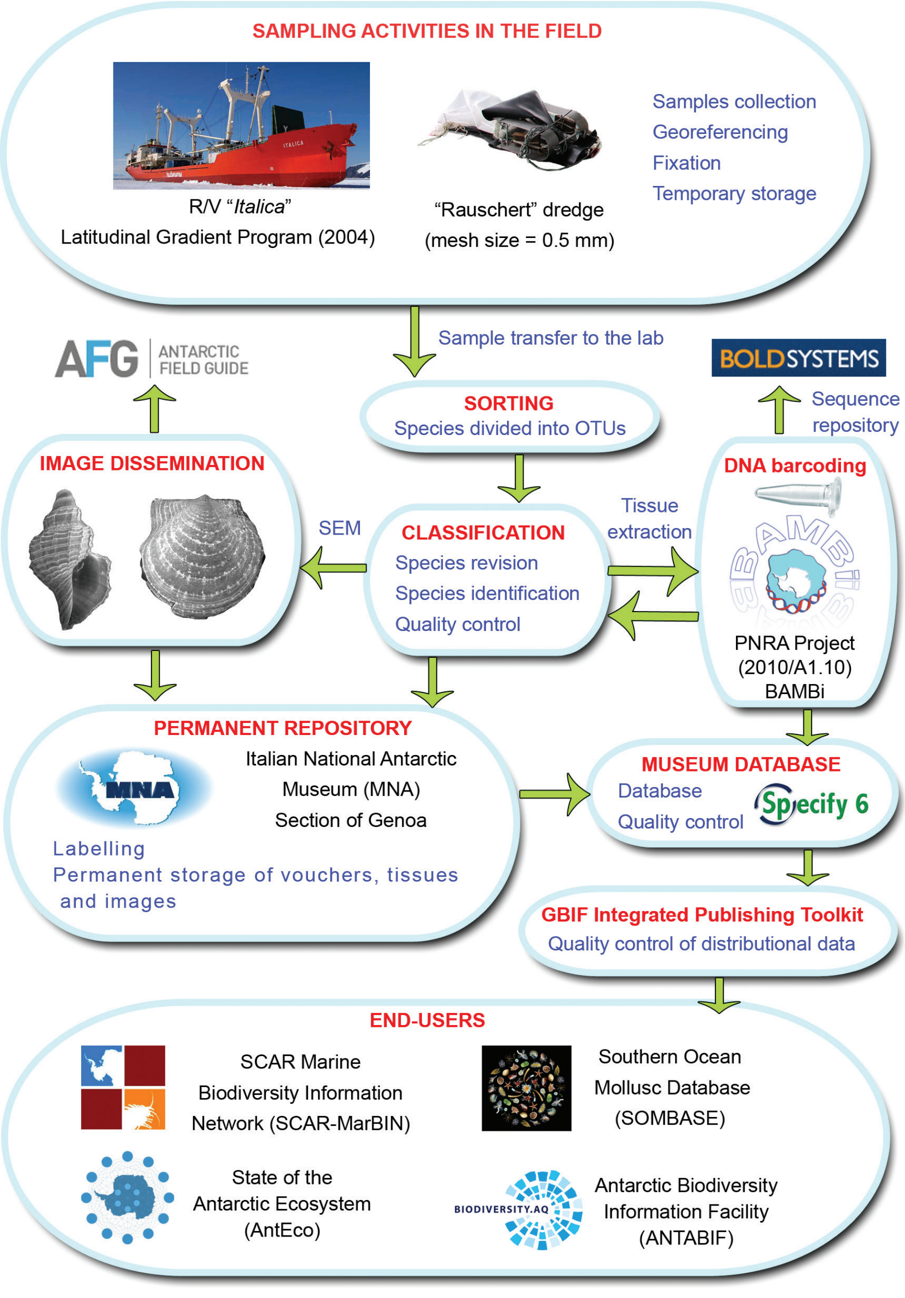

Figure 1. Flowchart depicting major steps in dataset development and publishing.

Study extent: This dataset lists the species that have been collected by deploying for the first time a Rauschert dredge in the Ross Sea (Rehm et al. 2006). Samples were obtained during the Austral summer 2004 in the framework of the 19th PNRA

Antarctic expedition, on board the R/V "*Italica*". The study area was the continental shelf along the latitudinal transect comprised between Cape Adare (~71°S) and Terra Nova Bay (~75°S). On the whole,eighteen stations, comprised between 84 and 515m of depth, were sampled.

Sampling description: Sampling activities were done in four main areas of the Ross Sea: Cape Adare, Cape Hallett, Coulman Island, Cape Russell (Fig. 2). The eighteen Rauschert dredge samples were obtained at Cape Adare (five sampling sites: A1, A2, A3, A4, A5), at Cape Hallett (seven sampling sites: H out 1, H out 2, H out 4, H in 2, H in 3; H in 4, H in 5), at Coulmann Island (two sites: C1, C2) and at Cape Russell (four sites: SMN, R2, R3, R4) (Rehm et al. 2006).

Quality control description: Specimens were classified at the lowest possible taxonomic level. A 18% of species were classified at the or above the generic level due to an uncertainty about their status. The same was for another 6% of species that potentially represent new species. Although these taxa will require further studies (e.g. morphological and genetic, currently underway) these have been included in this dataset as they could be clearly distinguished during sorting activities and were therefore considered as morphospecies. During all the phases of sorting, classification and storage of samples at the Italian National Antarctic Museum, quality controls and data cleaning have been undertaken at various steps in order to produce quality data and make consistent cross-references between the database and samples' labels. The MNA uses an SQL-based database (Specify 6) to manage its collections and link all the data (photos, sequences, etc.) to the physical samples. Georeferencing on board the R/V "*Italica*" is based on the interpolation of GPS satellite receivers (models 3S Navigation and Glonass ASHTECH GG24) and a gyrocompass. Station coordinates and sampling events were recorded during sampling activities through the "Italica" NetNav WEB system, which is based on the above GPS systems.

Taxonomic coverage

General taxonomic coverage description: The present dataset focuses on the Kingdom Animalia, Phylum Mollusca and includes six molluscs classes: Gastropoda, Bivalvia, Monoplacophora, Solenogastres, Polyplacophora and Scaphopoda. In total 8,359 specimens have been collected belonging to 161 species and corresponding to 505 species distributional records. Of these, in order of abundance, 5,965 specimens were Gastropoda (accounting for 113 species), 1,323 were Bivalvia (accounting for 36 species), 949 were Aplacophora (accounting for 7 species), 74 specimens were Scaphopoda (3 species), 38 were Monoplacophora (1 species) and, finally, 10 specimens were Polyplacophora (1 species). This data set represent the first large-scale survey of benthic micromolluscs for the area and provides important information about the distribution of several species which have been seldom or never recorded before in the Ross Sea. A detailed analysis of the distribution of mollusc species sampled by

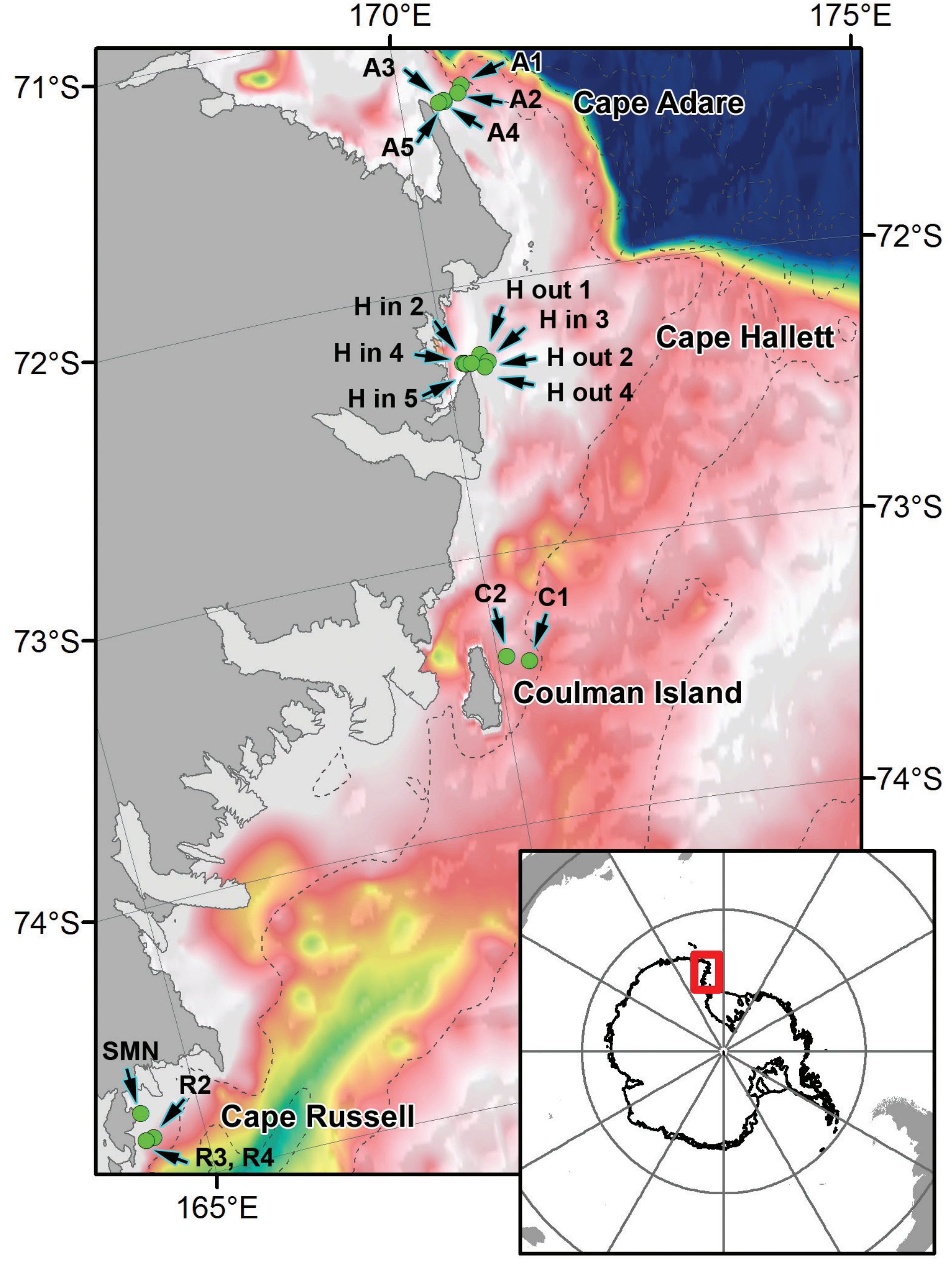

Figure 2. Map of sampling stations.

the Rauschert dredge as well as the illustration of all new records for the Ross Sea is in Ghiglione et al. (submitted). The number of newly reported species for the Ross Sea is compared with the available base line, i.e. the SOMBASE records, in Figure 3.

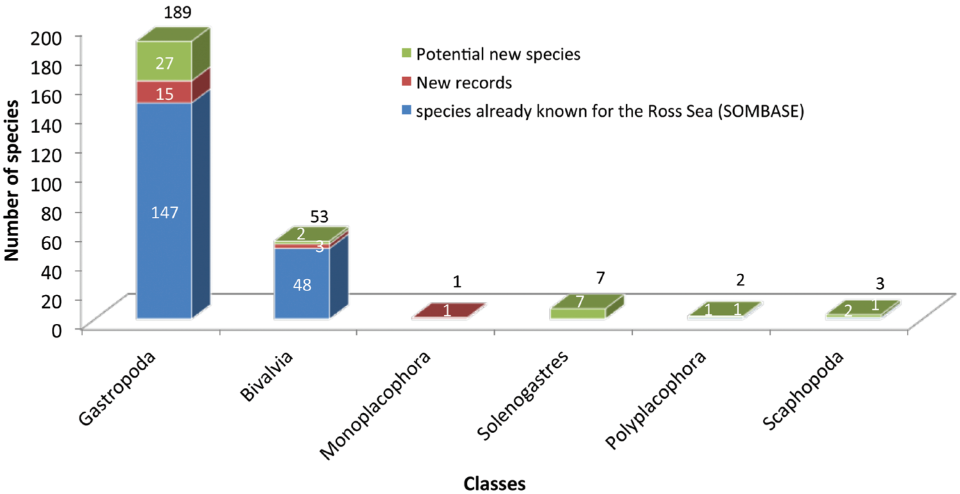

Figure 3. Number of new species records compared to the available baseline (SOMBASE, www.antarctica.ac.uk/sombase). In light blue: species already known for the Ross Sea; in red: new record of know species never found before in the Ross Sea; in green: species classified at the generic level only a potentially representing new species for the area.

The dataset includes respectively for each class:

Kingdom: Animalia
Phylum: Mollusca
Class: Solenogastres
Family: Neomeniidae
Species: Solenogastres sp. 1, Solenogastres sp. 2, Solenogastres sp. 3, Solenogastres sp. 4, Solenogastres sp. 5, Solenogastres sp. 6, *Neomenia* sp. 1

Kingdom: Animalia
Phylum: Mollusca
Class: Polyplacophora
Family: Callochitonidae
Genus: *Callochiton*
Species: *Callochiton* sp. 1

Kingdom: Animalia
Phylum: Mollusca
Class: Monoplacophora
Family: Micropilinidae
Genus: *Micropilina*
Species: *Micropilina arntzi* Warén & Hain, 1992

Kingdom: Animalia
Phylum: Mollusca
Class: Gastropoda
Family: Acteonidae, Cancellaridae, Anatomidae, Margaritidae, Doridae, Eulimidae, Mangeliidae, Seguenzioidea, Calliotropidae, Capulidae, Newtoniellidae, Buccinidae, Skeneidae, Cylichnidae, Diaphanidae, Dotidae, Eatoniellidae, Zerotulidae, Lepetidae, Naticidae, Cerithiopsidae, Collonidae, Skeneidae, Mangellidae, Margaritidae, Orbitestellidae, Triviidae, Omalogyridae, Volutomitridae, Buccinidae, Philinidae, Raphitomidae, Rissoidae, Akiodorididae, Cingulopsidae, Pyramidellidae, Tjaernoeiidae, Muricidae, Mathildidae, Borsoniidae
Genus: *Acteon*, *Admete*, *Aegires*, *Anatoma*, *Antimargarita*, *Antistreptus*, *Austrodoris*, *Bathycrinicola*, *Belalora*, *Brookula*, *Calliotropis*, *Capulus*, *Cerithiella*, *Chlanidota*, *Cirsonella*, *Cylichna*, *Diaphana*, *Doto*, *Eatoniella*, *Eumetula*, *Frovina*, *Fusceulima*, *Haliella*, *Hemiaclis*, *Iothia*, *Kerguelenatica*, *Krachia*, *Leptocollonia*, *Liotella*, *Lissotesta*, *Lorabela*, *Margarites*, *Melanella*, *Microdiscula*, *Newnesia*, *Nothoadmete*, *Notoficula*, *Omalogyra*, *Paradmete*, *Pareuthria*, *Philine*, *Pleurotomella*, *Powellisetia*, *Probuccinum*, *Prodoridunculus*, *Prosipho*, *Sinuber*, *Skenella*, *Streptocionella*, *Thjaernoeia*, *Toledonia*, *Torellia*, *Trilirata*, *Trophon*, *Turritellopsis*, *Typhlodaphne*
Species: *Acteon antarcticus* Thiele, 1912, *Admete haini* Numanami, 1996, *Aegires albus* Thiele, 1912, *Anatoma euglypta* (Pelseneer, 1903), *Antimargarita dulcis* (E. A. Smith, 1907), *Doris kerguelensis* (Bergh, 1884), *Bathycrinicola tumidula* (Thiele, 1912), *Oneopota striatula* (Thiele, 1912), *Bertellidae* sp.1, *Bertellidae* sp.2, *Brookula pfefferi* Powell, 1951, *Brookula* cf. *argentina* Zelaya, Absalao & Pimienta, 2006, *Brookula strebeli* A.W.B. Powell, 1951, *Calliotropis antarctica* Dell, 1990, *Cancellaridae* sp.1, *Cancellaridae* sp.2, *Capulus subcompressus* Pelseneer, 1903, *Cerithiella seymouriana* (Strebel, 1908), *Chlanidota signeyana* A.W.B. Powell, 1951, *Cirsonella extrema* Thiele, 1912, *Cylichna gelida* (E. A. Smith, 1907), *Diaphana paessleri* (Strebel, 1905), *Doto antarctica* Eliot, 1907, *Doto* sp., *Eatoniella* aff. *cana* Ponder, 1983, *Eatoniella* cf. *demissa* (E. A. Smith, 1915), *Eatoniella kerguelensis* (E. A. Smith, 1875), *Eulimidae* sp.1, *Eulimidae* sp.2, *Eulimidae* sp.3, *Eulimidae* sp.4, *Eulimidae* sp.5, *Eumetula dilecta* (Thiele, 1912), *Eumetula* cf. *dilecta* (Thiele, 1912), *Eumetula strebeli* (Thiele, 1912), *Frovina* sp.1, *Frovina* sp.2, *Fusceulima* sp.1, *Fusceulima* sp.2, *Gastropoda* sp.1, *Haliella* sp.1, *Hemiaclis incolorata* (Thiele, 1912), *Hemiaclis* sp.1, *Hemiaclis* sp.2, *Iothia emarginuloides* (Philippi, 1868), *Kerguelenatica delicatula* (E. A. Smith, 1902), *Krachia antartica* (E. A. Smith, 1907), *Leptocollonia innocens* (Thiele, 1912), *Liotella* sp.1, *Lissotesta macknighti* (Dell, 1990), *Lissotesta mammillata* (Thiele, 1912), *Lissotesta minutissima* (E. A. Smith, 1907), *Lissotesta notalis* (Strebel, 1908), *Lissotesta similis* (Thiele, 1912), *Lissotesta* sp.1, *Lissotesta strebeli* (Thiele, 1912), *Lissotesta unifilosa* (Thiele, 1912), *Lorabela davisi* (Hedley, 1916), *Margarites crebrilirulata* (E. A. Smith, 1907), *Margarites refulgens* (E. A. Smith, 1907), *Marseniopsis* sp., *Melanella antarctica* (Strebel, 1908), *Melanella convexa* (E. A. Smith, 1907), *Microdiscula vanhoeffeni* Thiele, 1912, *Naticidae* sp.1, *Newnesia antartica* E. A. Smith, 1902, *Nothoadmete* cf. *delicatula*

(E. A. Smith, 1907), *Notoficula bouveti* (Thiele, 1912), *Omalogyra burdwoodiana* Strebel, 1908, *Omalogyra* sp.1, *Onoba egorovae* Numanami, 1996, *Onoba gelida* (E. A. Smith, 1907), *Onoba kergueleni* (E. A. Smith, 1875), *Onoba paucilirata* (Melvill & Standen, 1912), *Onoba* sp.1, *Onoba subantarctica wilkesiana* (Hedley, 1916), *Onoba turqueti* (Lamy, 1905), *Paradmete fragillima* (Watson, 1882), *Pareuthria plicatula* Thiele, 1912, *Philine alata* Thiele, 1912, *Pleurotomella deliciosa* Thiele, 1912, *Powellisetia deserta* (E. A. Smith, 1907), *Probuccinum tenerum* (E. A. Smith, 1907), *Prodoridunculus gaussianus* Thiele, 1912, *Prosipho nodosus* Thiele, 1912, *Antistreptus contrarius* (Thiele, 1912), *Prosipho glacialis* Thiele, 1912, *Prosipho mundus* E. A. Smith, 1915, *Sinuber microstriatum* Dell, 1990, *Skenella paludinoides* (E. A. Smith, 1902), *Streptocionella pluralis* Dell, 1990, *Tjaernoeia michaeli* Engl, 2002, *Toledonia* cf. *perplexa* Dall, 1902, *Toledonia elata* Thiele, 1912, *Toledonia globosa* Hedley, 1916, *Toledonia limnaeaeformis* (E. A. Smith, 1879), *Toledonia major* (Hedley, 1911), *Toledonia palmeri* Dell, 1990, *Toledonia punctata* Thiele, 1912, *Toledonia* sp.1, *Toledonia* sp.2, *Toledonia* sp.3, *Toledonia striata* Thiele, 1912, *Torellia antarctica* (Thiele, 1912), *Torellia exilis* (Powell, 1958), *Trilirata macmurdensis* (Hedley, 1911), *Trilirata sexcarinata* Warén & Hain, 1996, *Trophon coulmanensis* E. A. Smith, 1907, *Trophon minutus* Melvill & Standen, 1907, *Turritellopsis latior* Thiele, 1912, *Typhlodaphne innocentia* Dell, 1990, *Typhlodaphne* sp.1

Kingdom: Animalia
Phylum: Mollusca
Class: Bivalvia
Family: Philobryidae, Astartidae, Cuspidariidae, Cyamiidae, Carditidae, Cyclochlamydidae, Propeamussiidae, Mytilidae, Kelliidae, Limidae, Limopsidae, Philibryidae, Lyonsiidae, Montacutidae, Poromyidae, Nuculanidae, Siliculidae, Cuspidariidae, Thraciidae, Thyasiridae, Galeommatoidea, Yoldiidae
Genus: *Adacnarca*, *Astarte*, *Cuspidaria*, *Cyamiomactra*, *Cyclocardia*, *Cyclochlamys*, *Cyclopecten*, *Dacrydium*, *Kellia*, *Limatula*, *Limopsis*, *Lissarca*, *Lyonsia*, *Montacuta*, *Mysella*, *Parathyasira*, *Philobrya*, *Poromya*, *Propeleda*, *Pseudokellya*, *Silicula*, *Subcuspidaria*, *Thracia*, *Waldo*, *Yoldiella*
Species: *Adacnarca nitens* Pelseneer, 1903, *Astarte longirostris* d'Orbigny, 1842, *Cuspidaria tenella* E. A. Smith, 1907, *Cuspidaria kerguelensis* (E. A. Smith, 1885), *Cyamiomactra laminifera* (Lamy, 1906), *Cyamiomactra robusta* Nicol, 1964, *Cyclocardia astartoides* (Martens, 1878), *Cyclochlamys gaussiana* (Thiele, 1912), *Cyclochlamys pteriola* (Melvill & Standen, 1907), *Dacrydium albidum* Pelseneer, 1903, *Kellia simulans* E. A. Smith, 1907, *Limatula hodgsoni* (E. A. Smith, 1907), *Limatula ovalis* (Thiele, 1912), *Limatula simillima* (Thiele, 1912), *Limopsis lilliei* E. A. Smith, 1915, *Limopsis marionensis* E. A. Smith, 1885, *Lissarca notorcadensis* Melvill & Standen, 1907, *Lyonsia arcaeformis* Martens, 1885, *Montacuta nimrodiana* Hedley, 1911, *Mysella* cf. *antarctica* (E. A. Smith, 1907), *Mysella charcoti* Lamy, 1906, *Mysella gibbosa* (Thiele, 1912), *Mysella* sp.1, *Philobrya sublaevis*

Pelseneer, 1903, *Philobrya wandelensis* Lamy, 1906, *Philobrydae* sp.1, *Poromya spinosula* Thiele, 1912, *Propeleda longicaudata* (Thiele, 1912), *Pseudokellya gradate* Thiele, 1912, *Pseudokellya* sp. juv., *Silicula rouchi* Lamy, 1911, *Thracia meridionalis* E. A. Smith, 1885, *Parathyasira dearborni* (Nicol, 1965), *Thyasira debilis* (Thiele, 1912), *Waldo parasiticus* (Dall, 1876), *Yoldiella antarctica* (Thiele, 1912)

Kingdom: Animalia
Phylum: Mollusca
Class: Scaphopoda
Family: Pulsellidae, Gadilidae
Genus: *Pulsellum, Siphonodentalium*
Species: *Pulsellum* sp. 1, *Siphonodentalium dalli* (Pilsbry & Sharp, 1898), *Siphonodentalium* sp. 1

Spatial coverage

General spatial coverage

Ross Sea, Antarctica (Figure 2).

Coordinates

71°15'5"S and 74°49'3"S Latitude; 164°11'5"E and 170°41'9"E Longitude.

Temporal coverage

February 9, 2004–February 21, 2004.

Natural collections description

Parent collection identifier: Italian Antarctic National Museum (Section of Genoa, Italy)

Collection name: Italica 2004 Rauschert Molluscs

Collection identifier: http://www.mna.it

Specimen preservation method: Specimens were fixed in pre-cooled Ethanol immediately after the extraction from the dredge net. In this way any thermal shock which could potentially alter the integrity of DNA was avoided. After fixation, specimens were sorted under a stereomicroscope, divided into morphospecies and stored in „Screw Thread Vials“ (National Scientific, USA). For study, some specimens per species have been dissected under the stereomicroscope and soft parts used for DNA extractions. Shells corresponding to these specimens have been dried in increasing ethanol concentrations, mounted on stubs and gold sputtered for scanning electron microscope observation. These specimens are maintained in a laboratory kiln with silica gel to prevent deterioration. All the other specimens are kept in ethanol in the collections of the Italian National Antarctic Museum.

Datasets

Dataset description

This dataset contains data about the Phylum Mollusca in the Ross Sea. In particular, it includes 161 species for a total of 8,359 specimens. By cconsidering this dataset in terms of incidence, it encompasses 505 discrete distributional records.

The Darwin Core elements included in the dataset are: scientific name, collection code (i.e. MNA acronym), catalogue number (i.e. MNA catalogue number), year of collection, date of collection, latitude and longitude (in decimal degrees), individual counts, and basis of records (type of preservation).

Object name: Italica 2004_Rauschert dredge_Ross_sea_Mollusca_lgp
Character encoding: UTF-8
Format name: Darwin Core Archive format
Format version: 1.0
Distribution: http://ipt.biodiversity.aq/resource.do?r=ross_sea_mollusca_lgp
Language: English
Metadata language: English
License of use: This dataset [Italica 2004_Rauschert dredge_Ross_sea_Mollusca_lgp] is made available under the Open Data Commons Attribution License: http://www.opendatacommons.org/licenses/by/1.0/
Date of metadata creation: 2013-01-08
Hierarchy level: Dataset

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Ghiglione C, Alvaro MC, Griffiths HJ, Linse K, Schiaparelli S (submitted) Fine-mesh towed gears sampling at high latitudes: a considerable leap toward alpha-diversity assessment for benthic Mollusca from the Ross Sea (Antarctica). Polar Biology.

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RESEARCH ARTICLE

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Diversity and distribution of reptiles in Romania

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Abstract

The reptile fauna of Romania comprises 23 species, out of which 12 species reach here the limit of their geographic range. We compiled and updated a national database of the reptile species occurrences from a variety of sources including our own field surveys, personal communication from specialists, museum collections and the scientific literature. The occurrence records were georeferenced and stored in a geodatabase for additional analysis of their spatial patterns. The spatial analysis revealed a biased sampling effort concentrated in various protected areas, and deficient in the vast agricultural areas of the southern part of Romania. The patterns of species richness showed a higher number of species in the warmer and drier regions, and a relatively low number of species in the rest of the country. Our database provides a starting point for further analyses, and represents a reliable tool for drafting conservation plans.

Keywords

Reptilia, species distribution, species range, biodiversity data, species richness, rarity

Introduction

Reptiles are declining worldwide at an alarming rate (Gibbons et al. 2000, Böhm et al. 2013) and, along with amphibians, are considered among the most threatened vertebrate groups (Stuart et al. 2008, Hof et al. 2011). The decline of reptiles has been induced by a variety of threats such as habitat loss, degradation and fragmentation, pet trade, invasive species, pollution and diseases (Gibbons et al. 2000, Cox and Temple 2009). Currently, it is considered that climate changes severely affect reptiles (Böhm et al. 2013). Therefore, we need to assess the potential impacts of the forecasted global changes by assessing anticipated changes in the ecological niche of species. Although complex species distribution models have been developed, with some managing to predict the species ecological niches from just a few known localities (Phillips et al. 2006, Peterson et al. 2011), we still face difficulties to accurately assess the impact of these future threats. Among the limitations encountered when modeling ecological niches is the quality of the biological data used to train the models, which is the first condition to meet certain standards (Pineda and Lobo 2009). Data quality issues are triggered by use of improper spatial resolution, misidentification, missing data, and the lack of a proper sampling design (Araújo and Guisan 2006, Peterson et al. 2011). In this manner, it is mandatory to check for any bias in the sampling effort when mapping species distribution (e.g., Proess 2003, Loureiro et al. 2010).

Romania has five biogeographic regions (i.e., Alpine, Continental, Pannonian, Black Sea, and Steppic) out of the nine regions recognized by the European Union (Cogălniceanu and Cogălniceanu 2010, Iojă et al. 2010, Evans 2012). Romania still maintains a significant proportion of habitats with high conservation value, such as boreal coniferous forests, mesophilous, hygrophilous and xerothermic broadleaved forests, grassland and shrubby ecosystems. There is also a rich diversity of aquatic ecosystems including mountain springs and rivers, river floodplains, glacial lakes, coastal wetlands and bogs (Rey et al. 2007).

The diversity of reptiles is surprisingly high for a country with a mostly temperate and continental climate. There are 23 reptile species in Romania, out of which 12 species reach the limit of their geographic range (i.e., *Testudo hermanni, T. graeca, Ablepharus kitaibelii, Lacerta trilineata, Podarcis tauricus, P. muralis, Eremias arguta, Darevskia praticola, Eryx jaculus, Dolichophis caspius, Elaphe sauromates, Vipera ammodytes*), while other two species are near their range edge in Romania (i.e., *Zamenis longissimus, Vipera ursinii*) (Gasc et al. 1997).

No updated distribution maps have been published since the publication of the milestone volume on Reptiles in the series Fauna of Romania fifty-two years ago (Fuhn and Vancea 1961), despite a substantial increase in the inventory effort over the following years. However, there are published papers compiling species distributions of single species such as *Darevskia praticola* (Sós et al. 2012), *Vipera ursinii* (Krecsák and Zamfirescu 2008), *Natrix tessellata* (Strugariu et al. 2011), *Emys orbicularis* (Sós 2011), *Testudo hermanni* (Rozylowicz and Dobre 2010), *Eryx jaculus* (Krecsák and Iftime 2006), or restricted to particular geographical areas (e.g., Ghira et al. 2002, Covaciu-Marcov et al. 2006).

We here present an updated overview of the distribution and diversity of reptiles in Romania. The aims of our study are to (1) map the distribution of reptile species in Romania and (2) analyze the spatial pattern of distribution data.

Materials and methods

Mapping species occurrences

We extracted the occurrence records from four major sources: published data, museum collections, personal communications from specialists, and our own unpublished field data. The records were primarily stored and managed in a Microsoft Access database, and later imported it in an ESRI file geodatabase using ArcGIS Desktop 10.1 (ESRI, CA). We checked for data quality by (1) filtering the database for doubtful and erroneous records, (2) aggregating the known localities to a finer resolution, and (3) assessing the bias in sampling effort. Our own data were collected over a period of almost 25 years and it involved a large variety of methods. Since the majority of studies carried out were of ecology, the detailed distribution data was not made available in the resulting publications. Our own few publications presenting species distribution data were included in Appendix I. No voucher specimens were collected during our studies.

The distribution records that could not be georeferenced to an actual locality or toponym (e.g., occurrences assigned to mountain ranges, geographical provinces or hydrographic basins) or records with unspecified taxa within genera were not included in the geodatabase. Other doubtful or erroneous records such as species out of their known range or vagrant individuals *sensu* IUCN (2001) were also discarded.

The species taxonomy considered in the present paper is based on Speybroeck et al. (2010). Due to rapid changes in taxonomy, we did not analyze the subspecies in our study, except for *Vipera* (*Acridophaga*) *ursinii,* to which detailed studies have confirmed the relevance of taxonomic unit (Ferchaud et al. 2012). While the taxonomic status of *Anguis fragilis* is still under debate, we considered the species complex as a single species (Gvoždík et al. 2010). We encountered a similar problem for *Vipera* (*berus*) *nikolskii;* therefore we did not examine it separately from *V. berus* (Zinenko et al. 2010).

We aggregated the occurrence records to the Universal Transverse Mercator (UTM) grid system at a spatial resolution of 25 km^2 (UTM 5 × 5 km). The records with a spatial resolution of ≤ 25 km^2 were assigned the corresponding UTM 5 × 5 km grid cell code using primarily the UTM index of localities (Lehrer and Lehrer 1990). The species occurrences with a spatial resolution of > 25 km^2 were assigned only one grid cell code based on expert knowledge of the species' habitat requirements (Scott et al. 2002, Franklin 2009) and visual help from the available satellite imagery and an overlaid KMZ file with the UTM 5 × 5 km grid in Google Earth v. 7.0.2 (Google Inc., CA). In order to georeference all records in the geodatabase in ArcGIS Desktop, we created a relationship between the table with species occurrence records and the UTM 5 × 5 km polygon feature class based on the grid cell code as a common attribute.

The occurrences were characterized based on the year of observation into old (if recorded before 1990) and recent (if after 1990, i.e. post Cold-War period) records. The distinction is based on the type of studies published and the style of work. Most papers before 1990 did not indicate the year of observation/collection and some did not even differentiate between new and old records. After 1990 the trend was to publish new locations in pure faunistic studies done within administrative units. Moreover, after 1990 access was not restricted anymore in areas close to the border and it involved also major changes in landscape use and an overall reduction of threats, mostly caused by a reduction in the use of pesticides and fertilizers in agriculture, land abandonment, changes in local hydrology caused by the decline in irrigation intensity and the decline of mining and industrial activities. If the year of observation was not mentioned in the publications, mostly in our national and local journals, then we subtracted 3 to 5 years from the date of publication, based on our estimate of the delay between actual fieldwork and time of publication.

Spatial patterns in species occurrences

Based on the number of reptile records per UTM 5 × 5 km grid cell, we tested for spatial autocorrelation using Global Moran's I statistic under the null hypothesis that the occurrence records were evenly distributed. If the null hypothesis is rejected, the occurrence records are more spatially clustered ($Z > 0$) or dispersed ($Z < 0$) than expected (Fortin and Dale 2005). We assessed the local patterns of sampling bias using Getis Ord Gi* spatial statistic (Ord and Getis 1995). The metric allowed us to identify the clusters of UTM 5 × 5 cells where the sampling effort was significantly lower (GiZScore < -1.96; i.e., coldspots of occurrences) or higher (GiZScore > 1.96; i.e., hotspots of occurrences) than expected by chance. We set up the distance threshold to 7100 m in order to include the surrounding eight UTM grid cells (Getis and Ord 1992).

In order to assess the altitudinal distribution of each species, we extracted the mean altitude per grid cell from the SRTM digital topographic database (Jarvis et al. 2008) using ArcGIS Desktop Zonal Statistics geoprocessing tool. The grid cells intersecting the Romanian border were excluded from the analysis.

We calculated the species richness at a spatial resolution of 50 × 50 km and 10 × 10 km without considering subspecies separately. Mapping the species richness at a coarser resolution reduced the potential bias in sampling effort and allowed us a better understanding and visualization of regional patterns (Graham and Hijmans 2006).

We then calculated the Extent of Occurrence (EOO) as the minimum convex polygon, and the Area of Occupancy (AOO) as the total area of UTM 5 × 5 km grid cells where a species was reported (IUCN 2001). The exact area of UTM grid cells situated along the border and only partially located in Romania was taken into account in order to avoid overestimation.

Finally, we calculated a rarity index at a 50 × 50 km resolution (RI: Romano et al. 2012) as a measure of species range size in relation to the country area. The rarity index took values between 0 for widespread species and close to 100 for species with a restricted distribution.

All spatial statistics analyses were performed using geoprocessing tools under ArcGIS for Desktop 10.1 (ESRI, CA). Non-spatial statistical analyses were performed in Minitab 16 (Minitab Inc., PA).

Results

Species occurrences and ranges

We extracted and georeferenced 18036 reptile records from published papers (66%), museum collections (2%), personal communication from specialists, and our own field surveys (32%). The published papers with the reptile distribution records used in this study are listed in Appendix I, while the dynamics in time of their publication is presented in Figure 1. Among the records, 87.1% were dated after 1990, and 12.9% before 1990 (Appendix II and Table 1). Compared to the national density of reptile records per 100 km^2 of 0.029 in the GBIF dataset (http://data.gbif.org, accessed 30.03.2013), our database increased it to 7.5 reptile records per 100 km^2.

The species' Extent of Occurrence ranged from 6439 km^2 (*Testudo hermanni*) to 233497 km^2 (*Natrix natrix*), while species' Area of Occupancy ranged from 125 km^2 (*Eryx jaculus*) to 37346 km^2 (*Lacerta agilis*, Table 1).

Table 1. The occurrence records for reptile species in Romania. EOO was estimated as 100% minimum convex polygon, and AOO was estimated as the total area of all UTM grid cell containing species records. Since not all UTM cells matched the 25 km² area, the computed AOO is not a multiple of this value. Rarity index was calculated relative to a 50 × 50 km cell in order to check for regional patterns.

Species	Total number of records	Old records (before 1990)	New records (after 1990)	Number of UTM5 squares	EOO (km^2)	AOO (km^2)	Rarity index
Emys orbicularis	753	131	622	561	232748	13491	22.7
Testudo graeca	1159	117	1042	154	14441	3748	91.1
Testudo hermanni	891	83	808	96	6439	2120	93.4
Anguis fragilis	1006	111	895	728	211520	17994	38.2
Eremias arguta	85	23	62	30	10851	625	95.1
Lacerta agilis	2554	268	2286	1521	231768	37346	13.8
Darevskia praticola	93	34	59	60	80161	1449	84.5
Lacerta trilineata	133	26	107	64	14028	1589	91.1
Lacerta viridis	2737	214	2523	1101	228111	26886	19.5
Zootoca vivipara	805	105	700	463	114513	11488	60.9
Podarcis muralis	672	111	561	374	167436	9093	56.9
Podarcis tauricus	1399	188	1211	358	163668	8671	70.7
Ablepharus kitaibelii	250	56	194	100	63728	2413	80.4
Eryx jaculus	5	4	1	5	10692	125	96.7
Coronella austriaca	527	98	429	389	213819	9581	39.8
Zamenis longissimus	500	73	427	363	201245	8868	50.4
Elaphe sauromates	47	15	32	27	17099	667	91.8
Dolichophis caspius	351	50	301	202	83585	4810	79.6
Natrix natrix	2180	163	2017	1361	233497	33202	15.4
Natrix tessellata	843	139	704	406	193909	9758	47.9
Vipera ammodytes	305	95	210	142	94177	3423	82.9
Vipera berus	663	138	525	464	144079	11515	47.1
Vipera ursinii	78	35	43	33	67560	729	91.1
Total	**18036**	**2277**	**15759**	-	-	-	

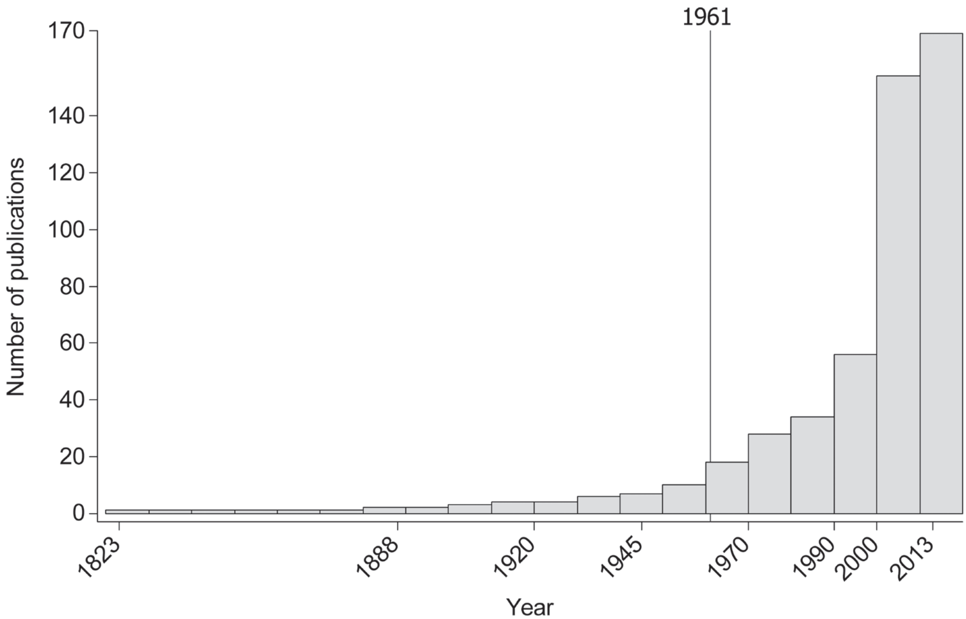

Figure 1. Number of publications with distribution data of reptiles in Romania (1823–2013). The reference line indicates the last country wide assessment published in 1961 (Fuhn and Vancea 1961).

Spatial patterns in species occurrences

Only 27.7% of the total UTM 5 × 5 km grid cells in Romania contained the sighting of at least one reptile species (Figure 2). The number of cumulative reptile records per cell had a clustered pattern, supporting the hypothesis of an overall bias in sampling effort (Z = 19.98, p < 0.001). Getis Ord Gi* spatial statistic identified several isolated sites, mainly protected areas, as hotspots of sampling effort (Figure 3).

The species richness map highlighted a lower sampling effort in the vast agricultural areas in the southern part of Romania (Figure 4 and Appendix III). By contrast, the southeastern and southwestern part of Romania, with Mediterranean influences (Rey et al. 2007), presented the highest diversity of reptile species with a maximum richness of 17 species per 50 × 50 km grid cell.

The altitudinal range of reptiles varied between 0 and 2075 m (Figure 5), with only *Zootoca vivipara* and *Vipera berus* occurring above 2000 m, while *Eremias arguta* (occurring at maximum 34 m) and *Eryx jaculus* (occurring at maximum 88 m) are clearly restricted to lowlands. The updated distribution maps of reptile species in Romania are presented in Figures 6–28.

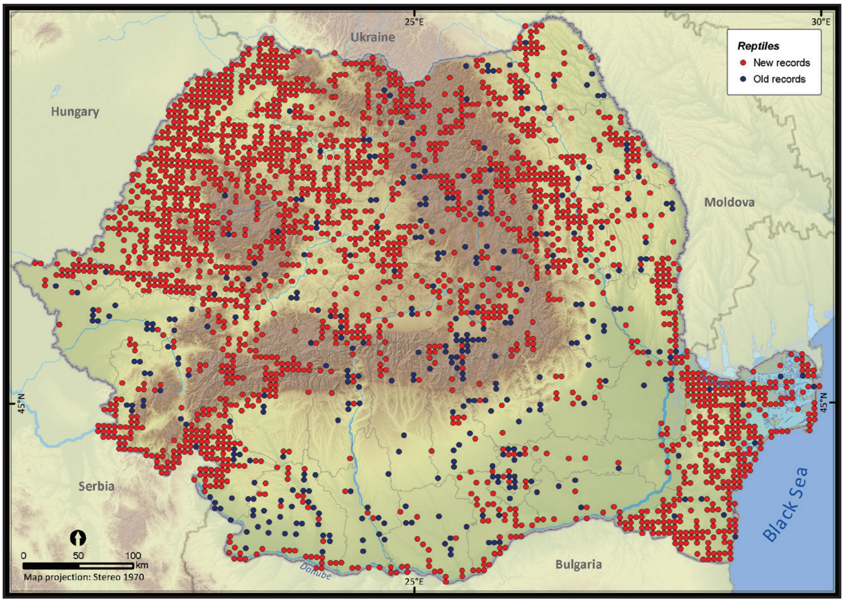

Figure 2. The presence records of reptiles per UTM 5 × 5 km grid cell in Romania. Records reported before 1990 were plotted as old records whereas those reported after 1990 were considered new records.

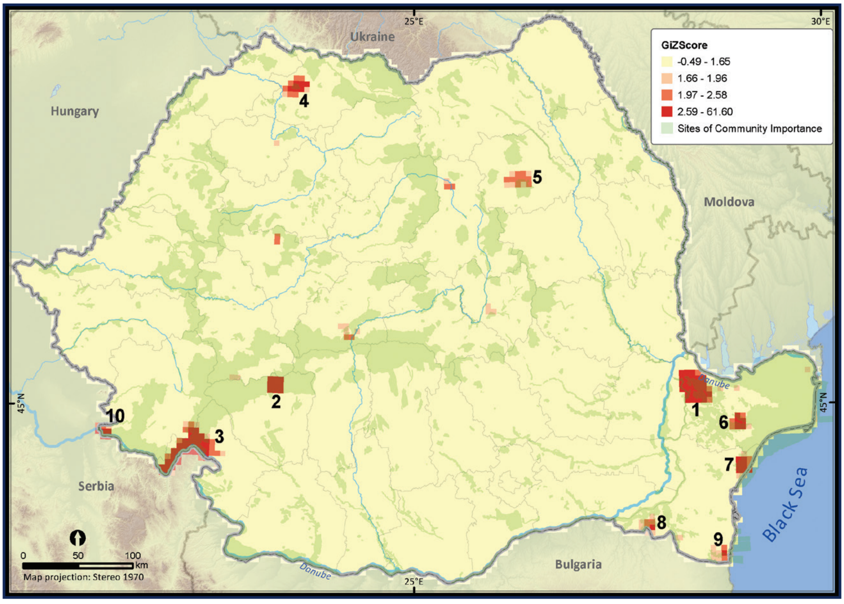

Figure 3. The hotspots of sampling efforts within Romania. The *p* value was < 0.05 when Z scores took values between 1.96 and 61.60, suggesting a highly clustered pattern in the number of reptile occurrences per UTM 5 × 5 km grid cell. The numbered hotspots were: **1** Măcin Mountains **2** Jiului Gorges **3** Iron Gates and Mehedinți Plateau **4** Sweet chestnut Arboretum of Baia Mare and the surroundings of Baia Mare town **5** Goșman Mountains and the surroundings of Piatra Neamț town **6** the Danube Delta and Babadag Forest **7** the Danube Delta and Histria Archaeological Complex **8** Canaraua Fetii – Iortmac **9** Hagieni – Cotu Văii Forest **10** Nera river mouth and Baziaș.

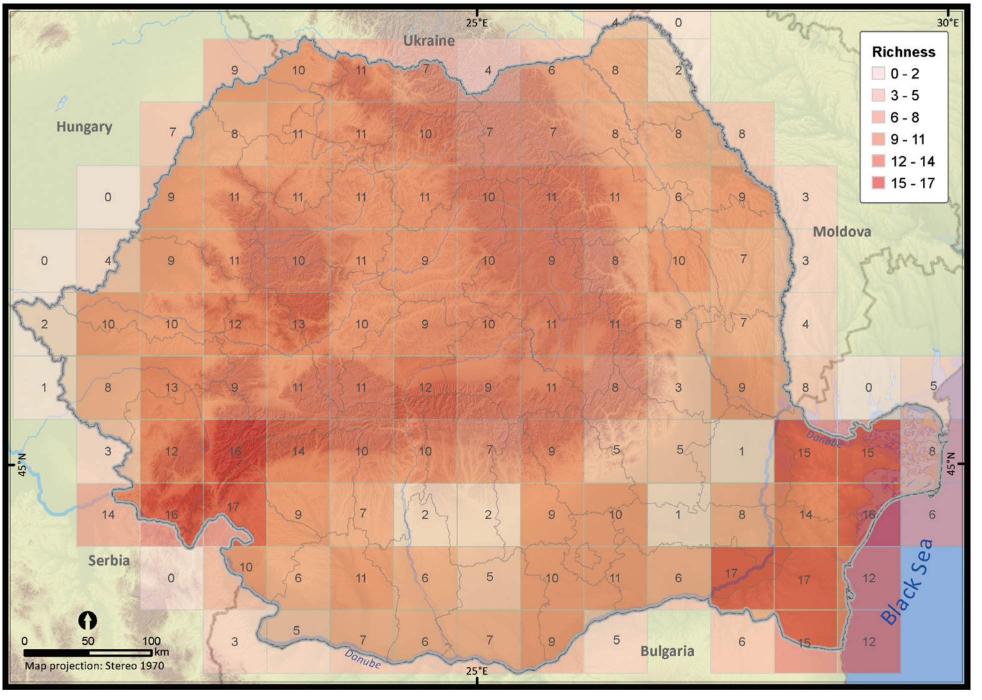

Figure 4. The reptile species richness at a 50 × 50 km grid resolution within Romania.

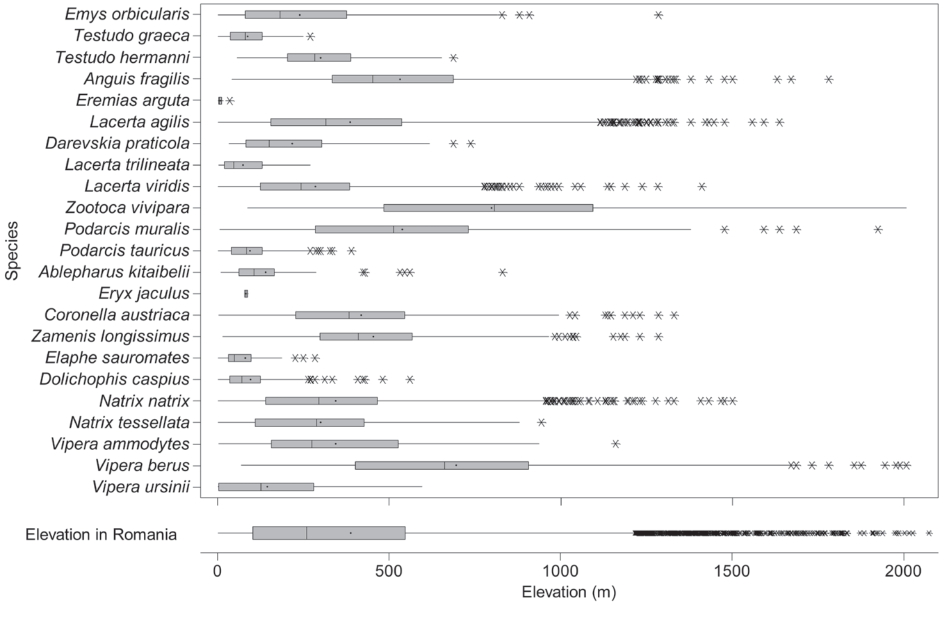

Figure 5. The box and whisker plot of altitudinal distribution of reptile species in Romania. The boxes represent 25th–75th percentiles, upper and lower whiskers extends minimum and maximum data point within 1.5 box heights from the bottom and from the top of the boxes. Asterisks indicate outliers, lines and dots inside the boxes denote medians and means, respectively.

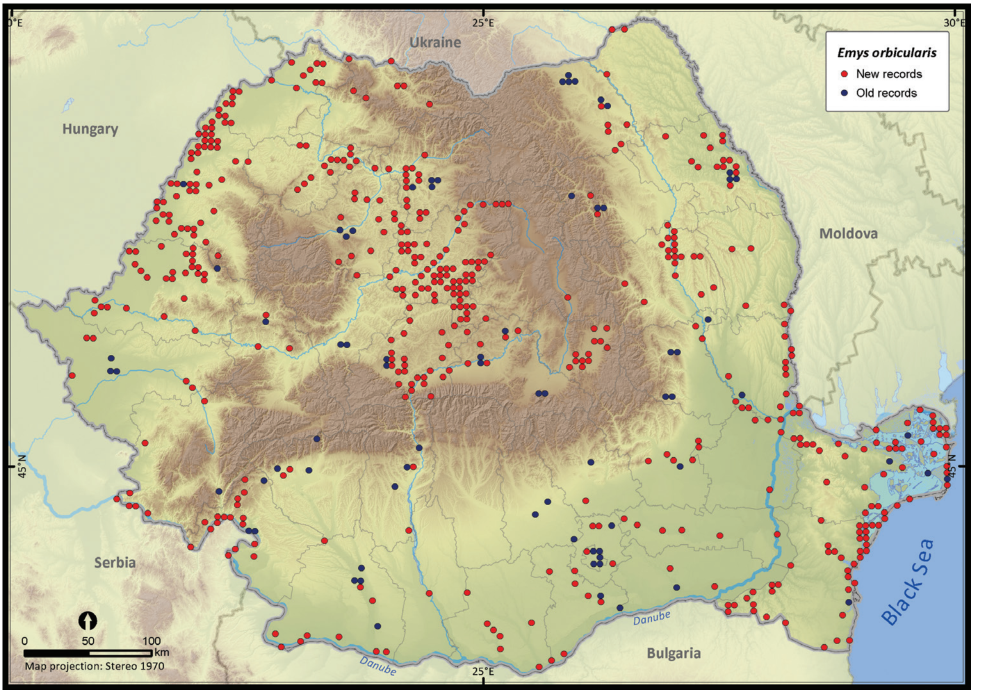

Figure 6. *Emys orbicularis.*

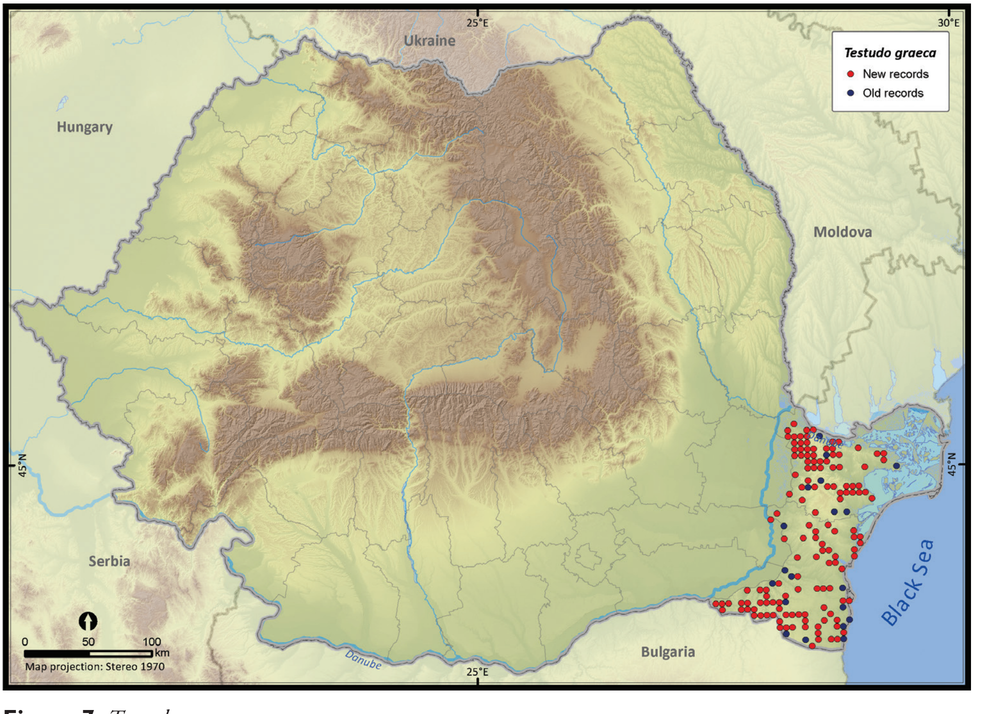

Figure 7. *Testudo graeca.*

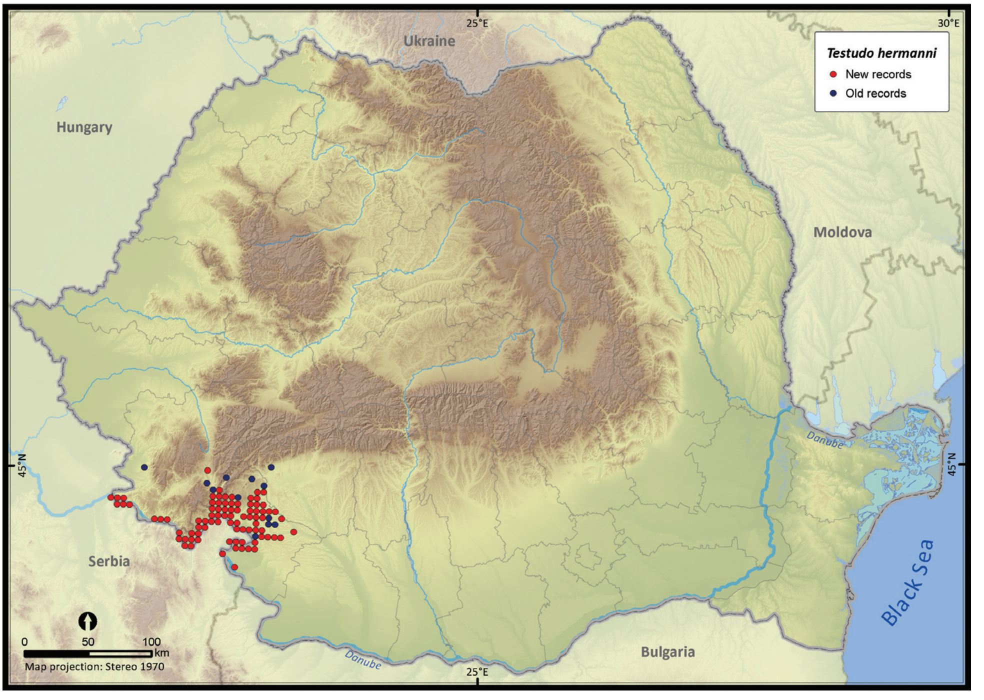

Figure 8. *Testudo hermanni.*

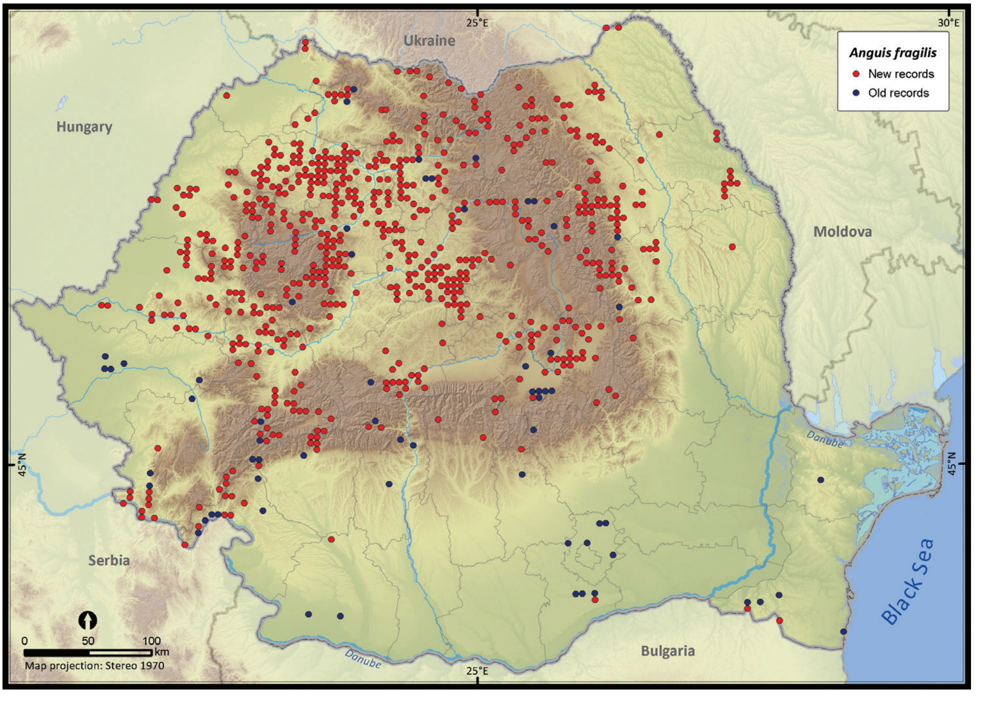

Figure 9. *Anguis fragilis.*

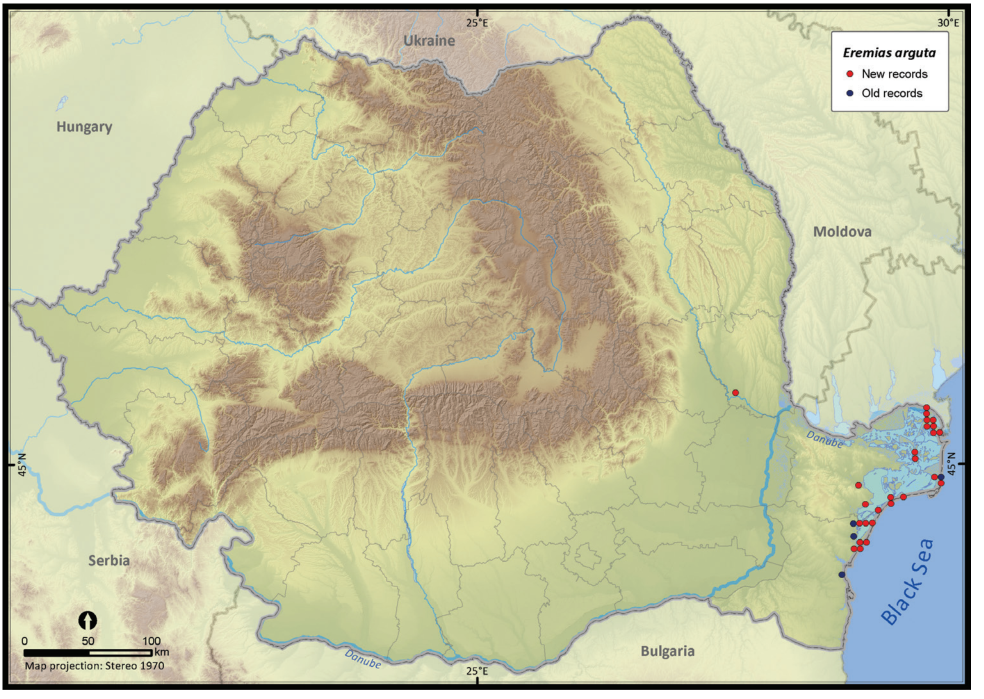

Figure 10. *Eremias arguta.*

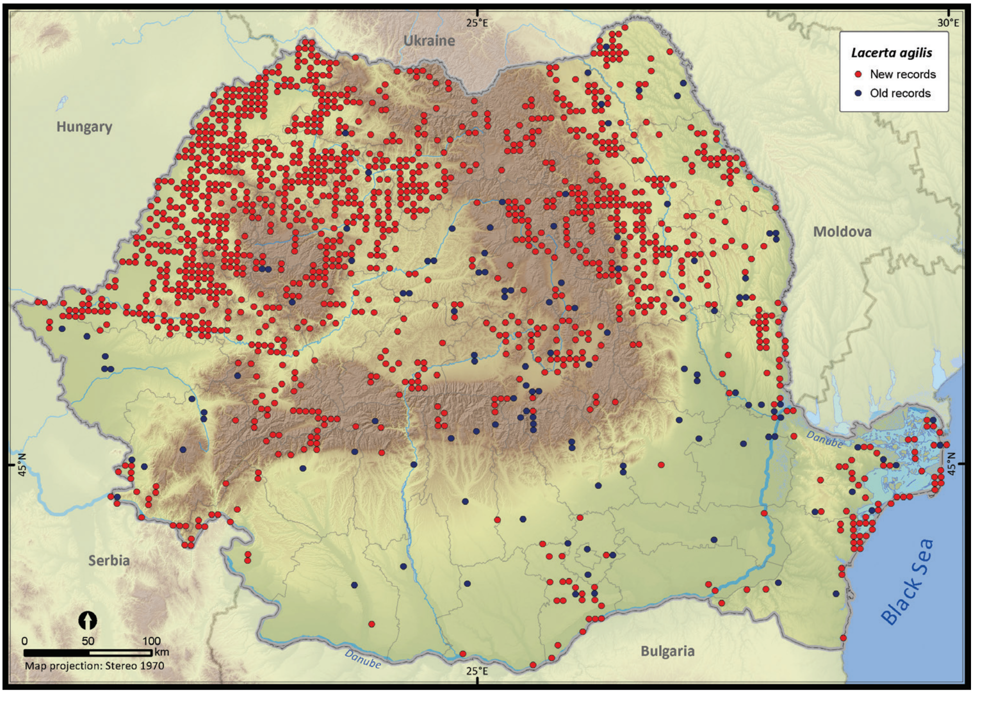

Figure 11. *Lacerta agilis.*

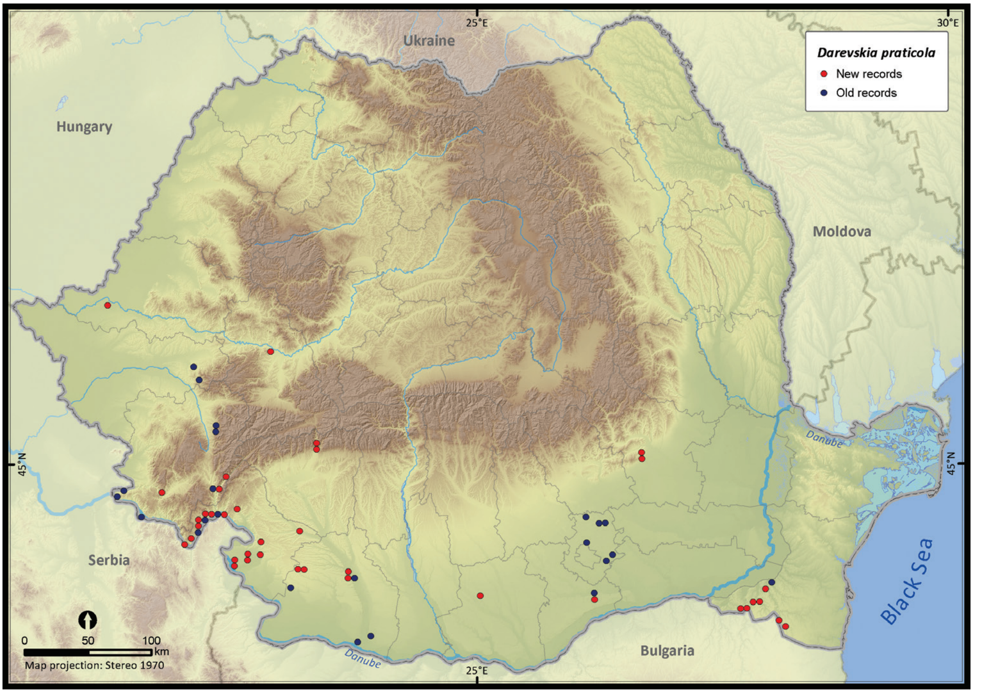

Figure 12. *Darevskia praticola.*

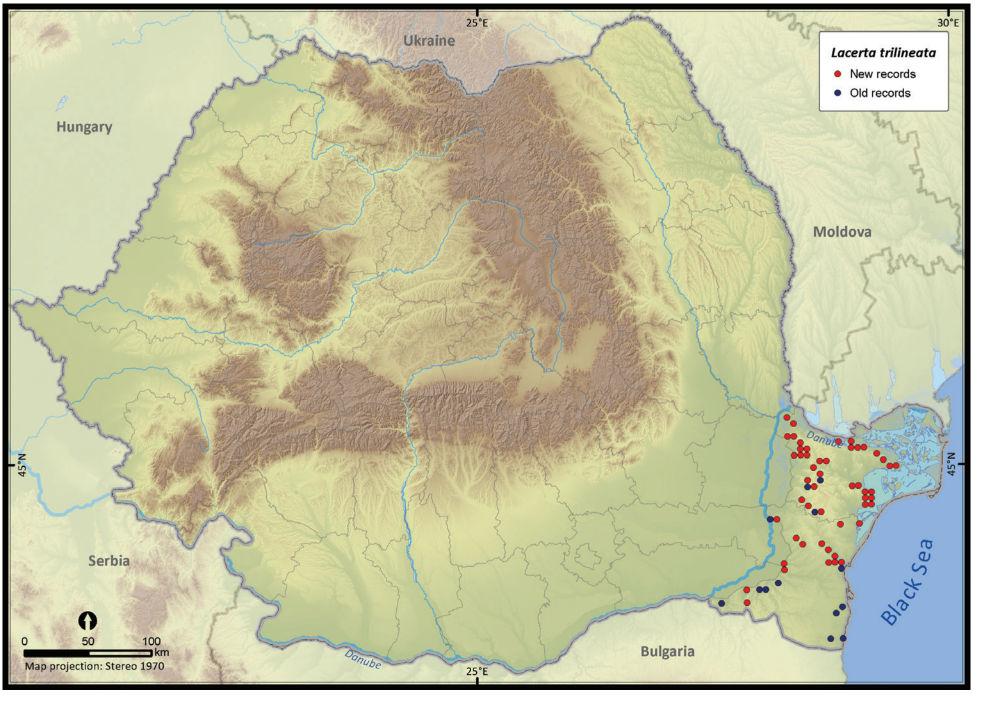

Figure 13. *Lacerta trilineata.*

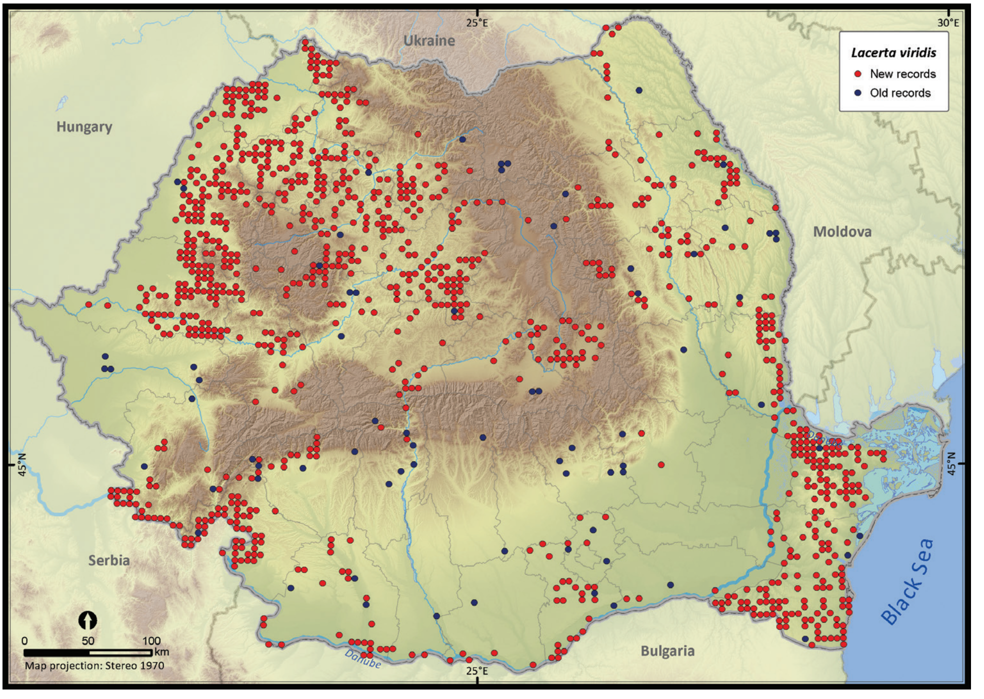

Figure 14. *Lacerta viridis.*

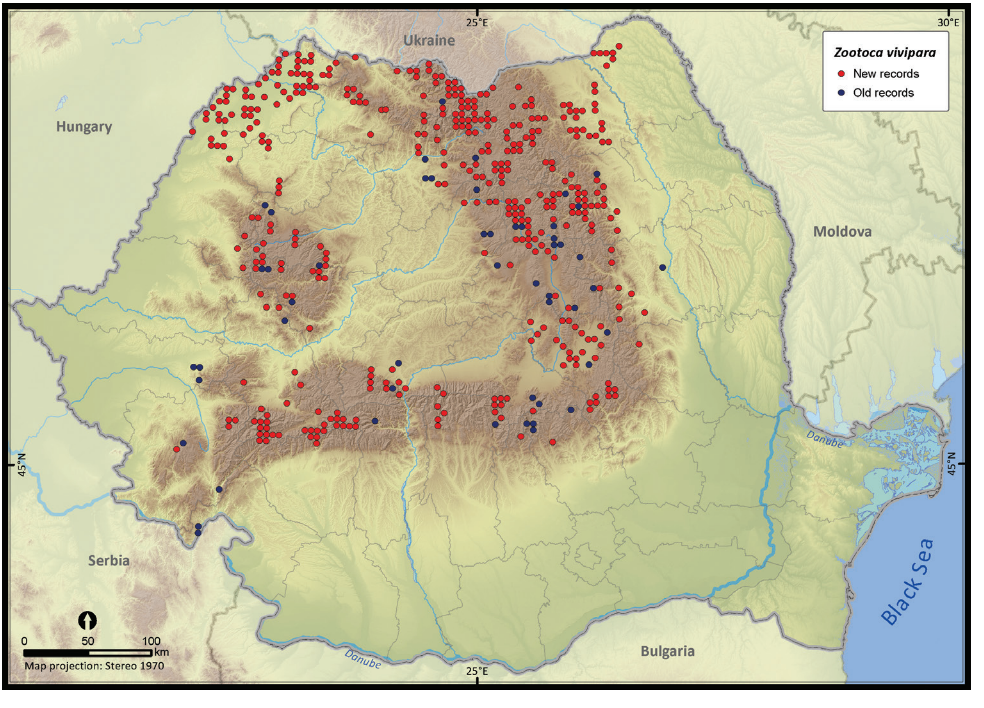

Figure 15. *Zootoca vivipara.*

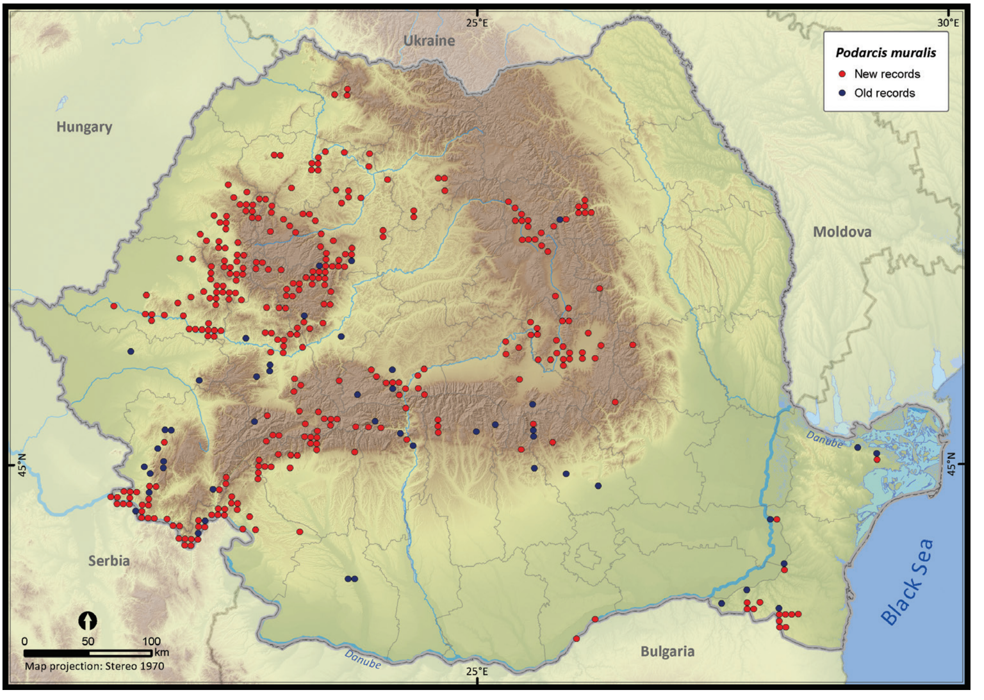

Figure 16. *Podarcis muralis.*

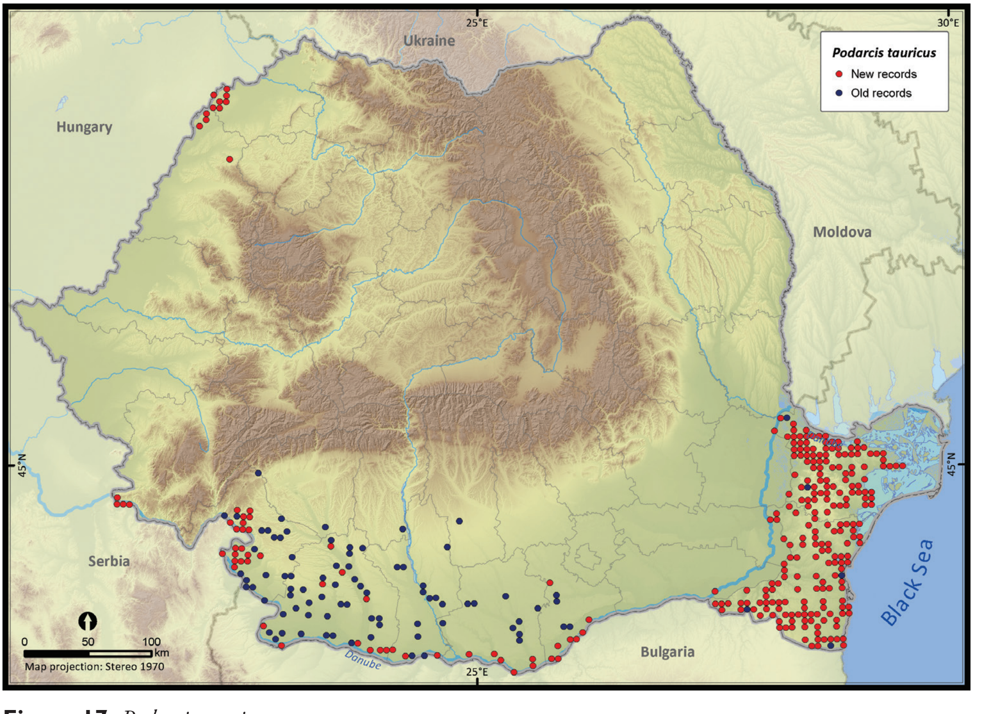

Figure 17. *Podarcis tauricus.*

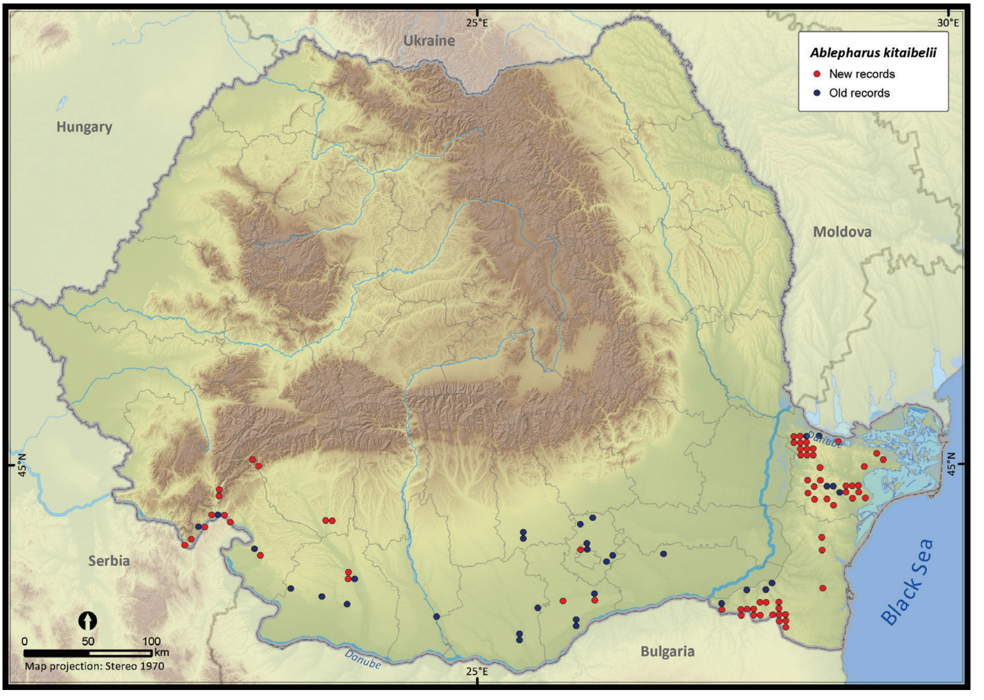

Figure 18. *Ablepharus kitaibelii.*

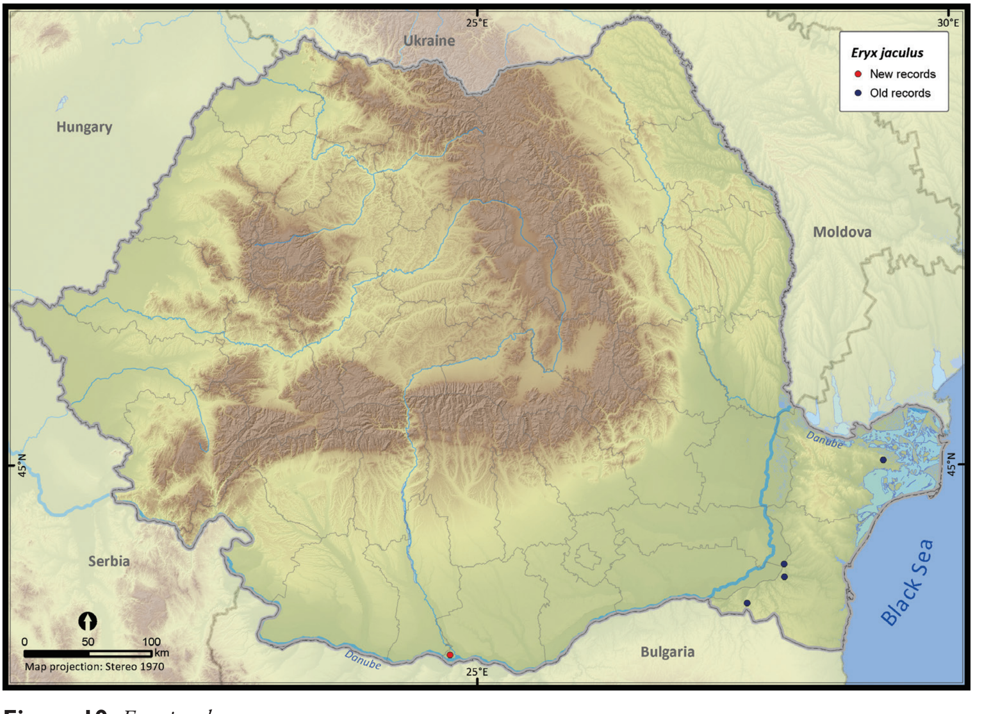

Figure 19. *Eryx jaculus.*

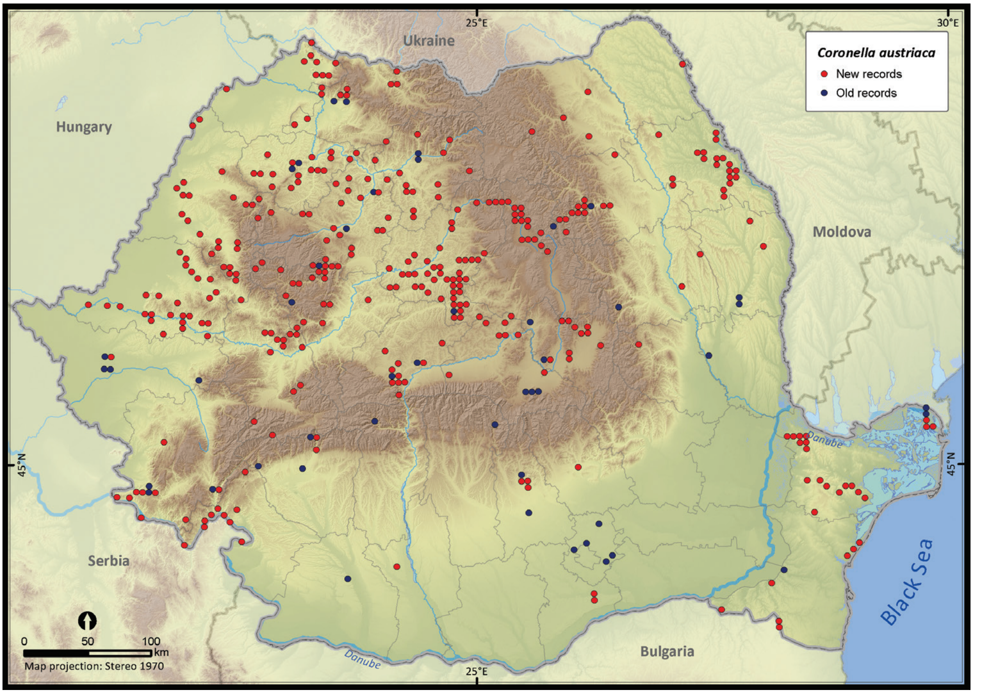

Figure 20. *Coronella austriaca.*

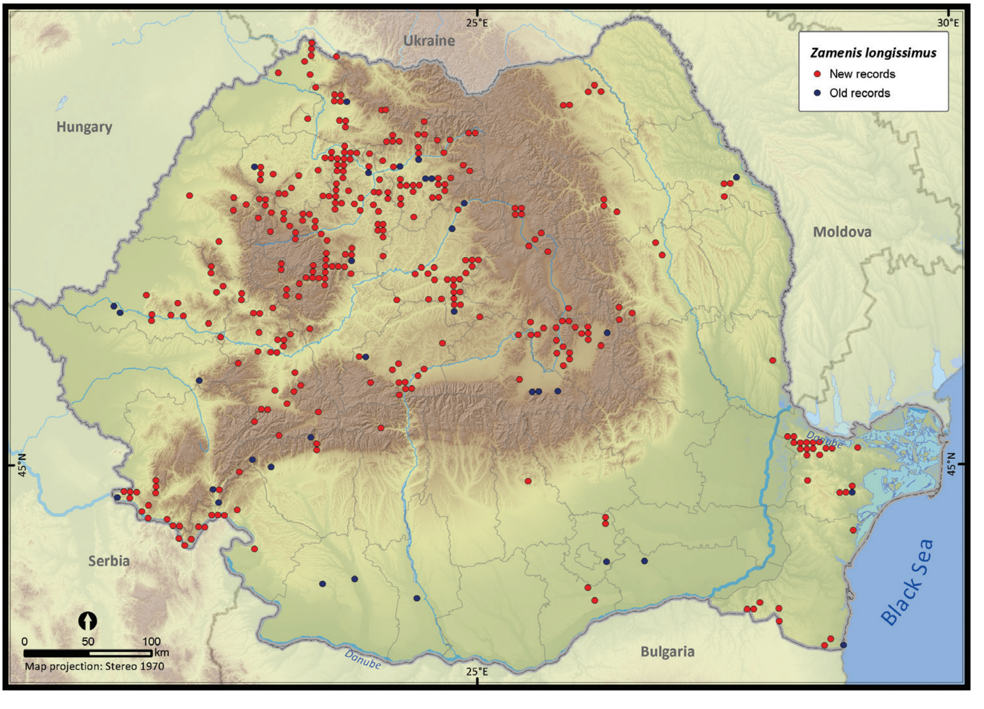

Figure 21. *Zamenis longissimus.*

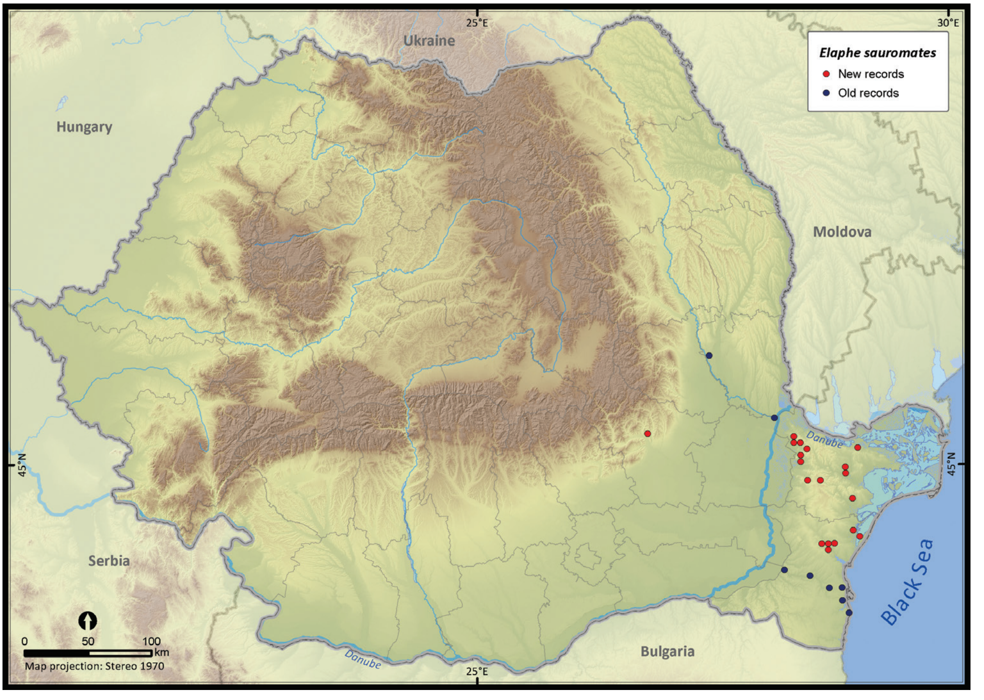

Figure 22. *Elaphe sauromates.*

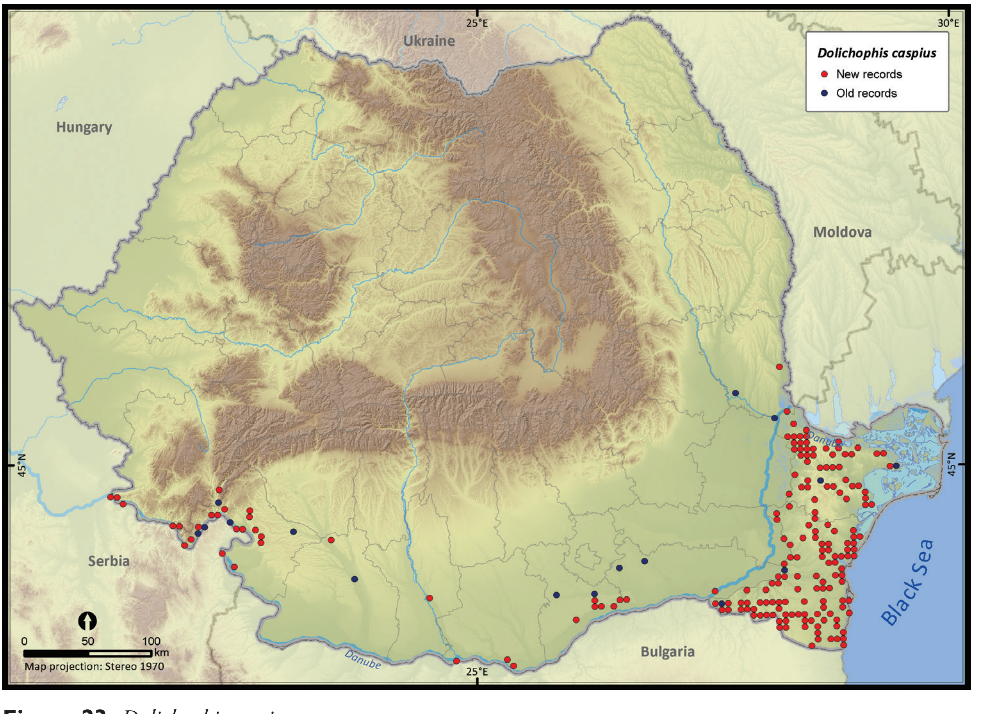

Figure 23. *Dolichophis caspius.*

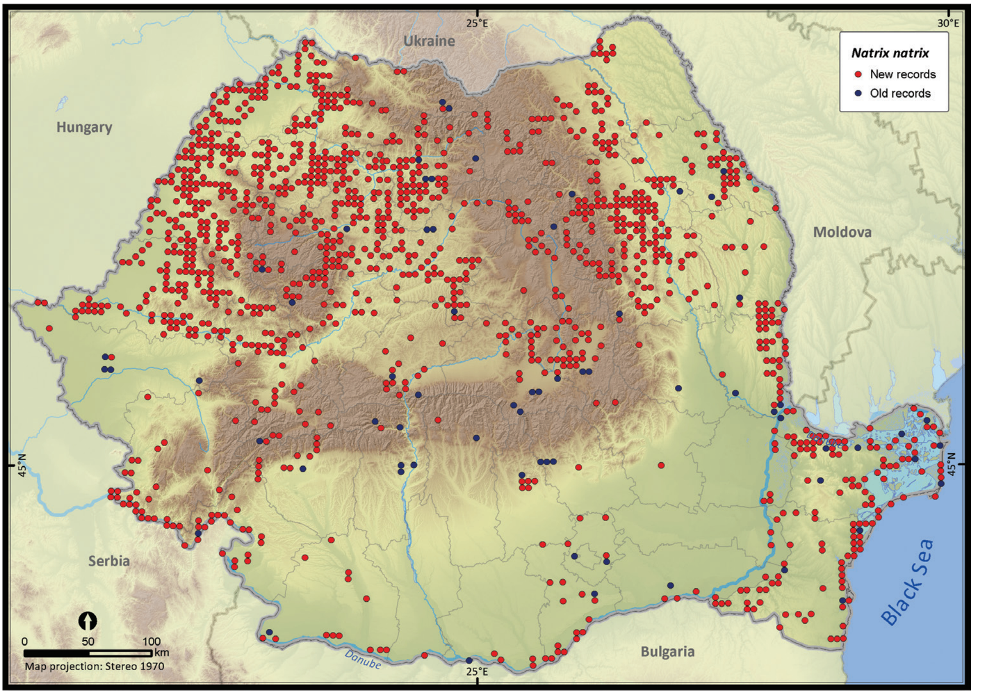

Figure 24. *Natrix natrix.*

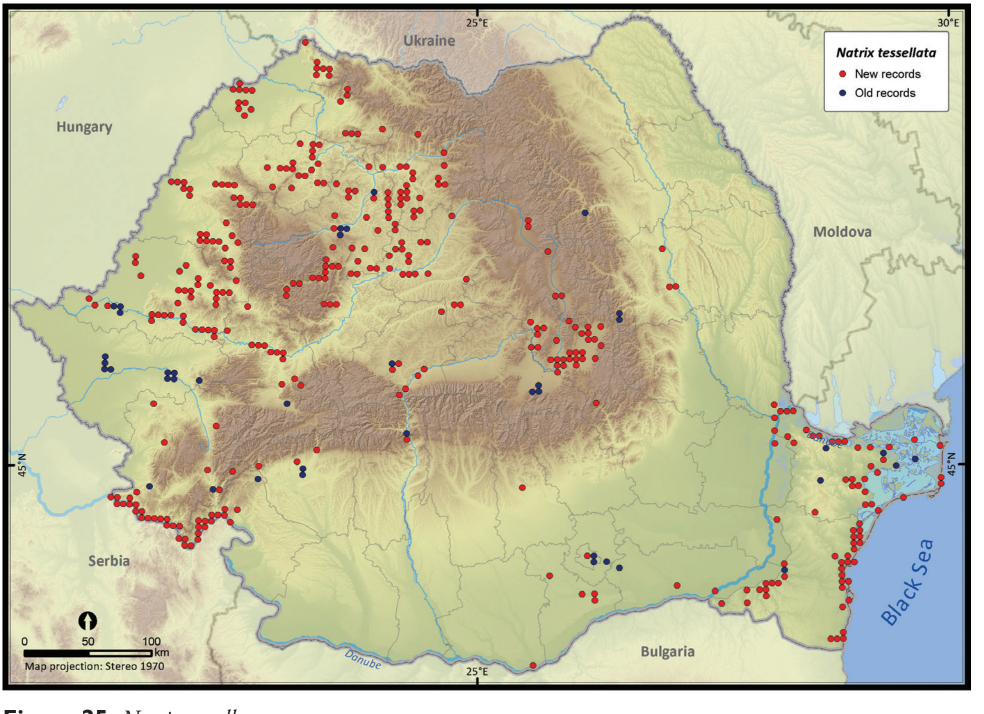

Figure 25. *Natrix tessellata.*

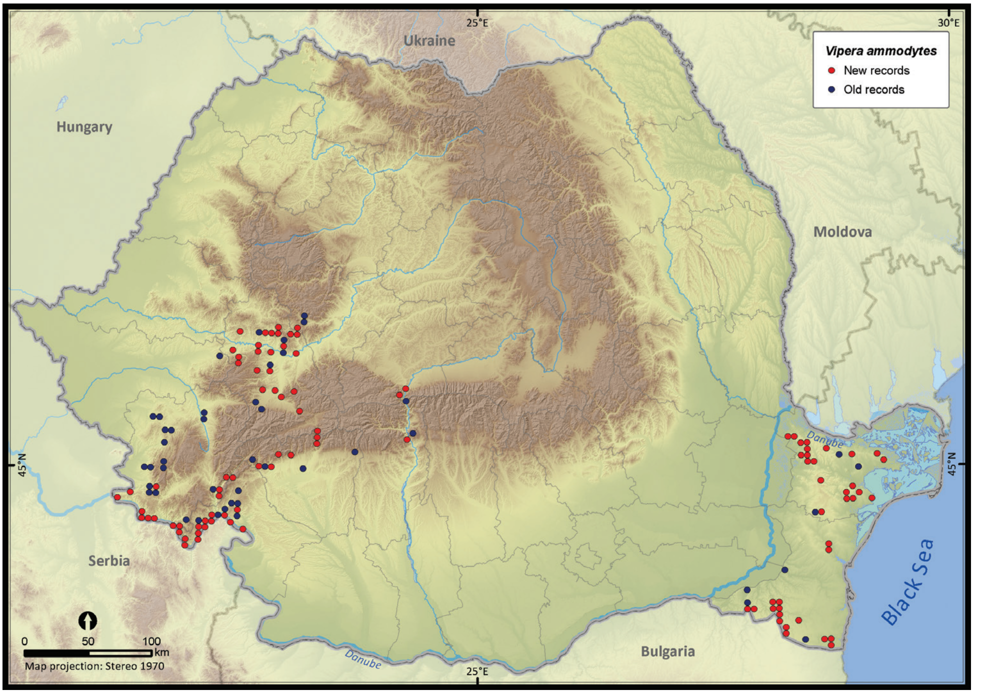

Figure 26. *Vipera ammodytes.*

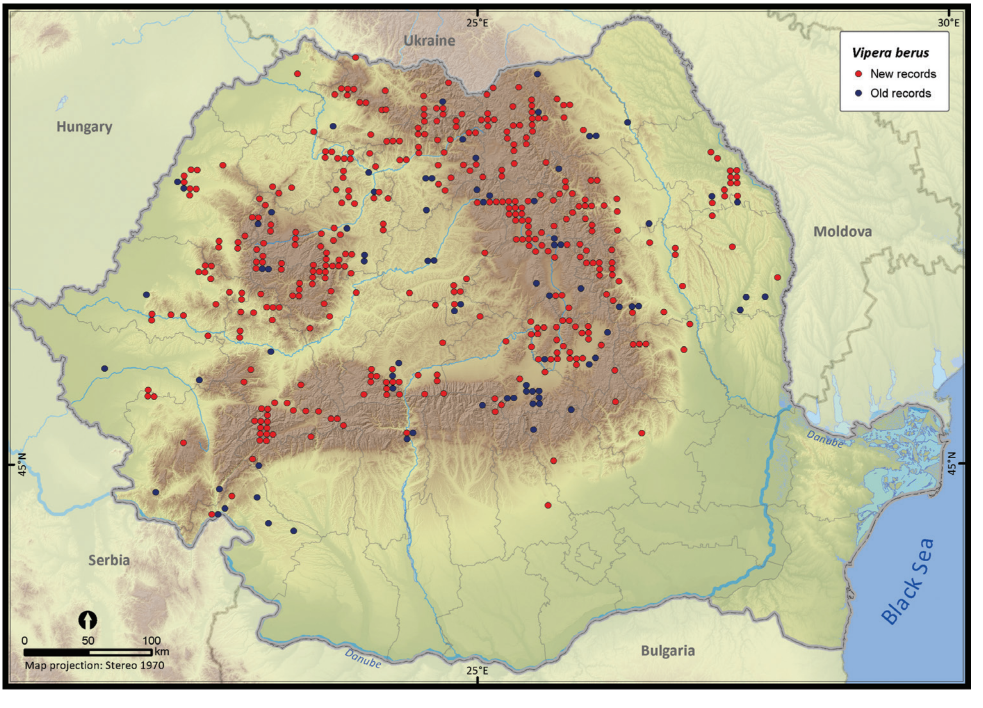

Figure 27. *Vipera berus.*

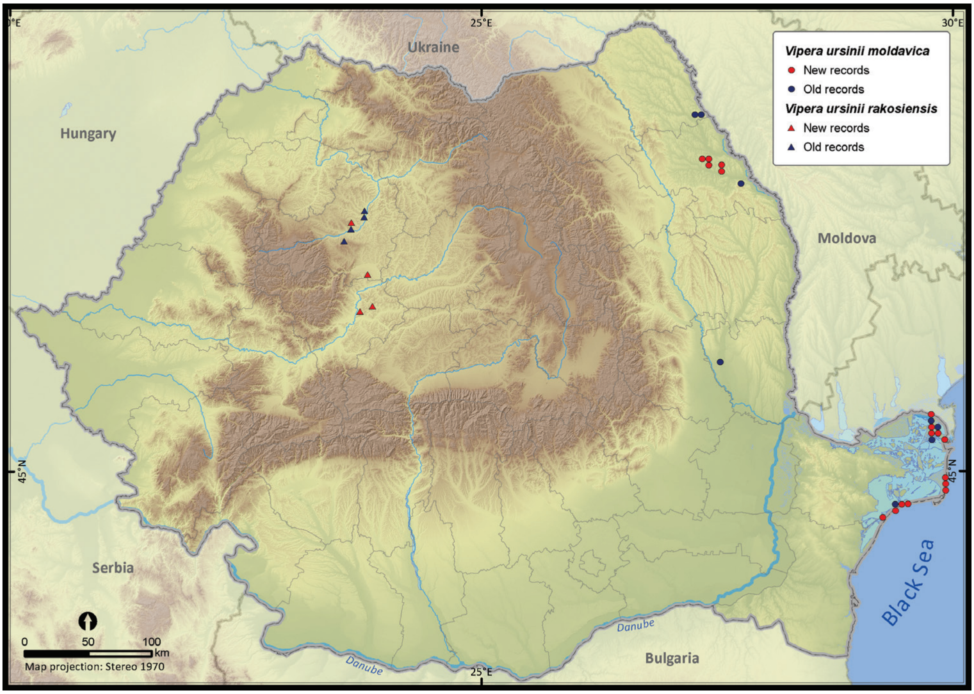

Figure 28. *Vipera ursinii moldavica* and *Vipera ursinii rakosiensis.*

Discussion

We here present the first comprehensive distribution database of the reptile species occurring in Romania. We fulfilled the major requirements of data quality by (1) filtering the large amount of data for doubtful and erroneous records, (2) aggregating the known localities to a fine resolution of 25 km^2, and (3) assessing the bias in sampling effort and thus providing useful information for further analyses.

We addressed a series of issues related to the quality and relevance of occurrence records. The most conspicuous issue was the overall biased density of records, which might appear due to differences in species detectability. For instance, our database showed that the snake species with low detectability (Hartel et al. 2009, Durso et al. 2011) had a low number of occurrences despite their wide range. Notable exceptions are the grass snake and the dice snake (genus *Natrix*), both of them being active during the day and easy to identify. The higher detectability of most lizards and both tortoise species resulted in a large number of occurrences and thus, more detailed distribution maps.

Another issue of concern was misidentification (e.g., Török 2012), due to difficulties in distinguishing the actual species based only on sightings. For example, it is rather difficult to distinguish among green lizards, especially between *Lacerta viridis* and *L. trilineata* and we assumed that some of the occurrence records for those species were misallocated.

Although individuals of *Testudo hermanni* were reported from south-east Romania (Iftime 2002, Sós et al. 2008), we chose not to map the respective occurrences, considering them a case of vagrancy (Rozylowicz and Dobre 2010). The presence report of *T. hermanni* from Hunedoara county (Togănel 1993) was also not considered since it was the case of a recent human introduction into the wild (Rozylowicz 2008).

The analysis of sampling effort revealed a significantly higher number of sightings per grid cell within certain areas, mostly protected areas, such as the Jiului Gorges National Park, the Iron Gates Natural Park or the Măcin Mountains National Park. That was a common pattern previously reported from other countries and for different taxa (e.g., Loureiro et al. 2010, Botts et al. 2011). Despite those hotspots, the sampling effort was balanced across the country; therefore the dataset might be useful for additional analyses with only a simple trimming procedure required (Peterson et al. 2011). In the case of amphibians (Cogălniceanu et al. 2013), the sampling effort was biased towards the same hotspots but their number was significantly less numerous for reptiles. Nevertheless, the patterns in species richness support a similar statement revealing a higher richness in the warmer and drier climate in the south-west and the south-east parts of Romania (e.g., Rodríguez et al. 2005) and a constant richness in the rest of the country. Two gaps that require further investigations were revealed in the southern part of Romania (Oltenia and Bărăgan plains), probably being determined by the lack of research interest in those regions, due to their dominant agricultural landscape (Rey et al. 2007, Iojă et al. 2011). The gaps in reptile richness were similar to those of amphibian richness (Cogălniceanu et al. 2013).

The number of reptile species observed in Romania might increase in the near future with two species, namely *Pseudopus apodus* (Lepşi 1926, Cogălniceanu et al. 2008) and *Mediodactylus kotschyi,* both present in Bulgaria and near the Romanian border (Gasc et al. 1997).

Several species were widespread across the country (e.g., *Emys orbicularis, Lacerta viridis, L. agilis, Natrix natrix, N. tessellata, Zamenis longissimus, Vipera berus*), while others occurred only in the south of Romania (e.g., *Testudo hermanni, T. graeca*, *Eremias arguta, Lacerta trilineata, Eryx jaculus, Elaphe sauromates, Dolichophis caspius*). *Lacerta viridis* had the largest number of sightings mainly because it is a highly detectable species. Its AOO was surpassed only by *L. agilis* and *Natrix natrix*, two other highly detectable species. *Eryx jaculus* is the rarest reptile in the country (see Table 1) with a single new report after 1990, based on a road-kill specimen (Covaciu-Marcov et al. 2012).

The different biogeographic regions overlapping in Romania will face different types and levels of these changes (Popescu et al. in press). Climate change may cause a shift in reptile ranges, although the Carpathian Mountains and the Steppic and Black Sea province of Dobrogea will act as a refuge, being considered critical areas for conservation (Araújo et al. 2006, Popescu et al. in press). To alleviate these threats by conservation activities (e.g., by establishing new protected areas), a key step is predicting the range responses to different climate change scenarios (Franklin 2009, Araújo et al. 2011). Our dataset provides a robust starting point for such analyses. Climate change alone does not result in a rapid range shift; instead, additionally, habitat loss due to the abandonment of traditional agricultural activities such as manual mowing, low-intensity grazing, small-size orchards and vineyards (Plieninger et al. 2006, Angelstam et al. 2013) might lead to a rapid contraction of the reptiles ranges (e.g., *Testudo hermanni*, Rozylowicz and Popescu 2013). Thus, our database also allows for further investigations resulting in concrete conservation activities.

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Appendix I

The publications used to compile the distribution of reptile species native to Romania. (doi: 10.3897/zookeys.341.5502.app1) File format: Microsoft Word file (doc).

Citation: Cogălniceanu D, Rozylowicz L, Székely P, Samoilă C, Stănescu F, Tudor M, Székely D, Iosif R (2013) Diversity and distribution of reptiles in Romania. ZooKeys 341: 49–76. doi: 10.3897/zookeys.341.5502 The publications used to compile the distribution of reptile species native to Romania. doi: 10.3897/zookeys.341.5502.app1

Appendix II

The reptiles occurrence records within Romania per time intervals. (1961 represented the publishing year of the last country wide assessment). (doi: 10.3897/zookeys.341.5502.app2) File format:Microsoft Word file (doc).

Citation: Cogălniceanu D, Rozylowicz L, Székely P, Samoilă C, Stănescu F, Tudor M, Székely D, Iosif R (2013) Diversity and distribution of reptiles in Romania. ZooKeys 341: 49–76. doi: 10.3897/zookeys.341.5502 The reptiles occurrence records within Romania per time intervals. doi: 10.3897/zookeys.341.5502.app2

Appendix III

The reptile species richness at a 10 × 10 km grid resolution within Romania. (SCI = Natura 2000 Sites of Community Importance). (doi: 10.3897/zookeys.341.5502.app3) File format: Microsoft Word file (doc).

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RESEARCH ARTICLE

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Sea anemones (Cnidaria, Anthozoa, Actiniaria) from coral reefs in the southern Gulf of Mexico

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Abstract

Seven sea anemone species from coral reefs in the southern Gulf of Mexico are taxonomically diagnosed and images from living specimens including external and internal features, and cnidae are provided. Furthermore, the known distribution ranges from another 10 species are extended. No species records of sea anemones have been previously published in the primary scientific literature for coral reefs in the southern Gulf of Mexico and thus, this study represents the first inventory for the local actiniarian fauna.

Keywords

Anthozoa, Veracruz Reef System, Cayo Arenas, Alacranes Reef, Banco de Campeche, Yucatán

Introduction

Sea anemones (order Actiniaria) are among the benthic and sessile invertebrates inhabiting the southern Gulf of Mexico (SGM) coral reefs. Nevertheless, sea anemones are typically overlooked in assessments of coral reefs biodiversity due to the poor taxonomic knowledge available on local species. Although some studies provide records of sea anemone species from some coral reefs in the SGM (González-Solís 1985, Rosado-Matos 1990, González-Muñoz 2005, Vélez-Alavéz 2007, CONANP 2006), formal taxonomic identification was beyond their scope. Thus, no inventory of sea anemones has been previously published in the primary scientific literature for coral reefs in the SGM. The present contribution documents 17 species from 15 coral reefs of the Veracruz Reef System (VRS), and five coral reefs of the Campeche Bank, Yucatán Peninsula (Figure 1). Taxonomic diagnoses with images of living specimens, including external and internal features, and cnidae are provided for seven species: *Anemonia sargassensis* Hargitt, 1908; *Anthopleura pallida* Duchassaing and Michelotti, 1864; *Bunodosoma cavernatum* (Bosc, 1802); *Isoaulactinia stelloides* (McMurrich, 1889); *Actinoporus elegans* Duchassaing, 1850; *Lebrunia coralligens* (Wilson, 1890); and *Calliactis tricolor* (Le Sueur, 1817). The other 10 species were recently diagnosed in an inventory of the Mexican Caribbean sea anemone fauna (González-Muñoz et al. 2012); however, here we extend their distribution range for coral reef localities in the SGM (Table 1). Those species are: *Bunodeopsis antilliensis* Duerden, 1897; *Actinostella flosculifera* (Le Sueur, 1817); *Bunodosoma granuliferum* (Le Sueur, 1817); *Condylactis gigantea* (Weinland, 1860); *Lebrunia danae* (Duchassaing & Michelotti, 1860); *Phymanthus crucifer* (Le Sueur, 1817); *Stichodactyla helianthus* (Ellis, 1768), *Aiptasia pallida* (Agassiz in Verrill,

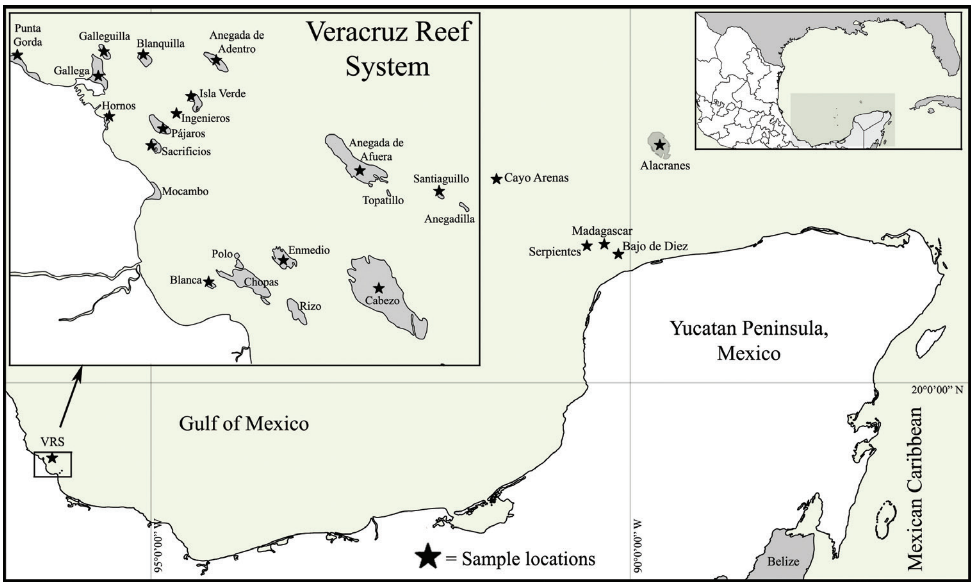

Figure 1. Map of the Southern Gulf of Mexico, indicating the localities sampled in this study.

Table 1. Distribution of sea anemones found on the coral reefs of SGM in the present study. The symbol "x" indicates localities of previous but not published records, "*" indicates new records for the locality found in the present study, and "†" indicates new records for Mexico.

	Veracruz Reef System															Campeche Bank Reefs				
Species	**Punta Gorda**	**Galleguilla**	**Gallega**	**Blanquilla**	**Anegada de Adentro**	**Hornos**	**Isla Verde**	**Pájaros**	**Isla Sacrificios**	**Ingenieros**	**Anegada de Afuera**	**Santiaguillo**	**Blanca**	**Isla de Enmedio**	**Cabezo**	**Bajo de Diez**	**Madagascar**	**Serpientes**	**Alacranes**	**Cayo Arenas**
Bunodeopsis antilliensis Duerden, 1897																			*	*
Actinostella flosculifera (Le Sueur, 1817)	*	x	*			*	x		*	*				*	*		*		*	
Anemonia sargassensis Hargitt, 1908	*		*			*	x			*									*	*
Anthopleura pallida Duchassaing & Michelotti, 1864 †																			*	
Bunodosoma cavernatum (Bosc, 1802) †	*	*	*			*	*			*				*						
Bunodosoma granuliferum (Le Sueur, 1817)														*					*	
Condylactis gigantea (Weinland, 1860)																*	*		x	*
Isoaulactinia stelloides (McMurrich, 1889) †	*		*						*						*					
Aiptasia pallida (Agassiz in Verrill 1864)	*	x	*			*			*	*			*				*	*	*	
Bartholomea annulata (Le Sueur, 1817)		*	*				*	*	*		*			*	*	*	*	*	*	*
Ragactis lucida (Duchassaing & Michelotti, 1860)		*							*		*								*	
Lebrunia coralligens (Wilson, 1890)		x		*	*		x	*	*	*		*	*	*	*					
Lebrunia danae (Duchassaing & Michelotti, 1860)																			*	
Actinoporus elegans Duchassaing, 1850 †			*				*		*					*	*					
Calliactis tricolor (Le Sueur, 1817) †																	*		*	
Phymanthus crucifer (Le Sueur, 1817)	*	x	*		*	*	x	*	*	*				*	*		*		*	*
Stichodactyla helianthus (Ellis, 1768)	*	x	*	*		*	x		*	*				*	*				x	

1864); *Bartholomea annulata* (Le Sueur, 1817); and *Ragactis lucida* (Duchassaing & Michelotti, 1860) (Figure 2). Although these 17 species have a widespread geographic distribution in the Caribbean Sea and Gulf of Mexico (Fautin and Daly 2009, Fautin 2013), this study represents the first inventory of sea anemones of coral reefs in the SGM. The aim of this contribution is to encourage biological and ecological research on sea anemones of the coral reefs of the SGM by facilitating identification work.

Methods

Observations and collections of specimens were done at 20 coral reef localities of the SGM during 2009–2011 (Figure 1). Habitats sampled include sandy patches, seagrass meadows, rocky pavement, coral rubble, and coral patches in several zones of coral

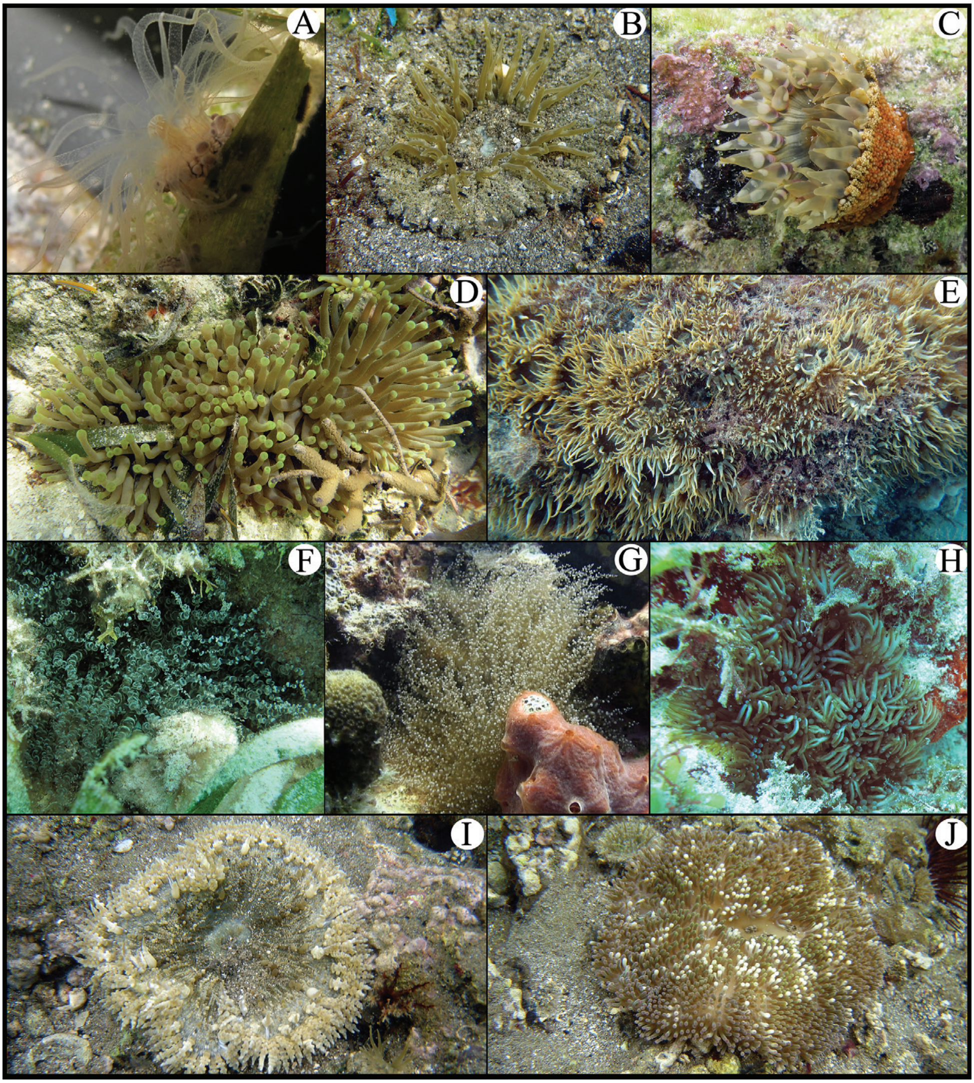

Figure 2. A *Bunodeopsis antilliensis* **B** *Actinostella flosculifera* **C** *Bunodosoma granuliferum* **D** *Condylactis gigantea* **E** *Aiptasia pallida* **F** *Bartholomea annulata* **G** *Ragactis lucida* **H** *Lebrunia danae* **I** *Phymanthus crucifer* **J** *Stichodactyla helianthus*.

reefs, and depth and habitat characteristics were recorded. Specimens were collected by hand, either by snorkeling or SCUBA diving, using a small shovel, and hammer and chisel. Collected specimens were transferred to the laboratory and maintained in an aquarium to photograph their color in life. Specimens were relaxed using 5% $MgSO_4$ seawater solution and subsequently fixed in 10% formalin in seawater. Measurements provided for pedal disc, column, oral disc and tentacles were obtained from living and relaxed specimens. Fragments of selected specimens were dehydrated and embedded in paraffin. Histological sections 6–10 μm thick were stained with hematoxylin-eosin

(Estrada et al. 1982) or Ramón and Cajal's Triple Stain (Gabe 1968). For cnidae examination, squash preparations of small amounts of tissue of two specimens from each species (tentacles, actinopharynx, filaments, column, and if present, marginal projections, acrorhagi, acontia and pseudotentacles) were examined using a Nikon Labophot-2 light microscope (1000x oil immersion), photographed and haphazardly measured. Nematocyst terminology follows Mariscal (1974) and Östman (2000).

Specimens were deposited in the Collection of the Gulf of Mexico and Mexican Caribbean Sea (Registration code: YUC–CC–254–11) of the Unidad Multidisciplinaria de Docencia e Investigación en Sisal (UMDI-Sisal) at the Universidad Nacional Autónoma de México (UNAM), and in the American Museum of Natural History (AMNH, accession number 65822). We followed the taxonomic classification and synonymies implemented in Fautin (2013) with modifications from Rodríguez et al. (2012). Taxa are arranged in families in alphabetical order. The diagnosis of each species is based on the features observed in the collected specimens. The synonym list for each species only contains reference to the first citation of the species by a particular name. The number of specimens examined of each species per locality is indicated in the material examined. Figure 1 displays the coral reef localities sampled in this study. Table 1 indicates previous and new records of the species observed and collected at each coral reef locality; Table 2 includes size ranges of length and width of cnidae capsules for each studied species.

Results

Systematic treatment

Order Actiniaria Hertwig, 1882
Suborder Nynantheae Carlgren, 1899
Infraorder Thenaria Carlgren, 1899
Superfamily Actinoidea Rafinesque, 1815
Family Actiniidae Rafinesque, 1815
Genus *Anemonia* Risso, 1826

***Anemonia sargassensis* Hargitt, 1908**
http://species-id.net/wiki/Anemonia_sargassensis
Figure 3, Table 2

Anemonia sargassensis Hargitt 1908: 117–118.
Anemonia antillensis Pax 1924: 94, 99–100, 119.
Anemonia sargassiensis [sic]: Carlgren 1949: 50.

Material examined. Alacranes reef (22°31'35"N, 89°46'05"W; two specimens), Cayo Arenas reef (22°07'05"N, 91°24'17"W; three specimens), La Gallega reef (19°13'20"N, 96°07'39"W; two specimens), Ingenieros reef (19°08'41"N, 96°05'22"W; two specimens).

Table 2. Size and distribution of preserved cnidae from specimens examined. "m_l" and "m_w" are the means (length and width respectively), "d_l" and "d_w" are the standard deviations (length and width respectively), all in µm. "#[1]" and "#[2]" is the number of capsules measured per each specimen examined, "p" is the proportion of animals examined with respective to the type of cnida present.

Species	Tissue	Cnida	Capsule length (µm)	m_l	d_l	Capsule width (µm)	m_w	d_w	#[1]	#[2]	p
Anemonia sargassensis	Tentacle	Basitrich	8.7–20.2	16.1	2.2	1.6–3.3	2.1	0.2	24	21	2/2
		Basitrich	21.0–36.8	30.8	3.6	2.4–3.6	3.0	0.2	23	21	2/2
		Spirocyst	15.1–40.0	25.3	7.0	2.2–3.5	2.9	0.3	21	20	2/2
	Actinopharynx	Basitrich	13.9–33.5	24.9	3.9	2.1–4.0	3.2	0.4	20	26	2/2
		Microbasic *p*-mastigophore	16.8–24.9	19.7	2.2	3.3–5.6	4.5	0.6	6	9	2/2
	Column	Basitrich	13.3–22.6	18.3	2.4	2.1–3.0	2.5	0.2	21	20	2/2
	Acrorhagi	Basitrich	14.6–26.4	20.1	3.0	2.1–3.2	2.4	0.1	20	22	2/2
		Basitrich	27.8–43.7	35.8	3.6	2.5–3.5	3.1	0.1	21	21	2/2
		Holotrich	31.1–42.4	36.8	2.6	4.4–6.9	5.1	0.4	22	20	2/2
	Filament	Basitrich	12.9–32.7	19.2	5.2	1.8–3.0	2.4	0.2	20	27	2/2
		Microbasic *b*-mastigophore	24.6–33.9	28.6	2.5	3.7–6.0	4.7	0.6	22	21	2/2
		Microbasic *p*-mastigophore	15.0–24.5	20.4	2.3	3.7–5.9	4.8	0.5	21	22	2/2
Anthopleura pallida	Tentacle	Basitrich	12.6–20.6	16.8	2.0	1.7–2.6	2.1	0.2	23	21	2/2
		Spirocyst	11.8–19.2	16.0	1.4	2.3–3.6	2.9	0.3	28	21	2/2
	Actinopharynx	Basitrich	15.0–27.0	21.6	3.1	1.8–3.1	2.5	0.3	23	24	2/2
		Basitrich	10.1–18.0	14.0	1.7	1.5–2.4	1.9	0.1	15	22	2/2
		Spirocyst	11.2–19.5	16.2	1.9	2.3–3.7	2.8	0.3	12	21	2/2
		Microbasic *b*-mastigophore	20.9–28.3	24.6	2.7	2.8–4.4	3.3	0.5	5	1	2/2
		Microbasic *p*-mastigophore	13.4–23.5	19.4	3.9	3.8–5.0	4.3	0.5	1	4	2/2
	Column	Basitrich	14.7–19.3	17.2	1.2	2.8–4.2	3.2	0.3	22	22	2/2
		Basitrich	8.7–17.1	14.2	1.6	1.4–2.4	2.0	0.1	26	21	2/2
		Spirocyst	10.3–14.7	12.6	1.5	2.3–2.6	2.5	0.1	5	1	2/2
	Acrorhagi	Basitrich	12.2–25.3	16.6	2.7	1.7–2.6	2.1	0.2	25	23	2/2
		Basitrich	7.6–14.9	11.8	1.4	1.4–2.1	1.7	0.1	23	0	1/2
		Spirocyst	11.3–23.9	17.8	2.6	1.9–3.5	2.6	0.4	22	20	2/2

Species	Tissue	Cnida	Capsule length (µm)	m_l	d_l	Capsule width (µm)	m_w	d_w	#[1]	#[2]	p
		Holotrich	17.9–39.3	31.8	3.8	2.4–4.7	3.6	0.5	29	25	2/2
		Holotrich	21.1–36.5	27.9	4.2	2.3–3.3	2.8	0.2	24	0	1/2
		Microbasic *p*-mastigophore	16.5–17.5	17.0	0.7	2.8–4.1	3.4	0.8	2	0	1/2
	Filament	Basitrich	13.1–33.7	17.3	3.9	1.9–3.0	2.3	0.3	15	7	2/2
		Basitrich	9.2–18.5	14.1	2.1	1.2–2.3	2.0	0.2	3	20	2/2
		Spirocyst	10.9–19.2	15.5	2.1	1.9–3.5	2.6	0.3	20	4	2/2
		Microbasic *b*-mastigophore	15.5–28.0	24.9	2.4	3.1–4.6	3.7	0.3	7	20	2/2
		Holotrich	29.7–33.5	31.6	2.6	2.8–3.0	2.9	0.1	2	0	1/2
		Microbasic *p*-mastigophore	17.2–23.4	20.5	2.2	4.2–4.8	4.5	0.2	1	4	2/2
Bunodosoma cavernatum	Tentacle	Basitrich	10.7–29.5	21.0	4.7	1.6–3.4	2.1	0.4	21	22	2/2
		Spirocyst	13.2–22.6	16.8	2.3	1.7–3.7	2.5	0.6	20	23	2/2
	Actinopharynx	Basitrich	21.0–27.2	24.7	1.2	2.8–3.5	3.2	0.1	22	20	2/2
		Microbasic *p*-mastigophore	16.3–21.1	18.5	1.5	3.7–6.0	4.9	0.5	4	22	2/2
	Column	Basitrich	14.7–19.8	16.8	1.2	1.8–2.5	2.2	0.1	20	20	2/2
		Basitrich	20.8–28.4	24.8	1.6	2.5–3.9	3.0	0.2	31	21	2/2
	Acrorhagi	Basitrich	17.2–28.8	22.8	3.5	2.1–3.5	2.7	0.4	21	20	2/2
		Holotrich	26.6–45.1	35.0	3.7	3.1–5.8	4.0	0.5	22	20	2/2
	Filament	Basitrich	11.9–28.5	23.9	4.7	1.6–4.0	3.0	0.5	6	21	2/2
		Microbasic *b*-mastigophore	20.5–37.4	28.0	4.3	4.2–8.9	6.2	1.7	30	22	2/2
		Microbasic *p*-mastigophore	14.4–23.1	18.7	2.9	3.2–6.7	4.6	0.9	20	21	2/2
Isoaulactinia stelloides	Tentacle	Basitrich	14.1–23.6	18.5	2.8	1.9–2.8	2.4	0.2	21	21	2/2
		Macrobasic *p*-mastigophore	16.0–25.6	22.0	1.6	5.1–9.2	7.3	0.9	23	22	2/2
		Spirocyst	12.2–22.2	17.4	2.6	1.9–3.0	2.4	0.2	21	21	2/2
	Actinopharynx	Basitrich	11.7–18.5	13.7	1.7	1.6–2.7	2.1	0.2	21	21	2/2
		Basitrich	16.6–34.1	26.4	2.9	2.3–3.2	2.9	0.2	29	22	2/2
		Macrobasic *p*-mastigophore	21.1–26.9	24.4	1.4	6.3–8.3	7.6	0.5	4	20	2/2
		Microbasic *p*-mastigophore	18.0–28.6	25.2	2.7	4.1–5.7	4.9	0.4	10	5	2/2
		Microbasic *b*-mastigophore	15.2–33.2	26.9	5.7	2.8–4.0	3.4	0.3	1	6	2/2
		Long, curved basitrich	18.9–32.8	24.9	4.8	1.6–2.2	1.9	0.2	6	6	2/2

Species	Tissue	Cnida	Capsule length (µm)	m_l	d_l	Capsule width (µm)	m_w	d_w	#[1]	#[2]	p
	Column	Basitrich	11.8–15.7	13.5	0.9	1.9–2.8	2.3	0.1	23	21	2/2
		Macrobasic *p*-mastigophore	22.2–27.7	24.5	1.2	5.2–7.5	6.3	0.5	26	20	2/2
		Long, curved basitrich	25.1–31.3	28.2	4.3	2.2–2.3	2.3	0.1	2	0	1/2
	Marginal projection	Basitrich	11.1–13.8	12.3	0.7	1.8–2.8	2.3	0.2	26	20	2/2
		Macrobasic *p*-mastigophore	20.1–25.9	22.7	1.4	5.2–8.5	6.5	0.8	32	20	2/2
	Filament	Basitrich	10.8–15.5	13.4	1.1	1.6–2.2	1.9	0.1	24	20	2/2
		Basitrich	17.6–31.8	22.2	3.4	1.7–3.1	2.3	0.3	20	21	2/2
		Macrobasic *p*-mastigophore	23.3–29.3	26.0	1.4	5.9–8.1	7.1	0.4	20	20	2/2
		Microbasic *p*-mastigophore	17.6–32.3	25.9	3.3	3.9–6.0	4.7	0.4	15	23	2/2
		Microbasic *b*-mastigophore	29.3–39.7	34.1	2.4	3.2–4.9	3.9	0.4	20	22	2/2
		Long, curved basitrich	17.0–29.7	24.1	5.5	1.5–2.2	1.9	0.3	4	0	1/2
Lebrunia coralligens	Tentacle	Basitrich	12.3–33.5	26.2	4.8	1.7–2.6	2.2	0.2	20	24	2/2
		Spirocyst	17.1–29.9	23.8	3.5	2.8–5.5	4.1	0.6	2	21	2/2
		Microbasic *p*-amastigophore	11.8–14.6	13.2	1.1	2.5–3.1	2.7	0.2	4	0	1/2
		Microbasic *p*-amastigophore	29.0–68.7	48.6	9.0	4.4–7.1	5.6	0.6	20	21	2/2
	Pseudotentacle	Basitrich	8.9–26.8	15.4	4.3	1.7–2.8	2.2	0.2	22	23	2/2
		Microbasic *p*-amastigophore	37.2–67.8	51.5	5.7	10.8–15.7	13.0	1.8	25	21	2/2
		Microbasic *p*-amastigophore	11.7–25.9	17.2	2.8	2.3–4.6	3.3	0.4	20	20	2/2
	Actinopharynx	Microbasic *p*-amastigophore	10.7–21.6	13.7	2.0	2.3–3.7	2.7	0.3	20	23	2/2
		Microbasic *p*-amastigophore	18.8–45.1	34.6	7.9	3.4–6.3	5.1	0.6	21	20	2/2
	Column	Basitrich	9.0–14.0	10.9	1.0	1.6–2.6	2.1	0.2	24	20	2/2
		Microbasic *p*-amastigophore	12.1–23.5	14.8	1.8	2.7–4.0	3.3	0.3	23	21	2/2
	Filament	Microbasic *p*-amastigophore	11.2–17.3	13.6	1.2	2.2–3.3	2.7	0.3	20	20	2/2
		Microbasic *p*-amastigophore	29.1–46.5	37.1	4.0	4.4–6.2	5.4	0.4	20	10	2/2
Actinoporus elegans	Tentacle	Basitrich	15.8–20.8	17.4	2.2	2.4–3.0	2.7	0.2	4	0	1/1
		Spirocyst	26.6–37.6	32.8	3.2	2.2–2.9	2.6	0.1	23	0	1/1
	Actinopharynx	Basitrich	25.6–32.5	27.9	1.7	3.5–4.8	4.2	0.3	21	0	1/1
		Microbasic *p*-mastigophore	29.8–34.9	31.9	1.4	6.6–9.0	7.8	0.5	22	0	1/1

Species	Tissue	Cnida	Capsule length (μm)	m_l	d_l	Capsule width (μm)	m_w	d_w	#[1]	#[2]	p
	Column	Basitrich	10.1–24.9	17.8	3.7	1.5–2.6	2.1	0.2	22	0	1/1
	Filament	Basitrich	16.1–24.5	21.3	2.2	2.1–3.1	2.6	0.2	20	0	1/1
		Microbasic *p*-mastigophore	25.7–30.2	27.8	1.1	5.3–6.9	6.0	0.4	20	0	1/1
	Tentacle	Basitrich	12.9–16.3	15.0	0.8	1.4–2.5	1.7	0.2	21	6	2/2
		Spirocyst	16.9–29.1	22.9	3.1	3.0–4.9	3.9	0.6	0	21	1/2
	Actinopharynx	Basitrich	13.3–25.5	19.3	4.4	1.4–3.3	2.3	0.4	24	21	2/2
		Microbasic *p*-mastigophore	13.4–18.2	16.0	1.0	2.3–3.1	2.6	0.2	20	0	1/2
Calliactis tricolor	Column	Basitrich	8.0–16.5	11.4	2.4	1.3–2.4	1.8	0.3	20	20	2/2
	Filament	Basitrich	13.7–26.2	19.5	4.1	1.9–3.0	2.3	0.2	20	21	2/2
		Basitrich	9.2–12.7	10.7	0.8	1.4–1.8	1.7	0.1	0	22	1/2
		Microbasic *p*-mastigophore	14.2–24.1	17.6	2.8	2.3–4.6	3.3	0.7	22	21	2/2
	Acontia	Basitrich	13.6–25.3	19.5	3.9	2.0–3.4	2.7	0.4	20	21	2/2

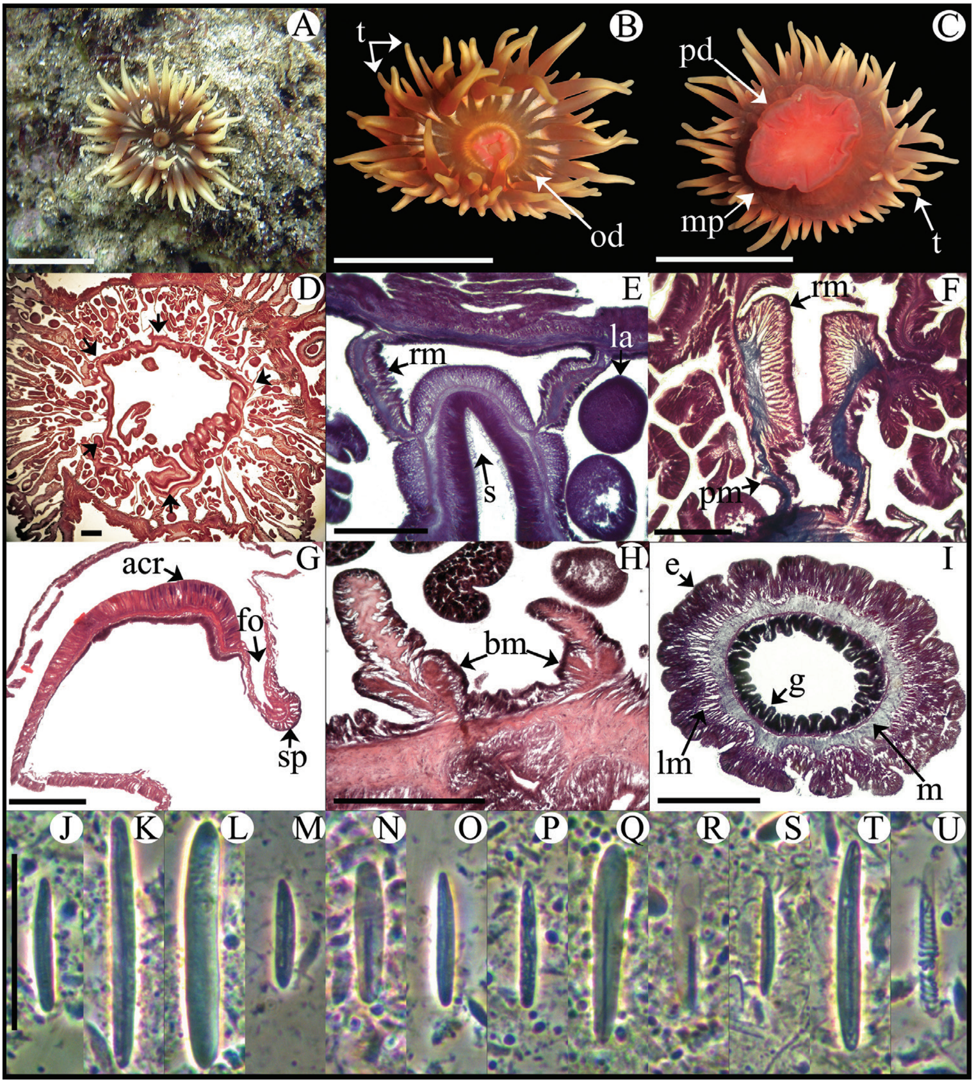

Figure 3. *Anemonia sargassensis.* **A** Live specimen in natural habitat **B** Oral view **C** Pedal disc view **D** Cross section through distal column showing mesenteries; arrows indicate siphonoglyphs **E** Detail of cross section through distal column showing a siphonoglyph **F** Detail of retractor and parietobasilar muscles **G** Longitudinal section through margin showing acrorhagi and marginal sphincter muscle **H** Longitudinal section through base showing basilar muscles **I** Cross section through tentacle **J–U** Cnidae.– acrorhagi: **J** small basitrich **K** basitrich **L** holotrich; actinopharynx: **M** small basitrich **N** microbasic *p*-mastigophore; column: **O** basitrich; filaments: **P** basitrich **Q** microbasic *b*-mastigophore **R** microbasic *p*-mastigophore; tentacle: **S** small basitrich **T** basitrich **U** spirocyst. Abbreviations.– acr: acrorhagi, bm: basilar muscle, e: epidermis, fo: fosse, g: gastrodermis, la: larvae, lm: longitudinal muscle, m: mesoglea, mp: marginal projection, od: oral disc, pd: pedal disc, pm: parietobasilar muscle, rm: retractor muscle, s: siphonoglyph, sp: sphincter, t: tentacle. Scale bars: **A–C**: 10 mm; D–I: 200 µm; **J–U**: 25 µm.

Diagnosis. Fully expanded oral disc and tentacles 9–50 mm in diameter. Oral disc smooth, 4–22 mm in diameter, wider than column, dark-orange, brownish, greenish or dark-red, with white or yellowish endocoelic radial stripes tapering from tentacle bases (Figure 3A, B); mouth bright orange or pink (Figure 3B). Tentacles hexamerously arranged in 4–5 cycles (48–76 in number), moderately long (to 6–19 mm length), smooth, slender, tapering distally, inner ones longer than outer ones, contractile, dark-orange to reddish, sometimes with whitish or yellowish tips and pink or purple flashes (Figure 3A–C). Fossa well marked (Figure 3G). Poorly marked endocoelic marginal projections, 17–35, forming acrorhagi (Figure 3G), with holotrichs and basitrichs. Column cylindrical, short, smooth, 5–11 mm in diameter and 5–12 mm in height, dark-orange to dark-red. Pedal disc well-developed, 6–16 mm in diameter, wider than column (Figure 3C), bright-orange or pink. Mesenteries irregularly arranged in four cycles: first and second cycles perfect, others imperfect; more mesenteries proximally than distally (82–89 and 44–48 pairs respectively in specimens examined). Directives absent, 5–6 siphonoglyphs in specimens examined (Figure 3D, E). Gametogenic tissue not observed in specimens examined. Larvae observed in coelenteron of one specimen examined (Figure 3E). Retractor muscles diffuse to restricted; parietobasilar muscles weak with short mesogleal pennon (Figure 3F). Basilar muscles well-developed (Figure 3H). Marginal sphincter muscle endodermal, diffuse (Figure 3G). Longitudinal muscles of tentacles ectodermal (Figure 3I). Zooxanthellae present. Cnidom: basitrichs, holotrichs, microbasic *b*- and *p*-mastigophores and spirocysts (Figure 3J–U; see Table 2).

Natural history. *Anemonia sargassensis* inhabits shallow waters of the lagoon reef zone, often above *Thalassia testudinum* blades, but is also found under stones and coral gravel, between 0.5–2 m. It is often reported on floating *Sargassum* (Carlgren and Hedgpeth 1952). Asexual propagation by longitudinal fission is common (Carlgren and Hedgpeth 1952) and bifurcated tentacles can occur (Hargitt 1908, 1912, Pax 1924, Corrêa 1964, present study).

Distribution. Western Atlantic, from the northern coast of USA and Caribbean Sea, to the northern coast of Brazil (Carlgren and Hedgpeth 1952, Varela 2002, Zamponi et al. 1998).

Remarks. Of the 20 valid species of *Anemonia*, four species have been recorded in the Gulf of Mexico and Caribbean Sea (Fautin 2013): *A. sargassensis, A. melanaster* (Verrill, 1901), *A. depressa* Duchassaing & Michelotti, 1860, and *A. elegans* Verrill, 1901. The anatomy described for *A. sargassensis* is conflicting mainly in the presence of directives, siphonoglyphs, and marginal projections (e.g. Hargitt 1908, 1912, Pax 1924, Field 1949, Carlgren and Hedgpeth 1952). Just as in Field (1949), Carlgren and Hedgpeth (1952), and Corrêa (1964), we did not find directives in our specimens but 5–6 siphonoglyphs were present. Although some authors suggest that *A. sargassensis* and *A. melanaster* are synonymous (Cairns et al. 1986, Ocaña and den Hartog 2002, Wirtz et al. 2003), further studies are necessary to establish the current taxonomic status of both species. Differences between the other two species of the genus in the region, *A. depressa* and *A. elegans*, and *A. sargassensis* are not clear based on the scarce information available and also require further revision.

Genus *Anthopleura* Duchassaing & Michelotti, 1860

Anthopleura pallida **Duchassaing & Michelotti, 1864**
http://species-id.net/wiki/Anthopleura_pallida
Figure 4, Table 2

Anthopleura pallida Duchassaing and Michelotti 1864: 32–33; Pl. V, fig. 10.
Anthopleura Pallida [sic]: Duchassaing 1870: 20.
non *Gyractis pallida* Boveri, 1893: 251–252.
Actinioides pallida: Duerden 1897: 453.
Actinoides pallida: Verrill 1900: 558.
Bunodactis stelloides catenulata Verrill, 1905: 263.
non *Anthopleura pallida* Carlgren, 1949: 53.
Anthopleura catenulata: Cairns, den Hartog and Arneson 1986: 177–178; Pl. 51.

Material examined. Alacranes reef (22°22'54"N, 89°40'59"W; four specimens).

Diagnosis. Fully expanded oral disc and tentacles 10–19 mm in diameter. Oral disc narrow, smooth, 3–8 mm in diameter, pale green or gray (Figure 4A). Tentacles hexamerously arranged in three cycles (24 in number), smooth, slender, relatively short (to 4–9 mm), tapering distally, inner ones longer than outer ones, contractile, whitish or gray, translucent, oral side with opaque white roundish spots (Figure 4A, B). Fosse well marked (Figure 4E). Column cylindrical, relatively elongate, 3–6 mm in diameter and 6–12 mm in height, with 12 longitudinal rows of verrucae from mid-column to distal margin (Figure 4B, G). Twelve endocoelic marginal projections forming acrorhagi (Figure 4B, E) with holotrichs, basitrichs, microbasic *p*-mastigophores, and spirocysts. Pedal disc well-developed, 4–8 mm in diameter, slightly wider than column (Figure 4B). Pedal disc and column white to pale green (Figure 4B). Mesenteries hexamerously arranged in 2–3 cycles: only first cycle perfect or first two cycles perfect and third imperfect; same number of mesenteries distally and proximally (12–32 pairs in specimens examined). Only first two cycles fertile (except directives); gonochoric (?), only spermatic cysts observed in specimens examined (Figure 4F). Two pairs of directives each attached to a well-developed siphonoglyph (Figure 4C). Retractor muscles diffuse; parietobasilar muscles well-developed with short mesogleal pennon (Figure 4D). Basilar muscles well-developed (Figure 4H). Marginal sphincter muscle endodermal, weak and diffuse (Figure 4E). Longitudinal muscles of tentacles ectodermal. Cnidom: basitrichs, microbasic *b*- and *p*-mastigophores, holotrichs, and spirocysts (Figure 4I–X; see Table 2).

Natural history. *Anthopleura pallida* inhabits the intertidal to shallow subtidal zone attached to coral on sandy shores, at 0.5 m. It is azooxanthellate and it broadcast spawns (Daly and den Hartog 2004).

Distribution. Western Atlantic, from Bermuda (Verrill 1900) to Virgin Islands (Duchassaing and Michelotti 1864). This is the first record for the coast of Mexico; found in Alacranes reef (see Table 1).

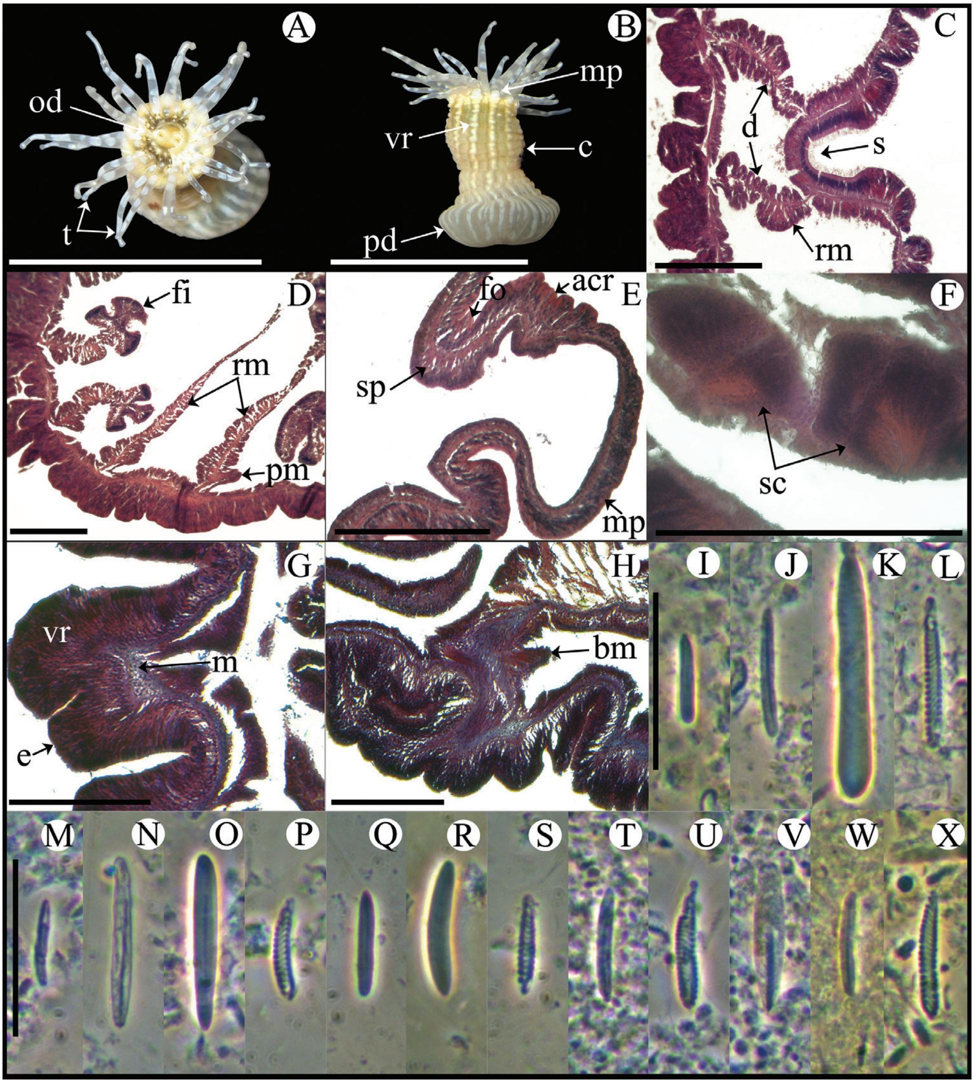

Figure 4. *Anthopleura pallida.* **A** Oral view **B** Lateral view **C** Detail of directives and siphonoglyph **D** Cross section through proximal column **E** Longitudinal section through margin showing acrorhagi and marginal sphincter muscle **F** Detail of spermatic cysts **G** Longitudinal section through distal column showing one verruca **H** Longitudinal section through base showing basilar muscles **I–X** Cnidae.– acrorhagi: **I** small basitrich **J** basitrich **K** holotrich **L** spirocyst; actinopharynx: **M** small basitrich **N** basitrich **O** microbasic *b*-mastigophore **P** spirocyst; column: **Q** small basitrich **R** basitrich **S** spirocyst; filament: **T** basitrich **U** spirocyst **V** microbasic *p*-mastigophore; tentacle: **W** basitrich **X** spirocyst. Abbreviations.– acr: acrorhagi, bm: basilar muscle, c: column, d: directives, fo: fosse, mp: marginal projection, od: oral disc, pd: pedal disc, pm: parietobasilar muscle, rm: retractor muscle, s: siphonoglyph, sc: spermatic cyst, sp: sphincter, t: tentacles, vr: verruca. Scale bars: **A–B**: 10 mm; **C–H**: 200 µm; **I–X**: 25 µm.

Remarks. Currently there are three valid species of *Anthopleura* in the Gulf of Mexico and Caribbean Sea: *Anthopleura krebsi* (Duchassaing & Michelotti, 1860), *Anthopleura texaensis* (Carlgren and Hedgpeth, 1952), and *A. pallida* (Daly and den Hartog 2004). *Anthopleura pallida* is distinguished mainly in column color and shape, and the arrangement of verrucae in rows, only present from the margin to the mid-column (Daly and den Hartog 2004). However, in *A. krebsi* and *A. texaensis*, the column is stout rather than elongate, and the verrucae are arranged in rows along the entire column length, from margin to limbus (Daly and den Hartog 2004). Although we found the marginal sphincter muscle diffuse rather than circumscribed-diffuse, all other features including external and internal anatomy and cnidae fit well with the redescription of *A. pallida* by Daly and den Hartog (2004).

Genus *Bunodosoma* Verrill, 1899

***Bunodosoma cavernatum* (Bosc, 1802)**
http://species-id.net/wiki/Bunodosoma_cavernatum
Figure 5, Table 2

Actinia cavernata Bosc 1802: 221–222.
Urticina cavernata: Duchassaing 1850: 9.
Bunodes cavernata: Verrill 1864: 17–18.
Phymactis cavernata: Andres 1883: 448.
Bunodosoma cavernata: Verrill 1899: 45.
Anthopleura cavernata: Cary 1906: 51.
Bunodosma cavernata: Daly 2003: 92.

Material examined. La Gallega reef (19°13'20"N, 96°07'39"W; thirteen specimens), Ingenieros reef (19°08'41"N, 96°05'22"W; two specimens).

Diagnosis. Fully expanded oral disc and tentacles to 20–38 mm in diameter. Oral disc 10–22 mm in diameter, smooth, brown-yellowish, brown-reddish or pale olive-green, sometimes with white or yellowish radial stripes in endocoelic spaces of first two or three tentacular cycles (Figure 5A, B). Tentacles hexamerously arranged in five cycles (about 96 in number), smooth, simple, conical, moderately long (3–5 mm in length), tapering distally, inner ones longer than outer ones, contractile, olive-green, reddish or pale-orange (Figure 5A, B), often with white or yellowish spots on oral side and sometimes with purple flashes. Deep fosse (Figure 5I). Forty-eight endocoelic rounded marginal projections forming acrorhagi (Figure 5C, I) with holotrichs and basitrichs. Column cylindrical, 12–22 in diameter and 7–15 mm in height, densely covered with rounded vesicles, arranged in 96 longitudinal rows from margin to limbus (Figure 5C, G). Pedal disc well-developed, 12–19 mm in diameter (Figure 5C). Column and pedal disc light-brown, orange, reddish, yellowish or olive-green. Mesenteries hexamerously arranged in four cycles (48 pairs in specimens examined): first, second and some mesen-

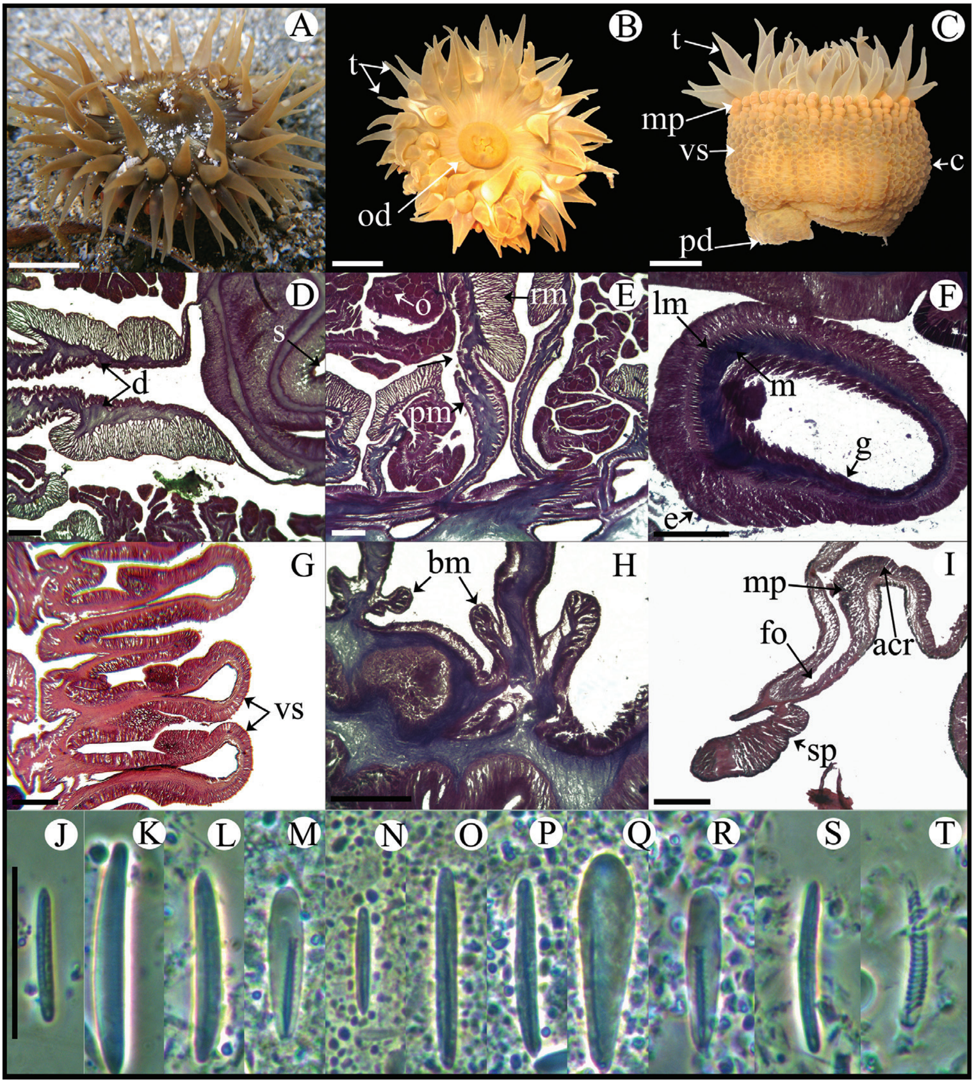

Figure 5. *Bunodosoma cavernatum.* **A** Live specimen in natural habitat **B** Oral view **C** Lateral view **D** Detail of directives; notice siphonoglyph **E** Cross section through proximal column showing oocytes **F** Cross section through tentacle **G** Longitudinal section through column showing vesicles **H** Longitudinal section though base showing basilar muscles **I** Longitudinal section through margin showing acrorhagi and marginal sphincter muscle **J–T** Cnidae.– acrorhagi: **J** basitrich **K** holotrich; actinopharynx: **L** basitrich **M** microbasic *p*-mastigophore; column: **N** small basitrich **O** basitrich; filament: **P** basitrich **Q** microbasic *b*-mastigophore **R** microbasic *p*-mastigophore; tentacle **S** basitrich **T** spirocyst. Abbreviations.– acr: acrorhagi, bm: basilar muscle, c: column, d: directives, e: epidermis, fo: fosse, g: gastrodermis, lm: longitudinal muscles, m: mesoglea, mp: marginal projection, o: oocyst, od: oral disc, pd: pedal disc, pm: parietobasilar muscle, rm: retractor muscle, s: siphonoglyph, sp: sphincter, t: tentacle, vs: vesicles. Scale bars: **A–C**: 10 mm; **D–I**: 200 µm; **J–T**: 25 µm.

teries of third cycle perfect, others imperfect; same number of mesenteries distally and proximally. All mesenteries fertile (except directives); gonochoric; oocytes and spermatic cysts well-developed in specimens collected in January and May (Figure 5E). Two pairs of directives each attached to a well-developed siphonoglyph (Figure 5D). Retractor muscles strong and restricted; parietobasilar muscles well-developed with a relatively long free mesogleal pennon (Figure 5E). Basilar muscles well-developed (Figure 5H). Marginal sphincter muscle endodermal, strong and circumscribed (Figure 5I). Longitudinal muscles of tentacles ectodermal (Figure 5F). Zooxanthellae present. Cnidom: basitrichs, microbasic *b*- and *p*-mastigophores, holotrichs and spirocysts (Figure 5J–T; see Table 2).

Natural history. *Bunodosoma cavernatum* inhabits shallow waters, attached to rocks and coral rubble, in the lagoon zone; between 2–6 m.

Distribution. Western Atlantic, from North Caroline to Barbados; along the Caribbean Sea and Gulf of Mexico (Carlgren and Hedgpeth 1952); and Caroline Islands, Micronesia (Bosc 1802). This is the first record for the coast of Mexico; found in the VRS (see Table 1).

Remarks. Currently four valid species of *Bunodosoma* have been reported in the Gulf of Mexico and Caribbean Sea (González-Muñoz et al. 2012, Fautin 2013): *B. cavernatum*, *B. granuliferum* (Le Sueur, 1817), *B. kuekenthali* Pax, 1910, and *B. sphaerulatum* Duerden, 1902. *Bunodosoma cavernatum* differs from *B. granuliferum* because it lacks the distinct chromatic pattern of the column with alternating pale and dark longitudinal bands but also based on molecular evidence (reviewed in González-Muñoz et al. 2012). Our specimens show that the circumscribed marginal sphincter muscle tends to split in two parts as suggested by Carlgren (1952) (Figure 5I). The distinction between *B. sphaerulatum* and *B. kuekenthali* and their Caribbean congeners are not clear based on the information available.

Genus *Isoaulactinia* Belém, Herrera-Moreno & Schlenz, 1996

Isoaulactinia stelloides (McMurrich, 1889)

http://species-id.net/wiki/Isoaulactinia_stelloides
Figure 6, Table 2

Aulactinia stelloides McMurrich 1889: 28–31.
Aulactinia stella: Duerden 1897: 454–455.
Bunodella stelloides: Verrill 1899: 43–44.
Bunodes stella: Duerden 1898: 455.
Bunodactis stelloides: Verrill 1900: 556.
Anthopleura catenulata: Cairns, den Hartog and Arneson 1986: 177–178; Pl. 51.
Anthopleura carneola: Cairns, den Hartog and Arneson 1986: 177–178; Pl. 51.
Isoaulactinia stelloides: Belém, Herrera-Moreno and Schlenz 1996: 77–88.

Material examined. La Gallega reef (19°13'20"N, 96°07'39"W; six specimens).

Diagnosis. Fully expanded oral disc and tentacles to 24–38 mm in diameter. Oral disc smooth, slightly wider than column, 9–11 mm in diameter, light- or olive-green, sometimes with small white stripes near tentacles bases (Figure 6A, B). Tentacles hexamerously arranged in four cycles (about 48 in number), simple, smooth, moderately long (9–14 mm in length), conical, tapering distally, inner ones longer than outer ones, contractile, olive-green with white bands along entire length (Figure 6A, B). Deep fosse (Figure 6G). Twenty-four endocoelic marginal projections (Figure 6C, G) with basitrichs and macrobasic *p*-mastigophores. Column cylindrical, 8–12 in diameter and 13–22 mm in height, with approximately 48 longitudinal rows of verrucae along entire column, but more conspicuous distally (Figure 6C). Pedal disc well-developed, 9–16 mm in diameter (Figure 6C). Column, verrucae, and pedal disc light-brown or beige (Figure 6C). Mesenteries hexamerously arranged in three cycles (24 pairs in specimens examined): all cycles perfect; same number of mesenteries distally and proximally. First and second cycles fertile (except directives); hermaphroditic (?), only oocytes observed in specimens examined (Figure 6E). Developing polyps in coelenteron (Figure 6F). Two pairs of directives each attached to a well-developed siphonoglyph (Figure 6D). Retractor muscles strong and restricted; parietobasilar muscles well-developed with relatively long and thick free mesogleal pennon (Figure 6E). Basilar muscles well-developed (Figure 6H). Marginal sphincter muscle endodermal, strong and circumscribed, palmate (Figure 6G). Longitudinal muscles of tentacles ectodermal (Figure 6I). Zooxanthellae present. Cnidom: basitrichs, microbasic *b*-mastigophores, macrobasic and microbasic *p*-mastigophores, and spirocysts (Figure 6J–Y; see Table 2).

Natural history. *Isoaulactinia stelloides* inhabits shallow waters in the lagoon reef zone, at 1–2 m, near *Actinostella flosculifera*, *Stichodactyla helianthus*, and the zoanthid *Palythoa caribaeorum* (Duchassaing & Michelotti, 1860). It lives with the column burrowed in the sand but the pedal disc attached to rocks and coral rubble. Although we only observed developing oocytes in the two specimens histologically examined, *I. stelloides* has been reported as a simultaneous hermaphroditic, internally brooding, often with developing polyps in the coelenteron (Belém et al. 1996, Daly and den Hartog 2004); the latter have also been observed in the present study (Figure 6F).

Distribution. Western Atlantic, from Bermuda to Barbados, and along the Caribbean Sea (Belém et al. 1996, Daly and den Hartog 2004). This is the first record for the coast of Mexico; found in the VRS (see Table 1).

Remarks. Currently *Isoaulactinia* has two valid species (Daly 2004, Fautin 2013): *I. hespervolita* Daly, 2004, and *I. stelloides*. According to Daly (2004) *I. hespervolita* differs from *I. stelloides* in having an unmarked oral disc and tentacles, spinose holotrichs in the column and being gonochoric rather than hermaphroditic. In addition, *I. hespervolita* has a reddish-orange to greenish-brown column, oral disc and tentacles; approximately 80 tentacles arranged in up to five cycles, and macrobasic *p*-mastigophores only in the column and tentacles (Daly 2004). We found additional microbasic *b*-mastigophores in the actinopharynx of *I. stelloides* but they were not abundant (Table 2). This category of nematocyst has not been previously reported in the actinopharynx of either of the species (Belém et al. 1996, Daly and den Hartog 2004).

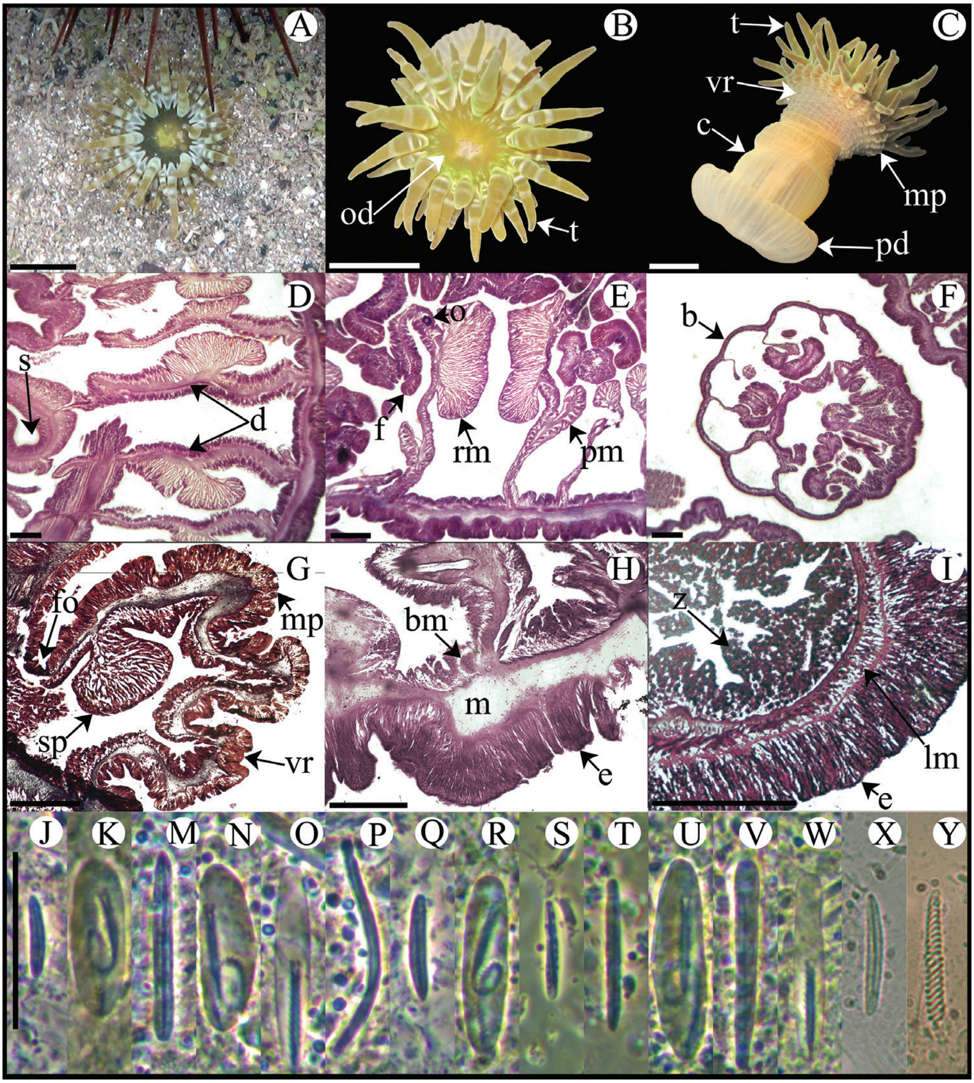

Figure 6. *Isoaulactinia stelloides.* **A** Live specimen in natural habitat **B** Oral view **C** Lateral view **D** Detail of directives showing a siphonoglyph **E** Cross section through proximal column **F** Detail of brooded juvenile **G** Longitudinal section through margin showing marginal sphincter muscle and marginal projection **H** Longitudinal section though base showing basilar muscles **I** Cross section through tentacle **J–Y** Cnidae.– marginal projection: **J** small basitrich **K** macrobasic p-mastigophore; actinopharynx: **M** basitrich **N** macrobasic p-mastigophore **O** microbasic p-mastigophore **P** long, curved basitrich; column: **Q** small basitrich **R** macrobasic p-mastigophore; filament: **S** small basitrich **T** basitrich **U** macrobasic p-mastigophore **V** microbasic b-mastigophore **W** microbasic p-mastigophore; tentacle: **X** basitrich **Y** spirocyst. Abbreviations.– b: brooded juvenile, bm: basilar muscle, c: column, d: directives, e: epidermis, fo: fosse, lm: longitudinal muscle, m: mesoglea, mp: marginal projection, o: oocyst, od: oral disc, pd: pedal disc, pm: parietobasilar muscle, rm: retractor muscle, s: siphonoglyph, sp: sphincter, t: tentacle, vr: verrucae, z: zooxanthellae. Scale bars: **A–C**: 10 mm; **D–I**: 200 μm; **J–Y**: 25 μm.

Family Aliciidae Duerden, 1895
Genus *Lebrunia* Duchassaing & Michelotti, 1860

Lebrunia coralligens (Wilson, 1890)

http://species-id.net/wiki/Lebrunia_coralligens
Figure 7; Table 2

Hoplophoria coralligens Wilson 1890: 379–386.
Lebrunea coralligens: Duerden 1898: 456–457.
Lebrunia coralligens: Stephenson 1922: 288.

Material examined. Isla Verde reef (19°13'26"N, 96°05'56"W; three specimens); Isla Sacrificios reef (19°10'36"N, 96°05'39"W; three specimens).

Diagnosis. Fully expanded oral disc and tentacles to 18–22 mm in diameter. Oral disc smooth, 3–5 mm in diameter, beige and translucent (Figure 7B). Tentacles hexamerously arranged in 3–4 cycles (about 24–52 in number), moderately long (about 5–8 mm length), tapering distally, inner ones longer than outer ones, contractile, gray or beige, translucent, with tips whitish or yellowish and scattered bluish dots along the entire length (Figure 7B, C). Column short, smooth, 3–6 mm in diameter and 6–10 mm in height, bright-brown with faint stripes corresponding to mesenterial insertions. Column distally with 4–6 outgrowths (pseudotentacles). Pseudotentacles branched, ending in globular-shaped vesicles with batteries of macro- and micro-basic *p*-amastigophores and basitrichs; bluish with gray or brown circle in center (Figure 7A–C). Pedal disc well-developed, circular, 3–7 mm in diameter, light brown or beige, translucent (Figure 7C). Mesenteries hexamerously arranged in 2–3 cycles (12–24 pairs in specimens examined): first cycle perfect and sterile, others imperfect and fertile; more mesenteries proximally than distally (two and three cycles, respectively). Hermaphroditic (Figure 7G). Two pairs of directives each attached to a well-developed siphonoglyph (Figure 7D). Retractor muscles diffuse, strong; parietobasilar muscles with short and thick mesogleal pennon (Figure 7E, F). Basilar muscles relatively poorly developed (Figure 7H). Marginal sphincter muscle absent. Ectodermal longitudinal muscles in distal column. Longitudinal muscles of tentacles ectodermal (Figure 7I). Zooxanthellae present (Figure 7F). Cnidom: basitrichs, macrobasic and microbasic *p*-amastigophores, and spirocysts (Figure 7J–V; see Table 2).

Natural history. *Lebrunia coralligens* inhabits narrow fissures of live coral with only the end of the pseudotentacles visible, between 3–6 m. During the day, the tentacles remain contracted and the pseudotentacles fully expanded allowing the zooxanthellae (particularly abundant in this area) to capture sunlight; at night the situation is the opposite, allowing tentacles to capture food (Sebens and DeRiemer 1977).

Distribution. Western Atlantic, from Bahamas to Brazil, and along the Caribbean Sea (Wilson 1890, Manjarrés 1978, Acuña et al. 2013, Varela 2002, Herrera-Moreno and Betancourt 2002). *Lebrunia coralligens* has been recorded in the Mexican Caribbean (Jordán-Dahlgren 2008), and in the VRS (González-Muñoz 2005, see Table 1).

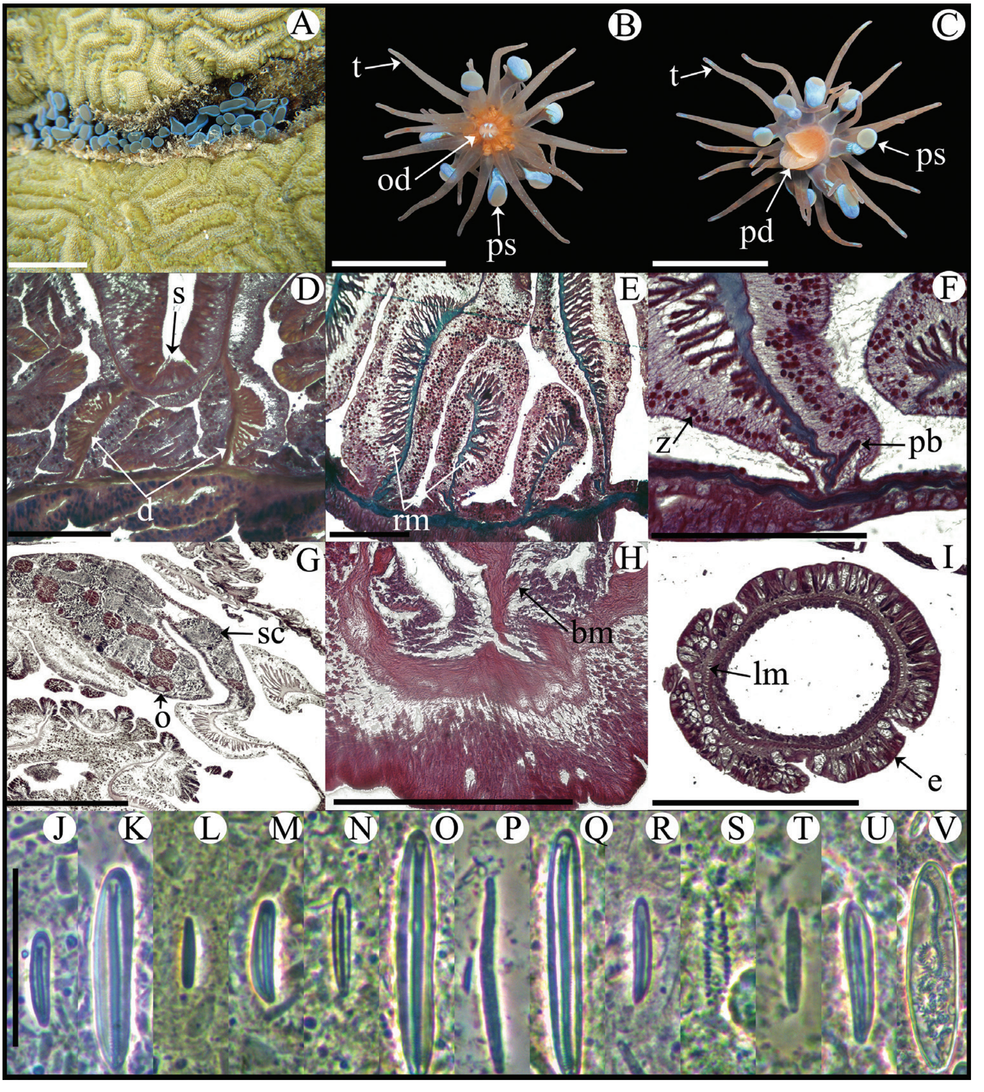

Figure 7. *Lebrunia coralligens.* **A** Live specimen in natural habitat **B** Oral view **C** Pedal disc view **D** Cross section through distal column showing a siphonoglyph **E** Detail of retractor muscles **F** Detail of parietobasilar muscles **G** Detail of a mesentery showing oocytes and spermatic cysts **H** Longitudinal section through base showing basilar muscles **I** Cross section through tentacle **J–V** Cnidae.– actinopharynx: **J** small microbasic *p*-amastigopore **K** microbasic *p*-amastigophore; column: **L** small basitrich **M** small microbasic *p*-amastigophore; filament: **N** small microbasic *p*-amastigophore **O** microbasic *p*-amastigophore; tentacle: **P** basitrich **Q** microbasic *p*-amastigophore **R** small microbasic *p*-amastigophore **S** spirocyst; pseudotentacle: **T** basitrich **U** microbasic *p*-amastigophore **V** macrobasic *p*-amastigophore. Abbreviations.– bm: basilar muscle, d: directives, e: epidermis, lm: longitudinal muscle, o: oocyst, od: oral disc, pd: pedal disc, pm: parietobasilar muscle, ps: pseudotentacle, rm: retractor muscle, s: siphonoglyph, sc: spermatic cyst; t: tentacle, z: zooxanthellae. Scale bars: **A–C**: 10 mm; D–H: 200 μm; I: 100 μm; **J–U**: 25 μm; **V**: 20 μm.

Remarks. Currently there are two valid species of *Lebrunia*, both of them distributed in the Western Atlantic (Fautin 2013). They differ in the branched pseudotentacles: those of *L. danae* are long and dark-brown whereas those of *L. coralligens* are shorter, bright bluish-gray, with rounded ends (González-Muñoz et al. 2012).

Family Capneidae Gosse, 1860
Genus *Actinoporus* Duchassaing, 1850

Actinoporus elegans Duchassaing, 1850
http://species-id.net/wiki/Actinoporus_elegans
Figure 8, Table 2

Actinoporus elegans Duchassaing 1850: 10.
Actinoporus Elegans [sic]: Duchassaing 1870: 21.
Aureliana elegans: Andres 1883: 289.

Material examined. La Gallega reef (19°13'20"N, 96°07'39"W; one specimen).

Diagnosis. Fully expanded oral disc and tentacles up to 52 mm in diameter. Central part of oral disc smooth, narrow, to 16 mm diameter, beige; mouth oval with a well-developed conchula (Figure 8C). Tentacles small, vesicle-like, arranged in double radial rows covering almost entire oral disc, on endocoelic and exocoelic spaces, 24–26 tentacles per double row; reddish or pinkish rows of tentacles alternating with pale brown rows (Figure 8A–D). Deep fosse (Figure 8G). Column elongated, funnel-shaped, to 60 mm in height, wider distally than proximally; column diameter: distally 38 mm, mid-column 27 mm, proximally 13 mm (Figure 8E). Column with longitudinal rows of vesicles (6–8 vesicles per row) distally (Figure 8B, E). Pedal disc well-developed, narrow, 19 mm in diameter. Column and pedal disc white to pale-brown; mesenterial insertions visible distally (Figure 8E). Mesenteries irregularly arranged in three cycles (28 pairs in specimen examined): first cycle perfect, others imperfect. Gametogenic tissue not observed in specimen examined. Two pairs of directives, only one pair attached to a single well-developed siphonoglyph. Retractor muscles strong, circumscribed, with main muscle lamella divided in two parts; parietobasilar muscles strong with thick mesogleal pennon (Figure 8F). Basilar muscles well-developed (Figure 8H). Marginal sphincter muscle endodermal, strong and circumscribed, pinnate (Figure 8G). Longitudinal muscles of the tentacles ectodermal (Figure 8I). Zooxanthellae absent. Cnidom: basitrichs, microbasic *p*-mastigophores, and spirocysts (Figure 8J–P, Table 2).

Natural history. *Actinoporus elegans* inhabits sandy bottoms, at 1–2 m; the column is burrowed in the sand but the pedal disc is strongly attached to rocks. When disturbed, it contracts the oral disc suddenly, completely burrowing the entire body.

Distribution. Western Atlantic, from the northern coast of Brazil to Guadeloupe, Jamaica, and Curaçao (Corrêa 1973), and Cape Verde Islands (Wirtz 2009). This is the first record for the coast of Mexico; found in the VRS.

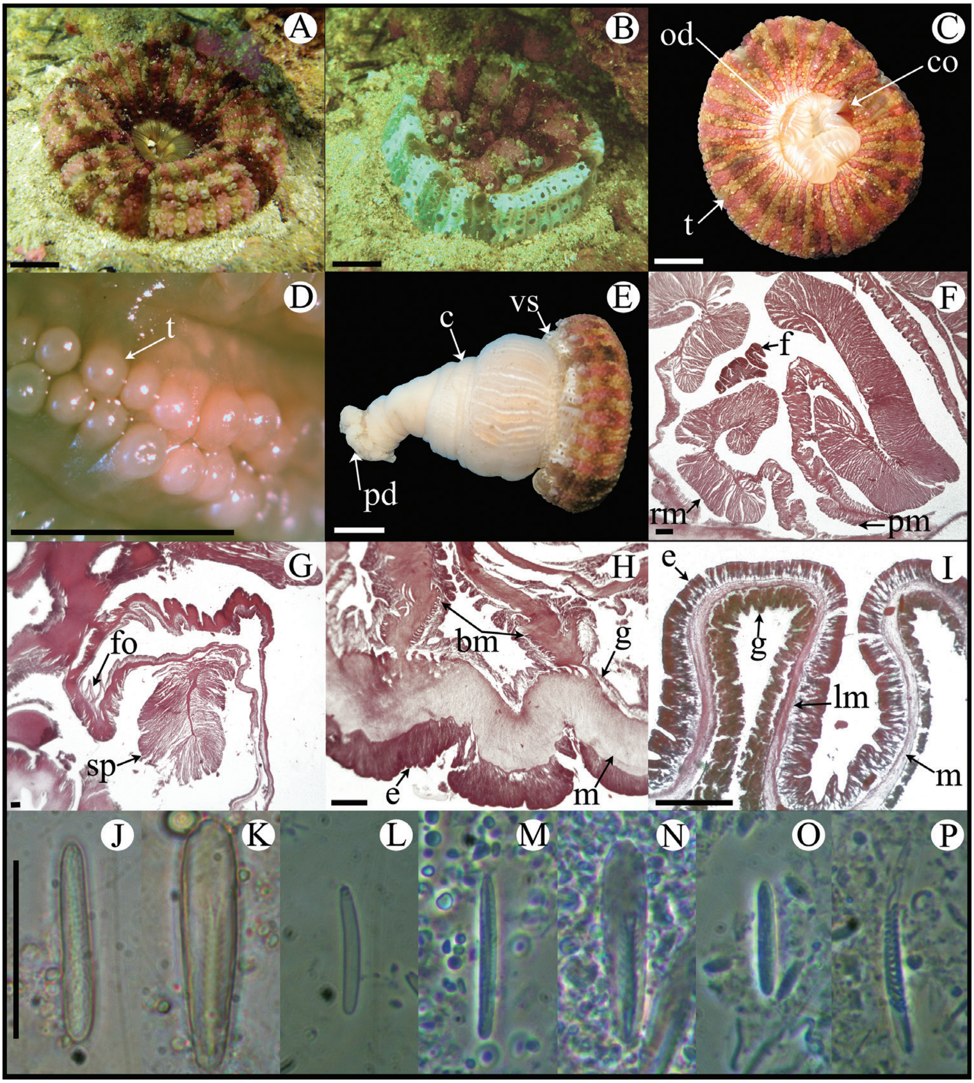

Figure 8. *Actinoporus elegans.* **A** Fully expanded specimen in natural habitat **B** Partially contracted specimen in natural habitat **C** Oral view **D** Detail of double rows of tentacles **E** Lateral view **F** Cross section through proximal column, showing retractor and parietobasilar muscles **G** Longitudinal section through column margin showing marginal sphincter muscle **H** Longitudinal section through base showing basilar muscles **I** Longitudinal section through tentacles **J–P** Cnidae.– actinopharynx: **J** basitrich **K** microbasic *p*-mastigophore; column: **L** basitrich; filament: **M** basitrich **N** microbasic *p*-mastigophore; tentacle: **O** basitrich **P** spirocyst. Abbreviations.– bm: basilar muscle, e: epidermis, f: filament, fo: fosse, g: gastrodermis, lm: longitudinal muscle, m: mesoglea, od: oral disc, pd: pedal disc, pm: parietobasilar muscle, rm: retractor muscle, sp: sphincter, t: tentacle, vs: vesicles. Scale bars: **A–C, E** : 10 mm; **D**: 2 mm; **F–I**: 200 µm; **J–P**: 25 µm.

Remarks. Currently there are two valid species of *Actinoporus*: *A. elegans* and *A. elongatus* Carlgren, 1900 (Fautin 2013). *Actinoporus elongatus* is reported for India, Mozambique and Australia (Carlgren 1900, Menon 1927, Clayton and Collins 1992), and it lacks the longitudinal rows of vesicles in the distal column of *A. elegans* (Carlgren 1900, Corrêa 1973). Additional color patterns observed for *A. elegans* in coral reefs off the coast of Venezuela include tentacles and oral disc almost completely white with dark-brown stripes, or completely bright orange (unpublished data).

Superfamily Metridioidea Carlgren, 1893
Family Hormathiidae Carlgren, 1932
Genus *Calliactis* Verrill, 1869

***Calliactis tricolor* (Le Sueur, 1817)**
http://species-id.net/wiki/Calliactis_tricolor
Figure 9, Table 2

Actinia tricolor Le Sueur 1817: 171.
Actinia bicolor Le Sueur 1817: 171.
Cereus bicolor: Milne-Edwards 1857: 273.
Adamsia tricolor: Milne-Edwards 1857: 281.
Adamsia Egletes [sic] Duchassaing and Michelotti 1864: 40.
Adamsia egletes: Duchassaing and Michelotti 1866: 134.
Calliactis bicolor: Verrill 1869: 481.
Adamsia sol McMurrich 1893: 183.
Adamsia bicolor: Andres 1883: 179.
Adamsia tricolor Andres 1883: 180.
Calliactis tricolor: Haddon 1898: 457.

Material examined. Alacranes reef (22°31'35"N, 89°46'05"W; eight specimens), Serpientes reef (21°26'22"N, 90°28'25"W; five specimens).

Diagnosis. Fully expanded oral disc and tentacles 9–48 mm in diameter. Oral disc smooth, wider than column, 3–20 mm in diameter, pale-brown translucent, with small white stripes in endocoelic spaces, sometimes forming a white ring; some specimens also with pink flashes (Figure 9A). Mouth bright yellow, orange, or white; often with purple ring around lips (Figure 9A). Tentacles hexamerously arranged in 5–6 cycles (96–192 in number), smooth, thin, short (2.5–15.5 mm), inner ones longer than outer ones, contractile (Figure 9A, B), tapering distally, pale-brown with a longitudinal row of white dots along entire length (Figure 9A, B); some specimens also with bright-pink flashes mainly at tips. Column trumpet-shaped in extended position, dome-shaped when contracted, 5–24.5 mm in diameter and 4–31 mm in height, divided into narrow, smooth capitulum and wrinkled-texture scapus (Figure 9B). Capitulum pale-brown to yellowish, scapus bright to dark orange often with small white stripes or white flashes slightly above limbus (Figure 9B). Pedal disc well-developed, circular to irregular, wider than column, 6–36 mm in diameter, with mesenterial insertions visible, pale-brown and translucent (Figure 9C). One or two rows of cinclides proximally, near limbus; dark-red

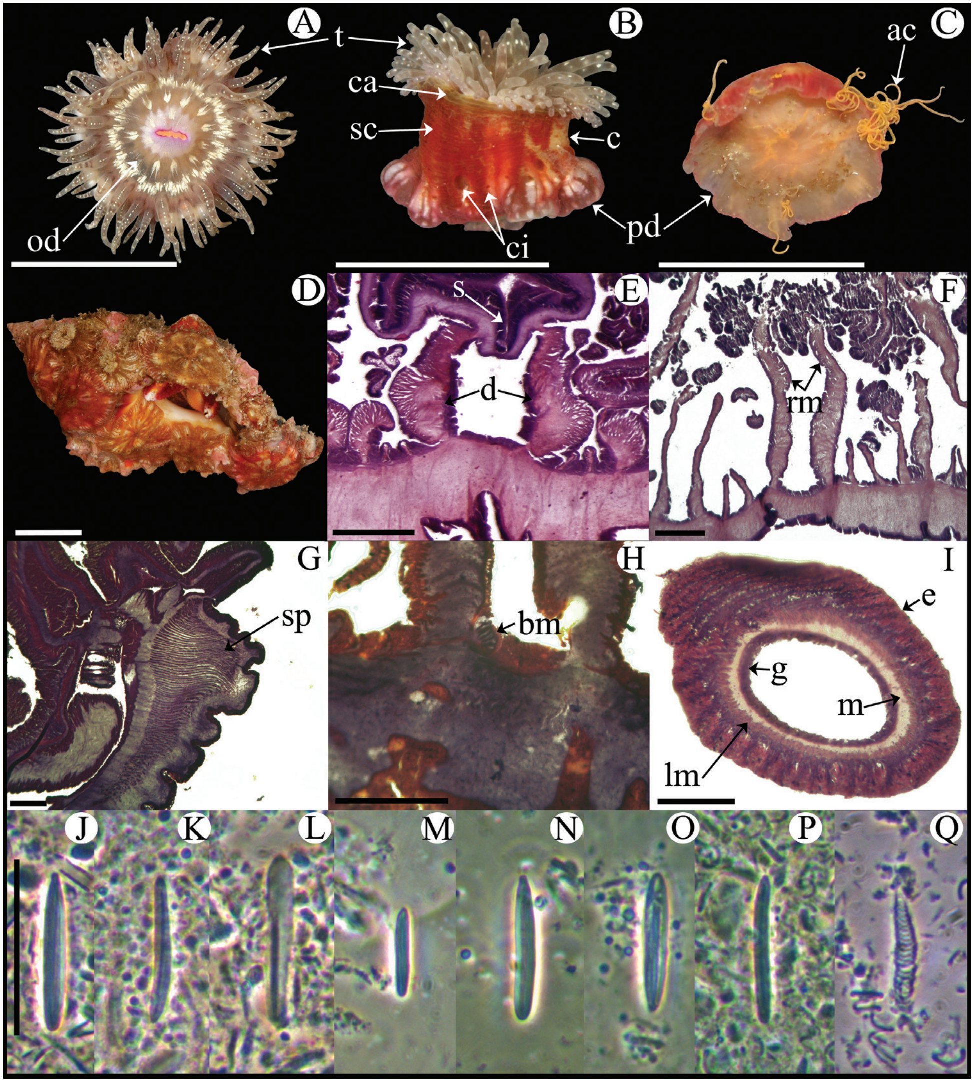

Figure 9. *Calliactis tricolor*. **A** Oral view **B** Lateral view **C** Pedal disc view **D** Specimens on hermit crab shell **E** Detail of directives showing a siphonoglyph **F** Cross section through proximal column **G** Longitudinal section through margin showing the marginal sphincter muscle **H** Longitudinal section through base showing basilar muscles **I** Cross section through tentacle **J–Q** Cnidae.– acontio: **J** basitrich; actinopharynx: **K** basitrich **L** microbasic *p*-mastigophore; column: **M** small basitrich; filament: **N** basitrich **O** microbasic *p*-mastigophore; tentacle: **P** basitrich **Q** spirocysts. Abbreviations.– ac: acontia, bm: basilar muscle, c: column, ca: capitulum, ci: cinclides, e: epidermis, g: gastrodermis, lm: longitudinal muscle, m: mesoglea, od: oral disc, pd: pedal disc, rm: retractor muscle, sc: scapus, sp: sphincter, t: tentacle. Scale bars: **A–D**: 10 mm; **E–I**: 200 μm; **J–Q**: 25 μm.

or brown (Figure 9B). Mesenteries hexamerously arranged in four cycles; same number of mesenteries proximally and distally (to 48 pairs in specimens examined): first cycle perfect, others imperfect; third and fourth cycles poorly developed, without filaments or acontia. Gametogenic tissue not observed in specimens examined. Two pairs of directives each attached to a well-developed siphonoglyph (Figure 9E). Retractor muscles weak and diffuse; parietobasilar muscles poorly developed (Figure 9E, F). Basilar muscles poorly developed (Figure 9H). Marginal sphincter muscle mesogleal, strong, transversally stratified (Figure 9G). Longitudinal muscles of tentacles ectodermal. Acontia numerous, bright orange (Figure 9C), with basitrichs. Zooxanthellae present. Cnidom: basitrichs, microbasic *p*-mastigophores, and spirocysts (Figure 9J–Q; see Table 2).

Natural history. *Calliactis tricolor* typically dwells on the shells of living hermit crabs often carrying more than one individual (Figure 9D), between 10–30 m. This peculiar symbiotic relationship has been widely studied (reviewed in Gusmão and Daly 2010).

Distribution. Western Atlantic, from the northern coast of USA to the northern coast of Brazil, along the Caribbean Sea and Gulf of Mexico (Carlgren and Hedgpeth 1952, Zamponi et al. 1998). This is the first record for the coast of Mexico; found in Serpientes and Alacranes reefs.

Remarks. Of the 18 valid species currently considered as valid of *Calliactis*, only two have been reported in the Gulf of Mexico and Caribbean Sea (Fautin 2013): *Calliactis polypus* (Forsskål, 1775) and *C. tricolor*. These two species differ in the color of the cinclides, white in *C. polypus* and dark-red in *C. tricolor* (Gusmão 2010). In addition, *C. tricolor* is distributed almost exclusively in the western Atlantic whereas *C. polypus* has a wide distribution range, being found in the Red Sea, Hawaii, French Polynesia, Australia, South Africa, East Africa, Maldives, Cape Verde Islands, Japan, Galapagos, and Louisiana (Gusmão 2010, Fautin 2013).

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RESEARCH ARTICLE

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Bambusananus cuihuashanensis, a new bamboo-feeding leafhopper species of Athysanini (Hemiptera, Cicadellidae, Deltocephalinae) from Shaanxi, China

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Abstract
Bambusananus cuihuashanensis **sp. n.** (Hemiptera: Cicadellidae: Deltocephalinae: Athysanini), a new bamboo-feeding leafhopper species, is described and illustrated from Shaanxi Province of China. Checklist, host plants and distribution for each species of *Bambusananus* is given along with a key to all known species.

Keywords
Bamboo leafhopper, Cicadomorpha, distribution, Homoptera, taxonomy

Introduction

The leafhopper tribe, Athysanini, was established by Van Duzee in 1892 and is the largest tribe of Deltocephalinae, including 228 genera and 1123 species (Zahniser and Dietrich 2013). Because this is such a large tribe, it is difficult or impossible to provide a set of characters that will easily diagnose it. There is substantial morphological diversity in the group, but most members have a Y-shaped connective and lack the distinctive features of other tribes (Zahniser and Dietrich 2013). Athysanini can be found in nearly all terrestrial ecosystems. Athysanini feed on a wide variety of eudicots and some species occasionally feed on grasses or sedges.

The leafhopper genus *Bambusananus* (Deltocephalinae: Athysanini) was established by Li et al. (2011) with the species *Bambusananus furcatus* Li & Xing, 2011, from Guizhou Province of China as its type species, and three new combinations: *Bambusananus binotatus* (Li & Dai, 2003), *Bambusananus bipunctatus* (Li, 1999) and *Bambusananus maculipennis* (Li & Wang, 1993) were proposed at the same time. Yang and Chen (2012) described one new species and summarized information on host plants and geographical distribution of the known species. Up to now, five species were recognised within this genus: *B. bipunctatus* (Li, 1999), *B. maculipennis* (Li & Wang, 1993), *B. furcatus* Li & Xing, 2011, *B. lii* (McKamey & Hicks, 2007) and *B. yangae* Xing & Chen, 2013 (Xing and Chen 2013). All members of the genus feed exclusively on Bambusoideae (Yang and Chen, 2012) and are currently known only from southern mainland China and Taiwan (Fig. 12).

During on-going studies on species biodiversity of the bamboo-feeding leafhoppers in China, several specimens belonging to an undescribed species of *Bambusananus* were found. The purpose of this paper is to describe this new species, to summarize information on host plants and geographical distribution of the known species and to provide a key to species in the genus.

Materials and methods

In the present paper, terminology follows Li et al. (2011) except that for leg chaetotaxy follows Zahniser and Dietrich (2013). Dry specimens were used for the descriptions and illustrations. External morphology was observed under a stereoscopic microscope and characters were measured with an ocular micrometer. Measurements are given in millimeters; body length is measured from the apex of the head to the apex of the forewing in repose. The genital segments of the examined specimens were macerated in 10% KOH, washed in water and transferred to glycerine. Illustrations of the specimens were made with a Leica MZ 12.5 stereomicroscope. Photographs of the types were taken with a Leica D-lux 3 digital camera. The digital images were then imported into Adobe Photoshop 8.0 for labeling and plate composition. The type specimens and material examined are deposited in the Institute of Entomology, Guizhou University, Guiyang, China (IEGU).

Taxonomy

Checklist, host plant and distribution of species of genus *Bambusananus*

1. *Bambusananus bipunctatus* (Li, 1999) (in Cai and Huang 1999)

Host plant. Bamboo (*Indocalamus hirsutissimus* Z. P. Wang & P. X. Zhang and *Qiongzhuea communis* Hsueh & Yi) (Yang and Chen 2012).

Distribution. China (Guizhou, Fujian and Sichuan) (Fig. 12).

2. *Bambusananus maculipennis* (Li & Wang, 1993)

Host plant. Bamboo (*Chimonobambusa pachystachys* Hsuch & W. P. Zhang and *Qiongzhuea communis* Hsueh & Yi) (Yang and Chen 2012).

Distribution. China (Guizhou) (Fig. 12).

3. *Bambusananus cuihuashanensis* sp. n.

Host plant. Bamboo.

Distribution. China (Shaanxi) (Fig. 12).

4. *Bambusananus furcatus* Li & Xing, 2011

Host plant. Bamboo (*Chimonobambusa angustifolia* C. D. Chu & C. S. Chao) (Chen et al. 2012).

Distribution. China (Guizhou) (Fig. 12).

5. *Bambusananus lii* (McKamey & Hicks, 2007)

Host plant. Bamboo (Li et al. 2011).

Distribution. China (Taiwan) (Fig. 12).

6. *Bambusananus yangae* Xing & Chen, 2013

Host plant. Bamboo (*Indocalamus* sp.) (Yang and Chen 2012).

Distribution. China (Guizhou) (Fig. 12).

Key to species of *Bambusananus* Li & Xing (male)

1	Upper area of frontoclypeus with a large black transverse marking.............**2**
–	Upper area of frontoclypeus without above marking (Fig. 2) **3**
2	Aedeagal shaft with appendages long, reaching to middle of aedeagus (Fig. 11) ....***B. cuihuashanensis* sp. n.**
–	Aedeagal shaft with appendages short, only reaching to apical one-fifth of aedeagus .... ***B. bipunctata* (Li)**
3	Ventral processes of male pygofer curved dorsad.. ....***B. maculipennis* (Li & Wang)**
–	Ventral processes of male pygofer with apical half curved ventrad (Fig. 6) 4
4	Appendages of aedeagal shaft branched......................***B. furcatus* Li & Xing**
–	Appendages of aedeagal shaft not branched (Figs 10, 11)...........................**5**
5	Aedeagal appendages arising from middle of aedeagus, straight, with apex directed apically; ventral margin of aedeagus without any teeth .... ***B. yangae* Xing & Chen**
–	Aedeagal appendages arising from apical 1/3 of aedeagus, curved, with apex directed basolaterally; ventral margin of aedeagus with a row of teeth ....***B. lii* (McKamey & Hicks)**

Bambusananus cuihuashanensis **sp. n.**
http://zoobank.org/4B853422-EEC6-41EB-AD6B-B1570C4E92E2
http://species-id.net/wiki/Bambusananus_cuihuashanensis
Figs 1–11

Type material. Holotype: ♂, **China:** Shaanxi, Xi'an, Cuihuashan (108°57'E, 34°10'N), on bamboo, 37 Aug. 2008, J.-D. Li; paratypes: 2 ♂♂, 4 ♀♀, same data as holotype.

Etymology. The new species is named after its locality, Cuihuashan, Shaanxi Province, China.

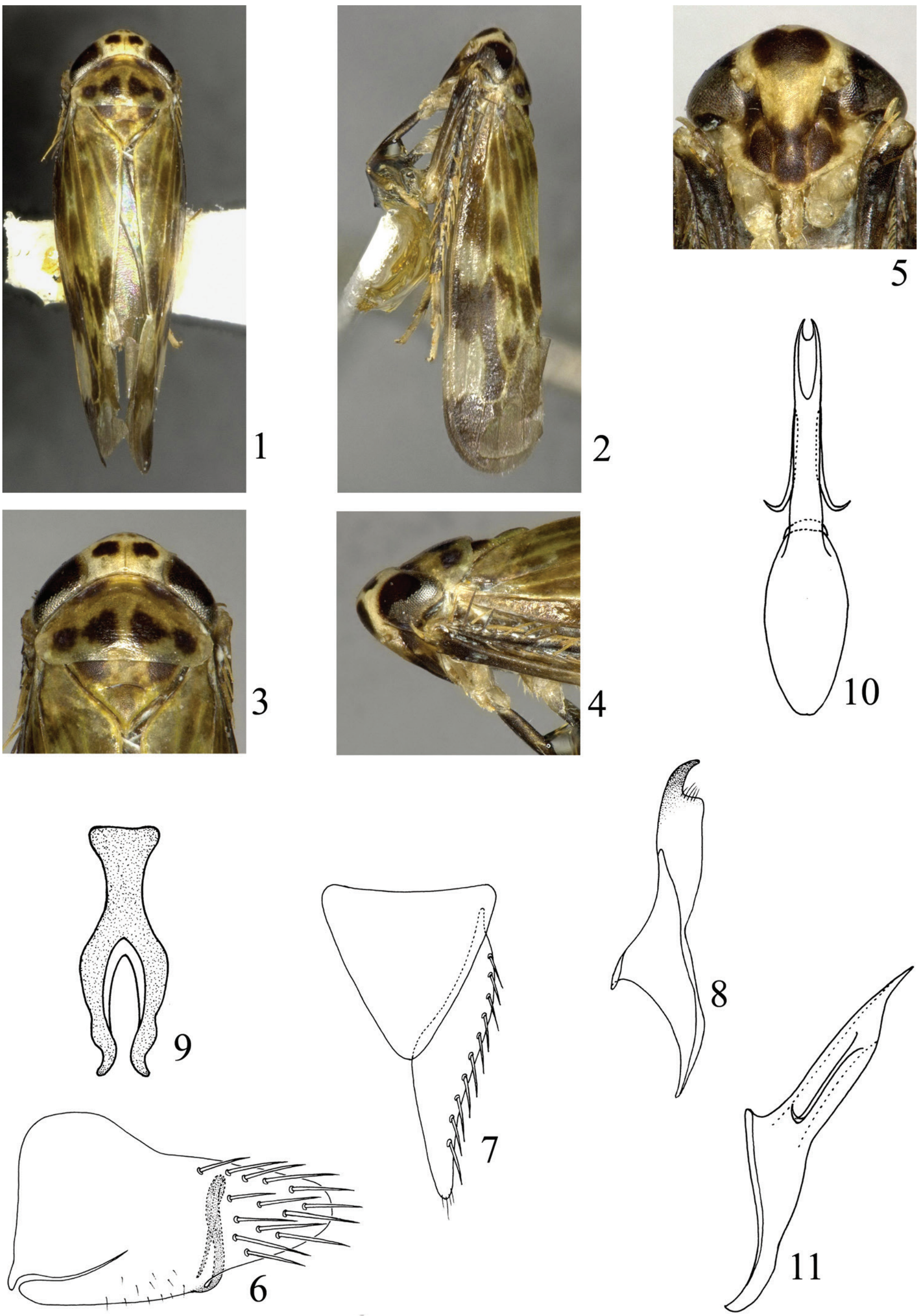
Measurements. Body length (from apex of vertex to tip of forewings): male 4.75–4.85 mm (N = 2); female 5.75–5.90 mm (N = 4); forewing length: male 3.95–4.05 mm (N = 2); female 5.00–5.15 mm (N = 4).

Coloration. Crown (Fig. 1) pale yellowish white, two markings behind ocelli blackish brown. Eyes (Fig. 1) blackish brown, ocelli yellowish white. Frontoclypeus (Fig. 5) pale yellowish white, with lower area dark brown and a large kidney-shaped black marking at upper area; anteclypeus, lorums, genae with upper areas dark brown. Antennae (Fig. 5) pale yellowish brown. Pronotum (Figs 1, 3) pale yellowish brown, anterior areas with two dark brown markings, posterior areas with four blackish brown markings. Scutellum (Figs 1, 3) pale yellowish brown, with two brown markings basally. Forewing (Figs 1, 2) pale yellowish white to yellowish brown, veins yellowish white, with irregular blackish brown markings at median and posterior region. Thorax dark brown ventrally; legs brown to dark brown, except base of tarsus yellowish brown. Abdomen dark brown dorsally and ventrally, lateral margins of each segment pale yellowish white.

Head and thorax. External features as in generic description. Crown shorter medially than width between eyes (0.54:1). Pronotum longer medially than crown (2.10:1). Scutellum shorter medially than pronotum (0.89:1). Forewing longer medially than width at widest part (3.38:1).

Male genitalia. Male pygofer (Fig. 6) with basal half nearly quadrate, then narrowing to apex, dorsal margin slightly sinuate, ventral margin broadly curved, smooth, apical margin acute and rounded, with several macrosetae at apical area; ventral process slender and long, slightly widening at middle, narrowing apically, arising from inner side of ventral margin, produced dorsad, then abruptly strongly curved ventrally. Genital valve (Fig. 7) triangular, basal width slightly longer than median length (1.06:1). Subgenital plate (Fig. 7) moderately narrow, triangular, inner margin nearly straight, outer margin slightly concave, narrowing apically, apex acute and rounded, with row of macrosetae laterally. Style (Fig. 8) broad at base, abruptly narrowing subapically and curved hook-like. Aedeagus (Figs 10, 11) with shaft broad at middle, narrowing basally and apically, gonopore at apex, paired appendages slender and long, apex acute, arising from apical one-fourth, directed basally, then laterally. Connective (Fig. 9) Y-shaped, stem robust and arms well developed, stem slightly shorter than arm (0.79:1).

Host plant. Bamboo.



Figures 1–11. *Bambusananus cuihuashanensis* sp. n. **1** Male habitus, dorsal view **2** Male habitus, lateral view **3** Head and thorax, dorsal view **4** Head and thorax, lateral view **5** Head and thorax, ventral view **6** Male pygofer, lateral view **7** Genital valve and left subgenital plate, ventral view **8** Left style, dorsal view **9** Connective, dorsal view **10** Aedeagus, ventral view **11** Aedeagus, lateral view.

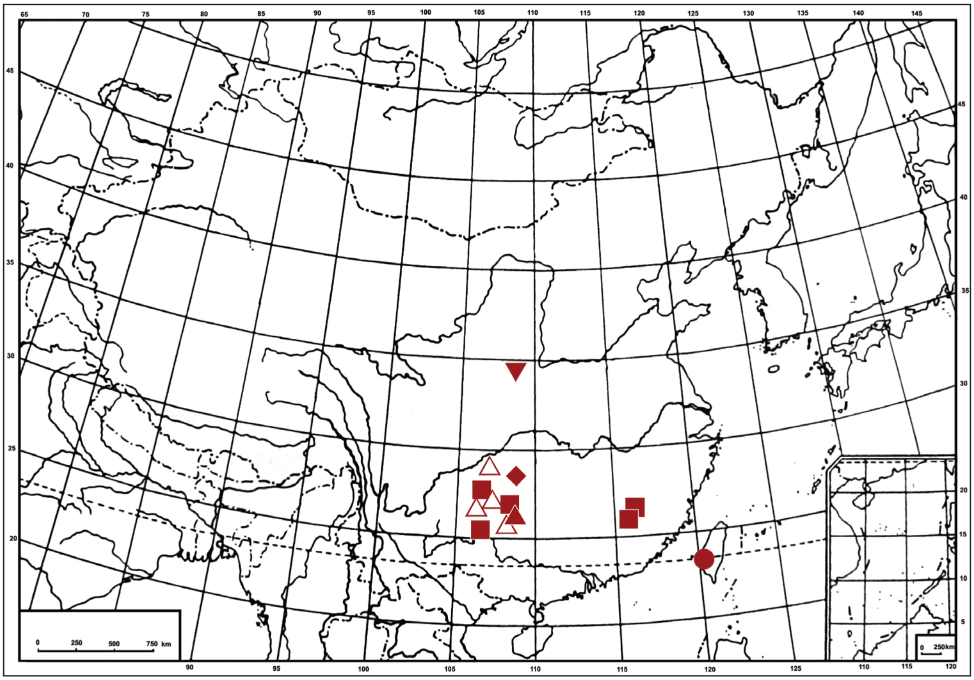


Figure 12. Geographic distribution of *Bambusananus* species: *B. bipunctatus* (Li) (■) *B. cuihuashanensis* sp. n. (▼) *B. furcatus* Li & Xing (▲) *B. lii* (McKamey & Hicks) (●) *B. maculipennis* (Li & Wang) (△) *B. yangae* Xing & Chen (♦).

Distribution. China (Shaanxi) (Fig. 12).

Remarks. This new species is similar to *B. bipunctatus* (Li, 1999) in general appearance, but can be distinguished by: pygofer in lateral view with ventral margin broadly smoothly rounded, without notch at base of ventral process (with notch in *bipunctatus*); connective with stem slightly shorter than arms (longer in *bipunctatus*); aedeagal shaft with appendages longer, in lateral view with apex reaching to middle of aedeagus (in *bipunctatus*, appendages shorter and apex only reaching to apical one-fifth of aedeagus). This new species is also similar to *B. lii* (McKamey & Hicks, 2007), but can be distinguished by: upper area of frontoclypeus with a large kidney-shaped black marking (lacking in *lii*); ventral margin of pygoger without any lobe (with a lobe near middle in *lii*); appendages of aedeagal shaft mostly straight basally, apex directed laterally (elbow-like and curved basally, apex directed caudad in *lii*); ventral margin of aedeagus without any teeth (with a row of teeth at middle in *lii*).

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