

Epiphytic bryozoans on Neptune grass – a sample-based data set

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Abstract

Background

The seagrass *Posidonia oceanica* L. Delile, commonly known as Neptune grass, is an endemic species of the Mediterranean Sea. It hosts a distinctive and diverse epiphytic community, dominated by various macroalgal and animal organisms. Mediterranean bryozoans have been extensively studied but quantitative data assessing temporal and spatial variability have rarely been documented. In Lepoint et al. (2014a, b) occurrence and abundance data of epiphytic bryozoan communities on leaves of *P. oceanica* inhabiting Revellata Bay (Corsica, Mediterranean Sea) were reported and trophic ecology of *Electra posidoniae* Gautier assessed.

New information

Here, metadata information is provided on the data set discussed in Lepoint et al. (2014a) and published on the GBIF portal as a sampling-event data set: http://ipt.biodiversity.be/resource?r=ulg_bryozoa&v=1.0. The data set is enriched by data concerning species settled on *Posidonia* scales (dead petiole of *Posidonia* leaves, remaining after limb abscission).

Keywords

Epiphytism, biofouling, seagrass, Bryozoa, biodiversity, sample-based data set, ecological traits, Mediterranean Sea

Introduction

In the marine environment, the term “epiphyte” is defined as: “all micro- or macro-organism living attached on a plant substrate” (Steel and Bastow Wilson 2003). The seagrass *Posidonia oceanica* L. Delile, commonly known as Neptune grass, is an endemic species of the Mediterranean Sea that hosts a distinctive and diverse epiphytic community, dominated by various macroalgal and animal organisms (Boero et al. 1985; Mazzella et al. 1989; Peres and Picard 1964; Van Der Ben 1971). Among epiphytic animals fixed on seagrass substrates, cheilostome bryozoans are often the most abundant and diverse taxa (Balata et al. 2007; Lepoint et al. 1999; Nesti et al. 2009; Pardi et al. 2006). Some species, like *Electra posidoniae* Gautier, are strictly found on Neptune grass leaves (Gautier 1961; Lepoint et al. 2014b; Matricardi et al. 1991). Due to this important contribution, cheilostome bryozoan diversity has received particular attention (Balduzzi et al. 1983; Gautier 1961; Harmelin 1973; Hayward 1975; Kocak et al. 2002; Lepoint et al. 2014a), but quantitative data are often lacking and seasonal variability is less often documented than spatial variability. This spatio-temporal variability was assessed quantitatively in Lepoint et al. (2014a) and the occurrence and abundance data set resulting from this study was made freely available on the GBIF portal as a sample-based data set. Biological and ecological features of the leaves’ community are also presented and discussed in Lepoint et al. (2014a). Trophic ecology of *Electra posidoniae*, an obligate epiphyte of *P. oceanica*, are discussed in Lepoint et al. (2014b). Scale community data were only published in the GBIF data set but not discussed.

General description of the dataset

The data set is a sample-based data set ($n = 103$ sampling events), recording occurrence ($n = 1234$) and abundance of cheilostome Bryozoa ($n = 6488$ counted colonies) settled as epiphytes on leaves and scales of the seagrass *P. oceanica*. Sampling encompasses an entire annual cycle (from November 2002 to December 2003) ($n = 5$ sampling seasons) and six sampling depths (7, 10, 15, 20, 25, 30 m). The data set package is composed of two data files: the former describing sampling events and the latter reporting occurrence and abundance of bryozoan colonies.

Project description

The data were collected during a postdoctoral project (G.L.) entitled: “Nitrogen dynamics and ecology of the epiphyte community in a *Posidonia oceanica* seagrass bed”.

The *Posidonia* seagrass beds are one of the most important ecosystems in the Mediterranean coastal zone. Seagrass beds are in regression in many areas of the world, while

the reasons of such regression are complex and often poorly understood. The epiphyte community constitutes an important component of the seagrass meadow. Variability in epiphyte community composition and/or biomass may sometimes be linked to anthropogenic disturbance and used as monitoring tool (Mabrouk et al. 2013; Martinez-Crego et al. 2010; Piazzini et al. 2004). This argues for more fundamental studies of the seagrass ecosystem functioning and epiphyte biodiversity.

The general objective of this project was to study the dynamics of nitrogen in the epiphyte community of the *Posidonia* leaves in relation with its ecology and its spatio-temporal structure.

Sampling and experiments were performed in Revellata Bay (Corsica, France), near the STARESO oceanographic station between 2002 and 2004. Samples were taken at a reference site (depth 10 m) followed by our laboratory since the 1970s, as well as along a permanent transect (7 to 35 m depth). At the level of a *Posidonia* shoot, particular attention was given to the spatio-temporal evolution of the structure of the epiphytic community. Specific composition of sessile fauna (mainly Bryozoa) was established at 7, 10, 15, 20, 25 and 30 m depth (Lepoint et al. 2014a). Temporal dynamics and trophic ecology of the dominant species *Electra posidoniae* was studied using seasonal sampling and isotopic approach (Lepoint et al. 2014b). Finally, we have measured experimentally the nitrogen uptake by different epiphytic macroalgae components (Lepoint et al. 2007). Complementary information about the epiphytic community of *P. oceanica* in Revellata Bay may be also found in, for example, Dalla Via et al. 1998; Jacquemart and Demoulin 2006; Lepoint et al. 1999; Michel et al. 2015; Pête et al. 2015.

Sampling methods

Study extent

All sampling events ($n = 103$) and measurements were performed in Revellata Bay (Calvi, Corsica, France), near the marine research centre of STARESO (42°35'N, °43'E) (University of Liège) along the same permanent transects. Sampling encompassed one complete seasonal cycle and the 7 to 30 m depth range occupied by *P. oceanica* shoots in Revellata Bay (see above).

Sampling description

Seagrass shoots were collected in triplicate in November 2002, March, June, September and November 2003 along the same permanent transects set at 7, 10, 15, 20, 25 and 30 m depth. Each sample is constituted of a single replicate gathering three shoots of *P. oceanica*.

Quality control

To determine sample size, previous work was performed to determine the number of shoots that accumulates at least the 75% of the leaf epiphyte bryozoan species. For publication on GBIF portal, synonymies were matched against the authoritative, expert-driven World Register of Marine Species (WoRMS) and corrected compared to Lepoint et al. (2014a).

Step description

The shoots were immediately frozen, then conserved in 4% formalin diluted in seawater. Identifications of species settled on leaves and scales (i.e. dead petioles remaining after leaf abscission) under a stereomicroscope (Stemi 2000, Zeiss) were done to the lowest systematic level using keys for Bryozoa (Prenant and Bobin 1966; Zabala and Maluquer 1988), and the works of Balduzzi et al. (1991), Gautier (1961) and Hayward and McKinney (2002). Colonies on scales were not counted and data are presented only as occurrence. All the colonies found on the two sides of leaves were counted. Colonies counted were reported per shoot and per metre square, accounting the average *P. oceanica* shoot number per metre square, measured at each sampling depth. This parameter was measured monthly using a quadrat with an area of 0.1 m² randomly set in the meadow. The shoot density did not show any significant variation during the duration of this study. Bathymetric variability of this parameter in Revellata Bay may be found in Gobert et al. (2003).

Geographic coverage

Description

Revellata Bay is a part of Calvi Bay and lies in the western Mediterranean, on the northwestern coast of Corsica (42°35'N, 8°45'E). Its western limit is Punta Revellata Cape, and its eastern limit is Punta San Francesco Cape. The STARESO (STATION de REcherches Sous-marines et OCéanographiques) research station (University of Liège) is located on Punta Revellata, at the western border of the bay. Salinity of the water of Calvi Bay is approximately 38‰, and is relatively invariant throughout the year. Temperature of water varies between minima of 12°C (February) and maxima of 26°C (August), with a notable vertical thermal stratification from May to September. Amplitude of tidal variation is weak. Nutrient concentrations (N, P) and particle load in the water column are typically low and characteristic of oligotrophic areas (Lepoint et al. 2004). *Posidonia oceanica* meadows cover approximately 50% of the area of the bay, and reach depths of nearly 40 m. Meadows show, in most places, a continuous extension, but local erosion (“intermattes”) occurs (Abadie et al. 2015). The vast majority of meadows grow on soft bottoms, but they seldom colonize rocky substrates. Meadows

of Calvi Bay are relatively dense, and show an important foliar biomass and production despite the oligotrophic character of the area (Gobert et al. 2003).

Coordinates

Latitude between 42.5799 and 42.5801; longitude between 8.7285 and 8.7245.

Taxonomic coverage

Description

The dataset includes 54 species of cheilostome Bryozoa, belonging to 25 different families.

Taxa included

A full list of taxa included in this dataset is given in Table 1.

Table 1. List of taxa included in the dataset.

Rank	Scientific name
Kingdom	Animalia
Phylum	Bryozoa
Class	Gymnolaemata
Order	Cheilostomatida
Family	Aeteidae, Beaniidae, Bitectiporidae, Calloporidae, Candidae, Celleporidae, Chlidoniidae, Chorizoporidae, Cribrilinidae, Electridae, Epistomiidae, Escharinidae, Exochellidae, Flustridae, Haplopomidae, Lacernidae, Margaretidae, Microporellidae, Phidoloporidae, Romancheinidae, Savignyellidae, Schizoporellidae, Smittinidae, Umbonulidae, Watersiporidae
Species	<i>Aetea lepadiformis</i> , <i>Aetea truncata</i> , <i>Arthropoma ceciliae</i> , <i>Beania birtissima</i> , <i>Beania mirabilis</i> , <i>Beania robusta</i> , <i>Caberea boryi</i> , <i>Callopora lineata</i> , <i>Cellepora pumicosa</i> , <i>Celleporina caliciformis</i> , <i>Celleporina caminata</i> , <i>Celleporina decipiens</i> , <i>Chartella papyrea</i> , <i>Chlidonia pyriformis</i> , <i>Chorizopora brongniartii</i> , <i>Collarina balzaci</i> , <i>Copidozoum tenuirostre</i> , <i>Cradoscrupocellaria reptans</i> , <i>Electra posidoniae</i> , <i>Escharella rylandi</i> , <i>Escharina vulgaris</i> , <i>Escharoides coccinea</i> , <i>Escharoides mamillata</i> , <i>Fenestrulina joannae</i> , <i>Fenestrulina malusii</i> , <i>Figularia figularis</i> , <i>Haplopoma graniferum</i> , <i>Haplopoma impressum</i> , <i>Hincksina flustroides</i> , <i>Margaretta cereoides</i> , <i>Membraniporella nitida</i> , <i>Microporella ciliata</i> , <i>Parasmittina raigii</i> , <i>Parasmittina tropica</i> , <i>Prenantia cheilostoma</i> , <i>Puellina gattyaee</i> , <i>Puellina hincksi</i> , <i>Puellina innominata</i> , <i>Puellina pedunculata</i> , <i>Savignyella lafontii</i> , <i>Schizobrachiella sanguinea</i> , <i>Schizomavella (Calvetomavella) discoidea</i> , <i>Schizomavella (Schizomavella) auriculata</i> , <i>Schizomavella (Schizomavella) cornuta</i> , <i>Schizomavella (Schizomavella) hastata</i> , <i>Schizoporella dunkeri</i> , <i>Schizotheca fissa</i> , <i>Scrupocellaria aegeensis</i> , <i>Scrupocellaria delilii</i> , <i>Scrupocellaria scrupea</i> , <i>Scrupocellaria scruposa</i> , <i>Synnotum aegyptiacum</i> , <i>Turbicellepora magnicostata</i> , <i>Umbonula ovicellata</i> , <i>Watersipora cucullata</i>

Temporal coverage

Data range

01 Nov 2002 – 31 Dec 2003.

Usage rights

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Data resources

Data package title:

Epiphytic Bryozoa of *Posidonia oceanica* leaves and scales. v1.0.

Resource link:

http://ipt.biodiversity.be/resource?r=ulg_bryozoa&cv=1.0

Alternative identifiers: doi: 10.15468/78vsgm

Data format: Darwin Core Archive

Data set version: 1.0

Data set description

Number of data files in the data set: 2

File 1 name: event.txt

Data format: CSV

Description: This file gathers data concerning sampling events (n= 103) (12 columns, 104 lines) (Table 2)

File 2 name:

occurrence.txt

Data format: CSV

Description: This file gathers occurrence data (n = 1234) (14 columns, 1235 lines) and is linked to file 1 by event identifiers (eventID column) (Table 3).

Author contributions

GL conceived the sampling design, performed the sampling and performed identification of specimens. LNM and AH formatted and published the dataset. LNM, GL & AH wrote the paper.

Table 2. Structure of the sampling events file.

Column label	Column description
eventID	Identification of the sampling event (n=103) (this key is used in the occurrence/abundance file (see below))
eventDate	Sampling event date
locationID	Sampling time (not location) identification number (n=5)
samplingSizeValue	Sampling area (in m ²) used to measure the number of <i>P. oceanica</i> shoots per metre square. This value was used to express our abundance data in number of colony per metre square.
sampleSizeUnit	Unit used to express abundance (number of colony per metre square)
minimumDepthInMeters	Depth of sampling locations (metres)
decimalLatitude	Latitude of sampling location (decimal)
decimalLongitude	Longitude of sampling location (decimal)
waterBody	Name of sampled water area (Revellata Bay, Mediterranean Sea)
locality	Name of sampled locality (Calvi, Corsica, France)
countryCode	International code of country
samplingProtocol	Url link to the web site (open repository of Liège University) to access the original paper explaining the protocol used to obtain this data set

Table 3. Structure of the occurrence/abundance file.

Column label	Column description
occurrenceID	Identification of the occurrence
eventID	Identification number of sampling event (cf. sampling events file, Table 2)
scientificName	Binominal scientific name
tKingdom	Kingdom of the occurrence
tPhylum	Phylum of the occurrence
tClass	Class of the occurrence
tOrder	Order of the occurrence
tFamily	Family of the occurrence
taxonRank	Taxon rank of the occurrence
occurrenceStatus	Occurrence status (presence/absence)
occurrenceRemarks	Localisation of the colony on the plant (on seagrass leaf or on seagrass scales)
organismQuantity	number of colonies per square metre
organismQuantityType	Nature of counted items (colonies for all species)
dynamicProperties	Remarks/number of ovicellated colonies

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A new solitary free-living species of the genus *Sphenopus* (Cnidaria, Anthozoa, Zoantharia, Sphenopidae) from Okinawa-jima Island, Japan

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Abstract

A new species of free-living solitary zoantharian is described from Okinawa, Japan. *Sphenopus exilis* **sp. n.** occurs on silty seafloors in Kin Bay and Oura Bay on the east coast of Okinawa-jima Island. *Sphenopus exilis* **sp. n.** is easily distinguished from other *Sphenopus* species by its small polyp size and slender shape, although there were relatively few differences between *Sphenopus exilis* **sp. n.** and *S. marsupialis* in the molecular phylogenetic analyses. Currently, very little is known about the ecology and diversity of *Sphenopus* species. Thus, reviewing each species carefully via combined morphological and molecular analyses by using newly obtained specimens from type localities is required to clearly understand and distinguish the species within the genus *Sphenopus*.

Keywords

Zoantharia, *Sphenopus*, new species, free-living, enclosed bay, identification key

Introduction

The suborder Brachycnemina (Cnidaria: Anthozoa: Hexacorallia: Zoantharia) consists of zoantharians commonly found in shallow warm waters, as almost all species within this group contain endosymbiotic photosynthetic *Symbiodinium* spp. (e.g. Swain 2010). The genus *Sphenopus* belongs to the family Sphenopidae within Brachycnemina based on its brachycnemic mesenterial arrangement, mesogleal sphincter muscles, and heavy encrustation of granules into the body column. This genus is unique as *Sphenopus* individuals consist of free-living solitary polyps, in contrast to not only other Sphenopidae and Brachycnemina species but also to all other known zoantharians. This unique feature is considered to be an adaptation to *Sphenopus*' muddy/sandy sea floor habitats that are difficult for most sessile benthos to inhabit (e.g. Soong et al. 1999, Reimer et al. 2012). Here they risk burial, which would require them to shed sediments in order to survive as seen in free-living scleractinians (e.g. Schuhmacher 1977, Fisk 1982, Bongaerts et al. 2013, Sentoku et al. 2016).

Three species are currently considered valid within the genus *Sphenopus*; *S. marsupialis* (Gmelin, 1791), *S. arenaceus* Hertwig, 1882, and *S. pedunculatus* Hertwig, 1888. In contrast to *S. marsupialis* with a wide distribution in the Indo-Pacific (Soong et al. 1999, Reimer et al. 2012, 2014), there have been no further records of *S. arenaceus* and only one additional record of *S. pedunculatus* (in Reimer et al. 2014) after their original descriptions. Although *S. marsupialis* has been reported in some field guides, formal taxonomic studies based on specimens are limited (Soong et al. 1999, Reimer et al. 2012). Thus, comparatively very little is known about the species diversity of the genus *Sphenopus*.

Recently, we discovered comparatively small *Sphenopus* specimens (polyp lengths <2.5 cm) from the shallow silty seafloors of enclosed bays on the east coast of Okinawa-jima Island, Japan. Combined morphological and molecular phylogenetic analyses lead us to conclude that the specimens belong to a previously unknown species. Thus, in this paper, a new *Sphenopus* species is formally described and a dichotomous key to identify all known *Sphenopus* species is provided. This report represents only the second formal record of this genus in Japan after Reimer et al. (2016).

Material and methods

Sample collection. Specimens from Okinawa were collected by SCUBA. Prior to collecting, *in situ* images of expanded polyps were taken to assist in morphological analyses (colour, tentacle counts and size, polyp form). Half of the specimens collected were preserved in 99% EtOH for DNA analyses, and the other specimens were fixed for morphological analyses in 5 to 10% formalin sea water after anesthesia using MgCl₂, and subsequently transferred to 70% EtOH some days later.

Morphological analyses. The lengths, maximum widths (largest diameter of column) and minimum widths (width at the top of physa where the aboral ampullaceous ends) of the column of preserved polyps were measured using calipers to the nearest

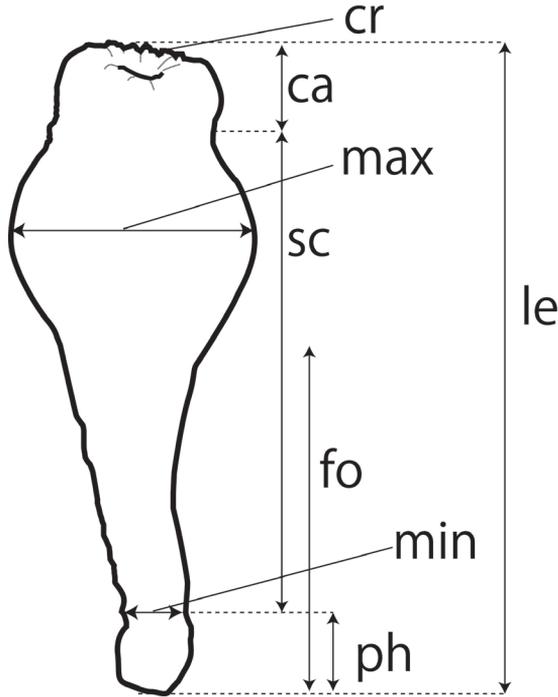


Figure 1. Diagram of external morphology of a contracted polyp of *Sphenopus exilis* sp. n.. ca = capitulum; cr = capitular ridge; fo = foot; le = length; max = maximum width; min = minimum width; ph = physa; sc = scapus, column.

0.1 mm (Figure 1). Gross shape of polyps, color of polyps, and numbers and lengths of the tentacles were recorded utilizing in situ images. Internal morphology was observed from horizontally and longitudinally hand-cutting polyps through the actinopharynx using a dissecting microscope.

Cnidae. Undischarged cnidae were measured from small pieces of tissue from the tentacles, column (external portion), actinopharynx, and mesenterial filaments of specimen NSMT-Co1576 (MISE-TF-107; fixed in 5–10% formalin seawater). Images of cnidae were obtained by differential interference contrast microscopy, and measured using the software ImageJ (National Institute of Health, Bethesda, Maryland, USA). Cnidae nomenclature generally followed England (1991) and Ryland and Lancaster (2003). However, both Schmidt (1974) and Hidaka et al. (1987, 1992) have suggested basitrichs and microbasic b-mastigophores are the same type of nematocyst, and in this study, as in recent zoantharians studies (e.g. Kise and Reimer 2016, Ryland and Ward 2016), these two types were treated as the same.

DNA processing and amplification. DNA was extracted from ethanol preserved specimens by following a guanidine extraction protocol (Sinniger et al. 2010). PCR amplifications were performed for mitochondrial cytochrome oxidase subunit I (COI), mitochondrial 16S ribosomal DNA (mt 16S rDNA), and the internal transcribed spacer region of ribosomal DNA (ITS-rDNA) region using the primer pairs

HCO and LCO (Folmer et al. 1994), 16SarmL (modified primer for mt 16S rDNA used in Sinniger et al. 2008, see Fujii and Reimer 2011) and 16SBmoH (Sinniger et al. 2005), and ITSf and ITSr (Swain 2009), respectively. Amplified PCR products were sequenced in both directions by Fasmac (Atsugi, Kanagawa, Japan).

Phylogenetic analyses. New sequences obtained in this study were deposited in GenBank (accession numbers: COI, KX400760–KX400768; mt 16S rDNA, KX400756–KX400759; ITS-rDNA, KX400769–KX400772). Obtained DNA sequences were manually aligned using Bioedit ver. 7.1.3.0 (Hall 1999). The nucleotide sequences of mt 16S rDNA, COI, and the ITS-rDNA region from specimens were separately aligned with previously obtained Sphenopidae (*Palythoa* and *Sphenopus*) sequences deposited in GenBank. Some sequences that were too short in length were removed from the analyses. For outgroups, sequences of *Zoanthus sansibaricus* (suborder Brachycnemina, family Zoanthidae) were used for all three DNA alignments' trees. Indels were kept unedited in the alignments of mt 16S rDNA. All phylogenetic alignments are available from the corresponding author.

For phylogenetic analyses of mt 16S rDNA, COI, and ITS-rDNA the same methods were independently applied. The maximum-likelihood (ML) method was performed using MEGA5 (Tamura et al. 2011), with 500 replicates performed using an input tree generated by BIONJ with the general time-reversible model (Rodriguez et al. 1990) of nucleotide substitution incorporating invariable sites and a discrete gamma distribution (eight categories) (GTR+I+C). The proportion of invariable sites, a discrete gamma distribution, and base frequencies of the model were estimated from the dataset. Bayesian trees for nuclear ITS-rDNA region were made by Mr. Bayes 3.2.5 (Ronquist and Huelsenbeck 2003) under GTR+I+C. One cold and three heated Markov chains Monte Carlo (MCMC) with default-chain temperatures were run for 10 million generations, sampling log-likelihoods (InLs), and trees at 100-generation intervals (100,000 InLs and trees were saved during MCMC). The likelihood plots for ITS-rDNA datasets suggested that MCMC reached the stationary phase after the first 10,000 generations (standard deviation of split frequencies = 0.004361). Thus, the remaining 90,000 trees of ITS-rDNA were used to obtain clade probabilities and branch-length estimates.

Results

Suborder Brachycnemina Haddon and Shackleton, 1891

Family Sphenopidae Hertwig, 1882

Genus *Sphenopus* Steenstrup, 1856

Sphenopus exilis sp. n.

<http://zoobank.org/30C107C6-8104-4EC9-9DC9-CF2DEE4A9638>

Figures 2, 3

Holotype. Specimen number NSMT-Co1576 (MISE-TF-107): Kin Bay, Uruma, Okinawa-jima Island, Japan (26°22'25"N, 127°53'30"E), 15 m depth, collected by

Takuma Fujii, 29 October 2011, fixed in 5–10% SW formalin, deposited in National Museum of Nature and Science, Tokyo, Japan (NSMT). Polyp length 2.4 cm, maximum width 0.8 cm, minimum width 0.3 cm. Figure 2B.

Paratypes. Specimen number NSMT-Co1577 (MISE-TF-107), a lot of total 11 polyps collected on the same dive, collection data same as holotype, five polyps fixed in 5–10% formalin, six polyps fixed in 99% EtOH, polyp length 1.3 to 2.2 cm (average 1.7 ± 0.3 cm), maximum width 0.4 to 1.0 cm (average 0.5 ± 0.2 cm), minimum width 0.2 cm, deposited in NSMT. GenBank accession numbers: COI, KX400760–KX400768; mt 16S rDNA, KX400756–KX400759; ITS-rDNA, KX400769–KX400772. Figure 2A and B; Specimen number RMNH Coel. 42121 (MISE-TF-144): a lot of total 16 polyps collected on the same dive, Kin Bay, Uruma, Okinawa-jima Island, Japan ($26^{\circ}22'25''\text{N}$, $127^{\circ}53'30''\text{E}$), 15 m depth, collected by Takuma Fujii, 24 May 2012, 11 polyps fixed in 5–10% formalin, five polyps fixed in 99% EtOH, polyp length 1.1 to 2.2 cm (average 1.7 ± 0.4 cm), maximum width 0.4 to 0.5 cm (average 0.5 ± 0.1 cm), minimum width 0.1 to 0.3 cm (average 0.2 ± 0.1), deposited in Naturalis Biodiversity Center, Leiden, Netherlands (RMNH); Specimen number NSMT-Co1578 (MISE-TF-151), a lot of total six polyps collected on the same dive, Oura Bay, Nago, Okinawa-jima Island, Japan ($26^{\circ}32'29''\text{N}$, $128^{\circ}3'16''\text{E}$), 17 m depth, collected by Takuma Fujii, 13 November 2012, five polyps fixed in 5–10% formalin, 1 polyp fixed in 99% EtOH, polyp length 1.0 to 1.9 cm (average 1.5 ± 0.4 cm), maximum width 0.3 to 1.1 cm (average 0.7 ± 0.3 cm), minimum width 0.1 to 0.3 cm (average 0.2 ± 0.1 cm), deposited in NSMT. Figure 2C and D.

Diagnosis: external morphology. Solitary, cylindrical polyp. Length of polyps 1.0 to 2.4 cm (average 1.7 ± 0.3 cm), maximum width 0.3 to 1.1 cm (average 0.6 ± 0.2 cm), minimum width 0.1 to 0.3 cm (average 0.2 ± 0.1 cm) ($n=34$). Tentacles longer than half diameter of the expanded oral disc (Figure 2A). Oral disc gently hollowing into mouth, with stellate grooves as many as tentacles (Figure 2A, C). Capitular ridges present but not strongly pronounced when polyps closed (Figure 1). The upper part of the polyp between capitulum and the column slightly constricted (the width of the most constricted region approximately 0.1 cm to 0.4 cm thinner than the width of contracted capitulum) when polyp contracted (Figures 1, 2B, D). Upper part of the column generally thick and oval (Figures 1, 2B, D). Aboral narrow bottom portion of column extended (=foot), thinner than upper portion of column, like a cone (Figures 1, 2B, D), with the distal portion round and thicker than the extended foot (=physa) (Figures 1, 2B, D). Column smooth, with encrusted fine dense sand particles. Occasionally broken piece(s) of bivalve shells attached to the aboral end (Figure 2B).

Diagnosis: internal morphology. Fine sand particles heavily encrusted into ectoderm and mesoglea. Mesenteries in brachycnemic arrangement. Mesentery number 36, complete 18, incomplete 18 (Figure 3A; $n=6$ polyps). Single siphonoglyph apparent. Mesogleal sphincter muscle well developed, visible under dissecting microscope (Figure 3B). Endosymbiotic *Symbiodinium* spp. (zooxanthellae) absent (=azooxanthellate).

Diagnosis: cnidae. Basitrichs and spirocysts in tentacles and actinopharynx. Basitrichs, holotrichs, microbasic p-mastigophores and basitrichs in mesenterial filaments. Holotrichs in column (Table 1).

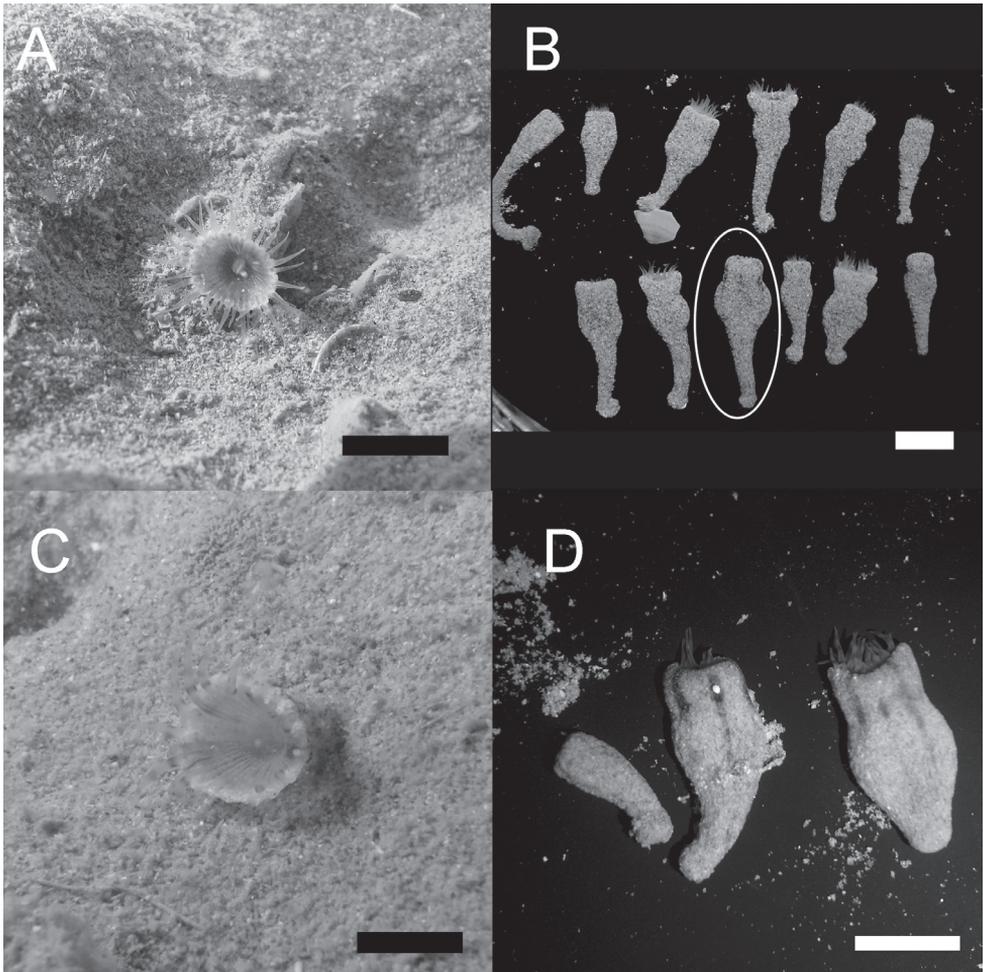
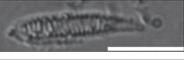
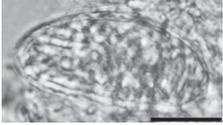
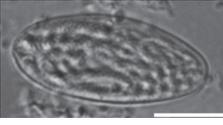
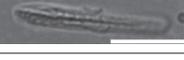
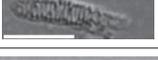


Figure 2. Polyps of *Sphenopus exilis* sp. n. **A** In situ image of *S. exilis* sp. n., polyp with no black patterns, from the type locality in Kin Bay, Okinawa, Japan on 29 October 2011 **B** Polyps of NSMT-Co1576 & NSMT-Co1577 from Kin Bay, Okinawa-jima Island, Japan. The white circle points to the holotype **C** In situ image of NSMT-Co1578 from Oura Bay, Okinawa-jima Island, Japan, on 13 November 2012. Faint black patterns and bands appear on the oral disc and the tentacles **D** Polyps of lot number NSMT-Co1578 showing phenotypic variation with black stripes on the upper part of the polyps. Scale bars: 1 cm.

Habitat. Specimens were found at approximately 10 to 20 m depths on the slopes of silty seafloors in enclosed bays. Most polyps semi-burrowed in silt, with only the open oral disc visible and protruding out from the seafloor.

Colour. Tentacles and oral disc whitish and translucent in life. Faint black narrow horizontal bands appear on tentacles, and similar faint patterns on the oral disc of a few polyps (Figure 2C). Column colour of encrusted sand particles, a few polyps with 2 to 6 faint black vertical stripes approximately 15 mm wide on the upper part of the column, reaching from oral end to aboral end (Figure 2C, D).

Table 1. Cnidae types and sizes in different tissue sections of the holotype of *Sphenopus exilis* sp. n.

		Image (Scale bars: 50 μ m)	Length*	Width*	Frequency**
Tentacle	Basitrich		10.4 (21.4–19.1)	3.0 (2.6–3.3)	Occasional (n=8)
	Spirocyst		13.1 (12.0–14.5)	2.6 (2.4–2.8)	Numerous (n=20)
Column	Holotrich		26.7 (16.3–34.5)	14.7 (12.5–16.2)	Rare (n=3)
Actinopharynx	Holotrich		28.0 (21.0–34.9)	10.5 (5.5–15.5)	Rare (n=2)
	Basitrich		26.9 (26.4–27.4)	4.4 (3.9–5.0)	Numerous (n=20)
	Spirocyst		13.4 (10.8–15.2)	2.9 (2.8–2.9)	Common (n=13)
Filaments	Holotrich		21.4 (17.0–25.6)	10.4 (5.9–15.25)	Occasional (n=4)
	Basitrich		31.1 (30.6–31.6)	3.2 (2.8–3.5)	Numerous (n=20)
	<i>p</i> -mastigophore		15.4 (14.6–16.2)	4.4 (3.7–4.9)	Occasional (n=5)

*Length and width: average, minimum–maximum, all sizes in μ m.

**Frequency: n=number of examined cnidae in these analyses. Frequency in decreasing order; numerous, common, occasional, rare.

Etymology. Named from latin ‘exilis’ meaning ‘slender’ or ‘small’, as polyps have an elongate and narrow foot more slender than other known species in this genus to the exception of *S. pedunculatus*. Polyps of this species are also much smaller than those of all three other species in the genus.

Common name. Hime-daruma-sunaginchaku (new Japanese name)

Molecular phylogeny. The results of the phylogenetic analyses of both mitochondrial cytochrome oxidase subunit I (COI) and 16S rDNA showed very few differences between sequences of our specimens and those of *S. marsupialis*, as well as compared with those of various *Palythoa* species. These results are not incongruous with previous studies on the molecular phylogeny of family Sphenopidae, where intra-family variation levels of mitochondrial DNA sequences were relatively low (Reimer et al. 2006, 2012).



Figure 3. Morphological features of *Sphenopus exilis* sp. n. **A** Cross section of holotype NSMT-Co1576 through the actinopharynx showing the mesenterial arrangement and dense sand encrustations **B** Well-developed mesogleal sphincter muscles visible on a hand-cut longitudinal section of the holotype NSMT-Co1576 **C** Comparison of polyp shape between *S. exilis* sp. n. NSMT-Co1577 and *S. marsupialis* (from Brunei, refer to Reimer et al. 2012).

The results of the phylogenetic analyses of nuclear internal transcribed spacer rDNA region showed *S. exilis* sp. n. forming a well-supported clade in the maximum likelihood and Bayesian analyses (Figure 4; ML=94%, Bayes=0.91). As well, together with sequences of *S. marsupialis*, *S. exilis* sp. n. formed a strongly supported *Sphenopus* clade (Figure 4; ML=99%, Bayes=1.00). In comparing the ITS-rDNA sequences between *S. exilis* sp. n. and *S. marsupialis*, there were 12 to 27 b.p. differences over a total 470 b.p. (=2.5–5.7% difference).

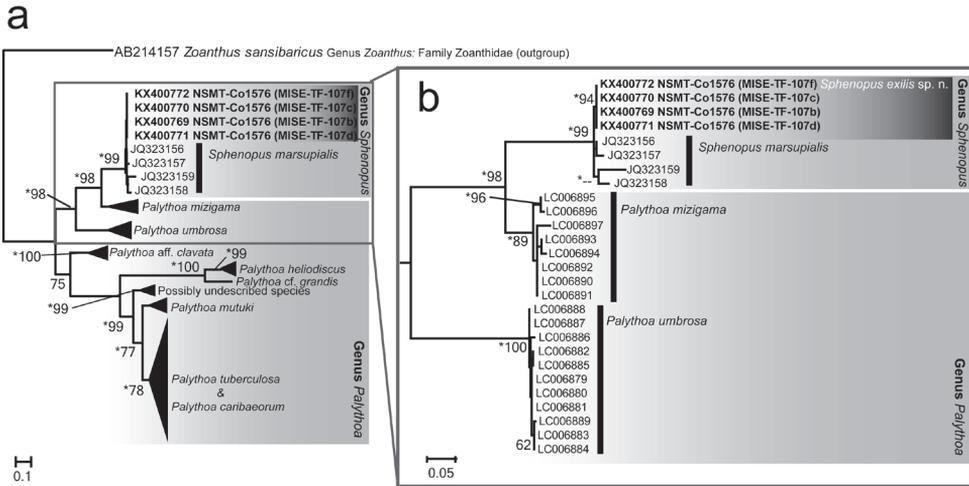


Figure 4. Maximum likelihood tree of nuclear internal transcribed spacer of ribosomal DNA (ITS-rDNA) region for newly obtained sequences from *Sphenopus exilis* sp. n. in this study along with previously published GenBank sequences of family Sphenopidae. Bootstrap values of ML >60% are shown at respective nodes. Nodes supported by Bayesian posterior probabilities >0.90 are marked with asterisks. Species names of sequences obtained from GenBank follow with accession numbers. The subtree shown in **b**) shows only the clade formed by genus *Sphenopus*, *Palythoa mizigama* and *P. umbrosa*, delineated by the gray square in **a**).

Remarks. Until now three species have been considered valid within *Sphenopus*; *S. marsupialis* (Gmelin, 1791), *S. arenaceus* Hertwig, 1882, and *S. pedunculatus* Hertwig, 1888. *S. exilis* sp. n. is easily distinguished from these other species by its small polyp size (length of *S. exilis* sp. n. <2.5 cm and width <1 cm), and by the shape of its elongated foot and physa. Polyps of both *S. marsupialis* and *S. arenaceus* are round on the aboral end, and not elongated as in *S. exilis* sp. n. (Figure 3C). Soong et al. (1999) examined various sized *S. marsupialis* collected from around Taiwan including small polyps without any narrow elongated foot (length < 2 cm). Additionally, Reimer et al. (2016) recently reported on a *S. marsupialis* specimen of the typical rounded shape and large size (~9 cm in height) from Okinawa-jima Island. No polyps with intermediate morphology between *S. marsupialis* and *S. exilis* sp. n. have ever been found. Thus, the specimens collected in this study cannot be considered to be immature polyps of *S. marsupialis*. The morphologically most similar species to *S. exilis* sp. n. is *S. pedunculatus* as it also has a narrow foot, but *S. pedunculatus* is much larger than *S. exilis* sp. n., with polyp lengths of 2.4 to 3.2 cm and widths of 2 to 2.4 cm, and with approximately 60 mesenteries. As well, the aboral end of *S. pedunculatus* is shaped like a clasping disc, different from that of *S. exilis* sp. n. with a narrow rounded shape (Hertwig 1888, Reimer et al. 2014).

In contrast to the morphological differentiation from other *Sphenopus* species, only a few differences were found in molecular analyses. The COI sequences of *S. exilis* sp. n. were identical to those of *S. marsupialis*, *Palythoa tuberculosa* (Esper, 1805), and

P. umbrosa Irei, Singer & Reimer, 2015. However, it is known that the evolutionary rate of mitochondrial DNA markers is quite slow in most Anthozoa (Shearer et al. 2004; Huang et al. 2008; Stampar et al. 2014), and the nuclear ITS-rDNA region is currently the fastest evolving DNA marker that has been utilized for species-level analyses of suborder Brachycnemina (Reimer et al. 2007). Although there are only relatively few differences between the ITS-rDNA sequences of *S. exilis* sp. n. and *S. marsupialis* (2.5–5.7% sequence divergence), the formation of a supported monophyletic clade confirms the results of our morphological analyses that the specimens collected in this study belong to a species different from *S. marsupialis* (Figure 4). Moreover, these results suggest the possibility of the presence of multiple, cryptic species within *S. marsupialis* as previously mentioned by Soong et al. (1999).

Currently, very little is known about the ecology and species diversity of the genus *Sphenopus*, demonstrated by the fact that there have been no or few records of both *S. arenaceus* and *S. pedunculatus* within the last 100 years. Thus, morphological and molecular analyses of newly obtained specimens from type localities followed by reviewing each species' description carefully are required to clearly understand the species distinction of *Sphenopus* species. As mentioned in previous studies, the phylogenetic results of this study indicate a need to re-examine the validity of the genus *Sphenopus* as it is positioned within the genus *Palythoa*, and by extension the definition of genera within the family Sphenopidae should be reconsidered (Reimer et al. 2012, Irei et al. 2015).

In the ITS-rDNA molecular phylogeny, it is notable that two recently described azooxanthellate *Palythoa* species from caves, *P. umbrosa* and *P. mizigama*, form a well-supported subclade with *S. exilis* sp. n. and *S. marsupialis*. As the phylogenetic relationship between *Sphenopus* and *Palythoa* is not yet clear, and likely does not reflect the traditional taxonomy (Reimer et al. 2012), construction of a large ITS-rDNA phylogeny with additional sequences from other *Palythoa* and *Sphenopus* species is needed. At the same time, investigation with additional DNA markers besides from the mt DNA and ITS-rDNA currently utilized in zoantharian phylogeny may be helpful.

Key to species of genus *Sphenopus*

- 1 Aboral end rounded, column shape oval, never having a very narrow stalk ...2
- Aboral end elongated and narrow, forming a foot3
- 2 Polyp colored earthy gray ***S. marsupialis***
- Polyp colored rusty red ***S. arenaceus***
- 3 Aboral end forms clasping disc, or the narrow stalk part of younger polyps very short compared to the oval part of the column. Comparatively large polyps (=polyp lengths > 2.4 cm, width > 2 cm) with approximately 60 mesenteries ***S. pedunculatus***
- Aboral end forms a rounded anchor. Comparatively small polyps (length < 2.4 cm, width < 2 cm), and approximately 36 mesenteries ***S. exilis* sp. n.**

Discussion

Unlike some other recently described zoantharian taxa such as Nanozoanthidae and Microzoanthidae, *S. exilis* sp. n. is not very small in size and does not inhabit a cryptic habitat. However, silty, sandy and rubble habitats are often overlooked in biodiversity surveys in favor of coral reef habitats, and this sampling bias has resulted in a relative lack of understanding of the diversity of these habitats and the evolutionary position of their inhabitants (Sheppard 1981, Obuchi et al. 2010, Fujii and Reimer 2011, Hoeksema 2012). In addition, not only are silty and muddy habitats less understood, but their ecosystem service value is often underestimated as well. For example, silty and muddy ecosystems on Okinawa-jima Island have been degraded by landfill dredging, and other development (Coral Reefs of Japan 2004), and over 35% of muddy tidal flats and shallow waters in Kin Bay have been lost (Uruma City Cultural Sea Museum 2007). Currently, *S. exilis* sp. n. is only known from two bays on the east coast of Okinawa-jima Island. Kin Bay, the type locality of *S. exilis* sp. n., has undergone ecological degradation over the past approximately 40 years (Reimer et al. 2015). The other locality, Oura Bay, is currently a center of controversy over proposed landfill and military base construction, while it is also known to house a unique benthic community (Fujii et al. 2015).

Thus, not only *S. exilis* sp. n., but also the diverse and various organisms that exclusively inhabit soft substrates in coral reef regions in the world face issues of decreasing habitat despite our lack of knowledge of their biodiversity (e.g. Cnidaria: Ceriantharia: Spier et al. 2012; Annelida: Polychaeta: Godet et al. 2008). *Sphenopus exilis* sp. n. serves as a clear reminder of how little we know of these ecosystems. It also provides a clear reason for better conservation and more exploration of the remaining silty and muddy areas.

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Revision of the genus *Paralipsis* Foerster, 1863 (Hymenoptera, Braconidae), with the description of two new species

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Abstract

The Palaearctic genus *Paralipsis* Foerster, 1863 (Hymenoptera: Braconidae: Aphidiinae) is revised and two new species are described: *P. tibiator* van Achterberg & Ortiz de Zugasti, **sp. n.** from Spain and *P. planus* van Achterberg, **sp. n.** from the Netherlands. Some biological notes are supplied for *P. tibiator* **sp. n.** A key to the four known species is added and all species are illustrated.

Keywords

Paralipsis, Aphidiinae, new species, Spain, Netherlands, Germany, key, biology, endoparasitoid, social parasite, root aphids, ants, *Lasius grandis*

Introduction

The subfamily Aphidiinae (Hymenoptera: Braconidae) contains exclusively koinobiont parasitoids of ovoviviparous aphids (Aphididae sensu lato) (Yu et al. 2012; Shaw and Huddleston 1991). Few genera specialise on concealed hosts and *Paralipsis* Foerster,

1863, is one of them, by attacking root aphids associated with ants. The genus is restricted to the Palearctic region and only two valid species are known: *P. enervis* (Nees, 1834) (West Palaearctic) and *P. eikoeae* (Yasumatsu, 1951) (East Palaearctic) (Yu et al. 2012). The detection of a new species of the genus in Spain by the second author triggered a revision of the genus and resulted in the discovery of a second new species from the Netherlands.

Material and methods

The second author detected the first *Paralipsis tibiator* sp. n. female during a routine myrmecological survey and conserved it in 70% ethanol. The following year, a focused search was undertaken to collect more *Paralipsis* by nest excavation and aspiration of the parasitoids. In addition, during two days, at haphazard moments, short (approx. 15 minutes) observations were conducted totalling about three hours. The specimens of *P. planus* sp. n. and *P. enervis* (Nees) were collected either in Malaise traps or in pit-fall traps and conserved in 70% ethanol. The specimens were prepared using the AXA method (van Achterberg 2009; van Achterberg et al. 2010) and glued on card points or pinned on minutins. Observations and descriptions were made with an Olympus SZX11 stereomicroscope and fluorescent lamps. Photographic images were made with an Olympus motorized stereomicroscope SZX12 and processed with Adobe Photoshop CS5, mostly to adjust the size and background. The examined material is deposited in collection of the Naturalis Biodiversity Center (RMNH), Leiden. POL stands for the distance between both posterior ocelli and OOL for the distance between posterior ocellus and compound eye.

Biology

Ants constitute complex and well organized societies, which normally defence their nests viciously against intruders (Hölldobler and Wilson 1990). Nonetheless, several arthropods belonging to the class Arachnida or to main orders as Hymenoptera, Orthoptera and Coleoptera, have evolved to overcome this defence. As a result, symbiotic relationships ranging from mutualism, parasitism and commensalism to inquilinism occur in ant nests (Kistner 1982, Völkl et al. 1996). The case of the myrmecophilic aphidiine parasitoid wasp genus *Paralipsis* is more complicated, because they parasitise root aphids herded by ants (Takada and Hashimoto 1985). Once the parasitoid wasp infiltrates the ant colony, it finds a source of food (aphids) for its offspring protected by ants and thus sheltered from potential predators.

On 23 July 2014 two small wasps were seen in a nest of *Lasius* (*Lasius*) *grandis* Forel, 1909, located under a small rock at the foot of a *Cedrus* sp. (cedar) with abundant grass cover (lawn, Poaceae) at the Parque del Oeste (Madrid, Spain;

40°25'55.8"N, 3°43'43.7"W). Both wasps were occupying the galleries jointly with the ants; one was collected and the other one escaped flying. On 3 July 2015 in the same park (40°26'05.5"N, 3°43'27"W) a *L. grandis* nest at the foot of a *Populus alba* tree (white poplar), also covered with abundant *Poaceae* turf, was excavated and two additional females were collected. The following root aphids were found in the nest: an adult female of *Tetraneura ulmi* (Linnaeus, 1758), a nymph of *T. nigriabdominalis* (Sasaki, 1899), a nymph of *Aploneura lentisci* (Passerini, 1856) and two nymphs of *Forda formicaria* (von Heyden, 1837).

One female wasp was kept alive for two days along with ten ant workers of the same nest where the wasp was found. They were kept in a plastic container (8 cm × 8 cm × 3 cm) with supply of moisture and fed once with diluted honey. During this period, the wasp actively looked for the company of the ants. Upon disturbing the artificial nest, the wasp was always, and promptly, looking for a concentration of standing (not running) ants to join. Most of the time the wasp was hiding under the legs of the ants and sometimes walking around the group. The wasp was observed being frequently groomed and antennated by the ants. The wasp always showed a submissive behaviour and it was once observed actively antennating an ant, an action that elicited ant-wasp trophallaxis. While the first specimen was kept alive along with the ants, no wasp-ant rubbing such as is described by Takada and Yashimoto (1985) was observed. Probably, the rubbing behaviour was not observed because the chemical mimicry was already obtained.

In an ongoing study on aphid-ant relationships at a similar environment in Spain, so far *L. grandis* has been observed attending only *F. formicaria* root aphids (Pérez Hidalgo, pers. com.). During this study *Paralipsis tibiator* sp. n. has been observed parasitizing *F. formicaria* aphids being attended by *L. grandis*. It suggests that *F. formicaria* is the preferred host of *Paralipsis tibiator* sp. n., but we cannot rule out that other root aphids are chosen as hosts. *Lasius grandis* “is the most abundant species of the subgenus on the Iberian peninsula” (Seifert 1992) with a continuous distribution across the Iberian Peninsula (Gómez and Espadaler 2007). Also *F. formicaria* occurs all over the Peninsula (Nieto Nafria et al. 2003). Hence, it can be expected that *Paralipsis tibiator* sp. n. occurs in nests of *L. grandis* across the Iberian Peninsula.

Systematics

Paralipsis Foerster, 1863

Paralipsis Foerster, 1863: 248, 250; Starý 1958: 85; Mackauer 1968: 22; Takada 1976:

1. Type species: *Aphidius enervis* Nees, 1834 (by original designation).

Myrmecobosca Maneval, 1940: 9. Type species: *Myrmecobosca mandibularis* Maneval, 1940 (by original designation). Synonymised with *Paralipsis* Foerster, 1863, by Starý (1958).

Diagnosis. Veins r + SR and 1-R1 of fore wing absent and if weakly indicated then continuous with postero-basal border of pterostigma (Fig. 1); pterostigma conspicuous and wide triangular (Figs 1, 14, 25); scapus much larger than pedicellus and apically widened (Fig. 4); first tergite parallel-sided or weakly widened posteriorly (Figs 3, 11, 19, 27); labial palp with 1 segment and maxillary palp with 2 segments; scutellum protuberant, but of ♀ of *P. eikoeae* and of males flattened; mandible strongly narrowed and twisted apically, with two minute apical teeth and with fine ventral carina (Fig. 22); fore and middle coxa nearly triangularly enlarged (Fig. 21); precoxal sulcus absent; ventrally head with long combined occipital and hypostomal carina (Fig. 23); length of body 2.0–2.7 mm.

Biology. Myrmecophylic endoparasitoids of root aphids (Aphididae) (Maneval 1940; Hincks 1949, 1958; Starý 1958; Pontin 1960). Fore wing frequently mutilated, possibly by ants during their stay inside the ant nest.

Distribution. Palaearctic; four species, of which two new to science.

Key to species of *Paralipsis* Foerster

- 1 Second-fourth segments of fore tarsus about as long as wide in dorsal view and with medium-sized bristles apically (Figs 1, 8); hind tibia medially and femur subbasally parallel-sided (Figs 1, 2, 8); subapically scapus subparallel-sided in lateral view (Figs 1, 4, 12); [rhinaria absent on fifth antennal segment; pterostigma nearly straight baso-posteriorly (Figs 1, 6, 13, 14)] **2**
- Second-fourth segments of fore tarsus distinctly longer than wide in dorsal view and with long apical bristles (Figs 21, 24); hind tibia medially and femur subbasally widened (Figs 16, 24); scapus distinctly widened dorsally in lateral view (vase-shaped: Figs 17, 21); [vein 2-1A of fore wing obsolescent or absent (Fig. 18); middle antennal segments of ♀ narrowed basally (Figs 17, 21)] **3**
- 2 Scutellum distinctly convex and shiny, smooth (Fig. 9); third–fifth antennal segments longer (Fig. 12); mesoscutum shiny and mainly smooth (Fig. 10); middle and hind femora and tibiae slenderer, hind tibia hardly or not sculptured (Fig. 8); vein 2-1A of fore wing largely or entirely sclerotized (Figs 13–14); first tergite less slender behind spiracles (Figs 9, 11); [width of first tergite at level of spiracles of ♀ equal to distance between spiracle and apex of tergite; middle antennal segments of ♀ more or less parallel-sided (Fig. 12)]; N & C. Europe *P. enervis* (Nees, 1834)
- Scutellum irregularly flattened and dull, finely sculptured posteriorly (Fig. 7); third–fifth antennal segments rather short (Fig. 4); mesoscutum largely dull and distinctly finely sculptured (Fig. 7); middle and hind femora and tibiae more robust, hind tibia micro-sculptured (Figs 1-2); vein 2-1A of fore wing absent (Fig. 6); first tergite slender behind spiracles (Fig. 3); Japan (Honshu, Kyushu), Far East Russia *P. eikoeae* (Yasumatsu, 1951)

- 3 Vertex and mesoscutum with satin sheen and vertex with dense short pubescence between sparse long setae (Fig. 26); first tergite more convex and less shiny, its maximum width at level of spiracles of ♀ 0.9 times distance between spiracle and apex of tergite (Fig. 27); mesopleuron with satin sheen (Fig. 23); antennal segments with adpressed setae (Fig. 21); fore basitarsus slender and with shorter setae (Fig. 21); hind basitarsus elongate (Fig. 24); pterostigma concave baso-posteriorly (Fig. 25); fifth antennal segment without distinct rhinaria; SW Europe *P. tibiator* sp. n.
- Vertex and posteriorly mesoscutum shiny and vertex with sparse short pubescence between long setae; first tergite flat and shiny, its maximum width at level of spiracles of ♀ 0.7 times distance between spiracle and apex of tergite (Fig. 19); mesopleuron shiny; antennal segments with long erect setae (Figs 17, 20); fore basitarsus rather robust and with longer setae; hind basitarsus robust (Fig. 16); pterostigma straight baso-posteriorly (Fig. 18), but slightly concave in right wing of holotype; few rhinaria present on fifth antennal segment; NW Europe..... *P. planus* sp. n.

***Paralipsis eikoeae* (Yasumatsu, 1951)**

Figs 1–7

Myrmecobosca eikoeae Yasumatsu, 1951: 171–174.

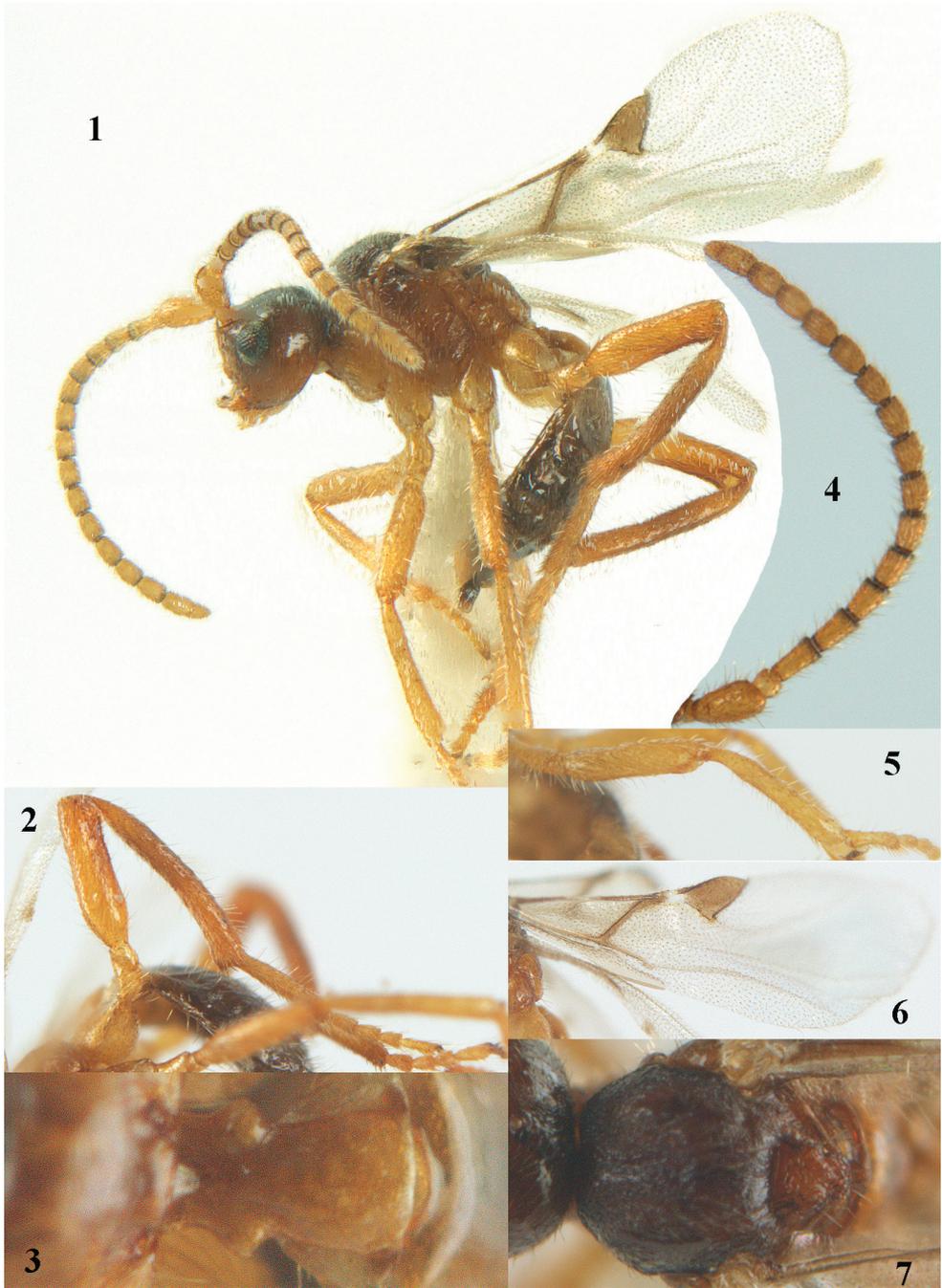
Paralipsis eikoeae; Starý 1958: 89; Yasumatsu 1960: 57; Mackauer 1968: 22; Takada 1968: 91, 1976: 1–5.

Material. 1 ♀ (RMNH), “[Japan:] Mt. Hiei, 15.v.1996, H. Takada”, “Host: *Sappaphis piri*”, “*Paralipsis eikoeae* (Yasumatsu), det. H. Takada, 2015”.

Diagnosis. This species shares with *P. enervis* having the second–fourth segments of fore tarsus about as long as wide in dorsal view, the fore tarsus with medium-sized bristles apically (Figs 1, 8) and the hind tibia medially and femur subbasally parallel-sided (Figs 1, 2, 8). Differs by the dull and posteriorly finely sculptured scutellum (Fig. 7), the rather short third–fifth antennal segments (Fig. 4), the largely dull and distinctly finely sculptured mesoscutum (Fig. 7), the more robust middle and hind femora and tibiae, the micro-sculptured hind tibia (Figs 1–2), the vein 2-1A of fore wing absent (Fig. 6) and the slenderer first tergite (Fig. 3).

Biology. Parasitoid of root aphids attended by the ants *Lasius sakagamii* Yamauchi & Hayashida, 1970 or *L. japonicus* Santschi, 1941 (Yu et al. 2012, Akino and Yamaoka 1998). Holotype male was collected from a nest of *Lasius japonicus* (published as *L. niger*; see Seifert 1992) in an old *Cryptomeria japonica* tree and the species was reared as parasitoid of the aphid *Sappaphis piri* Matsumura, 1918, on roots and subterranean stems of *Artemisia princeps* Pamp. (Takada 1976).

Distribution. Reported from Japan and Far East Russia (Yu et al. 2012).



Figures 1–7. *Paralipsis eikoeae* (Yasumatsu), female, Japan. **1** habitus lateral **2** hind leg **3** first metasomal tergite dorsal **4** antenna **5** fore leg **6** wings **7** mesonotum dorsal.

***Paralipsis enervis* (Nees, 1834)**

Figs 8–15

Aphidius enervis Nees, 1834: 26–27 (holotype male lost).*Paralipsis enervis*; Starý 1958: 85, 1961: 228–232; Hincks 1958: 20–21; Pontin 1960: 154–155; Mackauer 1968: 22.*Myrmecobosca mandibularis* Maneval, 1940: 10–11. Synonymised with *Paralipsis enervis* (Nees, 1834) by Starý (1958).*Myrmecobosca linnei* Hincks, 1949: 173–174. Synonymised with *Paralipsis enervis* (Nees, 1834) by Starý (1958).

Material. 1 ♀ (RMNH), “**Nederland:** Rotterdam (Z.H.), NS-driehoek”, “in ground-traps, 18.ix.1976, Insektenwerkgroep KNNV”; 1 ♀ (RMNH), id., but 20.viii.1976; 1 ♀ (RMNH), “Netherlands: Bennekom, 10.x.1971, D. Hille Ris Lambers”, “[ex] aphid mummy of *Brachycaudus jacobi* Stroyan”; 1 ♀ (RMNH), “[**Germany:**] German Dem. Rep., Museum Leiden”, “NSG Wernsdorfer See (n[ea]r Berlin), 1.vii.1979, G.N. Wendt”.

Diagnosis. This species shares with *P. eikoeae* having the second-fourth segments of fore tarsus about as long as wide in dorsal view, the fore tarsus with medium-sized bristles apically (Figs 1, 8) and the hind tibia medially and femur subbasally parallel-sided (Figs 1, 2, 8). Differs by the shiny and smooth scutellum (Fig. 9), the brownish scutellum, the longer third–fifth antennal segments (Fig. 12), the shiny and mainly smooth mesoscutum (Fig. 10), the slenderer middle and hind femora and tibiae, the hardly or not sculptured hind tibia (Fig. 8), the largely or entirely sclerotized vein 2-1A of fore wing (Figs 13–14) and the less slender first tergite (Figs 9, 11).

Biology. Parasitoid of root aphids belonging to the genera *Anoecia*, *Anuraphis*, *Aphis*, *Brachycaudus*, *Chromaphis*, *Dysaphis*, *Forda*, *Geocia* and *Tetraneura* (Yu et al. 2012) and associated with *Lasius* ants. *Brachycaudus jacobi* Stroyan is a new host.

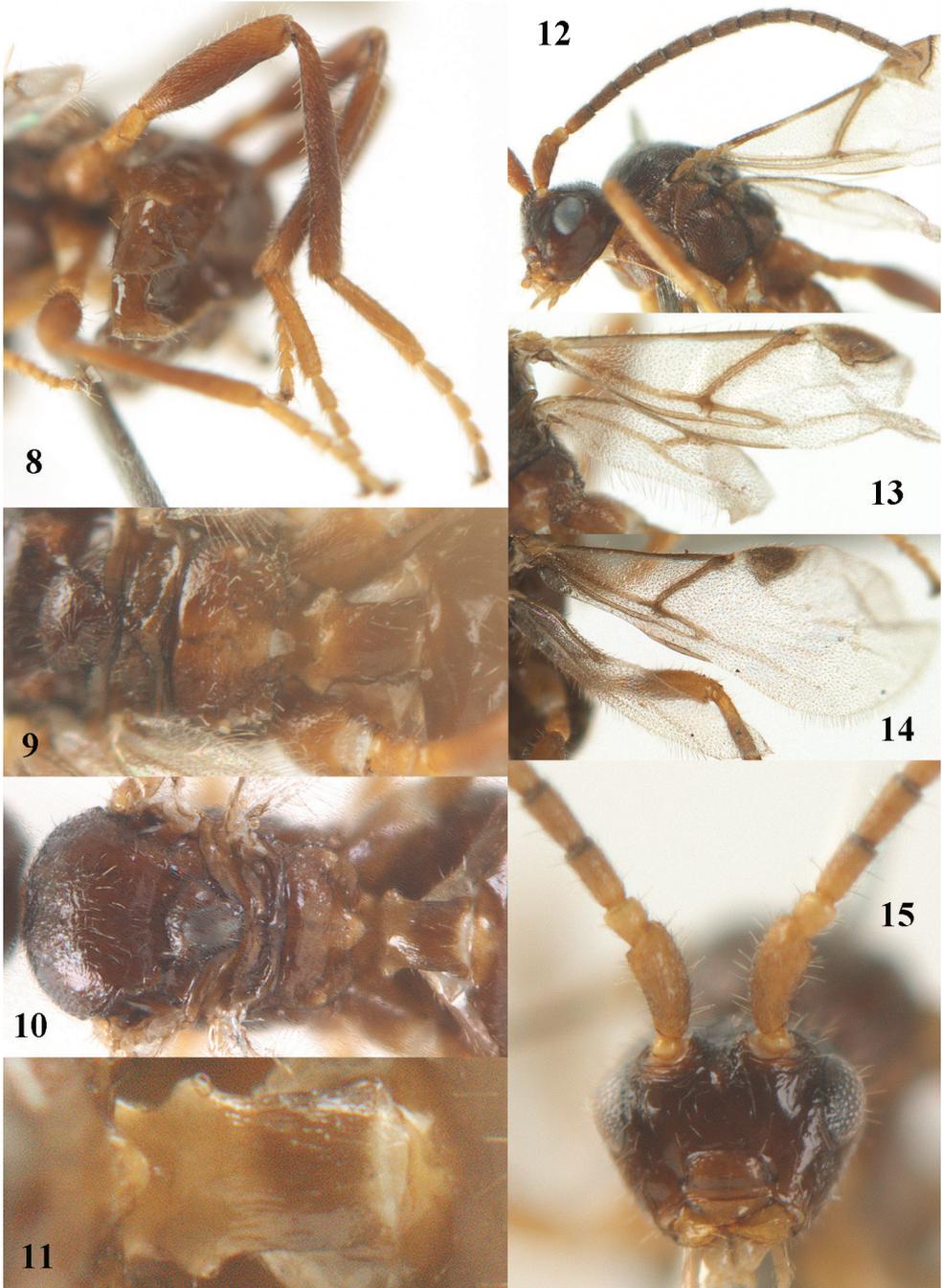
Distribution. Reported from Andorra, Czech Republic, Finland, France, Georgia, Germany, Hungary, Kazakhstan, Macedonia, Moldova, Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden, UK and Serbia (Yu et al. 2012). The reports from Spain, Portugal and Andorra may concern *P. tibiator* sp. n.

***Paralipsis planus* van Achterberg, sp. n.**<http://zoobank.org/C8E5EB50-4F3D-4071-9DE7-BFB816F31CE2>

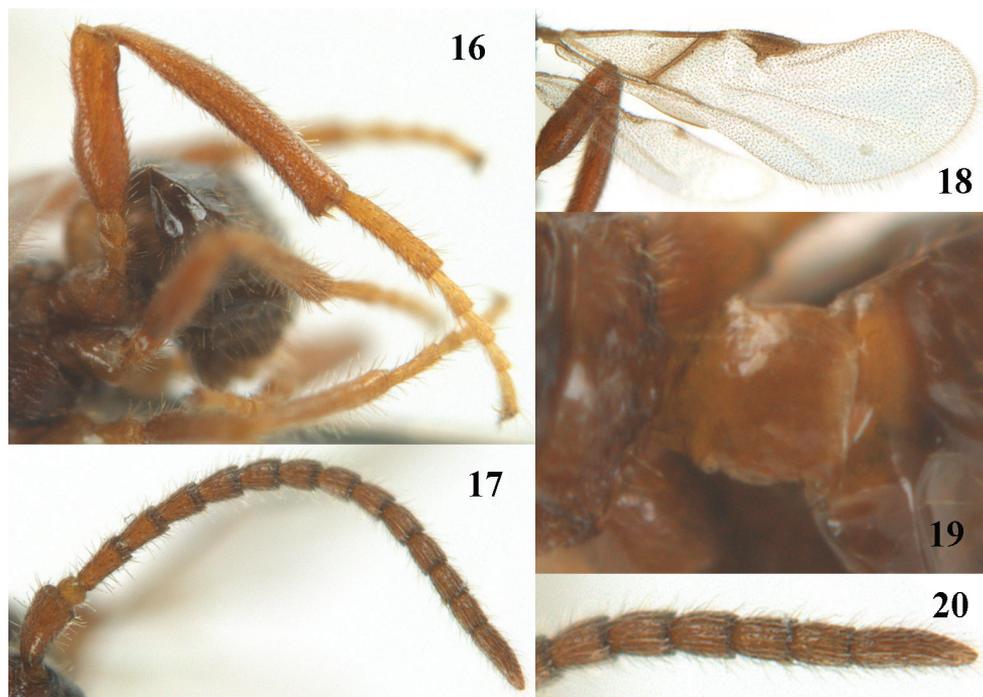
Figs 16–20

Material. Holotype, ♀ (RMNH), “**Nederland:** Wijster (Dr.), opposite Biol. Stat., 28.vii.-14.viii.1972, C. v. Achterberg”.

Diagnosis. Similar to *P. enervis* (Nees, 1834), but differs by the slenderer fore tarsus, the partly widened hind tibia and femur (Fig. 16) and the scapus distinctly widened dorsally in lateral view (vase-shaped: Fig. 17). Close to *P. tibiator* sp. n., but *P. planus* has the



Figures 8–15. *Paralipsis enervis* (Nees), female, Netherlands, but **10–11, 14–15** Germany. **8** hind leg **9** posterior part of mesosoma and first metasomal tergite dorsal **10** mesosoma and first metasomal tergite dorsal **11** first metasomal tergite dorsal **12** antenna **13–14** wings **15** head anterior.



Figures 16–20. *Paralipsis planus* van Achterberg, sp. n., female, holotype. **16** hind leg **17** antenna **18** wings **19** first metasomal tergite dorsal **20** apex of antenna.

vertex and mesoscutum shiny and with sparse short pubescence between long setae, the first tergite flat and shiny, its maximum width at level of spiracles of ♀ 0.7 times distance between spiracle and apex of tergite (Fig. 19), the mesopleuron shiny, the apical antennal segments with long erect setae (Figs 17, 20), the fore basitarsus rather robust, the fifth antennal segment with few rhinaria and the hind basitarsus robust (Fig. 16).

Holotype, ♀, length of fore wing 2.0 mm, and of body 2.1 mm.

Description. *Head.* Head 1.6 times wider than long medially in dorsal view and roundly narrowed behind eyes; antenna with 15 (left) or 16 (right) segments and 0.9 times as long as body, segments long erect setae (Figs 17, 20), third segment dull and 1.1 times as long as fourth segment, third-fourth segments without rhinaria and widened apically and fifth segments with few rhinaria, third, fourth and penultimate (= 14th) segments 2.2, 1.8 and 1.4 times as long as wide, respectively; maxillary and labial palpi with 2 and 1 segments, respectively; length of maxillary palp 0.2 times height of head; distance between anterior tentorial pits 1.4 times distance between pit and eye; eye with rather long setae; face mainly smooth, convex ventrally and laterally rather sparsely setose, with setae directed downwards; clypeus distinctly convex and smooth, with few erect setae; frons nearly flat (except superficial impression in front of anterior ocellus), without median groove, shiny, punctulate and rather densely setose; vertex with sparse short pubescence between sparse long setae and temple roundly narrowed

posteriorly and shiny; eye 0.9 times as long as temple in dorsal view; OOL:diameter of posterior ocellus:POL = 12:3:11; stemmaticum distinctly wider posteriorly than laterally; length of malar space 1.7 times basal width of mandible, malar depression absent.

Mesosoma. Length of mesosoma 1.3 times as long as high; pronotal side smooth and largely glabrous, with deep oblique groove and anteriorly short; mesopleuron mainly smooth, shiny, punctulate but superficially rugulose anteriorly and medially convex; pleural sulcus distinctly crenulate; metapleuron mainly rugose; mesoscutum with some micro-sculpture, posteriorly shiny and with dense short pubescence between long setae, but sparsely so posteriorly, antero-medially slightly depressed and with few striae; notauli absent on disc; scutellar sulcus very deep; scutellum strongly convex but slightly depressed antero-medially, posteriorly distinctly above level of mesoscutum, largely rugulose and with long setae; dorsal face of propodeum smooth and shiny, posterior face subvertical and indistinctly rugulose, without areolation and laterally with short setae.

Wings. Fore wing: pterostigma straight baso-posteriorly (Fig. 18), but slightly concave in right wing; pterostigma twice as long as wide and vein 1-R1 largely absent; first subdiscal cell open posteriorly and apically (Fig. 18), but veins 2-1A and CU1b as faintly pigmented and unsclerotized veins present.

Legs. Hind coxa mainly smooth, punctulate and setose; tarsal claws medium-sized and very slender; fore tarsal segments slender (second-fourth segments distinctly longer than wide in dorsal view), with long setae and with long apical bristles, but fore basitarsus rather robust; length of femur, tibia and basitarsus of hind leg 3.4, 6.1 and 4.8 times as long as wide, respectively; hind basitarsus robust (Fig. 16); hind femur subbasally and hind tibia medially widened (Fig. 16), both with erect setae; inner hind tibial spur 0.2 times as long as hind basitarsus.

Metasoma. First tergite smooth, flattened and shiny, its maximum width at level of spiracles of ♀ 0.7 times distance between spiracle and apex of tergite (Fig. 19), parallel-sided posteriorly, tergite 1.1 times long as wide apically; second tergite smooth and glabrous except some setae, third and following tergites smooth and only with a subapical row of long setae; length of visible (and sparsely setose) part of elliptical ovipositor sheath 0.05 times fore wing.

Colour. Head (including clypeus), mesosoma (but notaulic courses and posterior part of mesoscutum, scutellum, metanotum laterally and propodeum brown) and metasoma (but first tergite and second tergite basally brownish yellow) dark brown; palpi, mandible, tegulae (but tegulum brown) and legs (but femora and tibiae brown and tarsi pale yellowish) brownish yellow; antenna brown, but pedicellus pale yellowish; ovipositor sheath pale brownish yellow, distinctly paler than tergites; pterostigma (but basally and apically pale yellowish) and veins mainly brown; wing membrane infusate near vein 1-M of fore wing.

Biology. Unknown.

Distribution. Netherlands.

Etymology. Named “planus” (Latin for “smooth, even”) because of the smooth and even first metasomal tergite.

***Paralipsis tibiator* van Achterberg & Ortiz de Zugasti, sp. n.**

<http://zoobank.org/9B89A20B-3950-4FAC-931C-8D1FDD2C9A85>

Figs 21–27

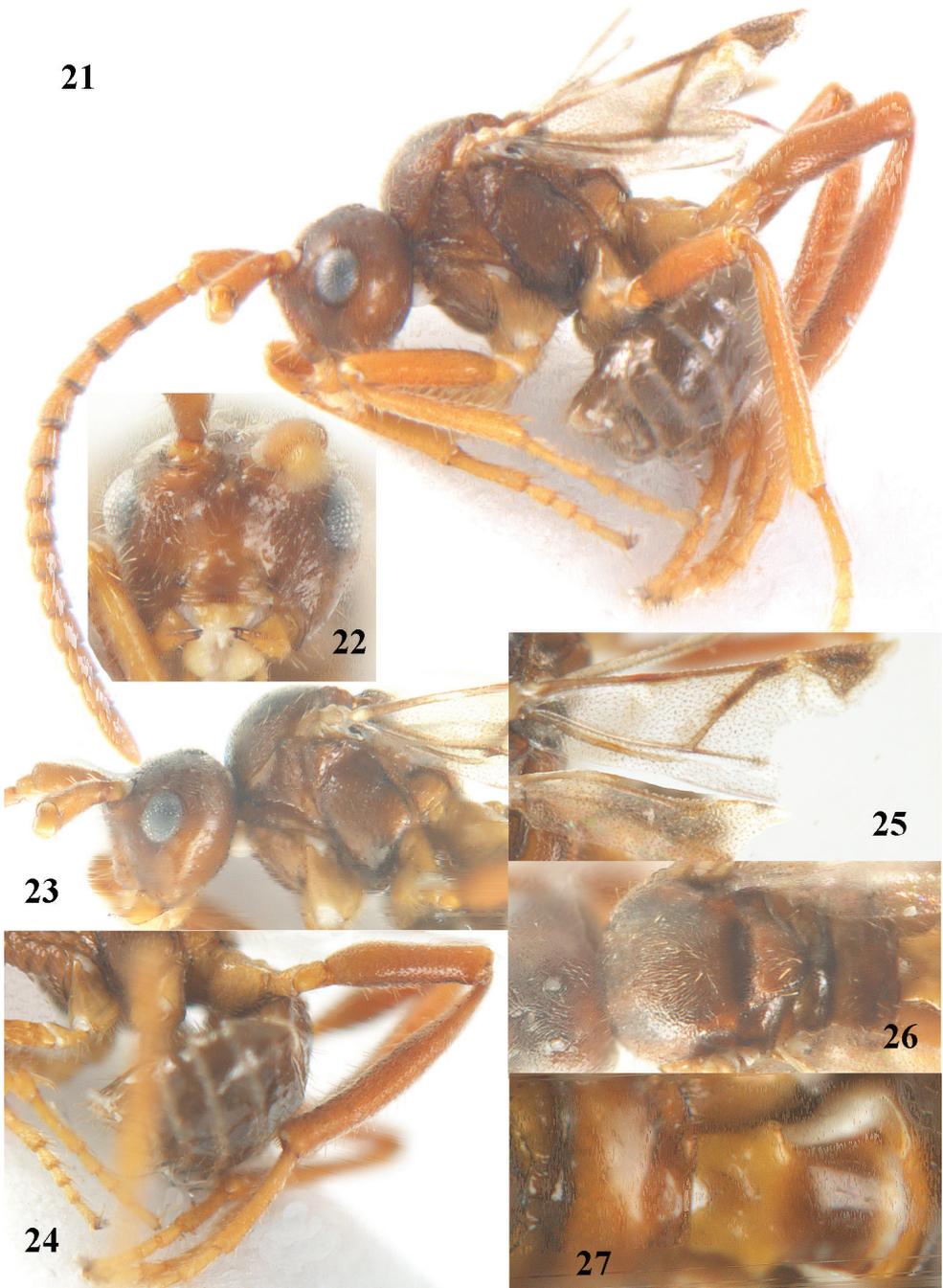
Material. Holotype, ♀ (RMNH), “Spain: Madrid, Parque del Oeste, from *Lasius grandis* nest, vii.2014, c. 600 m, N. Ortiz de Zugasti Carrón, RMNH”. Paratypes: 2 ♀ (RMNH), topotypic but 3.vii.2015.

Diagnosis. Similar to *P. enervis* (Nees, 1834), but differs by the slenderer fore tarsus (Fig. 21), the partly widened hind tibia and femur (Fig. 24) and the scapus distinctly widened dorsally in lateral view (vase-shaped: Fig. 21). Close to *P. planus* sp. n., but *P. tibiator* has the vertex and mesoscutum with satin sheen and with dense short pubescence between sparse long setae (Fig. 26), the first tergite more convex and less shiny, its maximum width at level of spiracles of ♀ 0.9 times distance between spiracle and apex of tergite (Fig. 27), the mesopleuron with satin sheen (Fig. 23), the apical antennal segments with adpressed setae (Fig. 21), the fore basitarsus slenderer (Fig. 21), the fifth antennal segment without distinct rhinaria and the hind basitarsus elongate (Fig. 24).

Holotype, ♀, length of body 2.2 mm and of damaged fore wing 1.1 mm.

Description. *Head.* Head 1.4 times wider than long medially in dorsal view and roundly narrowed behind eyes; antenna with 15 segments and as long as body, segments adpressed setose and setae rather short, third segment dull and 1.3 times as long as fourth segment, third-fifth segments without rhinaria and widened apically, third, fourth and penultimate segments 2.2, 1.8 and 1.4 times as long as wide, respectively; maxillary and labial palp with 2 and 1 segments, respectively; length of maxillary palp 0.2 times height of head; distance between anterior tentorial pits 1.2 times distance between pit and eye (Fig. 22); eye with long setae; face mainly smooth, convex ventrally and laterally rather densely moderately setose, with setae directed downwards; clypeus distinctly convex and smooth, with long erect setae (Fig. 21); frons convex, with shallow median groove, rather dull, punctulate and densely setose; vertex with dense short pubescence between sparse long setae and temple roundly narrowed posteriorly and with satin sheen; eye 0.9 times as long as temple in dorsal view; OOL: diameter of posterior ocellus: POL = 3:1:3; stemmaticum distinctly wider posteriorly than laterally (Fig. 26); length of malar space 1.9 times basal width of mandible, malar depression absent.

Mesosoma. Length of mesosoma 1.2 times as long as high; pronotal side smooth and largely glabrous, anteriorly very short; mesopleuron mainly smooth, with satin sheen, punctulate and medially flattened; pleural sulcus mainly micro-crenulate; metapleuron with some micro-sculpture; mesoscutum with some micro-sculpture, with satin sheen and with dense short pubescence between sparse long setae, without medio-posterior groove; notauli absent on disc; scutellar sulcus very deep; scutellum strongly convex, far above level of mesoscutum (Fig. 23), largely smooth and setose; propodeum smooth and shiny, posterior face angled with dorsal face (Fig. 21), without areolation and laterally with few long setae.



Figures 21–27. *Paralipsis tibiator* van Achterberg & Ortiz de Zugasti, sp. n, female, holotype. **21** habitus lateral **22** head anterior **23** head and mesosoma lateral **24** hind leg **25** wings **26** mesosoma dorsal **27** propodeum and first metasomal tergite dorsal.

Wings. Fore wing: pterostigma concave baso-posteriorly (Fig. 25); pterostigma twice as long as wide and vein 1-R1 largely absent; first subdiscal cell open posteriorly and apically (Fig. 21), vein 2-1A absent.

Legs. Hind coxa mainly smooth, punctulate and setose; tarsal claws medium-sized and very slender; fore tarsal segments slender (second-fourth segments distinctly longer than wide in dorsal view), with rather short setae and with long apical bristles (Fig. 21); length of femur, tibia and basitarsus of hind leg 3.6, 6.8 and 5.4 times as long as wide, respectively; hind femur subbasally and hind tibia medially widened (Fig. 24), both with erect setae; inner hind tibial spur 0.2 times as long as hind basitarsus.

Metasoma. First tergite smooth, rather convex and moderately shiny, its maximum width at level of spiracles of ♀ 0.9 times distance between spiracle and apex of tergite (Fig. 27), weakly diverging posteriorly, tergite 1.3 times as long as wide apically; second tergite smooth and setose, third and following tergites smooth and only with a subapical row of setae; length of visible (and sparsely setose) part of elliptical ovipositor sheath 0.05 times fore wing in paratype with complete wings.

Colour. Head (but clypeus brown), metasoma (but first tergite basally, narrowly apically and second tergite basally yellow) and mesoscutum (except brown notaulic courses) dark brown; antenna, palpi, mandible, tegulae, legs (but femora and tibiae brown) and propodeum brownish yellow; ovipositor sheath mainly dark brown, slightly paler than tergites; pterostigma (but basally and apically yellowish) and veins dark brown; wing membrane infusate near veins and pterostigma.

Variation. Antenna of ♀ with 15 (3) segments; length of complete fore wing 1.8 mm and of body 2.2 mm; first tergite 1.3–1.5 times as long as wide apically; femora and tibiae brown or largely dark brown.

Biology. Endoparasitoid of the aphid *Forda formicaria* (von Heyden, 1837) and a social parasite in nest of *Lasius (Lasius) grandis* Forel, 1909. The ant is known from the Iberian Peninsula, Maghreb, Balearic Islands, Macaronesia and SE France (<http://antmaps.org/?mode=species&species=Lasius.grandis>).

Distribution. Spain.

Etymology. Named “tibiator” (“tibia” is Latin for “shinbone”), because of the aberrant hind tibia.

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We thank Drs Juan M Nieto Nafria and Nicolás Pérez Hidalgo for their generous help identifying the aphids. Many thanks to Dr Xavier Espadaler for his invaluable advice and disposition and to Dr Hajimu Takada (Kyoto) for the gift of the *P. eikoeae* specimen. We are grateful to the Consejería de Medio Ambiente y Ordenación del Territorio de la Comunidad de Madrid for granting all the necessary authorizations for this study (register no.10/095500.9/15).

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New data on distribution, biology, and ecology of longhorn beetles from the area of west Tajikistan (Coleoptera, Cerambycidae)

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Abstract

New data on distribution, biology, and ecology of some little-known cerambycid species, collected in the western part of Tajikistan, are presented. *Arhopalus rusticus* (Linnaeus, 1758) is recorded in Tajikistan for the first time. New localities of species considered pests or invasive species such as *Aeolesthes sarta* (Solsky, 1871) and *Xylotrechus stebbingi* Gahan, 1906 are also given. The list of the taxa collected by the first author during many years of field research in Tajikistan as well as photographs of poorly known species from his collection, including some endemics, are additionally provided. Furthermore, high quality photographs of some extremely rare species that were collected during our expedition, i.e., *Turkaromia gromenkoi* Danilevsky, 2000 and *Ropalopus nadari* Pic, 1894, with images of their habitats or feeding grounds are also presented for the first time.

Keywords

Central Asia, endemic species, faunistics, invasive species, new records, zoogeography

Introduction

The longhorn beetle family (Cerambycidae) is one of the most species-rich groups of beetles (Coleoptera) with approximately 35,000 described species (Švácha and Lawrence 2014). The cerambycid fauna of Tajikistan is represented by only 58 species; however, many of them are endemic to the Central Asia region, including those that only occur on the territory of this country (Löbl and Smetana 2010, Danilevsky 2016).

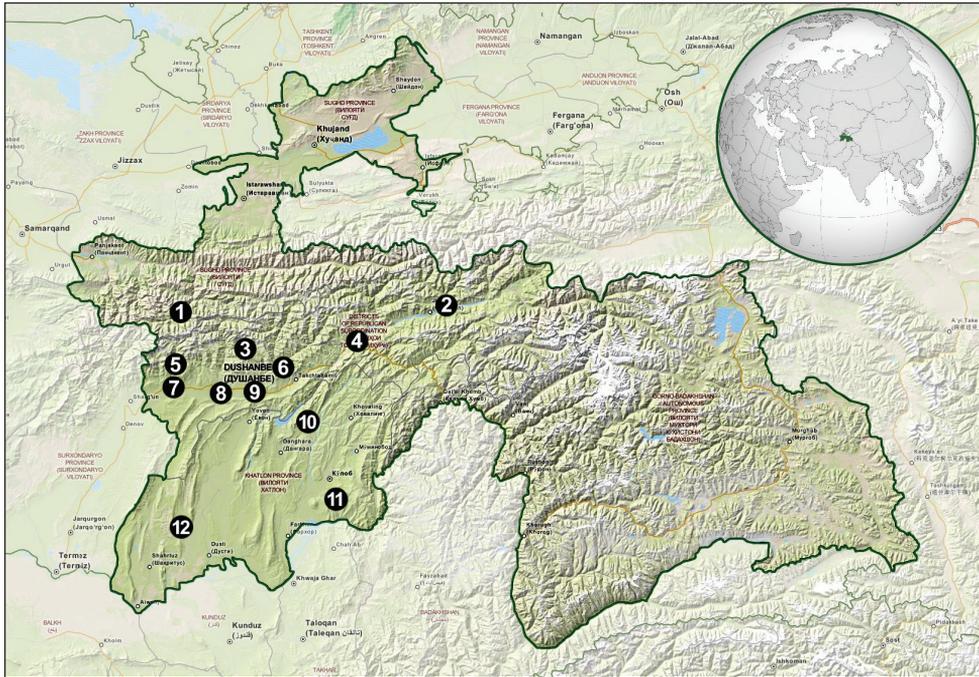
Tajikistan is located almost entirely within the Pamir-Alay Mountain range although forests only cover 2.6% of the area of the country. That places this country on one of the last positions regarding woodiness among the republics of the former Soviet Union. Some relict species such as *Juglans regia*, *Acer turkestanica*, and *A. reggeli* used to occur in Tajikistan in the past but they are totally extinct as a result of intensive cutting and burning of forests (Rahmonov et al. 2003). Due to a low level of afforestation, cerambycid fauna of Tajikistan is characteristic for the countries of the Central Asia. Species of the subfamily Prioninae which larvae develop in soil feeding on plant roots, as well as many representatives of the tribes of Agapanthiini and Phytoeciini (Lamiinae), whose development takes place in stems and roots of herbaceous plants, dominate in fauna of Tajikistan.

The state of the knowledge of the longhorn fauna of Tajikistan (particularly, of the region of the Pamir Mountains) as well as information about the biology and ecology of some species that are distributed in the region is very poor. Therefore, the present study aims to supplement the knowledge in this field.

Study area and methods

Tajikistan is a relatively small intra-continental country situated at the boundary of the subtropical and temperate climatic zones. It is located in the mountain desert zone of the Eurasian continent in the southern part of Central Asia, where ecosystems such as deserts, steppes, savannoides, conifer forests, mixed mountain forests, high-mountain deserts, and glaciers are widely represented. The changeable mountain climatic conditions and hard historical natural processes have promoted the formation of a unique biological diversity in Tajikistan, which counts many relict and endemic species (Safarov 2003).

The entomological expedition, which consisted of four scientists from the Department of Zoology, University of Silesia (Poland), took place at the turn of June and July 2014. During the research, several sampling trips were carried out to various locations in the western part of Tajikistan (Map 1). The most extensive studies were conducted within a radius of 60 km from the capital city, Dushanbe, and in the south-western part of the country along the Afghan border. The research were carried out in several research plots in the villages of Arykboshi, Dushanbe, Ganchi, Garavuti, Gharm, Iskanderkul, Kangurt, Karatag, Kolkhozabad, Kulob, Nurobod, Qurghonteppa, Romit, Sarband, Sarichashma, Shahrinav, Shurroabad, Takob, Tojikobod, and Vose.



Map 1. Research plots in the western part of Tajikistan: **1** Iskanderkul **2** Tojikobod **3** Takob **4** Garm **5** Karatag **6** Romit **7** Shahrinav **8** Dushanbe **9** Arykboshi **10** Kangurt **11** Sarichashma **12** Garavuti (Open-StreetMap contributors).

Tajikistan has a wide variety of habitats that range from gravel deserts in the south through green mountain valleys in the central part of the country to the high mountains with glaciers in the north and east. The area studied includes several different nature ecosystems such as alpine meadows, mesophilic shrubs, various shrub steppes, broad-leaf forests, light forests, and tugay as well as agroecosystems such as gardens, orchards, fields, and pastures.

The most effective, standard methods for collecting beetles such as attracting to artificial light sources, shaking down into an entomological umbrella, sweep netting, and rearing of inhabited material were used during the field research. The beetles were studied using an Optek SZM7045-J4L microscope at 7-90× magnifications. Photographs of the cerambycids in nature, their host plants and habitats were taken with Canon EOS 550D, Canon EOS 600D, and Olympus XZ-1 cameras. Produced images were stacked, aligned, and combined using ZERENE STACKER software (www.zerene-systems.com). Geographical coordinates were read off and recorded using Garmin Oregon 550T 3-Inch Handheld GPS Navigator. For each specimen collected, the exact location (including the GPS coordinates), altitude, date, and the names of the collectors are given. Additionally, information on the general distribution and biology of the species are provided. Some general data that had been collected by the first author during long-term field research were also used.

The following abbreviations are used in the text:

AT	Artur Taszakowski,
LK	Lech Karpiński,
MW	Marcin Walczak,
WTS	Wojciech T. Szczepański.

The nomenclature was adopted from the Catalogue of Palaearctic Coleoptera (Löbl and Smetana 2010) with further remarks (Danilevsky 2016).

The specimens are preserved in the entomological collection of the Department of Natural History of the Upper Silesian Museum in Bytom and in authors' collections.

Results

During the one-month expedition, a total number of 12 species (approximately 20% of the Tajik cerambycid fauna) belonging to three subfamilies (Prioninae 1 sp., Cerambycinae 10 spp., and Lamiinae 1 sp.) were recorded. The list of recorded taxa along with the new localities, general characteristics, and remarks on the species biology and ecology follow.

Prioninae Latreille, 1802

Psilotarsus turkestanicus (Semenov, 1888)

Figs 1A, B, 3A

Material examined. Khatlon Region, Sarichashma env. [Саричашма], a semi-ruderal plant community (37°45'N, 69°47'E), 1231 m, 25 VI 2014, 4♂♂, 2♀♀, leg. WTS; 2♂♂, leg. AT; 3♂♂, 1♀, leg. LK; 2♂♂, 1♀, leg. MW.

Although the species is distributed also in Turkmenistan and Tajikistan, most of the known specimens were collected in the Samarkand region in Uzbekistan. In Tajikistan, it was only observed in the north-western part of the country as far as the southern slope of the Gissar Mountain ridge (Danilevsky 2010). The locality in Sari-chashma, which is presented for the first time, extends the species range approximately 200 km to the south-east and is one of the first in the country.

Adults are active from early May to late July. In the hilly area of the Katagurgan environs (Uzbekistan), Danilevsky (2014) observed the mass flight of numerous males in the middle of a hot day (between 11 am and 4 pm) on 12 June 1992. This huge number of males was attracted by females standing motionlessly on the ground. Evidently, the daily activity of this species appears to be a unique behaviour among the representatives of the subfamily Prioninae, which is probably correlated with the small size of the eyes in this species in both males and females (Danilevsky 2014).

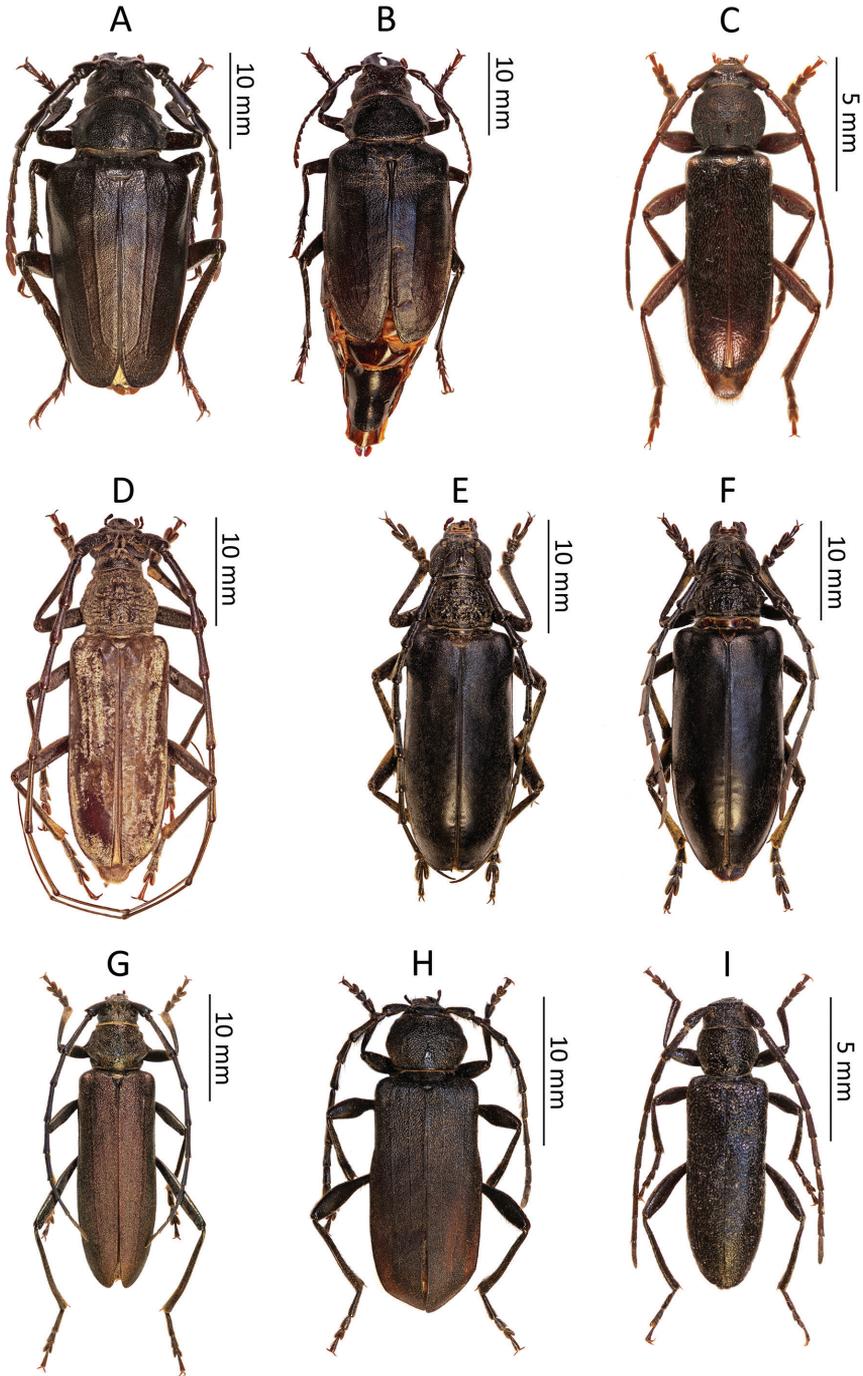


Figure 1. Photos of longhorn beetles specimens collected during the expedition to Tajikistan in 2014: **A** *Psilotarsus turkestanicus* (male) **B** *P. turkestanicus* (female) **C** *Trichoferus campestris* **D** *Aeolesthes sarta* **E** *Neoplocaederus scapularis* (male) **F** *N. scapularis* (female) **G** *Turkaromia gromenkoi* **H** *Ropalopus nadari* **I** *Turanium pilosum*.

The larvae develop in soil, where they probably feed on roots of various plants. According to Danilevsky (2014), the larva found in Uzbekistan feeding on roots of *Taraxacum kok-saghyz* and described as *P. turkestanicus* by Švácha and Danilevsky (1987) certainly belongs to another species common in that region: *Psilotarsus hirticollis hirticollis* Motschulsky, 1860. Therefore, the larval stage of *P. turkestanicus* has not been described yet.

According to Danilevsky (2010), species of the genus *Psilotarsus* Motschulsky, 1860 are often characterised by a very high degree of individual variability. This was also confirmed by us during examining of the collected specimens, which differed, inter alia, in details of elytra, punctuation of the pronotum, shape of the scutellum and size of the spikes on the pronotum.

In the Sarichashma environs, the specimens were collected in a semi-ruderal plant community (Fig. 3B, C) characterised by a variety of plants, including single trees. We observed flights of single males at about noon, although most of the specimens moved on the ground where they were fighting with each other and seeking females. Flying specimens sometimes became the prey of the European roller *Coracias garrulous*, which is a very common species in some regions of Tajikistan. The beetles emit characteristic, audible sounds that make it possible to detect their presence. We noticed many circular exit holes in the ground, which probably belong to this species. It is also noteworthy that the culmination of the occurrence of this species probably took place shortly before or during our first visit to this plot on 25 June. However, when we came back to this location on 3 July, we did not find even a single specimen.

Because this site is located directly on the Tajik-Afghan border, it can be expected that this species will also occur in Afghanistan. On the other hand, the bordering Panj River may form a natural migration barrier, particularly for the females, which are probably flightless. It is noteworthy that two other related Prionini species, *Mini-prionus pavlovskii* (Semenov, 1935) and *Pogonarthron semenovianum* (Plavilstshikov, 1936), were also recorded in the immediate vicinity of the plot mentioned above (Danilevsky 1999, Lorenc unpublished data).

The authors feel compelled to state that this plot is located in a strongly guarded zone just a few kilometres from the Afghan border. No foreigners are allowed to enter this area without the proper permits. Staying in this zone (especially at night) can have serious consequences from both the Tajik authorities and Taliban fighters from Afghanistan due to the large drug route in the region.

Cerambycinae Latreille, 1802

Trichoferus campestris (Faldermann, 1835)

Fig. 1C

Material examined. Dushanbe env. [Душанбе], an orchard, on *Salix* sp. (38°33'N, 68°54'E), 920 m, 29 VI 2014, 1♂, 1♀, leg. MW.

Region of Republican Subordination, Arykboshi [Арыкбoшӯ], a suburban area, at light (38°34'N, 69°04'E), 906 m, 28 VI 2014, 1♂, leg. LK.

Region of Republican Subordination, Tojikobod (Тоҷикoбoг), an orchard, at light (39°05'N, 70°51'E), 2223 m, 13 VII 2014, 1♀, leg. LK.

Trichoferus campestris is considered an invasive species, which has rapidly increased its range in recent years. Its presence in Europe has recently been confirmed inter alia in Romania (2003) (Dascălu and Serafim 2011), the Czech Republic (2006), Slovakia (2007) (Sabol 2009), and Poland (2009) (Kruszelnicki 2010). However, the species appears to be native to China, Japan, the Korean peninsula, Mongolia, Russia, and Central Asia, including Tajikistan (Grebennikov et al. 2010, Dascalu et al. 2013). The larvae are polyphagous on both deciduous and coniferous trees, although the species seems to prefer light deciduous forests and especially orchards. The adults are active at night from June to August and are often attracted to artificial sources of light (Kadyrov 2007).

Aeolesthes (Aeolesthes) sarta (Solsky, 1871)

Fig. 1D

Material examined. Dushanbe [Душанбе], city center, at light (38°34'N, 68°44'E), 871 m, 7 VII 2014, 1♂, leg. WTS.

Region of Republican Subordination, Romit [Рoмuм], river valley, at light (38°46'N, 69°16'E), 1283 m, 26 VI 2014, 1♂, 2♀♀, leg. LK.

Region of Republican Subordination, Karatag [Karamaг], at light, (38°41'N, 68°22'E), 1108 m, 30 VI 2014, 1♀, leg. LK.

The city longhorn beetle *A. sarta* is a species widely distributed throughout the Palaearctic and the Oriental region. It is believed that it originated in Pakistan and Western India from which it spread to Afghanistan, Iran, and to Central Asia (Orlinskii et al. 1991).

The species is polyphagous with a wide range of host plants and it primarily attacks tree trunks. For this reason, the species is considered a serious pest in the countries in which it occurs. In many cities of Central Asia, poplars and willows have been destroyed as well as plane trees, acacias, and ashes in Dushanbe (Kadyrov 2007). It takes two years for the larvae to develop. The adults overwinter in a pupal cell and emerge in the following spring. The flight period of adults begins in the second part of April and lasts more or less until mid-July. Imagines are generally active in the evening and night and very often are attracted to sources of light (Kadyrov 2007).

It was observed that *A. sarta* attacks both maximally exposed and shaded trees. The larval feeding grounds (Fig. 3D) of this species were additionally found in two other locations: Garavuti env. [37°35'N, 68°31'E] and Shahrinav env. [38°36'N, 68°19'E]. In above-mentioned Romit area, in addition to the imagines that were collected, about 20 larvae of *A. sarta* (Fig. 3E) were also found on a dead trunk of *Prunus* sp. (Fig. 3F).

***Neoplocaederus scapularis* (Fischer von Waldheim, 1821)**

Fig. 1E, F

Material examined. Region of Republican Subordination, Romit [Pomum], a river valley, at light (38°46'N, 69°16'E), 1283 m, 26 VI 2014, 1♂, leg. WTS; 1♂, 2♀♀, leg. LK.

Region of Republican Subordination, Takob [Tako6], an alpine meadow, on *Ferula* sp., (38°49'N, 68°56'E), 1850–1900 m, 9 VII 2014, 1♂, leg. WTS; 3♀♀, leg. LK.

It is distributed in several countries of Central Asia, Iran, Afghanistan, and western China (Kadyrov 2007, Danilevsky 2016). It is a common species in Tajikistan and occurs everywhere its host plant ferule (*Ferula* spp.) grows (Kadyrov 2007). In Tajikistan, the genus *Ferula* consists of nearly 40 species (Safarov 2003). According to Plavilstshikov (1940), larvae of *N. scapularis* may also develop in species of the genus *Scorodosma*. The larvae primarily feed on the rhizomes and roots of these plants and their development usually takes a year, sometimes even two (Plavilstshikov 1940). Pupation takes place in calcareous cocoons in the soil (Švácha and Danilevsky 1988). The adults appear and feed on the flowers or stems of the host plants from the end of April to July, depending on the local altitude (Kadyrov 2007).

The beetles are probably active in the evening and at night. We only observed adults on the ferule (Fig. 3G, H) in the early morning, due to the fact that the beetles still had not managed to hide after the night. Moreover, during the research, imagines were often attracted to an artificial light source.

***Turkaromia gromenkoi* Danilevsky, 2000**

Fig. 1G

Material examined. Sughd Region, Iskanderkul [Искандаркӯл], bushes near a river valley (39°05'N, 68°24'E), 2300 m, 18 VII 2014, 1♀, leg. AT.

The genus *Turkaromia* Danilevsky, 1993 was quite recently separated by Danilevsky (1993) and includes two species, *Turkaromia pruinosa* (Reitter, 1903) and *T. gromenkoi*, which are distributed in the region of Central Asia. According to Danilevsky (2000), *T. gromenkoi* is distributed in the western part of the Gissar Mountain ridge in Uzbekistan and Tajikistan. The species was described from four specimens: one male and two females from Kaltakol (Uzbekistan) and one female from Iskanderkul (Tajikistan). All specimens were observed in July. The biology and ecology of species as well as the stages of the larvae and pupae are unknown.

In the environs of the Iskanderkul Lake, we observed one female on a flower (Apiaceae) in a biotope near a river valley that had been overgrown by willows (*Salix* spp.) and shan birches *Betula tianschanica* (Fig. 4A). The larvae probably develop in the living wood of willows similar to the related species *T. pruinosa*. In the immediate vicinity of the area where the beetle was collected, we found sawdust-like waste on the outside of the trunk of a middle-aged willow (Fig. 4B), which was probably the result of the larval feeding of *T. gromenkoi*.

It is noteworthy that only one specimen was found despite a few hours of examining the plot using various methods. The presence of only a single female may indicate the end of the period of the occurrence of this species. It appears that *T. gromenkoi* is endemic to the Gissar Mountains.

***Ropalopus (Ropalopus) nadari* (Pic, 1894)**

Figs 1H, 4C

Material examined. Region of Republican Subordination, Takob [Такоб], an alpine meadow, on *Malus sieversii* (38°49'N, 68°56'E), 1850 m, 9 VII 2014, 1♀, leg. WTS.

This species occurs in Kyrgyzstan, Tajikistan, and Uzbekistan (Danilevsky 2016) and is endemic to the region of western Tian Shan Range (Kadyrov 2007). *R. nadari* is a polyphagous species, which usually inhabits growing wild fruit trees in the upper zone of deciduous forests (Fig. 4D). This species most frequently inhabits trunks and boughs of the wild apple tree *Malus sieversii*. Its larval development usually takes two years (Plavilstshikov 1940, Kadyrov 2007). Adults are found from June to July. After they emerge, the imagines are unwilling to fly and generally stay on the host plant and only visit flowers of *Ferula* spp. and *Prangos* spp. occasionally (Kadyrov 2007).

Only a single female was observed despite a 24-hour monitoring of the trees on the plot. This may either be related to the end of the period of the occurrence of the species or its hidden life in the treetops.

***Turanium (Turanium) pilosum* (Reitter, 1891)**

Fig. 1I

Material examined. Region of Republican Subordination, Takob [Такоб], on a tree branch fence, (38°49'N, 68°56'E), 1850 m, 9 VII 2014, 3♂♂, 1♀, leg. WTS; 2♂♂, 1♀, leg. LK; 1♂, leg. MW; (10 II 2015, 2♀♀, ex cult. *Malus sieversii*), leg. WTS; (7–21 XII 2014, 2♀♀, ex cult. *Malus sieversii*), leg. LK; (11–21 I 2015, 2♂♂, ex cult. *Malus sieversii*), leg. MW.

This species is distributed in the countries of Central Asia and the Xinjiang region of China (Danilevsky 2016). It inhabits the upper zone of deciduous forests and, less frequently, valleys. Although *T. pilosum* is polyphagous on deciduous trees (Kadyrov 2007), the larvae can also feed on conifers (Danilevsky 2001a). The species inhabits dry twigs and stems (Fig. 4E). Its development usually takes two years with pupation in spring. The adults fly from April to August (Danilevsky 2001a, Kadyrov 2007).

Mating of this species seems to start at the end of June. We observed adults flying into wooden components and actively moving on trunks of the wild apple tree *Malus sieversii*, where they were also mating. *T. pilosum* was recorded sympatrically with *R. nadari* in the same habitat (Fig. 4D).

***Xylotrechus (Xylotrechus) stebbingi* Gahan, 1906**

Fig. 2F

Material examined. Region of Republican Subordination, Arykboshi [Арыкбошӣ], on the wood piles of *Juglans* sp. (38°34'N, 69°04'E), 906 m, 28 VI 2014, 2♂♂, 3♀♀, leg. WTS; 2 VII 2014, 3♂♂, 2♀♀, leg. LK.; 28 VI 2014, at light 1♂ leg. LK.

Khatlon Region, Чаброк, N of Kangurt, at light (38°18'N, 69°32'E), 1217 m, 5 VII 2014, 1♂, 1♀, leg. LK.

This is a widely distributed species, whose origin is not clear (Cocquempot and Lindelöw 2010). It probably originally came from the region of northern India (Himalayas, Tibet). In recent years, this invasive species has spread to and become acclimated in the Middle East, the Mediterranean region (Sama 2002), and possibly in Central Asia. In Europe, it was recorded for the first time in Italy in 1990 (Dioli and Viganò 1990). The larvae are polyphagous on broad-leaved trees. Its life cycle lasts two years. Adults are usually encountered between May and November (Sama 2002, Ali et al. 2015).

It was observed that this species appears to be strongly synanthropic in Tajikistan: adults were found in various anthropogenic environments such as backyards and orchards, where they willingly flew to artificial light sources.

***Cleroclytus (Obliqueclytus) banghaasi* (Reitter, 1895)**

Fig. 2C

Material examined. Region of Republican Subordination, 30 km SW of Garm [Ғарм], Yakhoh env. (38°51'N, 70°01'E), ca 1300 m, 11 VII 2014 (8 XII 2014, 1♂; 21 XI 2014, 1♂; 28 XII 2014, 1♀, ex cult.), leg. LK; (28 XII 2014 – 26 I 2015, 2♂♂, 6♀♀, ex cult.), leg. MW.

This species occurs in Kyrgyzstan and Tajikistan (Danilevsky 2016), where it is widely distributed in both mountain areas and valleys. It is polyphagous on deciduous trees. The larvae feed subcortically on recently dead twigs or branches. Larva overwinters and then it pupates in the wood in the following spring; sometimes the imago overwinters. The adults fly from April to June and feed on flowers, especially those of *Cerasus*, *Prunus*, *Malus*, *Pyrus*, *Rosa*, *Cotoneaster*, *Atraphaxis*, and *Exochorda* (Kadyrov 2007).

***Chlorophorus (Immaculatus) elaeagni* Plavilstshikov, 1956**

Fig. 2G, H

Material examined. Region of Republican Subordination, Shahrinav env. (Шахрунаб), on the flowers of *Tamarix* sp. and on Apiaceae (38°36'N, 68°19'E), 868 m, 2 VII 2014, 1♂, leg. LK; 2 VII 2014, 5♂♂, 2♀♀, leg. MW; 1♀, leg. AT.

Khatlon Region, Garavuti env. [Ғаравӯтӣ], on the flowers of *Tamarix* sp. (37°35'N, 68°31'E), 356 m, 24 VI 2014, 2♂♂, leg. WTS; 2♂♂, leg. MW.

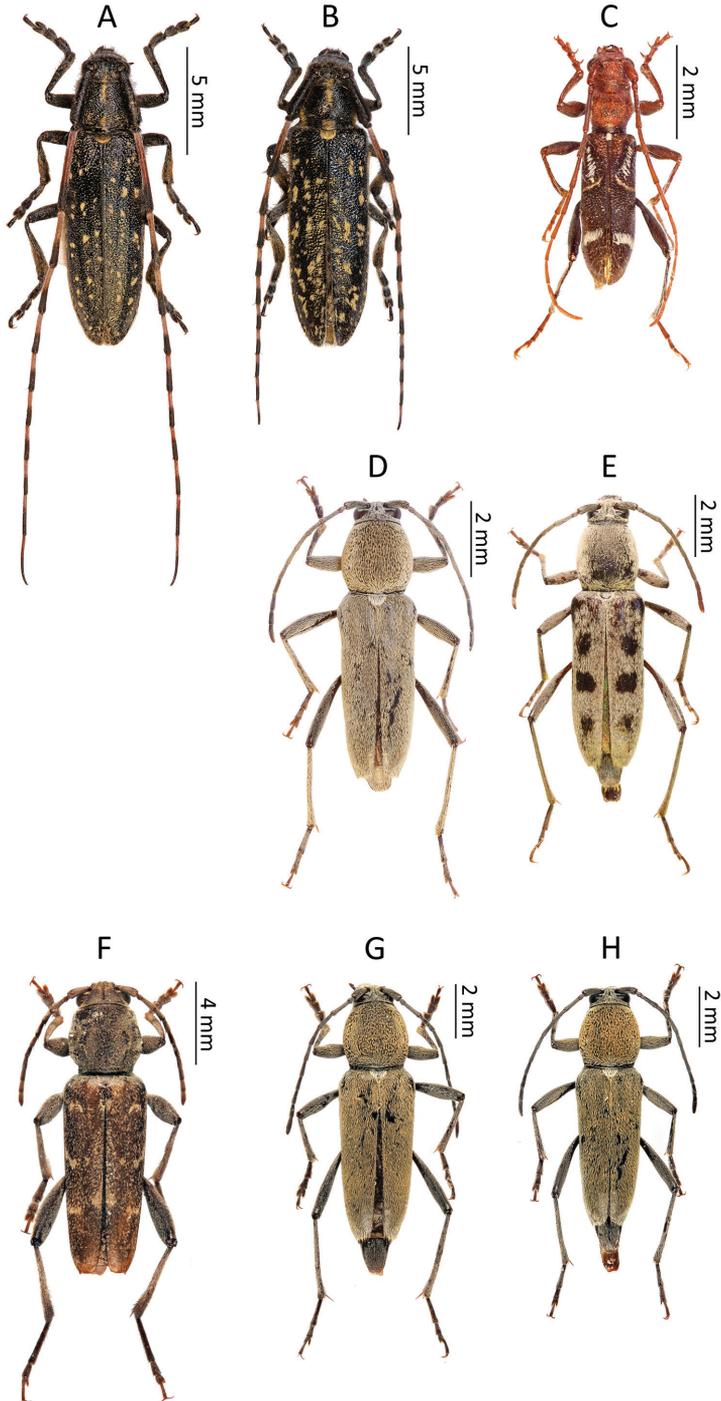


Figure 2. Photos of longhorn beetles specimens collected during the expedition to Tajikistan in 2014: **A** *Agapanthia soror* (male) **B** *A. soror* (female) **C** *Cleroclytus banghaasi* **D** *Chlorophorus faldermanni* (male) **E** *Ch. faldermanni* (female) **F** *Xylotrechus stebbingi*, **G** *Ch. elaeagni* (male) **H** *Ch. elaeagni* (female).

This species is distributed from the Caucasus to Central Asia (Danilevsky 2016) where it mainly inhabits floodplains and riparian forests (tugay) (Fig. 4F, G). The larvae feed on the dead wood of various deciduous trees. They were recorded inter alia on *Elaeagnus*, *Halimodendron*, *Caragana*, and *Robinia*. The life cycle of this species usually takes two years with pupation in spring and early summer. The adults feed on various flowers from April to July (Švácha and Danilevsky 1988, Kaliuzhnaja et al. 2000, Kadyrbekov and Tleppaeva 2004).

***Chlorophorus (Immaculatus) faldermanni* (Faldermann, 1837)**

Fig. 2D, E

Material examined. Region of Republican Subordination, Shahrinav env. (Шахринав), on the flowers of *Tamarix* sp. and on Apiaceae (38°36'N, 68°19'E), 868 m, 2 VII 2014, 2♂♂, 1♀, leg. WTS; 1♂, 2♀♀, leg. MW; 1♂, leg. AT.

This species is distributed in the Caucasus, the Far East, Central Asia, and Oriental region (Danilevsky 2016). It occurs in valleys as well as in mountain areas up to 2500 m. Like the previous species, it is rather common in a tugay habitat. It is polyphagous on deciduous trees, mostly on poplars and willows (Kadyrov 2007), although it also inhabits tamarisks *Tamarix*, oleasters *Elaeagnus*, elms *Ulmus* and pears *Pirus* (Švácha and Danilevsky 1988, Shapovalov 2012). Furthermore, its larvae also develop in wooden structures, which makes *Ch. faldermanni* one of the most serious pests of timber in Central Asia. Its life cycle lasts one or two years. Its flight period is from May to September (Švácha and Danilevsky 1988, Kadyrov 2007). The adults frequently visit flowers, especially Apiaceae (Kadyrov 2007).

This species was observed sympatrically with *Ch. elaeagni* on blossoming tamarisks (*Tamarix* spp.) (Fig. 4G).

Lamiinae Latreille, 1825

***Agapanthia (Stichodera) soror* Kraatz, 1882**

Figs 2A, B, 4H

Material examined. Region of Republican Subordination, Karatag [Kapamaž] (38°43'N, 68°22'E), 1108 m, 30 VI 2014, 1♀, leg. MW.

Region of Republican Subordination, Takob [Тakoб], alpine meadow, on *Ferula* sp., (38°49'N, 68°56'E), 1850–1900 m, 8 VII 2014 – 9 VII 2014, 10♂♂, 2♀♀, leg. AT; 22♂♂, 16♀♀, leg. WTS; 16♂♂, 8♀♀, leg. LK; 20♂♂, 17♀♀ leg. MW.

Region of Republican Subordination, Tojikobod (Тоҷукобод), alpine meadow (39°05'N, 70°51'E), 2223 m, 13 VII 2014, 2♂♂, leg. AT.

This species occurs in Tajikistan, Uzbekistan, Kyrgyzstan, and Kazakhstan (Danilevsky 2016). It is common in alpine meadow at altitudes of between 1000 and 3000 m (Fig. 3G). The larvae feed on the stems and rhizomes of *Prangos* spp. The adults

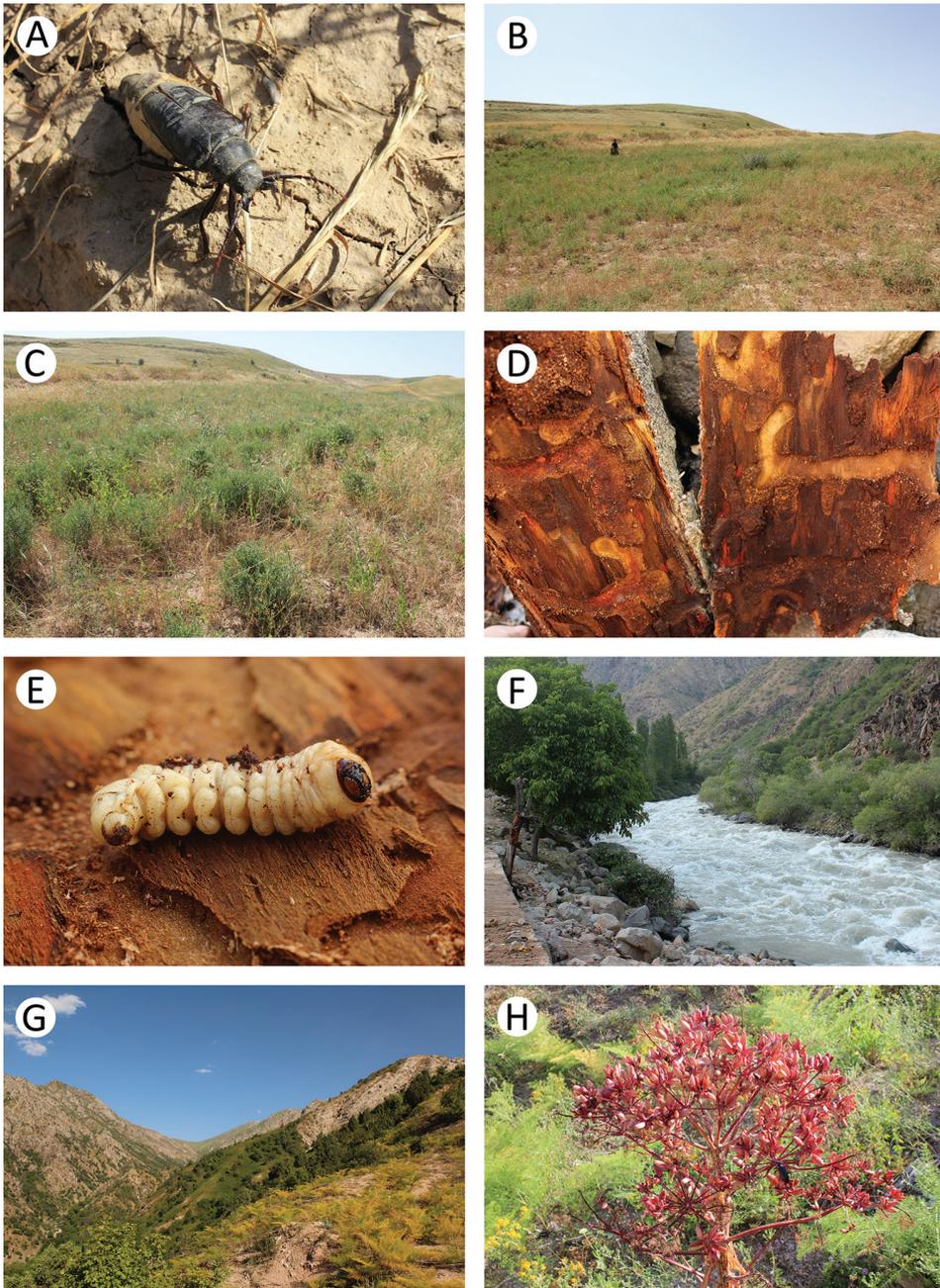


Figure 3. Field photos of imagines in nature, their habitats and larval feeding grounds of several Tajik cerambycid species: **A** female of *Psilotarsus turkestanicus* before laying of eggs **B** general view of the location of *P. turkestanicus* **C** detailed view of a semi-ruderal plant community, the habitat of *P. turkestanicus* **D** larval feeding grounds of *Aeolesthes sarta* **E** one of the last larval instars of *A. sarta* **F** riverside woodlands with dying trees, the habitat of *A. sarta* **G** mountain meadow overgrown by *Prangos* and *Ferula*, the habitat of *Agapanthia soror* and *Neoplocaederus scapularis* **H** *N. scapularis* on an overblown inflorescence of *Ferula*.

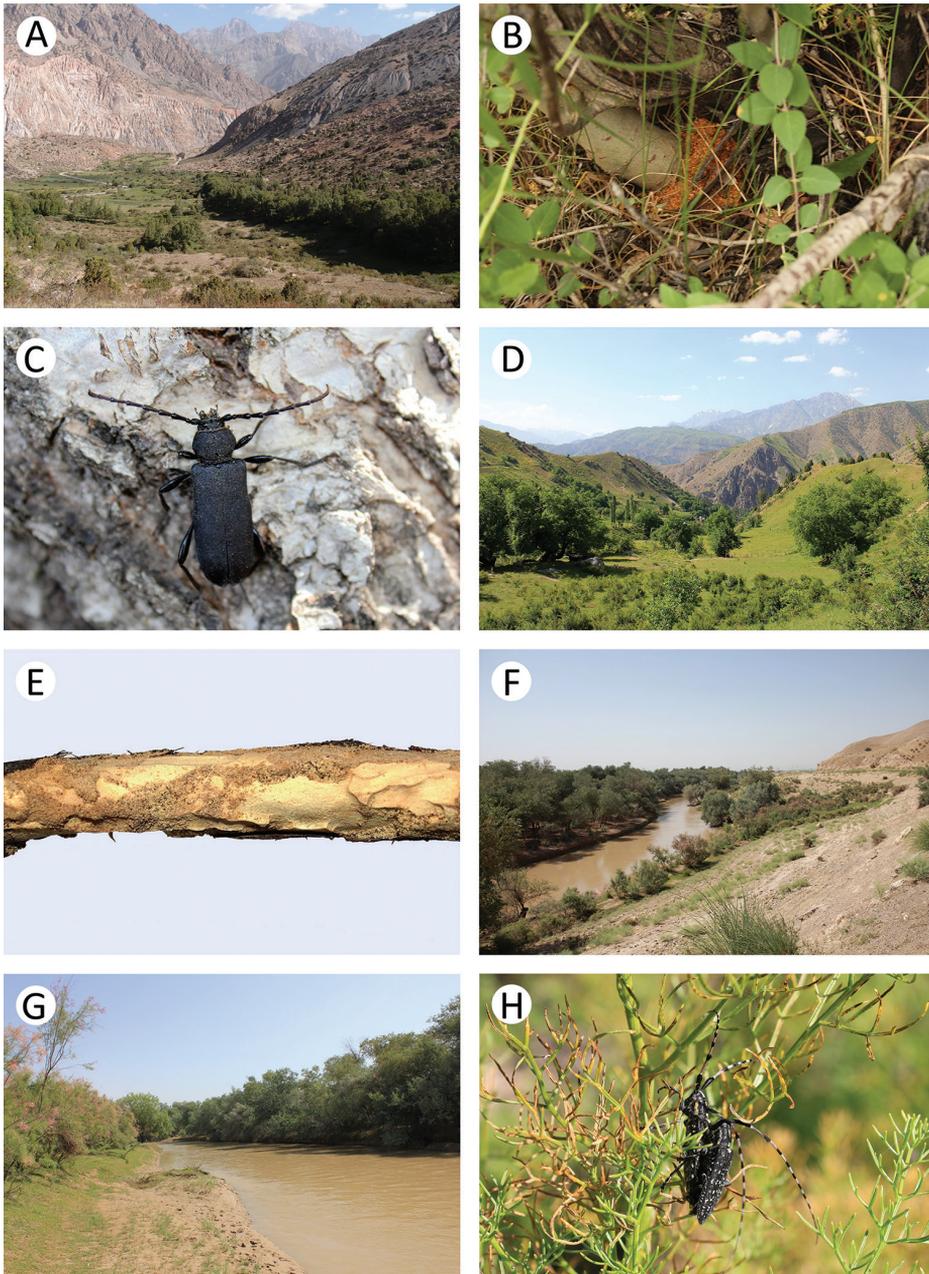


Figure 4. Field photos of imagines in nature, their habitats and larval feeding grounds of several Tajik cerambycid species: **A** birch and willow bushes near a river valley, the habitat of *Turkaromia gromenkoi* **B** sawdust-like waste on the outside of the trunk of a middle-aged willow, the probable result of the larval feeding of *T. gromenkoi* **C** female of *Ropalopus nadari* on the bark of *Malus sieversii* **D** walnut and apple trees in a mountain valley, the habitat of *Turanium pilosum* and *R. nadari* **E** larval feeding grounds of *T. pilosum* **F** tugay in the Vakhsh River valley, the habitat of *Chlorophorus elaeagni* and *Ch. faldermanni* **G** tugay with blossoming *Tamarix* in the Vakhsh River valley **H** male and female of *Agapanthia soror* in copula on *Prangos*.

feed on host plants from May until the end of July, although they were also observed on mallows *Malva* spp. The imagines usually stay on the stems of host plants, where they copulate and supplementary feed during summer. After that, the females lay eggs in the incisions in the stems. A female usually lays only one egg on each stem. In 8 to 12 days, the larva hatches and bites into the core of the stem where it moves towards the root. The larva forms a pupal cell and overwinters in the lower part of stem or the upper part of root. Pupation occurs in the spring (Kadyrov 2007).

A massive mating of this species was observed in the Takob environs between 8 and 10 July. The beetles performed characteristic slow flights during the day. It is noteworthy that no more species of the genera *Agapanthia* or *Phytoecia* were caught during the entire expedition, despite the very frequent use of the sweep-netting method in appropriate habitats (e.g. alpine meadows) in various parts of the country. This species seems to occur much later or longer than the other related species.

Checklist of the Cerambycidae of Tajikistan

The followed list is based on Danilevsky (2016). Species collected by the first author over many years of research are marked with an asterisk (*). Endemic taxa are marked with a letter (E).

Prioninae Latreille, 1802

1. *Mesoprionus angustatus* (Jakovlev, 1887) *
2. *Mesoprionus zarudnii* (Semenov, 1933) * E (Fig. 5C, D)
3. *Psilotarsus hirticollis hirticollis* Motschulsky, 1860
4. *Psilotarsus turkestanicus* (Semenov, 1888)
5. *Pogonarthron (Multicladum) semenovianum* (Plavilstshikov, 1936) E
6. *Pogonarthron (Pogonarthron) bedeli* (Semenov, 1900) * E (Fig. 5E, F)
7. *Pogonarthron (Pogonarthron) petrovi ivanovae* Pak & Skrylnik, 2014 E
8. *Pogonarthron (Pogonarthron) petrovi petrovi* Danilevsky, 2004 E
9. *Miniprionus pavlovskii* (Semenov, 1935) E
10. *Microarthron komaroffi* (Dohrn, 1885)

Lepturinae Latreille, 1802

11. *Stictoleptura (Stictoleptura) cardinalis* (K. Daniel & J. Daniel, 1898) * (Fig. 5G, H)
12. *Xenoleptura hecate* (Reitter, 1896) * (Fig. 6A, B)

Spondylidinae Audinet-Serville, 1832

13. *Arhopalus rusticus rusticus* (Linnaeus, 1758) * (Fig. 5A, B) – first record for Tajikistan

Apatophyseinae Lacordaire, 1869

14. *Apatophysis (Apatophysis) pavlovskii* Plavilstshikov, 1954 * (Fig. 6C, D)
15. *Apatophysis (Apatophysis) komarowi* Semenov, 1889

Cerambycinae Latreille, 1802

16. *Trichoferus campestris* (Faldermann, 1835)

17. *Aeolesthes (Aeolesthes) sarta* (Solsky, 1871) *
18. *Neoplocaederus scapularis* (Fischer von Waldheim, 1821) *
19. *Aromia moschata cruenta* Bogatchev, 1962 * (Fig. 7A–D)
20. *Turkaromia gromenkoi* Danilevsky, 2000
21. *Ropalopus (Ropalopus) nadari* (Pic, 1894) *
22. *Turanium (Turanium) pilosum* (Reitter, 1891) *
23. *Turanium (Turanium) scabrum* (Kraatz, 1882) *
24. *Semanotus semenovi* Okunev, 1933 * (Fig. 6E, F)
25. *Cleroclytus (Obliqueclytus) banghaasi* (Reitter, 1895) *
26. *Cleroclytus (Obliqueclytus) gracilis* Jakovlev, 1900 * E
27. *Anaglyptus (Anaglyptus) bicallosus* (Kraatz, 1882) * (Fig. 6G, H)
28. *Echinocerus floralis* (Pallas, 1773)
29. *Chlorophorus (Immaculatus) elaeagni* Plavilstshikov, 1956 *
30. *Chlorophorus (Immaculatus) faldermanni* (Faldermann, 1837) *
31. *Chlorophorus (Humeromaculatus) navratili* Holzschuh, 1981
32. *Xylotrechus (Xylotrechus) stebbingi* Gahan, 1906
33. *Xylotrechus (Turanoclytus) asellus* (Thieme, 1881)
34. *Xylotrechus (Turanoclytus) namanganensis* (Heyden, 1885) * (Fig. 7E, F)
35. *Xylotrechus (Rusticoclytus) rusticus* (Linnaeus, 1758)

Lamiinae Latreille, 1825

36. *Dorcadion (Ciberodorcadion) dokhtouroffi* Ganglbauer, 1886
37. *Dorcadion (Ciberodorcadion) turkestanicum* Kraatz, 1881
38. *Saperda (Saperda) similis* Laicharting, 1784 *
39. *Oberea (Amaurostoma) ruficeps muchei* Breuning, 1981 * E (Fig. 7C, D)
40. *Mallosiola regina* Heyden, 1887 * E (Fig. 7G, H)
41. *Phytoecia (Pseudocoptosia) cinerascens* Kraatz, 1882 *
42. *Phytoecia (Pseudocoptosia) eylandti* Semenov, 1891 * (Fig. 8E, F)
43. *Phytoecia (Pseudocoptosia) kubani* Holzschuh, 1991 E
44. *Phytoecia (Fulgophytoecia) circumdata* Kraatz, 1882 *
45. *Phytoecia (Phytoecia) acridula* Holzschuh, 1981 *
46. *Phytoecia (Phytoecia) caerulea caerulea* (Scopoli, 1772)
47. *Phytoecia (Phytoecia) pustulata pustulata* (Schränk, 1776)
48. *Phytoecia (Phytoecia) rufipes rufipes* (Olivier, 1795) *
49. *Phytoecia (Phytoecia) virgula* (Charpentier, 1825) *
50. *Phytoecia (Opsilia) bucharica* Breuning, 1943
51. *Phytoecia (Opsilia) coerulea Scopoli, 1763 **
52. *Phytoecia (Opsilia) varentzowi* Semenov, 1896
53. *Phytoecia (Blepisanis) nivea* Kraatz, 1882
54. *Phytoecia (Blepisanis) ochraceipennis* Kraatz, 1882 * (Fig. 7G, H)
55. *Agapanthia (Epopetes) dahli dahli* (C. F. W. Richter, 1820)
56. *Agapanthia (Epopetes) detrita* Kraatz, 1882 * (Fig. 8A, B)
57. *Agapanthia (Epopetes) ustinovi* Danilevsky, 2013 E



Figure 5. Several longhorn beetles specimens from the collection of the first author: **A** *Arhopalus rusticus rusticus* **B** label of *A. rusticus rusticus* – first record from Tajikistan **C** *Mesoprionus zarudnii* **D** label of *M. zarudnii* **E** *Pogonarthron bedeli* **F** label of *P. bedeli* **G** *Stictoleptura cardinalis* **H** label of *S. cardinalis*.



Figure 6. Several longhorn beetles specimens from the collection of the first author: **A** *Xenoleptura hecate* **B** label of *X. hecate* **C** *Apatophysis pavlovskii* **D** label of *A. pavlovskii* **E** *Semanotus semenovi* **F** label of *S. semenovi* **G** *Anaglyptus bicallosus* **H** label of *A. bicallosus*.



Figure 7. Several longhorn beetles specimens from the collection of the first author: **A** *Aromia moschata cruenta* **B** label of *A. moschata cruenta* **C** *A. moschata cruenta* **D** label of *A. moschata cruenta* **E** *Xylotrechus namanganensis* **F** label of *X. namanganensis* **G** *Mallosiola regina* **H** label of *M. regina*.

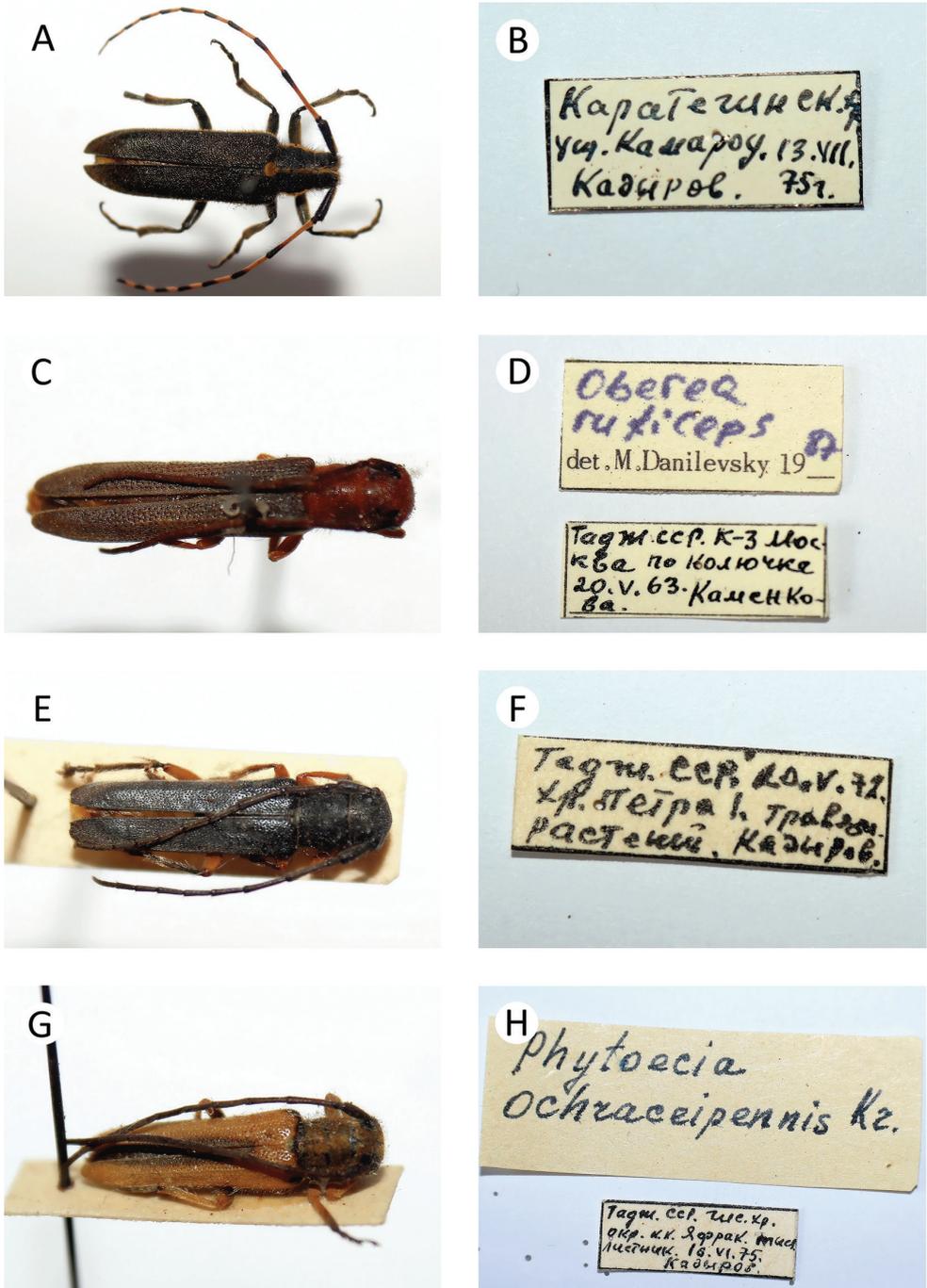


Figure 8. Several longhorn beetles specimens from the collection of the first author: **A** *Agapanthia detrita* **B** label of *A. detrita* **C** *Oberea ruficeps muchei* **D** label of *O. ruficeps muchei* **E** *Phytoecia eylandti* **F** label of *Ph. eylandti* **G** *Phytoecia ochraceipennis* **H** label of *Ph. ochraceipennis*.

58. *Agapanthia* (*Stichodera*) *soror* Kraatz, 1882 *
59. *Agapanthia* (*Smaragdula*) *incerta* Plavilstshikov, 1930 *
60. *Agapanthiola leucaspis* (Steven, 1817)

Discussion

Knowledge about the fauna of Tajikistan, particularly invertebrates, is still poor. Species of beetles that are new to science are increasingly being described, for example, *Kytorhinus kergoati* Delobel & Legalov, 2009 (Chrysomelidae) (Delobel and Legalov 2009), *Trachelanthus lopatini* Korotyayev & Nasreddinov, 2013 (Curculionidae) (Korotyayev and Nasreddinov 2013), *Meloe kulabensis* Shapovalov, 2014 (Meloidae) (Shapovalov 2014), or *Dryops renateae* Greń & Przewoźny, 2016 (Dryopidae) (Greń et al. 2016).

Longhorn beetles arouse great interest among beetle families, and therefore the current state of knowledge on Tajik cerambycids appears to be better than that for other groups. However, the knowledge about the species that occur in this country is still insufficient; thus, some new taxa have been described in recent years: *Turkarmia gromenkoi* (Danilevsky 2000), *Pogonarthron petrovi petrovi* (Danilevsky 2004), *P. petrovi ivanovae* (Pak and Skrylnik 2014), and *Agapanthia ustinovi* (Danilevsky 2013).

The distribution of species within the individual subfamilies is characteristic for Central Asia and it is presented as follows: Prioninae (9), Lepturinae (2), Spondylidiinae (1), Apatophyseinae (2), Cerambycinae (20), and Lamiinae (25). Species of the subfamily Prioninae, whose larvae develop in soil and feed on plant roots, as well as many representatives of the tribes of Agapanthiini and Phytoeciini (Lamiinae), whose development take place in the stems and roots of herbaceous plants, dominate the fauna of Tajikistan. Representatives of the subfamily Lepturinae are few in number possibly due to the lack of trees and, consequently, small amounts of deadwood, which is quite a normal situation in Central Asia. For example, the total number of Lepturinae species is: 5 (Uzbekistan), 6 (Turkmenistan), 9 (Kyrgyzstan), and 4 (Afghanistan).

Because of the many geographical barriers in Tajikistan, a high level of endemism occurs in this group of beetles. Currently among the 60 taxa, as many as eleven taxa occur exclusively in Tajikistan. The endemics include *Mesoprionus zarudnii*, *Pogonarthron semenovianum* (all known specimens were only collected in Tajikistan, near the Afghan border (Danilevsky 2004), but according to Danilevsky (2016) this species occurs also in Afghanistan), *P. bedeli*, *P. petrovi petrovi*, *P. petrovi ivanovae*, *Miniprionus pavlovskii*, *Cleroclytus gracilis*, *Agapanthia ustinovi*, *Mallosioloa regina*, *Oberea ruficeps muchei*, and *Phytoecia kubani*.

Due to its climatic conditions, Tajikistan is a very unique place to collect insects. The flight period of various groups of longhorn beetles is quite diverse. Some species only occur in spring, for example the genus *Phytoecia*, which is represented here by as many as 13 species. On the other hand, some species of the subfamily Prioninae begin to fly in late summer. There are also many nocturnal species that lead very cryptic life-

styles. For these reasons, comprehensive studies that include the entire growing season are needed to obtain a reasonably full and true picture of the composition of the species of longhorn beetles in this country.

Today, the industrial and economic activities of humans are the most important factors that influence ecosystems. Such anthropogenic activities cause important changes in fauna and flora that lead to the simplification of biogeocenosis structures and to decrease in the differences between landscape zones. Some agrotechnical measures, such as ploughing desert regions of a country, deforestation, intensive irrigation, chemical use, and the development of industry in large parts of southeast Central Asia have induced the development of specific fauna in the anthropogenic landscapes. Among the most important forms of human activity are ploughing and managing soils that had not been used earlier, which causes the formation of secondary biocoenosis and agrocoenosis, which in turn leads to disturbances of the ecosystems and, as a result, to the disappearance of many vulnerable species. Planting trees and shrubs in disturbed regions is extremely important due to their role as an ecological corridor (Rahmonov et al. 2003).

Other than the extensive research activities of the first author (e.g. Kadyrov 1989, 2007) and Danilevsky (e.g. 2001a, b), we do not know of any other studies on Cerambycidae in Tajikistan, with the exception of the activity of beetle collectors. In spite of the fact that access to the region of the Pamir Mountains is severely limited and probably requires special permits for entry, it seems to be particularly interesting in the context of research on longhorn beetles. We still do not know enough about the biology of the local endemic species and there are probably some species that are as yet undiscovered, and therefore new expeditions to this region are quite desirable.

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First Maltese record of *Stephanopachys quadricollis* (Marseul, 1879) (Coleoptera, Bostrichidae)

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Abstract

Three specimens of *Stephanopachys quadricollis* (Marseul, 1878) were recently found in Malta in UV light traps and represent the first record of this species for this country. Although *S. quadricollis* is native to the Mediterranean basin, it is not yet clear if these Maltese records are due to a natural population or to an interception. Distributional, nomenclatural and biological data on this species are summarized, and a new synonymy is established: *Stephanopachys quadricollis* (Marseul, 1879) = *Stephanopachys quadraticollis* Kocher, 1956, **syn. n.**

Keywords

Bostrichidae, new record, new synonymy, Malta, Italy

Introduction

The Bostrichidae of the Maltese Islands are represented by ten species of which two are definitely aliens but their establishment is unclear (Nardi and Mifsud 2015). A recent capture of *Stephanopachys quadricollis* (Marseul, 1879) in Malta, discussed herein, is recorded for the first time from the Maltese Islands.

Material and methods

The beetles were identified following the work of Borowski and Węgrzynowicz (2012). The authorship of *Stephanopachys quadricollis* is attribute to Marseul (1879) (see forward “Notes”). The distribution pattern is expressed also by a chorotype according to Vigna Taglianti et al. (1999). The systematic and botanic nomenclature follow The Plant List (2013). Possible interpolations are given in square brackets. The following abbreviations are used in the text: ex = specimen/s; leg. = legit or legerunt.

Acronyms of specimen depositories

- CDM** D. Mifsud private collection, Malta
CGN G. Nardi private collection, Cisterna di Latina (Latina), Italy
CNBFVR Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale “Bosco Fontana” di Verona, Sede di Bosco Fontana, Marmirolo (Mantua), Italy
MCSG C. Mancini collection c/o Museo civico di Storia naturale, Genoa, Italy (R. Poggi, pers. comm., 2016)
MZUF Museo di Storia Naturale, Sezione di Zoologia “La Specola”, Università degli Studi di Firenze, Florence.

Taxonomy

Stephanopachys quadricollis (Marseul, 1878)

Material examined. ITALY, Liguria: Monte di [= Mount of] Portofino [(Genova)], 1910, [C.] Mancini leg., 1 ex (MCSG); M.te [= Monte di] Portofino [(Genova)], VI.1923, Dr. [A.] Andreini leg., 1 ex (MZUF); Zignago [(La Spezia)], 17.VII.1963, S. Failla leg., 1 ex (MZUF). Calabria: [Sila National Park,] Camigliatello [(Cosenza), 1300 m], 18.VI.1978, [F. Angelini leg.], 1 ex (MZUF, collection F. Angelini); Parco Nazionale della Sila [= Sila National Park] (Cosenza), Monte Altare, 1580 m, 39°25.205700'N 16°34.694312'E, 24.VII.2009, L. Spada, M. Bardiani, A. Biscaccianti & A. Campanaro leg., [direct collection, in a forest of *Pinus nigra* ssp. *laricio* Maire (A.B. Biscaccianti & L. Spada, pers. comm., 2016)] 1 ex (CNBFVR). MALTA, Hal-Far [35°48.760020'N, 14°30.480840'E], 1.IX.–5.XI.2015, 3 ♀♀, in UV light traps situated in human habitation, D. Mifsud leg. (CDM, CGN).

Chorotype and distribution. Mediterranean (cf. Borowski 2007, as *S. quadricollis* (Fairmaire, 1878) [sic!], Borowski and Węgrzynowicz 2007, as *S. quadricollis* (Fairmaire in Marseul 1878) [sic!], Borowski and Węgrzynowicz 2012, as *S. quadricollis* (Fairmaire, 1878) [sic!]). This species is recorded from: Algeria, Croatia, France (Cor-

sica included), Greece, Israel, Italy (Sicily included), Lebanon, Morocco, Portugal, Spain (Balearic Islands included), Syria, Tunisia, Asiatic Turkey and Ukraine (cf. Halperin and Damoiseau 1980, Nardi 2004, Borowski 2007, Brustel et al. 2013). Moreover, it was intercepted in Sweden (Lundberg 1995, Borowski 2007, Brustel et al. 2013), Germany and Argentina (Walker 2005), while the record for Israel (Halperin and Damoiseau 1980) was recently overlooked (Borowski 2007, Brustel et al. 2013).

Ecology. *Stephanopachys* Waterhouse, 1888 is the sole genus of Bostrichidae specialized to feed on gymnosperms (Liu et al. 2008) and was considered as exclusively phloeophagous (cf. Lesne 1911, Lawrence 2010, Brustel et al. 2013). However, *S. conicola* Fisher, 1950, a Nearctic species develops in cones of *Pinus monophylla* Torr. et Fr. and on decaying *Juniperus occidentalis* Hooker berries (Borowski and Węgrzynowicz 2012, Tonkel et al. 2014), whereas *S. linearis* (Kugelann, 1792), a Palaearctic species, develop on coniferous trees (*Abies alba* Mill., *P. sylvestris* L., etc.) (Borowski and Węgrzynowicz 2012, Brustel et al. 2013), but exceptionally also in old wood of *Quercus* (Koch 1989).

Stephanopachys quadricollis is found from sea level up-to mountain biotopes (cf. Kocher 1956, as *S. quadraticollis* [sic!], Angelini 1986, 1991, Bahillo de la Puebla et al. 2007, Brustel et al. 2013) and the most important host-plants include *Pinus halepensis* Mill. and *P. pinaster* Aiton (Perris 1862, as *Dinoderus (Apate) substriatus* Payk. [misidentification], Lesne 1897, Sahlberg 1913b, Español 1955, 1965, Halperin and Damoiseau 1980, Bahillo de la Puebla et al. 2007, Borowski and Węgrzynowicz 2012, Brustel et al. 2013). The species is however known to develop on other Pinaceae including: *Abies alba* (Lesne 1897), *Cedrus atlantica* (Endl.) Manetti ex Carrière, *Pinus nigra* J.F. Arnold and *P. sylvestris* (Brustel et al. 2013). The larvae of *S. quadricollis* develop in or under bark of death wood in damaged trees which are still alive (under partially removed bark, in or near wounds following pruning by forest personnel or lightning) (Brustel et al. 2013). The larvae of *Clanoptilus marginellus* (Olivier, 1790) (Coleoptera, Malachiidae) (Perris 1862, as *Malachius marginellus* Fab.), *Opilo domesticus* (Sturm, 1837) and *O. mollis* Linnaeus, 1758 (Coleoptera, Cleridae) are predatory on those of *Stephanopachys quadricollis* (Perris 1862, Lesne 1904), whereas *Entedon stephanopachi* Heqvist, 1959 (Hymenoptera, Eulophidae) is a primary parasitoid of other *Stephanopachys* species in Sweden and USA (Heqvist 1959, Schauff 1988, Gumovsky 2010).

Notes. The Maltese specimens of *Stephanopachys quadricollis* do not show significant differences from those examined from other territories. In Italy, this species is rare and localized and was recorded from the following regions: Piemonte (Lesne 1897, Schilsky 1899, Lesne 1901, Luigioni 1929, Porta 1929), Liguria (Luigioni 1929), Basilicata (Angelini 1986), Calabria (Angelini 1991) and Sicily (Vitale 1928, Luigioni 1929, Porta 1929, Audisio et al. 1995, Sparacio 1997, Nardi 2004). A record from Maritime Alps (Porta 1929), probably refers to French sites near the Italian border (Lesne 1897: 339, 1901: 84). Specimens from Piemonte (without locality of collection) were originally collected and recorded by Baudi as *S. substriatus* (Paykull,

1800) (Baudi 1873, 1890, in both cases as *Dinoderus substriatus* Payk.). Lesne (1897, 1901) examined material collected by Baudi from Piemonte and recorded the presence of only *S. quadricollis* from the mentioned region. Thus, Baudi's records from Piemonte could in reality belong to only *S. quadricollis*, since this latter species was described (Marseul 1879) only after the first record of Baudi (1873). However, during the present study it was not possible to re-examine this material. The record of Luigioni (1929) for Liguria, is probably based on the above cited specimen collected in 1910, since A. Dodero from the Museo civico di Storia naturale (Genoa), previously sent many unpublished records from this region to his best friend, P. Luigioni (R. Poggi, pers. comm., 2016).

Most of the above-mentioned Italian literature records provide only the region of collection for *S. quadricollis*, with the consequence that few precise locations are known. These include: Cugno Ruggeri, 1400–1500 m, on the Pollino Massif in Basilicata (Angelini 1986); Camigliatello, 1250–1300 m, on the Sila plateau in Calabria (Angelini 1991); contrada Tremonti near Messina (Vitale 1928), and Messina (Luigioni 1929) in Sicily. *Stephanopachys quadricollis* was collected from very few coastal regions in Italy. These include localities in Sicily and Mount of Portofino in Liguria (see material examined). In Sicily, Vitale (1927) collected a specimen of this species beating *Juglans regia* tree on the 1st of April 1927.

The occurrence of *Stephanopachys quadricollis* in Malta, is not the sole insular record so far known; this species is also recorded from the Balearic Islands (cf. Bahillo de la Puebla et al. 2007), from Meleda Island in Croatia (Ganglbauer 1904, Vrydagh 1961) and from Lesbos Island in Greece (Sahlberg 1913a, 1913b). Moreover it is also known to occur in some mainland coastal areas: e.g. Mount of Portofino in northern Italy (see above), in southern France (Brustel and Aberlenc 2014), in the Iberian Peninsula (Español 1955, 1965, 1974, Bahillo de la Puebla et al. 2007, Baena and Zuzarte 2013, as *S. quadricollis* (Fairmaire, 1878) [sic!]) and in Turkey (Vrydagh 1962).

The native status of *Stephanopachys quadricollis* in Malta is highly probable considering the fact that is a typical Mediterranean species and that its main host plant, *Pinus halepensis* is autochthonous (Haslam et al. 1977). However, an anthropic origin cannot be excluded. The location from where the Maltese specimens were collected is mainly an industrialized area with several pharmaceutical companies however some pine trees are also present. Interceptions of Palaearctic *Stephanopachys* species are known in other countries. These include *S. quadricollis* in Sweden, Germany and Argentina (see above), *S. substriatus* (Paykull, 1800) in Belgium (Coulon 1993) and Germany (Lucht 1987, Köhler and Klausnitzer 1998, Geis 2002), and a southern European unidentified species in USA (Haack and Cavey 2000, Haack 2006).

As reported above, the Maltese specimens were taken at UV light. The use of light traps is a useful method to capture Bostrichidae. In fact, four other species of this family were previously collected at light in Malta (Nardi and Mifsud 2015), while 17 species were collected during a large light-traps project in Israel (Chikatunov et al. 2006). However, in Israel *S. quadricollis* was not collected in this project possibly due to the

fact that its abundance was reported as “sporadic and rare” (Halperin and Damoiseau 1980: 48). In France, in a large artificial forest of *Pinus pinaster*, a single specimen of *S. quadricollis* was collected by an emergence trap (Brin et al. 2011), and the capture of *Stephanopachys* spp. using intercept traps is rare (Brustel et al. 2013).

In the IUCN Red List of European saproxylic beetles, *Stephanopachys quadricollis* is classified as “Least concern” (Nieto and Alexander 2010), whereas in the Italian list its status is indicated as “Vulnerable” (Nardi et al. 2014, 2015). The only recent Italian record of this species is from the Sila National Park, and this provides further evidence of the coleopterological importance of this Park (cf. Angelini 1991, Mazzei et al. 2011), where the species probably develops on *Pinus nigra* ssp. *laricio* Maire. This same host plant for *S. quadricollis* was also recorded by Sainte-Claire Deville (1914: 545) in Corsica. From a conservation point of view, *S. quadricollis* is known from other Italian localities such as Pollino and Portofino which are already designated as protected areas and this should therefore contribute towards the survival of this species in Italy.

It must be underlined that Heyden (1891: 468) erroneously considered *Stephanopachys quadricollis* as a synonym of *S. substriatus* (Paykull, 1800), and attributed the description of the former to “Frm.Ab’. 1879. 83. [= Fairmaire, 1879: 83, L’Abeille]”. Later, he (Heyden 1906: 421) citing Lesne (1897: 339), listed correctly *S. “quadricollis* Mars. Ab’. 1879. 83 [= Marseul 1879: 83]” as a valid species. Fairmaire was indicated as the one who described this species as “(Fairmaire, 1878)” by various recent authors (Borowski 2007, Baena and Zuzarte 2013, Nardi et al. 2014, Borowski and Węgrzynowicz 2012, Nardi et al. 2015) or as “(Fairmaire in Marseul, 1878)” by others (Borowski and Węgrzynowicz 2007, Liu 2010). Nevertheless, this authorship is erroneous, since, this species was described by Marseul (1879: 83), as “*Dinoderus 4-collis* Fairm.”, who also wrote: “Discovered by M. Lamey, and described by M. Leon Fairmaire, I do not know where” [translated]. Probably, the material described by Marseul (1879) was labeled as “*Dinoderus 4-collis* Fairm.”, but this was an unpublished name. In fact, Bedel (1894: 149, footnote 3) wrote: “This species [= *Stephanopachys quadricollis* Mars.] was never described by Fairmaire; its first description appeared on *L’Abeille*, XVIII, Nouv. [2], p. 83 (1878). I saw the *type* [see also Vrydagh (1962: 6)] of *S. de Marseul*, belonging to M. A. Lamey” [translated]. This opinion was followed by almost all other authors (e.g. Lesne 1897, Schilsky 1899, Lesne 1901, Ganglbauer 1904, Lesne 1904, 1905, Heyden 1906, Lesne 1909, Sainte-Claire Deville 1910, 1914, Corrêa De Barros 1924, Winkler 1927, Luigioni 1929, Porta 1929, Portevin 1931, Peyerimhoff 1933, Normand 1936, Sainte-Claire Deville 1937, Lesne 1938, 1939, Seabra 1943, as *S. quadricollis* Marsh. [sic!], Novak 1952, Español 1955, Kocher 1956, Vrydagh 1956, 1960, 1961, 1962, Español 1965, 1974, Halperin and Damoiseau 1980, Lucht 1987, Audisio et al. 1995, Lundberg 1995, Sparacio 1997, Nardi 2004, Walker 2005, Bahillo de la Puebla et al. 2007, Brin et al. 2011, Brustel et al. 2013, Brustel 2014, Brustel and Aberlenc 2014), nevertheless as stated by Heyden (1891, 1906) and by other authors (López-Colón 2000, López-Colón et al. 2001, Grosso-Silva 2005), the year when *S. quadricollis* was described

is 1879 and not 1878. The year 1878 was included in the title of number 21 of the section “Nouvelles et Faits divers de L’Abeille” that includes the original description of this species (Marseul 1879). Numbers 18–25 of this section belong to volume 17 of 1879 and this information is also reported in the “Tables of Contents” [translated] of the same volume.

Finally, Kocher (1956: 114) published an unjustified emendation (ICZN 1999, art. 33.2.1) of *Stephanopachys quadricollis*: “*S. quadraticollis* (err. *quadricollis*) Mars.”. Unfortunately, this name is an available one (ICZN 1999, art. 19.1) and so the following synonymy is here established: *Stephanopachys quadricollis* (Marseul, 1879: 83) = *Stephanopachys quadraticollis* Kocher, 1956: 114, **syn. n.**

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A new species of *Pristimantis* from southern Ecuador (Anura, Craugastoridae)

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Abstract

A new species of *Pristimantis* is described from Reserva Buenaventura, southern Ecuador, at elevations between 878 and 1082 m. A molecular phylogeny based on nuclear and mitochondrial genes shows that the new species is closely related to *P. phoxocephalus*, *P. riveti*, and *P. versicolor*. The new species differs from them and other morphologically similar congeners in having a low W-shaped dermal ridge in the scapular region, a large conical tubercle on the upper eyelid and on the heel, a thin mid dorsal fold, and a longitudinal lateral fold starting behind the tympanic fold and extending along the anterior two thirds of the flank. The new species inhabits cloud forests in the Pacific slopes of the Andes.

Resumen

Describimos una nueva especie de *Pristimantis* de la Reserva Buenaventura, al sur del Ecuador, entre elevaciones de 878 y 1082 m. Una filogenia molecular basada en genes nucleares y mitocondriales revela que la nueva especie está cercanamente relacionada a *P. phoxocephalus*, *P. riveti* y *P. versicolor*. La nueva especie difiere de ellas y otros congéneres morfológicamente similares por presentar un pliegue bajo en forma de “W” en la región escapular, un tubérculo cónico sobre el párpado y en el talón, un delgado pliegue mediodorsal y un pliegue lateral longitudinal que se inicia detrás del pliegue timpánico y se extiende a lo largo de dos tercios del flanco. La nueva especie vive en bosques nublados de las estribaciones pacíficas de los Andes.

Keywords

Anura, Craugastoridae, *Pristimantis prometeii* sp. n., Reserva Buenaventura

Introduction

The Neotropics have the highest amphibian species diversity in the world, housing almost half the number of known species (Bolaños et al. 2008). This high species diversity is almost entirely endemic, with 96% occurring only in the Neotropics (Bolaños et al. 2008). Our knowledge of Neotropical amphibians is mediocre at best (Duellman 1999), with nearly one-quarter of all known species described over the last decade and 150 to 200 new species described yearly (Catenazzi 2015). A large proportion of South American frogs belong to Terrarana, a clade of direct developing frogs (Hedges et al. 2008; Heinicke et al. 2009) or otherwise known as the superfamily Brachycephaloidea (Padiál et al. 2014; Frost 2016). Their eggs are deposited in terrestrial habitats and the embryos develop directly into froglets, bypassing the tadpole stage. Currently this large group that contains more than 1000 species, consists of three families, Brachycephalidae, Craugastoridae and Eleutherodactylidae.

Most craugastorids belong to *Pristimantis* (Jiménez de la Espada 1870), the most speciose genus among terrestrial vertebrates with 494 species (Duellman 1993; Hedges et al. 2008; Frost 2016). Members of this genus, commonly called rain frogs, robber frogs or dirt frogs, are largely restricted to moist, forested habitats in the Andes of Colombia, Ecuador and Peru (Lynch and Duellman 1997; Frost 2016). The taxonomy of these species is challenging because of their high cryptic diversity, intraspecific variation, and the scant morphological characters available to diagnose species (Duellman and Lehr 2009). Despite recent reviews (e.g. Hedges et al. 2008; Padiál et al. 2014) the phylogenetic affinities of most species are unknown and numerous new species are discovered and described each year. During the last decade, 125 new species of *Pristimantis* have been described, 30% of which occur in Ecuador (AmphibiaWeb 2016). Just in the past several months, nine new *Pristimantis* species were described from Ecuador (Hutter and Guayasamin 2015; Reyes-Puig et al. 2015; Arteaga et al. 2016; Brito et al. 2016; Navarrete et al. 2016) with probably many more awaiting descriptions. Herein we describe a new species of *Pristimantis* from Reserva Buenaventura, El Oro province, southern Ecuador.

Materials and methods

Specimen collection

Field work was carried out between July and September in 2014 and March, April, and July to September in 2015 at several sites in Reserva Buenaventura. The reserve is private and belongs to the Jocotoco Conservation Foundation. The protected area has an altitudinal range between 400 and 1200 m a.s.l. and occurs in a transition zone between Deciduous Costa Forest and Western Montane Forest (*sensu* Ron et al. 2016). We made intensive visual encounter surveys, auditory surveys and leaf litter searches during evenings (18h00–01h00) and also daytime searches in bromeliads. Collected specimens were photographed alive and euthanized using 20% benzocaine, fixed in 10% formalin, and stored in 70% ethanol. Tissue samples that were used for genetic analyses were preserved in 96% ethanol. Examined specimens (listed in the type-series and Appendix I) are housed in Museo de Zoología de la Pontificia Universidad Católica del Ecuador (QCAZ).

Morphology

For the description of qualitative and quantitative morphological characters Duellman and Lehr (2009) was followed. Sex was determined by the presence of vocal slits and/or by gonadal inspection. Color data in life were based on field notes and digital photos. The capitalized colors and their corresponding color codes (in parentheses) used in the color in life descriptions follow Köhler (2012). Measurements were taken with a digital caliper and rounded to the nearest 0.1 mm. All well-preserved specimens were measured for the following morphometric variables: (1) snout-vent length (SVL), distance from tip snout to posterior margin of vent; (2) head width (HW), greatest width of head measured at level of jaw articulation; (3) head length (HL), distance from the tip of snout to posterior angle of jaw articulation; (4) interorbital distance (IOD), distance between the inner margins of the orbits; (5) internarial distance (IND), distance between the inner edges of the narial openings; (6) upper eyelid width (EW), the perpendicular distance to the outer edge of the eyelid; (7) eye diameter (ED), distance between anterior and posterior borders of eye; (8) eye-nostril distance (EN), distance from posterior margin of nostril to anterior margin of eye; (9) tympanum diameter (TD), horizontal distance between peripheral borders of tympanic annulus; (10) femur length (FL), length of femur from vent to knee; (11) tibia length (TL), length of flexed leg from knee to heel; (12) foot length (FoL), distance from proximal margin of inner metatarsal tubercle to tip of Toe IV; (13) hand length (HaL), distance from proximal edge of palmar tubercle to the tip of Finger III.

DNA extraction amplification and sequencing

DNA was extracted from muscle or liver tissue preserved in 96% ethanol or tissue storage buffer, using standard phenol–chloroform extraction protocols (Sambrook et al. 1989). We used a polymerase chain reaction (PCR) to amplify DNA fragments for the mitochondrial gene 16S rRNA (16S) and the nuclear gene RAG-1, using primers listed in Goebel et al. (1999), Moen and Wiens (2009) and Wiens et al. (2005). PCR amplification was performed under standard protocols and sequenced by the Macrogen Sequencing Team (Macrogen Inc., Seoul, Korea). The newly generated DNA sequences are available on GenBank (Table 1). We also included 12S, 16S and RAG-1 sequences from GenBank. To optimize taxon sampling within *Pristimantis* we carried out a preliminary phylogenetic analysis including all available sequences from GenBank. These analyses showed that the new species was closely related to *P. phoxocephalus*. Therefore, *P. phoxocephalus* and closely related species (based on Padial et al. 2014) are included as well as representative species of all major clades within *Pristimantis*. As outgroup we included sequences of *Diasporus*, *Eleutherodactylus*, *Holoaden*, *Hypodactylus*, *Ischnocnema*, *Lynchius*, and *Strabomantis*.

The combined DNA matrix had up to 2914 bp. Preliminary sequence alignment was done with MAFFT 7.2 software with the L-INS-i algorithm (Katoh and Standley 2013). The matrix was partitioned to allow independent inferences of models of evolution by gene and by codon position in coding genes. We used software PartitionFinder v. 1.1.1 (Lanfear et al. 2012) to simultaneously estimate both the best-fit model for each partition and the best partition strategy for our data. We defined five a priori partitions (12S, 16S, first, second and third codon position of RAG1). The best partition strategy was selected using the Akaike information criterion (AIC).

Phylogenetic analysis and genetic distances

Phylogenetic trees were obtained using maximum likelihood searches with software GARLI 2.0 (Zwickl 2006). We made two independent searches with 10 replicates each. The first search started with random trees and the second with stepwise addition trees. We increased the setting “genthreshfortopoterm” until all 10 searches resulted in similar likelihood values, indicating an efficient search. The final setting of “genthreshfortopoterm” was 100,000. Other settings were set to default values. Node support was assessed with 200 pseudoreplicate non-parametric bootstraps (npb; Felsenstein 1985), starting from random trees configured with the same settings of the full search, but with one replicate per run. Uncorrected p-genetic distances were estimated with software Mesquite 2.75 excluding ambiguous sites and gaps (Maddison and Maddison 2011).

Table 1. Voucher and GenBank accession numbers for specimens used in the phylogenetic analysis.

Voucher number	Species	16S	RAG1	12S
MVZ203844	<i>Diasporus diastema</i>	EU186682	EU186752	-
USNM314179	<i>Eleutherodactylus caribe</i>	EF493385	-	-
USNM327822	<i>Eleutherodactylus pantoni</i>	EF493616	-	-
USNM207945	<i>Holoaden bradei</i>	EF493366	-	-
MZUSP131872	<i>Holoaden luederwaldti</i>	EU186710	-	-
KU178258	<i>Hypodactylus brunneus</i>	GQ345248	-	-
ICNMNH23809	<i>Hypodactylus dolops</i>	EU368905	-	-
-	<i>Ischnocnema hoebnei</i>	EF493359	-	-
USNM318165	<i>Ischnocnema holti</i>	EU186722	-	-
KU218210	<i>Lynchius flavomaculatus</i>	EU186667	-	-
KU181408	<i>Lynchius nebulanastes</i>	EU186704	-	-
KU212327	<i>Oreobates saxatilis</i>	EU186708	-	-
USNM286919	<i>Phrynopus bracki</i>	EF493709	-	-
KU217786	<i>Pristimantis acerus</i>	EF493678	-	EF493678
AJC0573	<i>Pristimantis achatinus</i>	JN991420	JQ025168	JN991485
KU217830	<i>Pristimantis actites</i>	EF493696	EF493432	EF493696
KU215460	<i>Pristimantis altamazonicus</i>	EF493670	EF493441	EF493670
KU177637	<i>Pristimantis appendiculatus</i>	EF493524	-	EF493524
KU291638	<i>Pristimantis bipunctatus</i>	EF493702	EF493430	EF493702
KU291702	<i>Pristimantis bromeliaceus</i>	EF493351	-	EF493351
KU177658	<i>Pristimantis calcarulatus</i>	EF493523	-	EF493523
KU217857	<i>Pristimantis condor</i>	EF493701	EF493443	EF493701
KU177733	<i>Pristimantis crucifer</i>	EU186718	-	EU186736
QCAZ48309	<i>Pristimantis curtipes</i>	KX525474	KX525470	-
KU179090	<i>Pristimantis dissimulatus</i>	EF493522	-	EF493522
KU217998	<i>Pristimantis duellmani</i>	-	EF493438	-
NRPS0055	<i>Pristimantis erythropleura</i>	JN991445	JQ025182	JN991509
NRPS0009	<i>Pristimantis gagei</i>	JN991449	JQ025186	JN991513
KU218002	<i>Pristimantis glandulosus</i>	EF493676	-	EF493676
KU218015	<i>Pristimantis inusitatus</i>	EF493677	-	EF493677
KU218227	<i>Pristimantis leoni</i>	EF493684	EF493433	EF493684
MTD45080	<i>Pristimantis cf. mendax</i>	EU186659	-	EU186659
AJC1753	<i>Pristimantis moro</i>	JN991453	JQ025192	JN991519
AJC1860	<i>Pristimantis moro</i>	JN991454	JQ025191	JN991520
NRPS0048	<i>Pristimantis nervicus</i>	JN991456	JQ025194	JN991522
KU177812	<i>Pristimantis nyctophylax</i>	EF493526	EF493425	EF493526
KU222023	<i>Pristimantis ockenдени</i>	EF493519	EF493434	EF493519
KU218021	<i>Pristimantis orcesi</i>	EF493679	-	EF493679
MHNSM9267	<i>Pristimantis peruvianus</i>	EF493707	EF493436	EF493707
KU218025	<i>Pristimantis phoxocephalus</i>	EF493349	-	EF493349
AJC0594	<i>Pristimantis pirrensis</i>	JN991462	JQ025199	JN991528
QCAZ58040	<i>Pristimantis prometeii</i>	KX525475	-	-
QCAZ58042	<i>Pristimantis prometeii</i>	KX525476	KX525471	-
QCAZ58043	<i>Pristimantis prometeii</i>	KX525477	KX525473	-

Voucher number	Species	16S	RAG1	12S
QCAZ58044	<i>Pristimantis prometeii</i>	KX525478	KX525472	-
KU218028	<i>Pristimantis pycnodermis</i>	EF493680	-	EF493680
KU218035	<i>Pristimantis riveti</i>	EF493348	-	EF493348
KU291635	<i>Pristimantis sagittulus</i>	EF493705	EF493439	EF493705
NRPS0085	<i>Pristimantis savagei</i>	JN991467	JQ025205	JN991536
KU212220	<i>Pristimantis schultei</i>	EF493681	-	EF493681
KU218052	<i>Pristimantis spinosus</i>	EF493673	-	EF493673
KU291659	<i>Pristimantis stictogaster</i>	EF493704	EF493445	EF493704
KU218147	<i>Pristimantis subsigillatus</i>	EF493525	-	EF493525
NRPS0067	<i>Pristimantis</i> aff. <i>taeniatus</i>	JN991429	JQ025171	JN991493
NRPS0001	<i>Pristimantis</i> aff. <i>taeniatus</i>	JN991430	JQ025172	JN991494
USNM336098	<i>Pristimantis urichi</i>	EF493699	EF493426	EF493699
KU218096	<i>Pristimantis versicolor</i>	EF493389	EF493431	EF493389
KU218116	<i>Pristimantis walkeri</i>	EF493518	EF493428	EF493518
ROM43978	<i>Pristimantis zeuctotylus</i>	EU186678	-	EU186678
NRPS0060	<i>Pristimantis zophus</i>	JN991479	JQ025213	JN991549
CVULA7073	<i>Strabomantis biporcatus</i>	GQ345249	-	-
SIUC7062	<i>Strabomantis bufoniformis</i>	DQ283165	-	-

Results

Phylogeny

The best partitioning scheme consisted of three partitions with their models of evolution in parenthesis: 12S and 16S (GTR + I + G), RAG 1st and 2nd position (HKY + G), and RAG 3rd position (TrNef + G). The phylogeny shows that the new species is most closely related to *P. versicolor*, *P. riveti*, *P. phoxocephalus*, and *P. spinosus* (Fig. 1). This strongly supported clade is distributed in the Andes of northern Peru and central and southern Ecuador. Uncorrected *p*-genetic distances for the gene 16S between the new species and its closest relative, *P. versicolor*, range from 0.074 to 0.103. Distances with *P. phoxocephalus*, *P. riveti*, and *P. spinosus* range from 0.075 and 0.130. These large genetic distances and its morphological distinctiveness, clearly demonstrate *P. prometeii* sp. n. is in fact undescribed. We describe it below.

Taxonomy

Pristimantis prometeii sp. n.

<http://zoobank.org/EFAA799F-0DE2-4EE2-BDD3-3F22A5B648AB>

Common names. English: Prometeo Rain Frog. Spanish: Cutín Prometeo

Holotype (Figs 2–4). QCAZ 58044 (field no. SC-PUCE 47291), an adult female from Ecuador, Provincia El Oro, canton Piñas, Reserva Buenaventura, on the reserve's

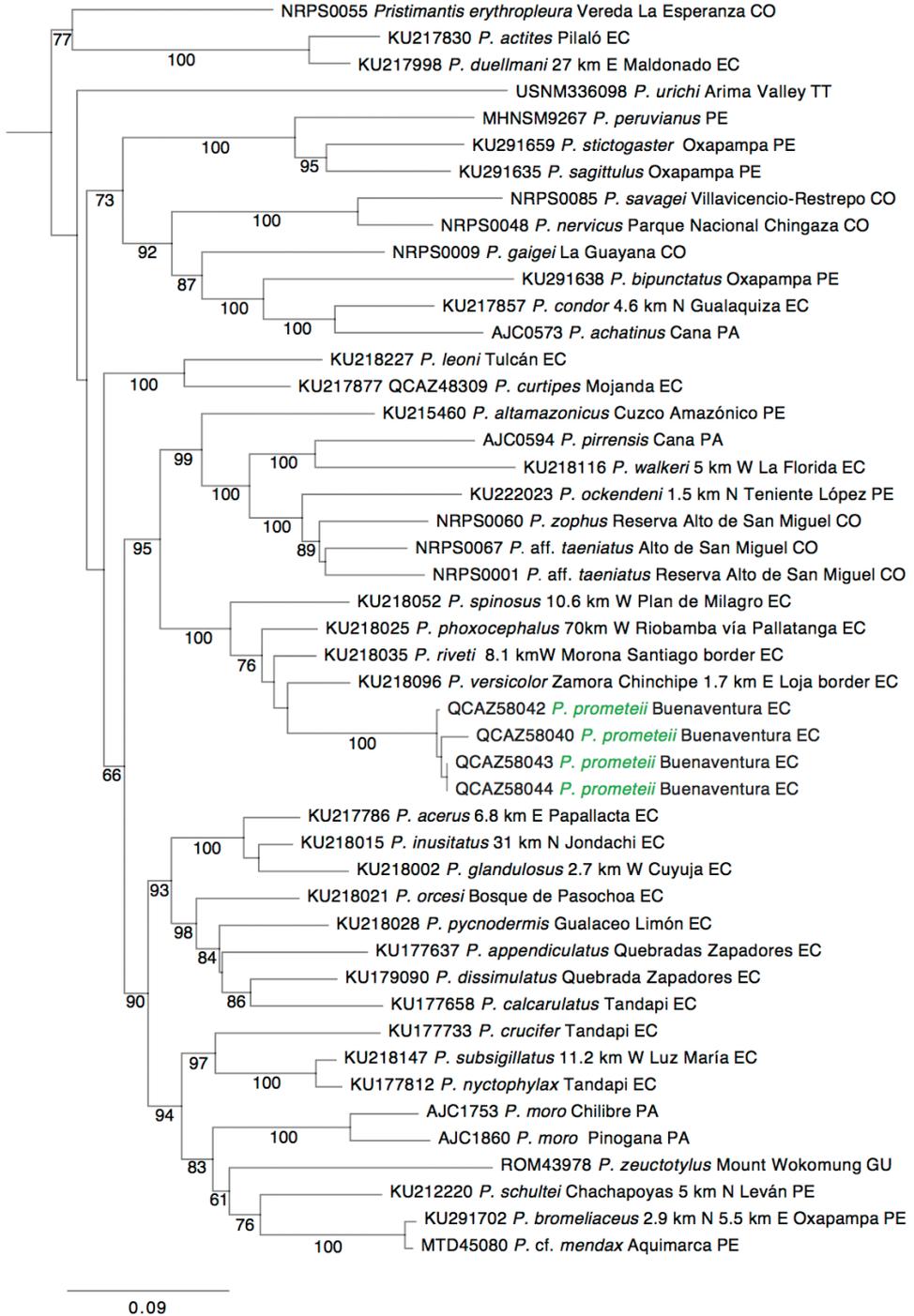


Figure 1. Maximum likelihood phylogram depicting phylogenetic relationships of *Pristimantis prometeii* sp. n. Bootstrap support values are shown under each branch.



Figure 2. Holotype of *Pristimantis prometeii* sp. n. in life, QCAZ 58044, adult female, SVL 37.6 mm: **A** lateral view **B** dorsal view **C** ventral view.

Sendero del Perico de Orcés (3.6470°S, 79.7565°W; datum WGS84), 878 m above sea level, collected by Dan Cogălniceanu and Paul Székely on 14 September 2014.

Paratopotypes. QCAZ 58045 (field no. SC-PUCE 47292), an adult female and QCAZ 58042 (field no. SC-PUCE 47289), an adult male (Fig. 5C, D) collected with the holotype; QCAZ 62540 (field no. SC-PUCE 51624), an adult female (Fig. 5A, B)

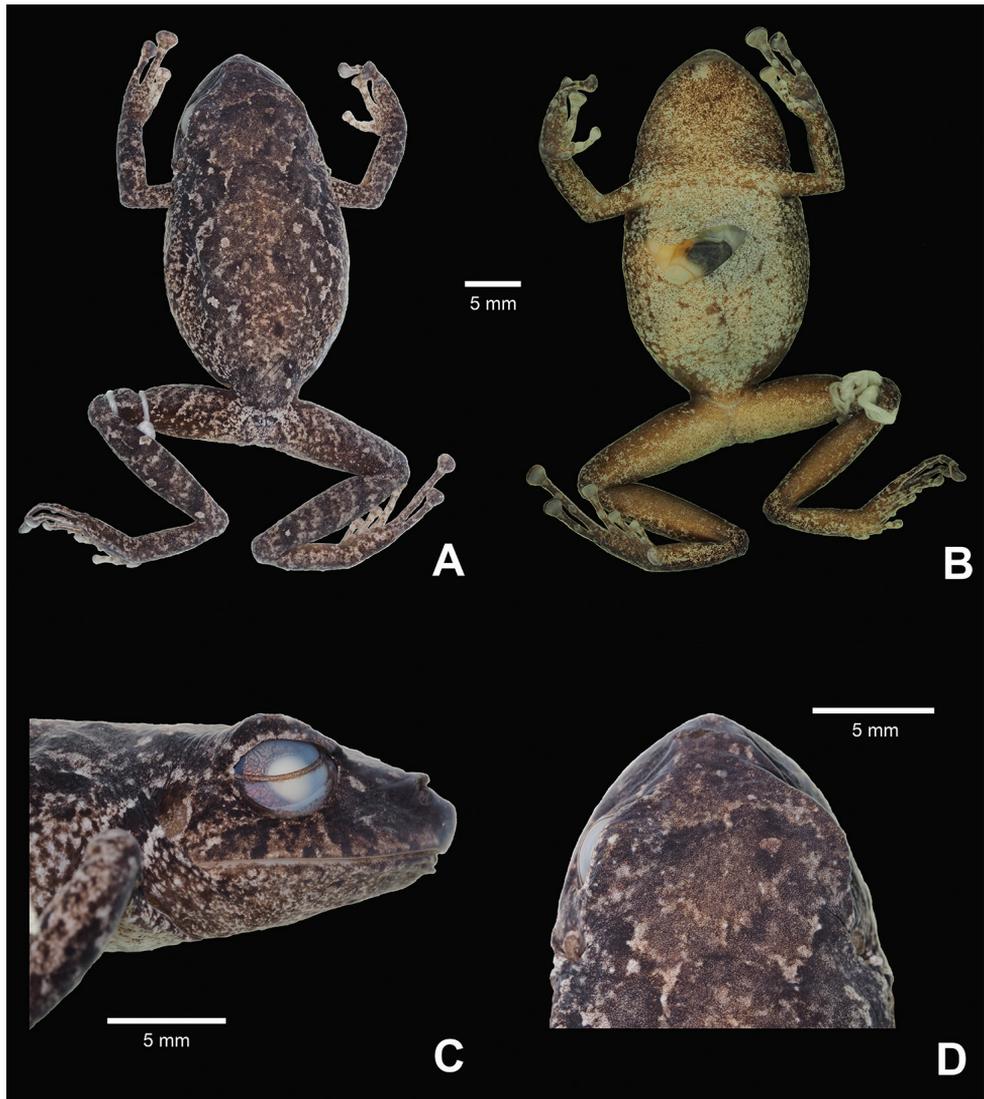


Figure 3. Holotype of *Pristimantis prometeii* sp. n. (QCAZ 58044, adult female) in preservative: **A** dorsal view **B** ventral view **C** head, lateral view **D** head, dorsal view.

and QCAZ 62541 (field no. SC-PUCE 51625), an adult male, same data as the holotype but collected by Dan Cogălniceanu on 13 September 2015.

Paratypes. QCAZ 58056 (field no. SC-PUCE 47353), an adult male and QCAZ 58058 (field no. SC-PUCE 47355), an adult female from Ecuador, Provincia El Oro, canton Piñas, Reserva Buenaventura, close to Finca Ramírez (3.6311°S, 79.7618°W), 1082 m above sea level, collected by Dan Cogălniceanu on 7 September 2014; QCAZ 62547 (field no. SC-PUCE 51631), an adult female and QCAZ 62548 (field no. SC-PUCE 51632), an adult male from Ecuador, Provincia El Oro, canton Piñas, Reserva

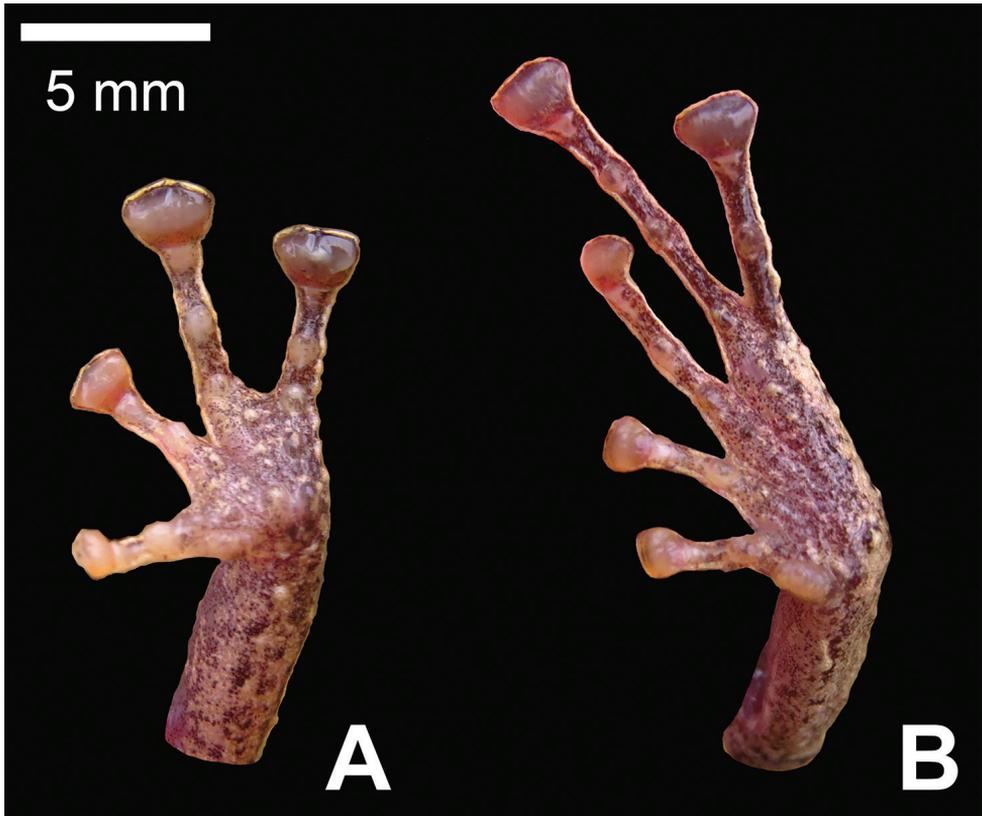


Figure 4. Hand and feet of the holotype of *Pristimantis prometeii* sp. n. in life, QCAZ 58044, adult female: **A** palmar view of hand **B** plantar view of foot.

Buenaventura, Quebrada Oscura (3.6652°S, 79.7417°W), 948 m above sea level, collected by Dan Cogălniceanu on 15 September 2015.

Additional specimens. Juveniles, QCAZ 58040 (field no. SC-PUCE 47287) (Fig. 5E, F) and QCAZ 58043 (field no. SC-PUCE 47290) with the same collecting data as the holotype.

Diagnosis. This species is placed in the genus *Pristimantis* based on the general morphological similarity to other members of the genus (e.g. characteristic T-shaped terminal phalanges, toes without membranes, and Toe V longer than Toe III) and based on phylogenetic evidence (Fig. 1). *Pristimantis prometeii* is a medium-sized species distinguished by the following combination of traits: (1) skin on dorsum shagreen with numerous small tubercles; a low W-shaped ridge in the scapular region, usually with four larger warts on it; skin on venter areolate; discoidal fold weak; thoracic fold present; dorsolateral folds absent but with a longitudinal lateral fold from behind the tympanic fold along the 2/3 of the flank length; low mid dorsal fold with rows of small tubercles, especially on the head; (2) tympanic membrane and tympanic annulus prominent, its length about 40% of the length of eye; supratympanic fold obscuring

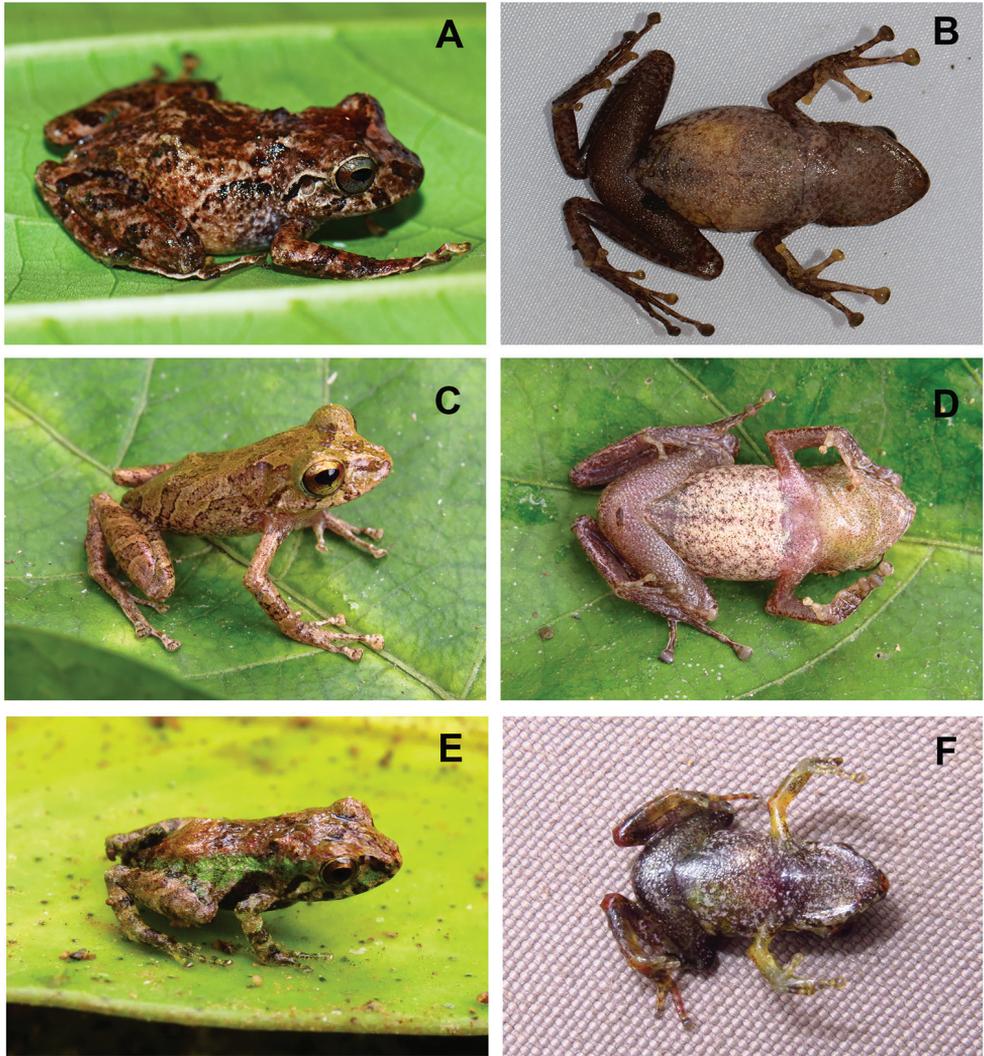


Figure 5. Color variation of *Pristimantis prometeii* sp. n. in life: female paratopotype, QCAZ 62540, SVL 32.6 mm: **A** dorsolateral view **B** ventral view; male paratopotype, QCAZ 58042, SVL 24.9 mm: **C** dorsolateral view **D** ventral view; juvenile, QCAZ 58040, SVL 10.4 mm: **E** dorsolateral view **F** ventral view.

upper and posterodorsal edges of tympanum; (3) snout short, subacuminate in dorsal view, rounded, slightly protruding in profile; canthus rostralis angular; (4) upper eyelid bearing one larger conical tubercle and numerous small tubercles, about 90% IOD in females and 85% IOD in males; cranial crests absent; (5) dentigerous processes of vomers prominent, triangular with 3 to 4 teeth; (6) males with a subgular vocal sac and vocal slits; (7) Finger I shorter than Finger II; discs on fingers broadly expanded, elliptical; (8) fingers bearing broad lateral fringes; (9) ulnar tubercles coalesced into

low ulnar fold; (10) heel bearing one larger, conical tubercle and several smaller tubercles; outer edge of tarsus with row of small, conical tubercles; inner edge of tarsus bearing a low fold; (11) inner metatarsal tubercle broadly ovoid, about 5x ovoid outer metatarsal tubercle; supernumerary plantar tubercles present; (12) toes bearing broad lateral fringes; webbing absent; Toe V much longer than Toe III; discs elliptical, about same size as those on fingers; (13) in life, dorsum of various shades of brown, with or without white spots, blotches, or dark brown bars or reticulum; flanks cream, yellow, or green; venter cream with dark flecks and blotches; yellow blotches on the groin, anterior, and posterior surfaces of thighs; iris bronze with fine black reticulations and a median, horizontal read streak; (14) SVL 20.4–24.9 mm in adult males (22.4 ± 1.86 SD, $n = 4$) and 29.9–37.6 mm in adult females (32.7 ± 2.91 SD, $n = 5$).

Comparisons with other species. Comparisons are based on molecular evidence to compare *Pristimantis prometeii* with close relatives and on morphologically similar species present in southern Ecuador and Northern Peru. The phylogenetically closest species are *Pristimantis versicolor*, *P. phoxocephalus* and *P. riveti* (Fig. 1). From these three *P. phoxocephalus* (Lynch 1979) is the most similar. However, it is easily distinguished from *P. prometeii* by a fleshy vertical keel on the snout. Furthermore, *P. phoxocephalus* lacks tubercles on the upper eyelid, heel and tarsus, and the low W-shaped dermal ridge in the scapular region. *Pristimantis riveti* (Despax 1911) differs from *P. prometeii* in having a heel without prominent tubercles (one prominent tubercle in *P. prometeii*), smaller finger and toe discs, and W-shaped dermal ridge in the scapular region absent. In *P. versicolor* (Lynch 1979), males lack vocal slits and vocal sacs (both present in *P. prometeii*), the tarsus lacks distinct tubercles (tubercles present in *P. prometeii*), lateral fringes are absent in toes (present in *P. prometeii*), and the dorsum lacks the low W-shaped dermal ridge in the scapular region. Additionally, all these three *Pristimantis* species inhabit upper humid montane forest and subparamo, habitats at higher elevations than those of *P. prometeii*: 1800–3100 m, in *P. phoxocephalus* (Lynch and Duellman 1997), 2,620–3,600 m in *P. riveti* (Coloma et al. 2004) and 2500–3100 m in *P. versicolor* (Frenkel et al. 2013). The related *Pristimantis spinosus* (Lynch 1979) is also easily distinguished by the presence of cranial crests (absent in *P. prometeii*), males lacking vocal slits and vocal sacs, and the coloration of groins and concealed surfaces of hind limbs which are black with white spots.

Among the few morphologically similar congeners from southern Ecuador, *Pristimantis sternothylax* (Duellman and Wild 1993) can be distinguished by lacking prominent tubercles on the upper eyelid, having smooth ulnar surfaces, and heel and tarsus lacking tubercles and folds. *Pristimantis buenaventura* (Arteaga et al. 2016) is somewhat similar but it is significantly smaller, and lacks prominent tubercles on the upper eyelid and heel. It also differs by having orange-red spots on the groins. Similar species in northern Peru include *Pristimantis rhodoplichus* (Duellman and Wild 1993), *P. wiensi* (Duellman and Wild 1993), and *P. petrobardus* (Duellman 1991). *Pristimantis rhodoplichus* and *P. petrobardus* differ by lacking prominent tubercles on the upper eyelid. The lack of tympanic membrane readily distinguishes *P. wiensi* from *P. prometeii*. Both species also differ in dorsal coloration: green dorsum with scattered bronze and dark blotches in *P. wiensi* vs. brown dorsum in *P. prometeii*.

Description of the holotype. Adult female (Fig. 3) with head slightly narrower than body, wider than long, head length 89% of head width, head width 36% of SVL; head length 32% of SVL; snout short (snout to eye distance 14% of SVL), subacuminate in dorsal view, rounded, slightly protruding in profile; canthus rostralis angular; loreal region flat; eye diameter notably greater than eye-nostril distance; nostrils slightly protuberant laterally; lips not flared; cranial crests absent; upper eyelid bearing one larger conical tubercle and numerous small tubercles, width of upper eyelid 94% of IOD; tympanic annulus prominent, round, its upper and posterodorsal part obscured by rounded supratympanic fold; tympanic membrane differentiated, visible; diameter of tympanum 41% of the length of eye; one larger and several low postrectal tubercles situated posteroventrally to tympanic annulus; choanae big, oval, not concealed by palatal shelf of maxillary; vomerine odontophores prominent, triangular, about 3x size of choana, separated medially by distance lower than width of odontophore; each odontophore has 3 to 4 teeth; tongue longer than wide, bilobate, posterior half not adherent to floor of mouth.

Skin on dorsum shagreen with numerous small tubercles; a low W-shaped dermal ridge is present in the scapular region, with 4 larger warts defining its corners (this trait is more visible in life, Fig. 2); thin, low mid dorsal fold starting at tip of snout and ending at cloaca, with rows of small tubercles, especially on the head (trait more visible in life, Fig. 2); dorsolateral folds absent; longitudinal lateral fold from behind the tympanic fold along the 2/3 of the flank length (trait more visible in life, Fig. 2); skin on throat, chest, belly, and ventral surfaces of thighs areolate; discoidal fold weak; thoracic fold present (trait more visible in life, Fig. 2); ornamentation in cloacal region absent.

Ulnar tubercles present, coalescing into low ulnar fold; outer palmar tubercle partially divided distally; thenar tubercle ovoid; subarticular tubercles prominent, round; supernumerary palmar tubercles rounded, smaller than subarticular tubercles; fingers bearing broad lateral fringes; Finger I shorter than Finger II; discs on fingers broadly expanded, elliptical; all fingers bearing pads well defined by circumferential grooves (Fig. 4).

Hind limbs moderately robust; tibia length 46.5% of SVL; foot length 40.7% of SVL; heel bearing one larger, conical tubercle and several smaller tubercles; outer edge of tarsus with row of small, conical tubercles; inner edge of tarsus bearing a low fold; inner metatarsal tubercle broadly ovoid, about 5x ovoid outer metatarsal tubercle; subarticular tubercles prominent, round; plantar supernumerary tubercles rounded, smaller than subarticular tubercles; toes bearing broad lateral fringes; webbing absent; discs on toes elliptical, about same size as those on fingers; toes with ventral pads well defined by circumferential grooves; relative length of toes $I < II < III < V < IV$; Toe V much longer than Toe III; tip of Toe III not reaching the distal subarticular tubercle on Toe IV; tip of Toe V extending to distal edge of distal subarticular tubercle on Toe IV (Fig. 4).

Coloration of holotype. In life: dorsal background coloration tan (Drab-19), with dirty white spots and blotches of various sizes; flanks cream (Pale Buff-1) with darker reticulum; venter and throat cream (Pale Buff-1) with dark flecks and blotches; dorsal

surface of hind limbs with faint darker transverse bars; ventral surfaces of hind limbs salmon (Light Flesh Color–250); groin, anterior and posterior surfaces of thighs with faint yellow (Light Sulphur Yellow–93) blotches; iris bronze with fine black reticulations and a median, horizontal red (Poppy Red–63) streak which is wider at the edges of the eye.

In preservative: dorsal background coloration grayish brown; the white dorsal spots and blotches become more contrasting than in life; venter and throat dirty white with brown flecks and blotches; ventral surfaces of hind limbs brown with white flecks and blotches; the yellow blotches on the groin and anterior and posterior surfaces of thighs visible in life disappear in preservative.

Measurements of holotype (in mm). SVL 37.6; head width 13.6; head length 12.1; IOD 3.4; internarial distance 2.9; upper eyelid width 3.2; eye diameter 4.4; eye-nostril distance 3.9; snout to eye distance 5.3; eye to tympanum distance 1.8; tympanum diameter 1.8; femur length 16.8; tibia length 17.5; foot length 15.3; hand length 10.6; Finger I length 5.1. For morphometric variation, see Table 2.

Variation. Males are smaller than females (Table 2). The dorsal coloration in *Pristimantis prometeii* varies from brown, to green with or without dark brown bars or reticulum. The examined males have dark dorsal bars of various shapes, dark labial bars, dark canthal and supratympanic stripes and on the dorsal surface of hind limbs obvious dark transverse bars (Fig. 5). Males sometimes have a darker reddish-brown (Vinaceous–247) middorsal band, yellow (Sulphur Yellow–80) or greenish (Light Lime Green–113) flanks, and a white or brownish (Tawny–60) interorbital bar. The W-shaped dermal ridge in the scapular region is usually bordered by dark brown or whitish markings, more evident in males than females. The ventral coloration is very similar between females and males, the most important difference being the coloration of the subgular vocal sac in the males, which is yellow (Pale Greenish Yellow–86) with black flecks.

Some females also have the W-shaped scapular dermal ridge dubbed by dark brown coloration and/or labial bars, canthal and supratympanic stripes like the males (Fig. 5). Two juveniles (QCAZ 58040, SVL = 10.4 mm and QCAZ 58043, SVL = 11.5 mm), identified based on the molecular data, have a darker reddish-brown (Kingfisher Rufous–28) middorsal band, green (Apple Green–104) flanks, dark dorsal bars of various shapes, brown (Kingfisher Rufous–28) dorsal surface of the hind limbs with dark transverse bars and present labial bars, canthal and supratympanic stripes (Fig. 5). The low W-shaped dermal ridge in the scapular region, the thin middorsal fold and the incomplete longitudinal lateral fold are also visible. The venter is blackish with white flecks and spots and it is darker than in the adults.

The degree of tuberculation and development of dermal ridges on the dorsum and flanks is usually more evident in males than females. However, the tubercles and dermal folds are difficult to observe in preservative. The low W-shaped dermal ridge in the scapular region, the thin mid dorsal fold, the incomplete longitudinal lateral fold and the thoracic fold are easily observable in life but can be very difficult to notice in the preserved specimens.

Etymology. The specific name is a noun in the genitive case and refers to the Prometeo program of Secretaría de Educación Superior, Ciencia, Tecnología e In-

Table 2. Measurements (in mm) and morphological proportions (in percentages) of adult males and females of *Pristimantis prometeii* sp. n. (range, average \pm SD). Abbreviations for characters are SVL, snout-vent length; HW, head width; HL, head length; IOD, interorbital distance; IND, internarial distance; EW, upper eyelid width; ED, eye diameter; EN, eye-nostril distance; TD, tympanum diameter; FL, femur length; TL, tibia length; FoL, foot length; HaL, hand length.

Character	females ($n = 5$)	males ($n = 4$)
SVL	29.9–37.6 (32.7 \pm 2.91)	20.4–24.9 (22.4 \pm 1.86)
HW	10.8–13.6 (12.1 \pm 0.99)	7.8–8.5 (8.1 \pm 0.33)
HL	9.2–12.1 (10.7 \pm 1.07)	5.6–7.8 (6.4 \pm 0.99)
IOD	3.1–3.4 (3.2 \pm 0.11)	2.2–2.5 (2.3 \pm 0.15)
IND	2.2–2.9 (2.5 \pm 0.29)	1.3–1.4 (1.4 \pm 0.05)
EW	2.8–3.2 (3.0 \pm 0.16)	1.7–2.3 (2.0 \pm 0.25)
ED	3.9–4.4 (4.1 \pm 0.19)	2.5–3.1 (2.8 \pm 0.25)
EN	2.9–3.9 (3.5 \pm 0.37)	2.4–2.9 (2.6 \pm 0.21)
TD	1.4–1.8 (1.6 \pm 0.15)	1.0–1.1 (1.1 \pm 0.05)
FL	14.7–16.8 (15.7 \pm 0.77)	10.3–11.3 (10.8 \pm 0.41)
TL	15.3–17.5 (16.7 \pm 1.01)	10.8–12.8 (11.9 \pm 0.82)
FoL	14.2–15.3 (14.7 \pm 0.41)	10.5–11.2 (10.8 \pm 0.29)
HaL	8.8–10.6 (9.7 \pm 0.66)	5.4–6.9 (6.3 \pm 0.65)
HW/SVL	36.1–38.0	34.1–38.2
HL/SVL	30.8–33.7	26.2–31.3
HL/HW	85.2–90.9	71.6–91.8
EN/HL	31.2–35.3	37.2–44.8
ED/HL	36.4–42.4	39.7–48.3
EW/IOD	90.3–94.1	77.3–92.0
EN/ED	74.4–88.6	92.9–96.3
TD/ED	35.9–41.5	35.5–40.7
FL/SVL	44.7–49.2	45.4–50.5
TL/SVL	46.5–53.6	51.4–53.9
FoL/SVL	40.7–47.4	44.9–51.6

novación, Republic of Ecuador (SENESCYT) through which Dan Cogălniceanu and Paul Székely received funding for their research in southern Ecuador.

Distribution and natural history. *Pristimantis prometeii* is known from three closely located sites at Reserva Buenaventura (Fig. 6), Provincia El Oro, southwestern Ecuador, at elevations between 878 and 1082 m (Fig. 7). Most of the specimens were encountered at night, usually after rains, perching on leaves 10 to 100 cm above the ground. No calling male was found. Two specimens (QCAZ 58056 and QCAZ 58058) were collected during the day in small bromeliads between 2.0 and 2.5 m. All specimens were found in September 2014 and 2015 and additional surveys carried out in 2016 failed to encounter this species. All individuals were found in fairly well-preserved forest areas, near the reserve's trails or in the vicinity of streams. One of the paratopotypes (QCAZ 58045), an adult female, was missing the right foreleg. Sympatric frog species at the type locality in Reserva Buenaventura include *Pristimantis achatinus*



Figure 6. Habitat at the type locality of *Pristimantis prometeii* sp. n. in Reserva Buenaventura.

and *P. subsigillatus* as well as *Epipedobates anthonyi*, *Hyloxalus infraguttatus*, *Espadarana prosoblepon*, *Hypsiboas pellucens* and an undescribed species of *Hyloscirtus*.

Conservation status. *Pristimantis prometeii* sp. n. is only known from three nearby sites in Reserva Buenaventura, Provincia El Oro. Given the scarcity of information on the distribution of the new species, we recommend *P. prometeii* to be considered as Data Deficient following IUCN's Red List categories (IUCN 2001).

Discussion

Our phylogenetic analysis indicates that *Pristimantis prometeii* is most closely related to *P. versicolor*, *P. riveti*, *P. phoxocephalus*, and *P. spinosus*. The most comprehensive molecular phylogenetic study of terraranas to date also found that these taxa form one clade (Padiá et al. 2014). These species were included by Hedges et al. (2008) in the *Pristimantis unistrigatus* group which is the most diverse group of the genus (with almost 200 species), distributed from the lowland Amazon Basin to the high Andes in northeastern South America. This is not a monophyletic group rather it is an assemblage of *Pristimantis* species that do not fit clearly in other groups (Hedges et al. 2008). For this reason, we preferred not to assign *P. prometeii* to this group until a taxonomic revision will clarify the ambiguous relationships of this large and widely distributed group.

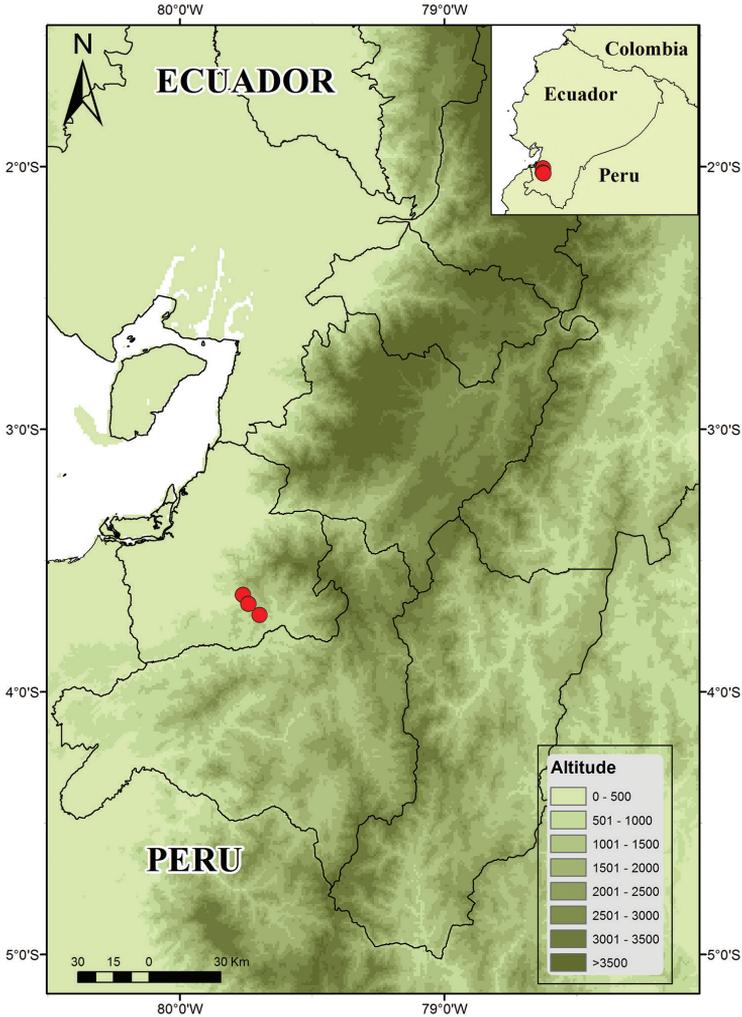


Figure 7. Distribution of *Pristimantis prometeii* sp. n. in Ecuador. Occurrence records are marked with red dots.

The Reserva Buenaventura was created in 1999 for the protection of two endemic species of birds, and despite its rather small size (about 2400 ha) is an important area for conservation in Southwestern Ecuador. Actually, the reserve is one of the most diverse sites in El Oro province hosting more than 60 species of amphibians and reptiles and 320 bird species (MECN-INB-GADPEO 2015). As for the amphibians, until 2015 there were known 24 species, 22 anurans (from seven families) and 2 caecilians from the reserve (MECN-INB-GADPEO 2015, Yáñez-Muñoz et al. 2013, authors' personal observations). The Craugastoridae family is represented by nine species in the reserve, *Barycholos pulcher* and eight *Pristimantis* species, with several more undescribed

ones (authors' personal observations). The description of this new *Pristimantis* species highlights both the still poor knowledge of amphibians in southern Ecuador and the importance for conservation of even small protected areas, like Reserva Buenaventura, in a constantly degrading environment.

Acknowledgments

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Appendix I

Examined specimens

Pristimantis cryophilus

Ecuador–Azuay: Patacocha, vía Gualaceo-Macas (QCAZ 16453); Azuay: Parque Nacional El Cajas, Patul (QCAZ 48677); Morona Santiago: Zuñiag, Galgalan (QCAZ 42513).

Pristimantis phoxocephalus

Ecuador–Cotopaxi: Pilaló (QCAZ 556); Alrededores de Pilaló (QCAZ 36846); Pilaló (QCAZ 58465).

Pristimantis riveti

Ecuador–Azuay: Parque Nacional El Cajas (QCAZ 7386); El Oro: Chillacocha, 8 km desde Chilla (QCAZ 45157); Chimborazo: vía Pallatanga (QCAZ 20979); Loja: Amaluzá–El Salado de Jimbura (QCAZ 30775); Tungurahua: Recinto–Caserío, margen del Parque Nacional Llanganates (QCAZ 46107); Zamora Chinchipe: Reserva Tapichalaca (QCAZ 45677).

Pristimantis spinosus

Ecuador–Zamora Chinchipe: Villa Nueva (QCAZ 54002).

Pristimantis sternothylax

Ecuador–Loja: 5-10 km de Loja (QCAZ 30600, QCAZ 30602, QCAZ 30604).

Pristimantis versicolor

Ecuador–Loja: Reserva Ecológica El Madrigal, Unidad Educativa Amauta (QCAZ 50733); Loja: Shucos (QCAZ 54330); Loja: Vía Yangana-Valladolid (QCAZ 36237).

Pristimantis walkeri

Ecuador–Azuay: Recinto La López (QCAZ 53616); Carchi: Cabeceras del Río Baboso al NE de Lita (QCAZ 49514); El Oro: Reserva Ecológica Buenaventura, Río Moromoro (QCAZ 17126); Loja: Cangonamá (QCAZ 49438).

Annotated checklist of the coastal ichthyofauna from Michoacán State, Mexico

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Abstract

This study is the first to complete an intensive and comprehensive list of the ichthyofauna of nearly all ecosystems of the Michoacán coast, Mexico. The resulting systematic checklist, supplemented with information from the literature and scientific collections, comprises 440 species belonging to two classes, 31 orders, 104 families, and 264 genera. The families with the highest number of species were Sciaenidae (30 spp.), Carangidae (26), Haemulidae (24), Serranidae (21), Paralichthyidae, and Gobiidae (13). Of the total species list, 134 represent first records for the Michoacán State, and one is a first record for Mexico. The results expand the number of known fish species of the Michoacán coast by almost one third and will help to develop conservation and management plans for this coastal zone.

Keywords

Coastal fish, estuaries, marine, Mexican Central Pacific, systematic list

Introduction

Mexico has a wealth of both marine species and ecosystems. The country has the world's twelfth longest marine territory, including both Atlantic and Pacific oceans. The geographic and geological history, as well as the ecological and biological richness of areas such as the Gulf of California, the Oceanic islands, and the Caribbean, expands the diversity of Mexican marine life (Lara-Lara et al. 2008), including the ichthyofauna. The few studies pertaining to these taxa have primarily focused on conservation priority zones such as the Gulf of California (e.g. Del Moral-Flores et al. 2013), protected marine areas (e.g. Galván-Villa et al. 2016), or on economically important species (e.g. Lara-Lara et al. 2008).

The Mexican tropical Pacific is part of the biogeographic region known as the Tropical Eastern Pacific (TEP), which comprises three provinces: Cortez or Sinuscaliforniana, Mexican, and Panamic (*sensu* Briggs 1974). An estimated 1358 fish species occur in the TEP region, along with an additional of approximately 59 undescribed species (Zapata and Robertson, 2007). The TEP could be considered an area of low richness compared to other biogeographical regions of tropical seas, such as the Indo-Malaysian or the Great Caribbean. However, approximately 71% of identified TEP fish species are considered endemic, making it the tropical region with the highest rate of endemism per unit area in the world (Robertson and Allen 2015). According to Robertson and Allen (2015), the Cortez province possesses 9% of the 515 endemic fish species identified in the coastal ecosystems of the TEP region, whereas the Mexican and the Panamic provinces host 2% and 29% of the endemic component, respectively. Nine percent of the endemic species occur in both the Cortez and Mexican provinces, 10% in both the Mexican and the Panamic provinces, and 37% of the species are found in the three provinces. The endemic fish fauna of the five TEP oceanic islands (Revillagigedo, Galapagos, Cliperton, Coco, and Malpelo) represent, on the other hand, 10% of the total.

The Mexican province is highly productive due to the convergence of the Costa Rica Coastal Current and the California Current, favoring the presence of tropical, temperate, and transitional fish species (Kessler 2006). Based on its lower number of endemic fish species, the Mexican province has been considered a transition zone between the Cortez province in the north and the Panamic to the south (Hastings 2000, Palacios-Salgado 2005, Robertson and Cramer 2009). Attempts to characterize the ichthyofauna of this province are scarce, and most of them refer to a particular group of fishes, region or are based on unpublished reports (Madrid-Vera et al. 1998; Palacios-Salgado 2005, Madrigal-Guridi 2006, Moncayo-Estrada et al. 2006, Chávez-Comparan et al. 2008, López-Pérez et al. 2010, Márquez-Espinoza 2012, Sandoval-Huerta et al. 2012, 2012b, 2014; Palacios-Morales et al. 2014).

The coastline of the Michoacán State, in the Mexican province, is 261.5 km in length and runs from Boca de Apiza, at the mouth of the Coahuayana River, which represents the border with the Colima State to the north, to Barra de San Francisco, at the mouth of the Balsas River, which represents the border with the Guerrero State to the south (Correa and Gómez 2003). There are two contrasting physiographic zones

differing markedly in the marine ecosystems and consequently in the fish species present: (1) the municipalities of Lazaro Cardenas and Coahuayana, which are characterized by coastal plains, with a wide sandy coastline, mangroves, and estuary zones, (2) and the municipality of Aquila comprising numerous cliffs extending into the sea and forming wide zones of rocky reefs, coralline patches, and intertidal pools; estuaries in the last zone are scarce and differ in size and dynamism from those found in Lazaro Cardenas and Coahuayana (Correa and Gómez 2003).

Such heterogeneity in a transitional zone potentially produces high fish species richness. Nevertheless, information on the ichthyofauna of the Michoacán coast is limited, including two study focused on artisanal fishery species (Amezcu-Linares 2009, Sánchez-Aguilar 2007), two on estuarine fishes (Madrigal-Guridi 2006, Sandoval-Huerta et al. 2014) and one including all habitats (Medina-Nava et al. 2001). Madrid-Vera et al. (1998) published the previously most extensive list of the fish fauna of the Michoacán coast, with 257 species, 157 genera, and 76 families recorded in a wide variety of environments. This limited knowledge of the fish fauna contrasts with the importance of the fishery to the economy of the region as the main economic activity, with about 11,931 fishermen producing 6525 tons with an estimated economic value of 145,255,860 MXN (CONAPESCA 2014).

The main goal of this study was to provide an updated checklist of the ichthyofauna from the Michoacán coast including information on fish of local commercial importance and their biogeographic affinity. This knowledge will increase the understanding of regional fish diversity and could be of usefulness for conservation and management strategies of the littoral zone of the Central Mexican Pacific and particularly for the Michoacán State.

Materials and methods

The study area encompassed the coastline of Michoacán state, with 110 locations directly sampled (Fig. 1) and information on 50 additional sites obtained from published literature or scientific collections. These data were obtained through extensive review of the biological material deposited at the Colección de Peces de la Universidad Michoacana de San Nicolás de Hidalgo (**CPUM**), the Colección Nacional de Peces (**UNAM**), the Colección Ictiológica del Instituto de Ciencias del Mar y Limnología (**UNAM**) and the Marine Vertebrate Collection, Scripps Institute of Oceanography (**SIO**). In addition, records from the data base of the fish collection of the California Academy of Sciences (**CAS**) were reviewed. These investigation also included an extensive review of specialized publications (books, catalogues, and field guides) and reports of specimens deposited in ichthyological collections recognized by the Secretaria de Medio Ambiente y Recursos Naturales, México, or specimens of which identification was corroborated by experts.

Field sampling was conducted bimonthly from February 2010 to February 2011, with intermittent sampling in the ensuing year. Sampling was carried out in estuarine

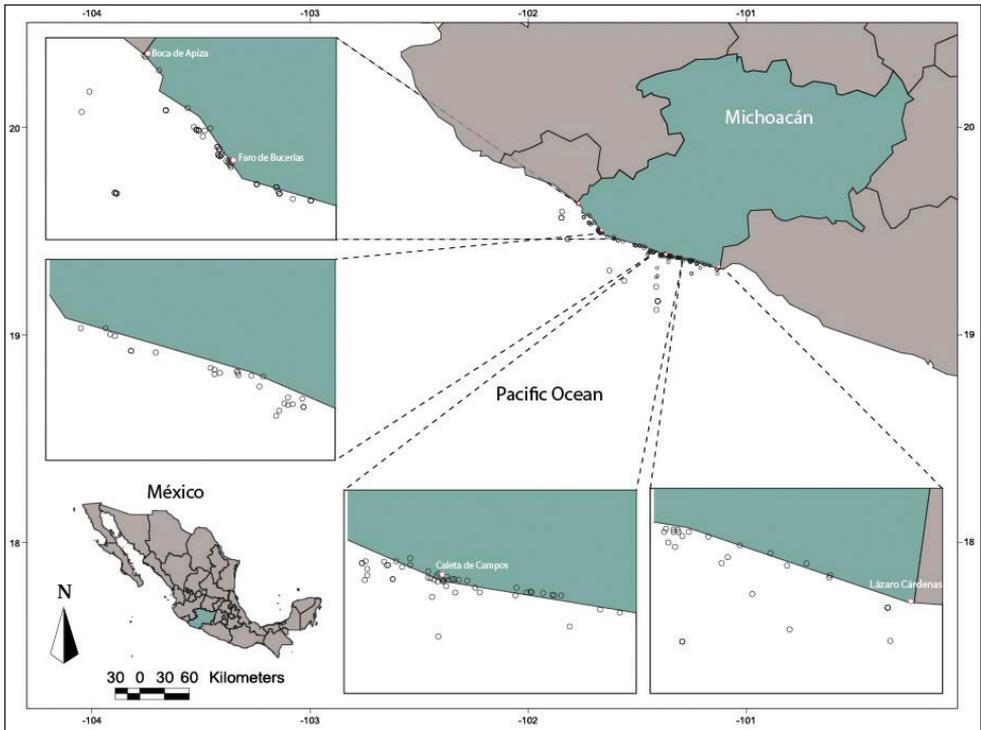


Figure 1. Sampling locations on the coast of Michoacán State.

zones, rocky intertidal pools, rocky reefs, sandy areas, coralline communities, artificial reefs, and the demersal-pelagic area. Methods were tailored to the ecosystem. Reef species were collected via SCUBA diving using elastic band harpoons. Ecologically cryptic (*sensu* Viesca-Lobatón 2005) and intertidal pool species were collected using eugenol (clove oil) anesthetic at a ratio of 1:5 (eugenol:ethanol) for reef and 0.25:9.75 for intertidal pool species. When the organisms were sedated, they were captured with a slurp gun or hand net. For estuarine locations, nocturnal sampling was done using gill nets (12 × 1.8 m and 0.7 to 1.2 cm mesh) and cast nets. For sandy-bottomed sites, a small fishing net (2 × 1.8 m, 1 cm mesh and 3 m bag) was used using a dragging period of 20 min. Captures from a shrimp fishing boat were also analyzed. Aggregations of debris in the open sea were investigated to collect ocean species rarely found in coastal areas. Cooperation with local artisanal fishermen was established to review incidental and commercial catches. Fishermen used lines of 50, 100, and 200 m at 5, 20, and 40 m depth, with hooks of various sizes, fishing with fishhook at a maximum depth of 80 m and gillnets of 7 to 12 cm mesh size. Information about the commercial value and uses of the species also was recorded.

Most specimens were photographed upon collection; tissue samples were taken and deposited at the tissue collection of the CPUM. Specimens were fixed in 5% or 10% formalin neutralized with sodium borate and posteriorly preserved in 70% etha-

nol. Fishes were identified using the keys and descriptions from Springer (1962), Allen and Robertson (1991, 1992, 1998), Fisher et al. (1995), Castro-Aguirre et al. (1999), Hastings and Robertson (1999, 1999b), Thomson et al. (2000), Carpenter and Niem (2001), Miller and Stefanni (2001), Miller et al. (2005), and Robertson and Allen (2015). For some groups, specialized literature was required: Balistidae (Latreille 1804, Shaw 1804-1805, Jordan and Evermann 1900, Froese and Pauly 2003), Rhinobatidae (Himaya and Kumada 1940), Gerreidae (Benitez 2004), Atherinopsidae (Lavenberg and Chernoff 1995), Labrisomidae (Hubbs 1953; Springer 1959, Rosenblatt and Parr 1969, Rosenblatt and Taylor 1971), Blenniidae (Springer 1962), Chaenopsidae (Hastings and Robertson 1999), Tripterygiidae (Allen and Robertson 1991, 1992, Rosenblatt et al. 2013), and for the genera *Abudefduf* Forsskål, 1775 (Lessios et al. 1995), *Tomicodon* Brisout de Barneville, 1846, *Gobiesox* Lacepède, 1800 (Briggs 1955; Briggs and Miller 1960), and *Albula* Scopoli, 1777 (Pfeiler 2008). All specimens were deposited at CPUM (MICH-PEC-227-07-09).

The systematic arrangement followed Nelson et al. (2016). The current taxonomic status of each species was corroborated in Eschmeyer et al. (2016). The arrangement of the genera and species was in alphabetical order. In the systematic list, the habitat-type from which each species was collected and the scientific collection by which the specimen was identified, or the scientific document from which information of the specimen was obtained, are indicated.

Finally, a zoogeographical affinity analysis of the species, based on the biogeographical regionalization proposed by Briggs (1974, 1995), was made. Accordingly, the Tropical Eastern Pacific was divided into three provinces. The San Diegan province was also included, since some species tended to have a northern distribution.

Results

Sampling was performed in 13 intertidal pool sites, 20 rocky reef sites, three coralline communities, two artificial reefs, 22 estuarine ecosystems, and 50 soft bottom and open sea sites, collecting 6963 fishes.

The compiled systematic list of ichthyofauna of the Michoacán coast comprises 436 species belonging to two classes, 31 orders, 104 families, and 260 genera (Table 1). The families representing the greatest number of species were Sciaenidae (30), Carangidae (26), Haemulidae (24), Serranidae (21), and Paralichthyidae and Gobiidae (13). The genera with the highest number of species were *Lutjanus* Bloch, 1790 (9), *Carcharhinus* Blainville, 1816 (7), *Anchoa* Jordan and Evermann, 1927 (6), *Diplectrum* Holbrook, 1855 (6), and *Caranx* Lacepède, 1801 (5).

Of the total identified species, 69% were collected and deposited at the CPUM, 22% were obtained from literature records, 7.5% from the review of museum specimens, and 1% from databases of ichthyological collections (Table 1). In addition, seven species were recorded through video and photographic evidence: *Ginglymostoma unami* Del Moral Flores, Ramírez-Antonio, Angulo y Pérez-Ponce de León, 2015,

Table 1. Updated checklist of the coastal ichthyofauna from Michoacán, Mexico.

	Collected habitat (2010–2011)	Ichthyogeographic affinity	References and organisms voucher	The importance in fisheries
CLASS ELASMOBRANCHII				
ORDER ORECTOLOBIFORMES				
FAMILY GINGLYMOSTOMATIDAE				
<i>Ginglymostoma unami</i> Del Moral Flores, Ramírez-Antonio, Angulo y Pérez-Ponce de León, 2015	R	AA	2, 4, 6, CPUM	A
ORDER LAMNIFORMES				
FAMILY LAMINIDAE				
<i>Isurus oxyrinchus</i> Rafinesque, 1810		CT	1	
FAMILY ALOPIIDAE				
<i>Alopias pelagicus</i> Nakamura, 1935		AP	2	
<i>Alopias superciliosus</i> (Lowe, 1841)		CT	2	
ORDER CARCHARHINIFORMES				
FAMILY TRIAKIDAE				
<i>Mustelus lunulatus</i> Jordan & Gilbert, 1882	D	TEP	2, 6	
FAMILY CARCHARHINIDAE				
<i>Carcharhinus albimarginatus</i> (Rüppell, 1837)		CT	2	
<i>Carcharhinus brachyurus</i> (Günther, 1870)		CT	2	
<i>Carcharhinus cerdale</i> Gilbert, 1898		TEP	1, 2	
<i>Carcharhinus falciformis</i> (Müller & Henle, 1839)		CT	2	
<i>Carcharhinus leucas</i> (Müller & Henle, 1839)		CT	1, 2	
<i>Carcharhinus limbatus</i> (Müller & Henle, 1839)	D	CT	1, 2, 6, CPUM	C
<i>Carcharhinus obscurus</i> (Lesueur, 1818)		CT	1, 2	
<i>Galeocerdo cuvier</i> (Péron & Lesueur, 1822)		CT	1, 2	
<i>Nasolamia velox</i> (Gilbert, 1898)		TEP	2	
<i>Negaprion brevirostris</i> (Poey, 1868)		AA	1, 2	
<i>Rhizoprionodon longurio</i> (Jordan & Gilbert, 1882)	D	SP, TEP	1, 2, CPUM	C
FAMILY SPHYRNIDAE				
<i>Sphyrna lewini</i> (Griffith & Smith, 1834)	D	CT	1, 2, 4, 6, 9, CPUM	C
<i>Sphyrna zygaena</i> (Linnaeus, 1758)		CT	2	
ORDER TORPEDINIFORMES				
FAMILY NARCINIDAE				
<i>Narcine entemedor</i> Jordan & Starks, 1895	D	TEP	1, 9, CPUM	I
* <i>Narcine vermiculatus</i> Breder, 1928	D	MP, PP	6, 9, CPUM, ICMYL, CIBNOR	I
ORDER PRISTIFORMES				
FAMILY PRISTIDAE				
* <i>Pristis pristis</i> (Linnaeus, 1758)	PD	AA	CPUM-photo	C
ORDER RAJIFORMES				
FAMILY RHINOBATIDAE				
<i>Rhinobatos glaucostigma</i> Jordan & Gilbert, 1883	R	TEP	1, 2, 4, 6, 9, CPUM, ICMYL	C
<i>Rhinobatos productus</i> Ayres, 1856		SP, TEP	2	
* <i>Zapteryx xyster</i> Jordan & Evermann, 1896	R	TEP	CPUM, SIO	I

	Collected habitat (2010–2011)	Ichthyogeographic affinity	References and organisms voucher	The importance in fisheries
FAMILY RAJIDAE				
<i>Raja equatorialis</i> Jordan & Bollman, 1890		MP, PP	1	
ORDER MYLIOBATIFORMES				
FAMILY UROTRYGONIDAE				
<i>Urotrygon</i> aff. <i>aspidura</i> (Jordan & Gilbert, 1882)		TEP	1	
<i>Urotrygon chilensis</i> (Günther, 1872)		TEP	1, 2, 9	
<i>Urotrygon munda</i> Gill, 1863		TEP	2	
<i>Urotrygon nana</i> Miyake & McEachran, 1988		TEP	1, 9	
<i>Urotrygon rogersi</i> (Jordan & Starks, 1895)	PD	TEP	1, 4, 9, CPUM, SIO	I
FAMILY GYMNURIDAE				
<i>Gymnura marmorata</i> (Cooper, 1863)		SP, TEP	1, 9, CPUM	C
FAMILY MYLIOBATIDAE				
<i>Aetobatus laticeps</i> (Euphrasen, 1790)	R	CT	2, 4, CPUM-photo	I
FAMILY MYLIOBATIDAE				
* <i>Rhinoptera steindachneri</i> Evermann & Jenkins, 1891	PD	TEP	CPUM	I
FAMILY MOBULIDAE				
* <i>Mobula munkiana</i> Notarbartolo di Sciarra, 1987	PD	TEP	CPUM	C
FAMILY UROTRYGONIDAE				
<i>Urobatis concentricus</i> Osburn & Nichols, 1916	R	TEP	1, 6, CPUM	
<i>Urobatis halleri</i> (Cooper, 1863)	R	TEP	2, CPUM	
FAMILY DASYATIDAE				
<i>Dasyatis dipterura</i> (Jordan & Gilbert, 1880)	D	TEP	2, 9, CIBNOR	
<i>Dasyatis longus</i> (Garman, 1880)	PD	SP, TEP	1, CPUM	I
CLASS ACTINOPTERYGII				
ORDER ELOPIFORMES				
FAMILY ELOPIDAE				
<i>Elops affinis</i> Regan, 1909	E	SP, TEP	2, CPUM	C
ORDER ALBULIFORMES				
FAMILY ALBULIDAE				
<i>Albula pacifica</i> (Beebe, 1942)	D	MP, PP	1, 2, 9, CPUM	C
ORDER ANGUILLIFORMES				
FAMILY MURAENIDAE				
* <i>Echidna nocturna</i> (Cope, 1872)	PM, R	CP, MP	CPUM	
* <i>Enchelycore octaviana</i> (Myers & Wade, 1941)	PM, R	CP, MP	CPUM	
<i>Gymnomuraena zebra</i> (Shaw, 1797)	R	AP	2, 6, CPUM	I
<i>Gymnothorax castaneus</i> (Jordan & Gilbert, 1883)	PM, R	TEP	2, 6, CPUM	
* <i>Gymnothorax equatorialis</i> (Hildebrand, 1946)	R	TEP	9, CPUM	
* <i>Muraena argus</i> (Steindachner, 1870)		TEP	ICMYL	
<i>Muraena lentiginosa</i> Jenyns, 1842	PM, R	TEP	2, 4, 5, 9, CPUM	
* <i>Uropterygius macrocephalus</i> (Bleeker, 1864)	PM	TEP	CPUM	
FAMILY OPHICHTHIDAE				
* <i>Apterichtus equatorialis</i> (Myers & Wade, 1941)	R	TEP	CPUM	
* <i>Echiophis brunneus</i> (Castro-Aguirre & Suárez de los Cobos, 1983)	R	TEP	9, CPUM	
* <i>Myrichthys aspetocheiros</i> McCosker & Rosenblatt, 1993	R	CP, MP	6, CPUM	

	Collected habitat (2010–2011)	Ichthyogeographic affinity	References and organisms voucher	The importance in fisheries
<i>Ophichthus triserialis</i> (Kaup, 1856)	R	TEP	2, CPUM, ICMYL	I
<i>Ophichthus zophochir</i> Jordan & Gilbert, 1882	R	TEP	1, 2, CPUM, ICMYL	I
FAMILY CONGRIDAE				
* <i>Ariosoma gilberti</i> (Ogilby, 1898)	D	MP, PP	9	
<i>Heteroconger digueti</i> (Pellegrin, 1923)		TEP	2	
* <i>Paraconger californiensis</i> Kanazawa, 1961		TEP	SIO	
* <i>Rhynchoconger nitens</i> (Jordan & Bollman, 1890)	D	TEP	9, CPUM, ICMYL	I
ORDER CLUPEIFORMES				
FAMILY CLUPEIDAE				
<i>Harengula thrissina</i> (Jordan & Gilbert, 1882)	PM	SP, TEP	2, 4, 6, 9, CPUM	A
<i>Lile gracilis</i> Castro-Aguirre & Vivero, 1990	E	MP, PP	1, 12, CPUM	
<i>Lile nigrofasciata</i> Castro-Aguirre, Ruiz-Campos & Balart, 2002	E	TEP	1, 10, 12, 13, CPUM	
<i>Lile stolifera</i> (Jordan & Gilbert, 1882)	E	TEP	CPUM	
* <i>Opisthonema bulleri</i> (Regan, 1904)	PD	TEP	CPUM	A
<i>Opisthonema libertate</i> (Günther, 1867)	E	SP, TEP	2, 8, CPUM	A
* <i>Opisthonema medinastrae</i> Berry & Barrett, 1963	PM	TEP	CPUM	A
FAMILY ENGRAULIDAE				
* <i>Anchoa argentivittata</i> (Regan, 1904)	PM	TEP	CPUM	A
<i>Anchoa ischana</i> (Jordan & Gilbert, 1882)		TEP	2, 5	
<i>Anchoa lucida</i> (Jordan & Gilbert, 1882)	E	TEP	2, 12, CPUM	
<i>Anchoa mundeola</i> (Gilbert & Pierson, 1898)		TEP	2	
* <i>Anchoa nasus</i> (Kner & Steindachner, 1867)	PM	TEP	CPUM, ICMYL	
<i>Anchoa scofieldi</i> (Jordan & Culver, 1895)	PD	MP, PP	2, 4, CPUM	A
* <i>Anchovia macrolepidota</i> (Kner, 1863)	PD	SP, TEP	CPUM	A
<i>Cetengraulis mysticetus</i> (Günther, 1867)	PD	TEP	2, CPUM	A
FAMILY PRISTIGASTERIDAE				
<i>Ilisha fuerthii</i> (Steindachner, 1875)		MP, PP	2, 7	
* <i>Opisthopterus dovii</i> (Günther, 1868)		TEP	8	
<i>Pliosteostoma lutipinnis</i> (Jordan & Gilbert, 1882)	E	TEP	1, 8, 9, 10, 12, 13, CPUM	A
ORDER GONORYNCHIFORMES				
FAMILY CHANIDAE				
<i>Chanos chanos</i> (Forsskål, 1775)	PD	CT	2, 7, CPUM	C
ORDER CYPRINIFORMES				
FAMILY CYPRINIDAE				
<i>Cyprinus carpio</i> Linnaeus, 1758	E	Introduced	CPUM	
ORDER SILURIFORMES				
FAMILY ARIIDAE				
<i>Bagre panamensis</i> (Gill, 1863)		TEP	2	
<i>Bagre pinnimaculatus</i> (Steindachner, 1876)		TEP	2	
<i>Catborops dasycephalus</i> (Günther, 1864)		MP, PP	2	
<i>Notarius kessleri</i> (Steindachner, 1877)		MP, PP	1, 2	
<i>Notarius planiceps</i> (Parr, 1931)		MP, PP	1, 2	
<i>Occidentarius platypogon</i> (Steindachner, 1877)	E, D	SP, TEP	1, 8, 9, CPUM	C
<i>Sciades guatemalensis</i> (Günther, 1864)	E	MP, PP	1, 2, CPUM	C
<i>Sciades seemanni</i> (Günther, 1864)		TEP	1, CNPE-IBUNAM	

	Collected habitat (2010–2011)	Ichthyogeographic affinity	References and organisms voucher	The importance in fisheries
FAMILY LORICARIIDAE				
<i>Prerygoplichthys disjunctivus</i> (Weber, 1991)	E	Introduced	10, CPUM	
ORDER OSMERIFORMES				
FAMILY BATHYLAGIDAE				
* <i>Bathylagoides nigrigenys</i> Garman, 1899		MP, PP	SIO	
ORDER STOMIIFORMES				
FAMILY GONOSTOMATIDAE				
* <i>Cyclothone acclinidens</i> (Garman, 1899)		CT	SIO	
FAMILY PHOSICHTHYIDAE				
* <i>Vinciguerria lucetia</i> (Garman, 1899)		AP	SIO	
FAMILY STOMIIDAE				
* <i>Bathophilus filifer</i> Gilbert, 1890		AP	SIO	
* <i>Idiacanthus antrostomus</i> (Parr, 1929)		AP	SIO	
ORDER AULOPIIFORMES				
FAMILY SCOPELARCHIDAE				
* <i>Scopelarchoides nicholsi</i> Jordan & Bollman, 1890		SP, TEP	SIO	
FAMILY SYNODONTIDAE				
* <i>Synodus evermanni</i> Gilbert, 1890	R	TEP	9, CPUM, SIO	I
* <i>Synodus lacertinus</i> Jordan & Gilbert, 1882	R	TEP	9, CPUM	
<i>Synodus scituliceps</i> Hildebrand, 1946		TEP	1, 2, 9, ICMYL	
* <i>Synodus sechurae</i> Parr, 1931	PD	TEP	CPUM	I
ORDER MYCTOPHIFORMES				
FAMILY MYCTOPHIDAE				
* <i>Diaphus pacificus</i> Hubbs, 1944		AP	CAS	
* <i>Diogenichthys laternatus</i> (Jordan & Bollman, 1890)		AP	CAS	
* <i>Lampanyctus omostigma</i> (Gilbert, 1890)		AP	CAS	
* <i>Lampanyctus parvicauda</i> Parr, 1931		AP	SIO	
* <i>Myctophum aurolaternatum</i> (Putnam, 1874)		AP	ANSP	
ORDER OPHIDIIFORMES				
FAMILY OPHIDIIDAE				
<i>Brotula clarkae</i> Hubbs, 1944		TEP	1	
* <i>Lepophidium prorates</i> (Jordan & Bollman, 1890)	D	TEP	9, SIO, ICMYL	
* <i>Otophidium indefatigabile</i> (Richardson, 1844)	D	TEP	9, ICMYL, CIBNOR	
FAMILY CARAPIDAE				
<i>Carapus dubius</i> (Putnam, 1874)		AP	1	
ORDER BATRACHOIDIFORMES				
FAMILY BATRACHOIDIDAE				
* <i>Batrachoides waltersi</i> Collette & Russo, 1981		MP, PP	ICMYL	
* <i>Porichthys ephippiatus</i> Walker y Rosenblatt, 1988		TEP	CPUM, SIO	I
* <i>Porichthys margaritatus</i> (Richardson, 1844)		TEP	9, CIBNOR	
ORDER LOPHIIFORMES				
FAMILY LOPHIIDAE				
<i>Lophiodes caulinaris</i> (Garman, 1899)		SP, TEP	1, 9, SIO, ICMYL	
<i>Lophiodes spilurus</i> (Garman, 1899)		TEP	1	

	Collected habitat (2010–2011)	Ichthyogeographic affinity	References and organisms voucher	The importance in fisheries
FAMILY ANTENNARIIDAE				
<i>*Antennatus sanguineus</i> (Gill, 1863)		SP, TEP	6	
<i>*Antennatus strigatus</i> (Gill, 1863)	R	TEP	6, CPUM, ICMYL	
<i>*Fowlerichthys avalonis</i> (Bancroft, 1834)	R	SP, TEP	6, 9, CPUM	
FAMILY OGCOEPHALIDAE				
<i>Zalientes elater</i> (Jordan y Gilbert, 1882)	PD	SP, TEP	1, 2, 9, CPUM, SIO, ICMYL	I
ORDER GOBIESOCIFORMES				
FAMILY GOBIESOCIDAE				
<i>*Arcos erythropros</i> (Jordan & Gilbert, 1882)	PM, R	CP, MP	CPUM	
<i>*Gobiesox adustus</i> Jordan & Gilbert, 1882	PM, R	TEP	CPUM	
<i>Gobiesox mexicanus</i> Briggs & Miller, 1960	E	Freshwater	CPUM	
<i>*Tomicodon petersii</i> (Garman, 1875)	R	MP, PP	CPUM	
<i>Tomicodon zebra</i> (Jordan & Gilbert, 1882)	PM	CP, MP	2, CPUM	
ORDER ATHERINIFORMES				
FAMILY ATHERINOPSIDAE				
<i>*Atherinella eriarcha</i> Jordan y Gilbert, 1882	PM	TEP	4, CPUM, CNPE-IBUNAM	
<i>Atherinella guatemalensis</i> (Günther, 1864)	E	MP, PP	1, 8, 12, CPUM, CNPE-IBUNAM	
<i>Atherinella panamensis</i> Steindachner, 1875	E	MP, PP	8, 10, 12, CPUM	
ORDER CYPRINODONTIFORMES				
FAMILIA POECILIDAE				
<i>Poecilia butleri</i> Jordan, 1889	E	Freshwater	8, 10, 12, 13, CPUM	
ORDER BELONIFORMES				
FAMILY BELONIDAE				
<i>Platybelone argalus</i> (Lesueur, 1821)		CT	2, SIO, ANSP	
<i>Strongylura exilis</i> (Girard, 1854)		SP, TEP	2, 6	
<i>Tylosurus fodiator</i> Jordan y Gilbert, 1882	PD	TEP	2, CPUM	C
FAMILY HEMIRAMPHIDAE				
<i>Hemiramphus saltator</i> Gilbert & Starks, 1904	PD	TEP	1, 6, CPUM	
<i>Hyporhamphus naos</i> Banford & Collette, 2001	PD	TEP	1, CPUM	A
<i>*Oxyporhamphus micropterus</i> (Valenciennes, 1847)		CT	SIO	
FAMILY EXOCOETIDAE				
<i>*Cheilopogon furcatus</i> (Mitchill, 1815)		CT	SIO	
<i>*Cheilopogon papilio</i> (Clark, 1936)		SP, CP, MP	SIO	
<i>Cypselurus callopterus</i> (Günther, 1866)		SP, CP, MP	1, 2, SIO	
<i>*Exocoetus monocirrhus</i> Richardson, 1846		AP	SIO	
<i>Fodiator rostratus</i> (Günther, 1866)		TEP	2, SIO	
<i>*Prognichthys tringa</i> Breder, 1928		AP	SIO	
ORDER STEPHANOBERYCIFORMES				
FAMILY MELAMPHIDAE				
<i>*Scopelogadus mizolepis</i> (Günther, 1878)		CT	CAS	
ORDER BERYCIFORMES				
FAMILY HOLOCENTRIDAE				
<i>Sargocentron suborbitale</i> (Gill, 1863)	PM, R	TEP	2, 4, 5, 6, CPUM, SIO, ICMYL	

	Collected habitat (2010–2011)	Ichthyogeographic affinity	References and organisms voucher	The importance in fisheries
<i>Myripristis leiognathus</i> Valenciennes, 1846	R	SP, TEP	2, 5, 6, 9, CPUM	
ORDER SYNGNATHIFORMES				
FAMILY FISTULARIIDAE				
<i>Fistularia commersonii</i> Rüppell, 1838	R	AP	1, 2, 6, CPUM	
* <i>Fistularia corneta</i> Gilbert & Starks, 1904	R	SP, TEP	CPUM	
FAMILY SYNGNATHIDAE				
* <i>Doryrhamphus excisus</i> Kaup, 1856	R	AP	CPUM	
<i>Hippocampus ingens</i> Girard, 1858	R	SP, TEP	1, 2, 6, 9, CPUM, ICMYL	
<i>Pseudophallus starksi</i> (Jordan & Culver, 1895)	E	TEP	1, 12, CPUM, CNPE-IBUNAM	
ORDER SCORPAENIFORMES				
FAMILY SCORPAENIDAE				
<i>Scorpaena histrio</i> Jenyns, 1840		TEP	2	
<i>Scorpaena mystes</i> (Jordan & Starks, 1895)	R	AA	1, 6, 9, CPUM, ICMYL	I
<i>Scorpaena russula</i> Jordan & Bollman, 1890		TEP	1, 9	
* <i>Scorpaena sonorae</i> Jenkins & Evermann, 1889	PD	CP, PP	CPUM	I
* <i>Scorpaenodes xyris</i> (Jordan & Gilbert, 1882)	R	SP, TEP	CPUM	
FAMILY TRIGLIDAE				
* <i>Bellator gymnostethus</i> (Gilbert, 1892)		TEP	9	
<i>Bellator loxias</i> (Jordan, 1897)		TEP	2	
<i>Bellator xenisma</i> (Jordan & Bollman, 1890)		TEP	1, 2, 9	
<i>Prionotus albirostris</i> Jordan & Bollman, 1890		TEP	1, 9	
<i>Prionotus horrens</i> Richardson, 1844		TEP	1	
<i>Prionotus ruscarius</i> Gilbert & Starks, 1904	R	SP, TEP	1, 2, 9, CPUM, SIO	A
<i>Prionotus stephanophrys</i> Lockington, 1881	R	SP, TEP	1, 2, 9, CPUM, ICMYL	A
ORDER PERCIFORMES				
FAMILY CENTROPOMIDAE				
<i>Centropomus armatus</i> Gill, 1863	PD	MP, PP	2, 7, 8, CPUM	C
<i>Centropomus medius</i> Günther, 1864	PD	SP, TEP	1, 2, CPUM	C
<i>Centropomus nigrescens</i> Günther, 1864	E	TEP	2, 4, 10, 12, 13, CPUM	C
<i>Centropomus robalito</i> Jordan & Gilbert, 1882	E	TEP	2, 3, CPUM	
<i>Centropomus viridis</i> Lockington, 1877	E	TEP	1, 2, 3, 7, 8, CPUM	
FAMILY SERRANIDAE				
<i>Alphestes immaculatus</i> Breder, 1936	R	TEP	2, 6, CPUM	I
<i>Alphestes multiguttatus</i> (Günther, 1867)	R	TEP	2, 4, 5, 6, CPUM	I
<i>Cephalopholis panamensis</i> (Steindachner, 1877)	R	TEP	2, 4, 6, CPUM	
<i>Dermatolepis dermatolepis</i> (Boulenger, 1895)	R	TEP	2, 6, CPUM-photo	
<i>Diplectrum eumelum</i> Rosenblatt & Johnson, 1974	R	TEP	1, 9, CPUM, SIO	
* <i>Diplectrum euryplectrum</i> Jordan & Bollman, 1890	R	TEP	CPUM, ICMYL	
<i>Diplectrum labarum</i> Rosenblatt & Johnson, 1974	R	TEP	1, 9, CPUM, SIO	

	Collected habitat (2010–2011)	Ichthyogeographic affinity	References and organisms voucher	The importance in fisheries
<i>Diplectrum macropoma</i> (Günther, 1864)	R	TEP	1, CPUM, SIO	
<i>Diplectrum pacificum</i> Meek & Hildebrand, 1925	R	TEP	2, 4, 6, 9, CPUM	
* <i>Diplectrum rostrum</i> Bortone, 1974	PD	TEP	CPUM	A
<i>Epinephelus analogus</i> Gill, 1863	R	SP, TEP	1, 2, 4, 6, 9, CPUM, ICMYL, CNPE-IBUNAM	C
<i>Epinephelus labriformis</i> (Jenyns, 1840)	PM, R	TEP	1, 2, 4, 6, 9, CPUM	C
<i>Hyporthodus acanthistius</i> (Gilbert, 1892)	R	TEP	1, 2, 4, 9, CPUM, ICMYL	C
* <i>Hyporthodus exsul</i> (Fowler, 1944)		TEP	SIO	
<i>Hyporthodus niphobles</i> Gilbert & Starks, 1897	R	SP, TEP	1, CPUM	C
* <i>Paralabrax lora</i> Walford, 1936	R	TEP	9, CPUM	C
<i>Paranthias colonus</i> (Valenciennes, 1846)	R	TEP	2, 6, CPUM, ICMYL	C
* <i>Pseudogramma thaumasia</i> (Gilbert, 1900)	R	TEP	CPUM	
<i>Rypticus bicolor</i> Valenciennes, 1846	PM, R	TEP	1, CPUM	A
* <i>Rypticus nigripinnis</i> Gill, 1861		TEP	9, ICMYL	
<i>Serranus psittacinus</i> Valenciennes, 1846		TEP	2	
FAMILY PRIACANTHIDAE				
<i>Heteropriacanthus cruentatus</i> (Lacepède, 1801)		CT	2, 6	
<i>Pristigenys serrula</i> (Gilbert, 1891)	D	TEP	1, 2, 6, 9, CPUM	
FAMILY APOGONIDAE				
<i>Apogon pacificus</i> (Herre, 1935)	R	TEP	1, 6, CPUM-photo, ICMYL	
<i>Apogon retrosella</i> (Gill, 1862)	PM, R	TEP	2, 6, CPUM	
FAMILY ECHENEIDAE				
* <i>Phtheichthys lineatus</i> (Menziés, 1791)		CT	ANSP	
* <i>Remora osteochir</i> (Cuvier, 1829)		CT	SIO	
<i>Remora remora</i> (Linnaeus, 1758)	D	CT	2, CPUM, CNPE-IBUNAM	
FAMILY CARANGIDAE				
<i>Alectis ciliaris</i> (Bloch, 1787)	PD	CT	1, 2, 9, CPUM	C
<i>Carangoides otrynter</i> (Jordan & Gilbert, 1883)	R	SP, TEP	1, 2, 4, CPUM, ICMYL	C
<i>Carangoides vinctus</i> Jordan & Gilbert, 1882	D	SP, TEP	1, 2, 9, CPUM, ICMYL, CNPE-IBUNAM	C
<i>Caranx caballus</i> Günther, 1868	PM, R	SP, TEP	1, 2, 4, 6, CPUM, ICMYL	C
<i>Caranx caninus</i> Günther, 1867	R, E	SP, TEP	1, 2, 9, 12, CPUM, SIO, CIBNOR	C
<i>Caranx lugubris</i> Poyé, 1860	PD	TEP	2, CPUM	C
<i>Caranx melampygus</i> Cuvier, 1833		CT	2, 6	
<i>Caranx sexfasciatus</i> Quoy & Gaimard, 1825	R, E	AP	2, 7, 8, CPUM	C
<i>Chloroscombrus orqueta</i> Jordan & Gilbert, 1883	PM	SP, TEP	1, 2, 9, CPUM, CNPE-IBUNAM	A
* <i>Decapterus macrosoma</i> Bleeker, 1851	PD	AP	CPUM	C
<i>Decapterus muroadsi</i> (Temminck & Schlegel, 1844)		CT	1, 2	

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<i>Elagatis bipinnulata</i> (Quoy & Gaimard, 1825)	PD	CT	1, 2, CPUM	C
<i>Gnathanodon speciosus</i> (Forskål, 1775)		AP	2	
<i>Hemicaranx leucurus</i> (Günther, 1864)		TEP	2	
<i>Hemicaranx zelotes</i> Gilbert, 1898		TEP	2, 7	
<i>Oligoplites altus</i> (Günther, 1868)	PD	TEP	2, CPUM	C
<i>Oligoplites refulgens</i> Gilbert & Starks, 1904	PD	TEP	2, CPUM	C
<i>Oligoplites saurus</i> (Bloch & Schneider, 1801)	E	TEP	2, CPUM	
<i>Selar crumenophthalmus</i> (Bloch, 1793)	R, E	CT	1, 2, 8, CPUM, SIO	C
<i>Selene brevoortii</i> (Gill, 1863)	R, E	SP, TEP	1, 2, CPUM	A
<i>Selene peruviana</i> (Guichenot, 1866)	R	TEP	1, 2, 9, CPUM	A
<i>Seriola peruana</i> Steindachner, 1881	R	TEP	2, CPUM	C
<i>Seriola rivoliana</i> Valenciennes, 1833	PD	CT	2, CPUM	C
* <i>Trachinotus kennedyi</i> Steindachner, 1876	E	TEP	2, CPUM, CNPE-IBUNAM	
<i>Trachinotus patiensis</i> Cuvier, 1832		TEP	1, 2	
<i>Trachinotus rhodopus</i> Gill, 1863	PM, R, E	SP, MP, PP	1, 2, 4, 6, 7, 12, CPUM, ICMYL	
FAMILY NEMATISTIIDAE				
<i>Nematistius pectoralis</i> Gill, 1862	PD	TEP	2, 4, CPUM	C
FAMILY CORYPHAENIDAE				
* <i>Coryphaena equiselis</i> Linnaeus, 1758		CT	SIO	
<i>Coryphaena hippurus</i> Linnaeus, 1758	PD	CT	2, 4, CPUM-photo	C
FAMILY LUTJANIDAE				
<i>Hoplopagrus guentherii</i> Gill, 1862	R	SP, TEP	1, 2, 6, CPUM	C
<i>Lutjanus aratus</i> (Günther, 1864)		TEP	1	
<i>Lutjanus argentiventris</i> (Peters, 1869)	PM, R, E	SP, TEP	1, 2, 6, 12, CPUM, CNPE-IBUNAM	C
<i>Lutjanus colorado</i> Jordan & Gilbert, 1882	R, E	SP, TEP	1, 2, 4, 6, 8, CPUM	C
<i>Lutjanus guttatus</i> (Steindachner, 1869)	R	TEP	1, 2, 4, 6, CPUM, SIO, ICMYL	C
<i>Lutjanus inermis</i> (Peters, 1869)	R	TEP	1, 2, CPUM, ICMYL	C
* <i>Lutjanus jordani</i> (Gilbert, 1898)		TEP	6	
<i>Lutjanus novemfasciatus</i> Gill, 1862	PM, R, E	SP, TEP	1, 2, 4, 6, 7, 8, 10, 12, 13, CPUM	C
<i>Lutjanus peru</i> (Nichols & Murphy, 1922)	R	SP, TEP	1, 2, 4, 9, CPUM, ICMYL	C
* <i>Lutjanus viridis</i> (Valenciennes, 1846)	PD	TEP	6, CPUM	
FAMILY LOBOTIDAE				
<i>Lobotes pacificus</i> Gilbert, 1898	PD	CT	1, CPUM	C
FAMILY GERREIDAE				
<i>Deckereichthys aureolus</i> (Jordan & Gilbert, 1882)	D	TEP	1, 2, 9, CPUM, ICMYL	C
<i>Diapterus brevirostris</i> (Sauvage, 1879)	E	TEP	1, 2, CPUM	C
<i>Eucinostomus currani</i> Zahuranec, 1980	PM, E	SP, TEP	1, 2, 7, 8, 9, 10, 12, 13, CPUM, CNPE-IBUNAM	C
<i>Eucinostomus dowii</i> (Gill, 1863)		SP, TEP	1	

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<i>*Eucinostomus entomelas</i> Zahuranec, 1980		SP, TEP	CNPE-IBUNAM	
<i>Eucinostomus gracilis</i> (Gill, 1862)		TEP	1, 2, 9	
<i>*Eugerres axillaris</i> (Günther, 1864)	R, E	TEP	CPUM	
<i>Eugerres brevimanus</i> (Günther, 1864)		MP, PP	1	
<i>*Eugerres lineatus</i> (Humboldt, 1821)	E	TEP	CPUM	
<i>Gerres simillimus</i> Reagan, 1907	R, E	TEP	1, 2, 4, 7, CPUM	C
FAMILY HAEMULIDAE				
<i>*Anisotremus caesius</i> (Jordan & Gilbert, 1882)	R	MP, PP	CPUM, CNPE-IBUNAM	C
<i>Anisotremus interruptus</i> (Gill, 1862)	R	SP, TEP	1, 2, 4, 6, CPUM, ICMYL, CNPE-IBUNAM	C
<i>Anisotremus taeniatus</i> Gill, 1861	R	SP, TEP	2, 6, CPUM	C
<i>Conodon serrifer</i> Jordan & Gilbert, 1882		SP, TEP	1, ICMYL	
<i>Genyatremus dovii</i> (Günther, 1864)	R	TEP	2, CPUM, ICMYL, CNPE-IBUNAM	C
<i>Genyatremus pacifici</i> (Günther, 1864)		MP, PP	2	
<i>Haemulon californiensis</i> (Steindachner, 1876)		TEP	2	
<i>Haemulon flaviguttatum</i> Gill, 1862	R	SP, TEP	1, 2, 4, 6, CPUM, ICMYL	C
<i>Haemulon maculicauda</i> (Gill, 1862)	R	SP, TEP	2, 6, CPUM, ICMYL	C
<i>Haemulon scudderii</i> Gill, 1862	R	SP, TEP	1, 2, CPUM	C
<i>Haemulon sexfasciatum</i> Gill, 1862	R	TEP	1, 2, 6, CPUM	C
<i>Haemulon steindachneri</i> (Jordan & Gilbert, 1882)	R	AA	2, CPUM, ICMYL, CNPE-IBUNAM	C
<i>Haemulopsis axillaris</i> (Steindachner, 1869)	R	MP, PP	2, CPUM	C
<i>Haemulopsis elongatus</i> (Steindachner, 1879)	R	MP, PP	1, CPUM, ICMYL	C
<i>Haemulopsis leuciscus</i> (Günther, 1864)	E	TEP	1, 2, 6, 9, CPUM, CNPE-IBUNAM	C
<i>Haemulopsis nitidus</i> (Steindachner, 1869)	R	TEP	1, CPUM	
<i>*Microlepidotus brevipinnis</i> (Steindachner, 1869)	R	TEP	CPUM	C
<i>Orthopristis chalceus</i> (Günther, 1864)	R	TEP	2, 4, CPUM	
<i>Orthopristis reddingi</i> Jordan & Richardson, 1895	R	TEP	1, 2, CPUM	
<i>Pomadasy bayanus</i> Jordan & Evermann, 1898	E	TEP	1, 2, CPUM	
<i>Pomadasy branickii</i> (Steindachner, 1879)	E	TEP	1, 7, 10, CPUM, ICMYL	
<i>Pomadasy macracanthus</i> (Günther, 1864)	E	TEP	2, CPUM	
<i>Pomadasy panamensis</i> (Steindachner, 1876)		TEP	1, 2, 9, CNPE-IBUNAM	C
<i>Xenichthys xanti</i> Gill, 1863	R	SP, TEP	2, CPUM, CNPE-IBUNAM	C
FAMILY SPARIDAE				
<i>Calamus brachysomus</i> (Lockington, 1880)	R	SP, TEP	1, 2, CPUM	C
FAMILY SCIAENIDAE				
<i>Bairdiella armata</i> Gill, 1863		TEP	1, 2	
<i>Bairdiella ensifera</i> (Jordan & Gilbert, 1882)		MP, PP	1, 2	
<i>Bairdiella icistia</i> (Jordan & Gilbert, 1882)		CP, MP	2	

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<i>*Corvula macrops</i> (Steindachner, 1876)	R	TEP	CPUM	
<i>Cynoscion nannus</i> Castro-Aguirre & Arvizu-Martínez, 1976	PD	CP, MP	1, CPUM	C
<i>Cynoscion phoxocephalus</i> Jordan & Gilbert, 1882		MP, PP	1, 9, CPUM, CIBNOR	C
<i>Cynoscion reticulatus</i> (Günther, 1864)		TEP	1, 2	
<i>*Cynoscion stolzmanni</i> (Steindachner, 1879)		TEP	ICMYL	
<i>Elattarchus archidium</i> (Jordan & Gilbert, 1882)	PD	TEP	2, CPUM	C
<i>Isopisthus remifer</i> Jordan & Gilbert, 1882		TEP	2	
<i>Larimus acclivis</i> Jordan & Bristol, 1898	PD	TEP	2, CPUM	C
<i>Larimus argenteus</i> (Gill, 1863)	PD	TEP	1, 2, CPUM, ICMYL	C
<i>Larimus effulgens</i> Gilbert, 1898	PD	TEP	1, 2, 9, CPUM	C
<i>Menticirrhus elongatus</i> (Günther, 1864)	E	SP, TEP	2, CPUM	C
<i>Menticirrhus nasus</i> (Günther, 1868)		TEP	2, CPUM, CNPE-IBUNAM	C
<i>Menticirrhus panamensis</i> (Steindachner, 1875)		TEP	1, 2	
<i>Menticirrhus undulatus</i> (Girard, 1854)	PD	SP, TEP	1, CPUM	C
<i>Micropogonias altipinnis</i> (Günther, 1864)		TEP	2	
<i>*Micropogonias ectenes</i> (Jordan & Gilbert, 1882)	PD	SP, TEP	CPUM	C
<i>Micropogonias megalops</i> (Jordan & Gilbert, 1884)		CP, MP	1	
<i>Odontoscion xanthops</i> Gilbert, 1898	R	TEP	2, CPUM	
<i>Ophioscion imiceps</i> (Jordan & Gilbert, 1882)		MP, PP	2, ICMYL, CNPE-IBUNAM	
<i>Ophioscion scierus</i> (Jordan & Gilbert, 1884)		MP, PP	2, ICMYL	
<i>*Ophioscion strabo</i> Gilbert, 1897		TEP	ICMYL	
<i>*Ophioscion typicus</i> Gill, 1863		TEP	CNPE-IBUNAM	
<i>*Ophioscion vermicularis</i> (Günther, 1867)	PD	MP, PP	CPUM	C
<i>*Pareques fuscovittatus</i> (Kendall & Radcliffe, 1912)	R	MP	6, CPUM	
<i>Umbrina bussingi</i> López S., 1980	PD	MP, PP	1, 9, CPUM, ICMYL	C
<i>Umbrina dorsalis</i> Gill, 1862	R, E	TEP	2, 12, CPUM	
<i>Umbrina xanti</i> Gill, 1862	R, E	SP, TEP	1, 2, CPUM	C
FAMILY POLYNEMIDAE				
<i>Polydactylus approximans</i> (Lay & Bennett, 1839)	E	TEP	1, 2, 9, CPUM, SIO, CNPE-IBUNAM	C
<i>Polydactylus opercularis</i> (Gill, 1863)	E	SP, TEP	1, 2, 8, CPUM	C
FAMILY MULLIDAE				
<i>Mulloidichthys dentatus</i> (Gill, 1862)	R	TEP	2, 6, CPUM, ICMYL	C
<i>Pseudupeneus grandisquamis</i> (Gill, 1863)	R	TEP	1, 2, 9, CPUM, CNPE-IBUNAM	C
FAMILY KYPHOSIDAE				
<i>Kyphosus analogus</i> (Gill, 1862)	R	TEP	2, 4, CPUM	C
<i>Kyphosus elegans</i> (Peters, 1869)	R	TEP	2, 4, 5, CPUM	C
<i>Kyphosus ocyurus</i> (Jordan & Gilbert, 1882)	R	CT	1, 2, CPUM, SIO, ICMYL	C

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FAMILY CHAETODONTIDAE				
<i>Chaetodon humeralis</i> Günther, 1860	PM, R	TEP	1, 2, 4, 5, 6, 9, CPUM	
<i>Johnrandallia nigrivittata</i> (Gill, 1862)	PM, R	SP, TEP	2, 6, CPUM	I
FAMILY POMACANTHIDAE				
<i>Holacanthus passer</i> Valenciennes, 1846	R	TEP	2, 6, CPUM	
<i>Pomacanthus zonipectus</i> (Gill, 1862)	R	SP, TEP	1, 2, 6, 9, CPUM, ICMYL	
FAMILY CIRRHITIDAE				
<i>Cirrhitichthys oxycephalus</i> (Bleeker, 1855)	R	TEP	2, 6, CPUM	
<i>Cirrhites rivulatus</i> Valenciennes, 1846	PM, R	TEP	2, 4, 5, 6, CPUM	
FAMILY MUGILIDAE				
<i>Agonostomus monticola</i> (Bancroft, 1882)	E	AA	1, 3, 10, 12, 13, CPUM, ICMYL	
* <i>Chaenomugil proboscideus</i> (Günther, 1861)	PM	TEP	CPUM, ICMYL	
<i>Mugil cephalus</i> Linnaeus, 1758		CT	1, 2	
<i>Mugil curema</i> Valenciennes, 1836	PM, E	AA	2, 3, 4, 5, 7, 8, 10, 12, 13, CPUM	C
FAMILY POMACENTRIDAE				
* <i>Abudefduf declivifrons</i> (Gill, 1862)	PM, R	TEP	4, 5, CPUM	
<i>Abudefduf troschelii</i> (Gill, 1862)	PM, R	SP, TEP	2, 5, 6, CPUM	
<i>Chromis atrilobata</i> Gill, 1862	R	TEP	2, 6, CPUM	
<i>Microspathodon bairdii</i> (Gill, 1862)	PM, R	TEP	2, 5, CPUM	
<i>Microspathodon dorsalis</i> (Gill, 1862)	PM, R	SP, TEP	2, 4, 5, 6, CPUM	I
<i>Stegastes acapulcoensis</i> (Fowler, 1944)	PM, R	MP, PP	2, 5, 6, CPUM	
<i>Stegastes flavilatus</i> (Gill, 1862)	PM, R	MP, PP	2, 5, 6, CPUM, ICMYL	
<i>Stegastes rectifraenum</i> (Gill, 1862)	PM, R	SP, CR, MP	2, 5, CPUM, ICMYL	
FAMILY LABRIDAE				
<i>Bodianus diplotaenia</i> (Gill, 1862)	R	SP, TEP	2, 6, CPUM, ICMYL	
<i>Halichoeres chierchiae</i> di Caporiacco, 1947	R	TEP	2, 6, CPUM	
<i>Halichoeres dispilus</i> (Günther, 1864)	PM, R	TEP	2, 4, 5, 6, CPUM	
<i>Halichoeres nicholsi</i> (Jordan & Gilbert, 1882)	R	TEP	2, 6, CPUM	
<i>Halichoeres notospilus</i> (Günther, 1864)	PM, R	TEP	2, 6, CPUM	
* <i>Iniistius pavo</i> (Valenciennes, 1840)	R	AP	CPUM	
* <i>Novaculichthys taeniourus</i> (Lacepède, 1801)	R	AP	6	
* <i>Thalassoma grammaticum</i> Gilbert, 1890	R	TEP	6, CPUM	
<i>Thalassoma lucasanum</i> (Gill, 1862)	PM, R	TEP	2, 5, 6, CPUM	
FAMILY SCARIDAE				
* <i>Calotomus carolinus</i> (Valenciennes, 1840)	PD	CT	6, CPUM	
* <i>Nicholsina denticulata</i> (Evermann & Radcliffe, 1917)	R	SP, TEP	CPUM	
* <i>Scarus compressus</i> (Osborn & Nichols, 1916)	R	TEP	6, CPUM	
<i>Scarus perrico</i> Jordan & Gilbert, 1882	R	TEP	2, 6, CPUM	C
FAMILY URANOSCOPIDAE				
<i>Astroscopus zephyreus</i> Gilbert & Starks, 1897	PD	SP, TEP	2, CPUM	A

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FAMILY TRIPTERYGIIDAE				
<i>Axoclinus storeyae</i> (Brock, 1940)	PM, R	CP, MP	2, CPUM	
<i>Enneanectes carminalis</i> Jordan & Gilbert, 1882		TEP	2	
* <i>Enneanectes glendae</i> Roseblatt, Miller & Hastings, 2013	R	CP, MP	CPUM	
* <i>Enneanectes macrops</i> Roseblatt, Miller & Hastings, 2013	R	MP	CPUM	
FAMILY LABRISOMIDAE				
<i>Brockius striatus</i> (Hubbs, 1953)	PM, R	CP, MP	2, CPUM	
* <i>Labrisomus multiporosus</i> Hubbs, 1953	PM, R	TEP	CPUM	
* <i>Labrisomus xanti</i> Gill, 1860		SP, TEP	ICMYL	
<i>Malacoctenus ebisui</i> Springer, 1959	R	TEP	2, CPUM	
<i>Malacoctenus hubbsi</i> Springer, 1959	R	TEP	2, 5, CPUM	
* <i>Malacoctenus mexicanus</i> Springer, 1959	R	TEP	CPUM	
* <i>Malacoctenus tetranemus</i> (Cope, 1877)	PM, R	TEP	CPUM	
* <i>Malacoctenus zonifer</i> (Jordan & Gilbert, 1882)	PM	TEP	CPUM	
* <i>Paraclinus mexicanus</i> (Gilbert, 1904)	PM	TEP	CPUM	
* <i>Starksia posthon</i> Rosenblatt & Taylor, 1971	R	MP, PP	CPUM	
* <i>Starksia spinipenis</i> (Al-Uthman, 1960)	R	CP, MP	CPUM	
FAMILY CHAENOPSIDAE				
<i>Acanthemblemaria balanorum</i> Brock, 1940		TEP	2	
* <i>Acanthemblemaria macrospilus</i> Brock, 1940	R	CP, MP	CPUM	
* <i>Coralliozetus boehlkei</i> Stephens, 1963	R	TEP	CPUM	
* <i>Ekemblemaria myersi</i> Stephens, 1963	R	TEP	CPUM	
* <i>Protemblemaria bicirrus</i> (Hildebrand, 1946)	R	TEP	CPUM	
FAMILY DACTYLOSCOPIDAE				
<i>Dactyloscopus amnis</i> Miller & Briggs, 1962	E	MP, PP	1, 12, CPUM	
FAMILY BLENNIIDAE				
* <i>Entomacrodus chiostictus</i> (Jordan & Gilbert, 1882)	PM	TEP	CPUM	
* <i>Hypsoblennius brevipinnis</i> (Günther, 1861)	R	TEP	CPUM, SIO, ICMYL	
<i>Ophioblennius steindachneri</i> Jordan & Evermann, 1898	PM, R	TEP	2, 5, 6, CPUM, ICMYL	
<i>Plagiotremus azaleus</i> (Jordan & Bollman, 1890)	R	TEP	2, 6, CPUM	
FAMILY ELEOTRIDAE				
<i>Dormitator latifrons</i> (Richardson, 1844)	E	SP, TEP	1, 7, 8, 10, 12, 13, CPUM, CNPE-IBUNAM	
<i>Eleotris picta</i> Kner, 1863	E	TEP	1, 7, 8, 10, 12, 13, CPUM, CNPE-IBUNAM	
<i>Gobiomorus maculatus</i> (Günther, 1859)	E	TEP	1, 2, 7, 8, 10, 12, 13, CPUM, CNPE-IBUNAM	
* <i>Gobiomorus polylepis</i> Ginsburg, 1953	E	Brackish	CPUM	
FAMILY GOBIIDAE				
<i>Awaous banana</i> (Valenciennes, 1837)	E	SP, TEP	3, 8, 12, CPUM	

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<i>Barbulifer mexicanus</i> Hoese & Larson, 1985		CP, MP	1	
* <i>Bathygobius andrei</i> (Sauvage, 1880)	E	MP, PP	CPUM	
<i>Bathygobius ramosus</i> Ginsburg, 1947	PM	SP, TEP	1, 2, 5, CPUM, ICMYL	
* <i>Bollmannia marginalis</i> Ginsburg, 1939		TEP	9	
* <i>Bollmannia stigmatura</i> Gilbert, 1892		TEP	ICMYL	
* <i>Coryphopterus urospilus</i> Ginsburg, 1938	R	TEP	CPUM	
<i>Ctenogobius sagittula</i> (Günther, 1861)	E	TEP	12, CPUM	
* <i>Elacatinus puncticulatus</i> (Ginsburg, 1938)	R	TEP	CPUM	
<i>Gobionellus microdon</i> (Gilbert, 1892)	E	TEP	1, 3, 7, 10, 12, 13, CPUM	
* <i>Gymneleotris seminuda</i> (Günther, 1864)	R	TEP	CPUM	
<i>Microgobius miraflorensis</i> Gilbert & Starks, 1904		TEP	1	
* <i>Sicydium multipunctatum</i> Regan, 1905	E	Freshwater	CPUM	
FAMILY MICRODESMIDAE				
<i>Clarkichthys bilineatus</i> (Clark, 1936)	PM	TEP	CPUM	
<i>Microdesmus dorsipunctatus</i> Dawson, 1968	E	TEP	12, CPUM	
FAMILY EPHIPPIDAE				
<i>Chaetodipterus zonatus</i> (Girard, 1858)	R	SP, TEP	1, 3, 8, 9, CPUM	C
<i>Parapsetus panamensis</i> Steindachner, 1876		TEP	1, 3	
FAMILY ZANCLIDAE				
* <i>Zanclus cornutus</i> (Linnaeus, 1758)	R	SP, TEP	6, CPUM	
FAMILY ACANTHURIDAE				
<i>Acanthurus triostegus</i> (Linnaeus, 1758)	PM, R	AP	2, 5, 6, CPUM	
<i>Acanthurus xanthopterus</i> Valenciennes, 1835	R	AP	2, 6, CPUM	A
<i>Prionurus punctatus</i> Gill, 1862	PM, R	TEP	2, 5, 6, CPUM	A
FAMILY SPHYRAENIDAE				
<i>Sphyaena ensis</i> Jordan & Gilbert, 1882	R	TEP	1, 2, CPUM	C
FAMILY TRICHIURIDAE				
* <i>Trichiurus nitens</i> Garman, 1899	PD	CT	CPUM	I
FAMILY SCOMBRIDAE				
<i>Auxis brachydorax</i> Collette & Aadland 1996		SP, TEP	2	
<i>Euthynnus lineatus</i> Kishinouye, 1920	PD	SP, TEP	1, 2, CPUM, SIO	C
<i>Katsuwonus pelamis</i> (Linnaeus, 1758)		CT	2	
* <i>Sarda orientalis</i> (Temminck & Schlegel, 1844)	PD	AP	CPUM	C
<i>Scomberomorus sierra</i> Jordan & Starks, 1895	PD	SP, TEP	1, 2, CPUM	C
* <i>Scomber japonicus</i> Houttuyn, 1782	PD	CT	CPUM	C
<i>Thunnus alalunga</i> (Bonnaterre, 1788)		CT	1	
FAMILY ISTIOPHORIDAE				
<i>Istiophorus platypterus</i> (Shaw, 1792)		AP	2	
FAMILY STROMATEIDAE				
<i>Pepnilus medius</i> (Peters, 1869)	PD	TEP	2, CPUM	C
* <i>Pepnilus snyderi</i> Gilbert & Starks, 1904	PD	SP, TEP	CPUM	C
ORDER PLEURONECTIFORMES				
FAMILY PARALICHTHYIDAE				
<i>Ancylopsetta dendritica</i> Gilbert, 1890	PD	TEP	1, 2, 9, CPUM	C
<i>Citharichthys gilberti</i> Jenkins & Evermann, 1889	E	SP, TEP	1, 8, 12, CPUM	
* <i>Citharichthys platophrys</i> Gilbert, 1891		TEP	SIO	

	Collected habitat (2010–2011)	Ichthyogeographic affinity	References and organisms voucher	The importance in fisheries
<i>Cyclopsetta panamensis</i> (Steindachner, 1876)		TEP	1	
<i>Cyclopsetta querna</i> (Jordan & Bollman, 1890)	PD	TEP	1, 2, 9, CPUM, SIO	C
<i>Etropus crossotus</i> Jordan & Gilbert, 1882	PD	SR, TEP	1, 2, 9, CPUM, SIO	C
* <i>Etropus ectenes</i> Jordan, 1889	PD	SR, TEP	CPUM, SIO	
<i>Etropus peruvianus</i> Hildebrand, 1946		TEP	1	
<i>Hippoglossina tetraphthalma</i> (Gilbert, 1890)		TEP	2	
<i>Paralichthys woolmani</i> Jordan & Williams, 1897	D	TEP	1, 2, 9, CPUM, ICMYL	C
<i>Syacium latifrons</i> (Jordan & Gilbert, 1882)	PD	SR, TEP	1, 9, CPUM	C
* <i>Syacium longidorsale</i> Murakami & Amaoka, 1992		PP	CIBNOR	
<i>Syacium ovale</i> (Günther, 1864)	PD	TEP	1, 2, 9, CPUM, ICMYL	C
FAMILY BOTHIDAE				
<i>Bothus constellatus</i> (Jordan, 1889)	PD	TEP	1, 2, 9, CPUM	A
* <i>Bothus leopardinus</i> (Günther, 1862)		TEP	9	
<i>Engyophrys sanctilawrentii</i> Jordan & Bollman, 1890		TEP	1, SIO	
FAMILY ACHIRIDAE				
<i>Achirus klunzingeri</i> (Steindachner, 1879)	E	MP, PP	12, CPUM	
<i>Achirus mazatlanus</i> (Steindachner, 1869)	E	TEP	1, 7, 12, CPUM	
<i>Achirus scutum</i> (Günther, 1862)	E	TEP	1, CPUM	
<i>Trinectes fonsecensis</i> (Günther, 1862)	E	TEP	1, 9, 10, 12, 13, CPUM	I
FAMILY CYNOGLOSSIDAE				
<i>Symphurus atricaudus</i> (Jordan & Gilbert, 1880)		CR, MP	1	
* <i>Symphurus callopterus</i> Munroe & Mahadeva, 1989		TEP	CAS	
<i>Symphurus elongatus</i> (Günther, 1868)	PD	SR, TEP	1, CPUM	I
* <i>Symphurus leei</i> Jordan & Bollman, 1890		MP, PP	9, SIO, ICMYL	
ORDER TETRADONTIFORMES				
FAMILY BALISTIDAE				
<i>Balistes polylepis</i> Steindachner, 1876	R	SR, TEP	1, 2, 4, 6, 9, CPUM	
* <i>Canthidermis maculata</i> (Bloch, 1786)	R	CT	CPUM	
<i>Pseudobalistes naufragium</i> (Jordan & Starks, 1895)	R	SR, TEP	2, 8, CPUM	
<i>Sufflamen fraenatum</i> (Latreille, 1804)	PD	AP	11, CPUM	
<i>Sufflamen verres</i> (Gilbert & Starks, 1904)	R	SR, TEP	2, 4, 6, CPUM	C
FAMILY MONACANTHIDAE				
* <i>Aluterus monoceros</i> (Linnaeus, 1758)	R	CT	9, CPUM	C
<i>Aluterus scriptus</i> (Osbeck, 1765)	R	CT	1, 6, CPUM-photo	
FAMILY OSTRACIIDAE				
<i>Ostracion meleagris</i> Shaw, 1796	R	AP	2, 6, CPUM	
FAMILY TETRAODONTIDAE				
* <i>Arothron hispidus</i> (Linnaeus, 1758)	R	CT	CPUM, ICMYL	
<i>Arothron meleagris</i> (Lacépède, 1798)	R	CT	2, 6, CPUM	I

	Collected habitat (2010–2011)	Ichthyogeographic affinity	References and organisms voucher	The importance in fisheries
** <i>Canthigaster janthinoptera</i> (Bleeker, 1855)	R	AP	CPUM	
<i>Canthigaster punctatissima</i> (Günther, 1870)	R	TEP	2, 6, CPUM	
* <i>Lagocephalus lagocephalus</i> (Linnaeus, 1758)		CT	9	
* <i>Sphoeroides sechuræ</i> Hildebrand, 1946	R	TEP	9, CPUM	A
<i>Sphoeroides annulatus</i> (Jenyns, 1842)	R, E	SP, TEP	1, 2, 4, 6, 8, 12, CPUM, SIO	
<i>Sphoeroides lobatus</i> (Steindachner, 1870)	R	TEP	2, 6, CPUM	I
FAMILY DIODONTIDAE				
<i>Diodon holocanthus</i> Linnaeus, 1758	R	CT	2, 6, 8, 9, CPUM	
<i>Diodon hystrix</i> Linnaeus, 1758	R	CT	1, 2, 4, 6, 9, CPUM	I

* New record for the state of Michoacan. **New record for the Mexico. Collection habitat: Reef (R), rocky intertidal or tidal pool (PM), estuary (E), demersal (D) pelagic-demersal (PD). Zoogeographical affinity: Circumtropical (CT), Amphiamerican (AA), Transpacific (AP) San Diegan province (SP), Cortés province (CP), Mexican province (MP), Panamic province (PP). Record from literature: Castro-Aguirre et al. 2006 (1), Madrid-Vera et al. 1998 (2), Medina-Nava et al. 2005 (3), Galván-Torres, 1989 (4), Aguirre-Villaseñor, 1991 (5), Domínguez-Domínguez, 1998 (6), González-Luna, 2000 (7), Madrigal-Guridi, 2006 (8), Sánchez-Aguilar, 2007 (9), Sandoval-Huerta et al. 2012 (10), Palacios-Morales et al. 2014 (11), Sandoval-Huerta et al. 2014 (12), Sandoval-Huerta et al. 2015 (13). Records from Fish Collection of Universidad Michoacana de San Nicolás de Hidalgo (CPUM), Fish Collection of the Institute of Biology of the National Autonomous University of Mexico (CNPE-IBUNA), fish collection of Instituto de Ciencias del Mar y Limnología (ICMYL), fish collection of California Academy of Sciences, San Francisco California, E.U.A. (CAS), the Marine Vertebrate Collection of Scripps Institution of Oceanography, San Diego, California (SIO) and fish collection of Biological Research Center Northwest S.C. (CIBNOR). Fishery importance: personal consumption (A), commercial use (C) and discarded (I).

Pristis pristis (Linnaeus, 1758), *Aetobatus laticeps* (Euphrasen, 1790), *Apogon pacificus* (Herre, 1935), *Coryphaena hippurus* Linnaeus, 1758, *Kyphosus ocyurus* (Jordan & Gilbert, 1882), and *Novaculichthys taeniourus* (Lacepède, 1801). Of the 436 species, 131 were new records for the Michoacán State, and *Canthigaster janthinoptera* (Bleeker, 1855) was a new record for Mexico (Table 1).

For the specimens collected during field trips, some were collected from a single habitat type: 123 (40%) were collected in reefs, 57 (19%) in the pelagic-demersal zone, 46 (15%) in estuarine zones, 17 (6%) in the demersal zones, and 14 (5%) in rocky intertidal zones. Forty-seven species were collected in more than one habitat type (Table 1 and Fig. 2).

The artisanal fishery captures yielded 154 species. The families with the highest number of species were Carangidae (17), Haemulidae (15), Sciaenidae (13), Serranidae (10), and Lutjanidae (7). Of these, 104 (68%) were commercially valuable, 23 (15%) were used for direct consumption or as bait. Twenty-seven (18%) were bycatch, that are normally rejected and thrown back (Fig. 3).

Forty-six (11%) of the species were circumtropical, 27 (6%) transpacific, and seven (2%) amphi-American; whereas 350 (81%) belonged to the TEP. Of these 77

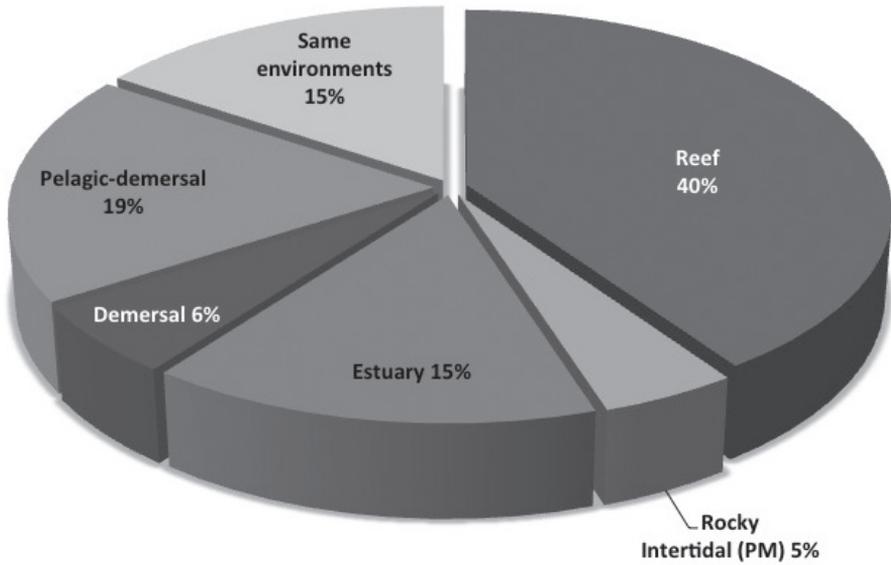


Figure 2. Percent of species collected in each habitat.

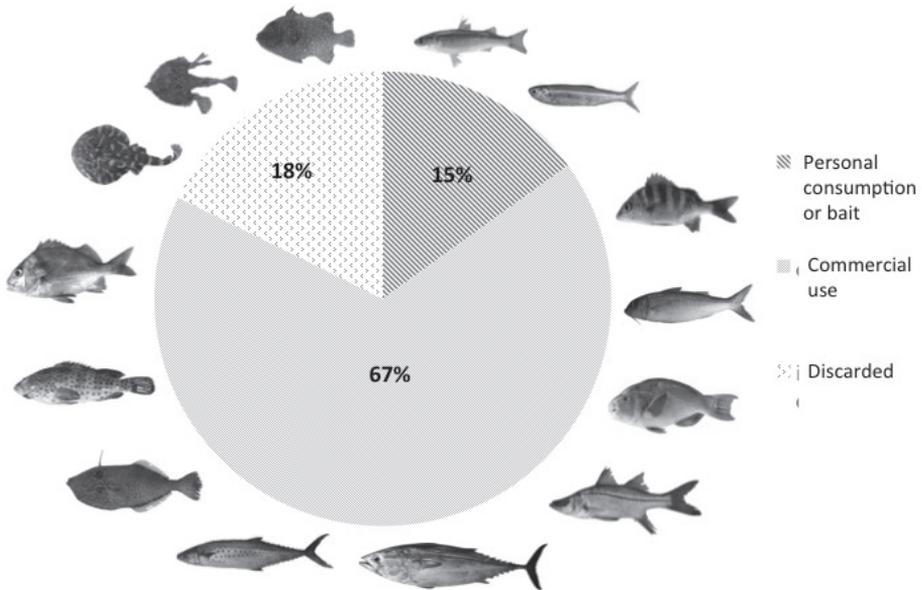


Figure 3. Classification of commercial importance of the species captured in the Michoacán coastal fisheries.

(18%) were widely distributed from the San Diegan province to the Panamic province, and 3 (1%) from the San Diegan province to the Mexican province. The largest number of species, 216 (49.2%), were found in the three provinces of the TEP; 15

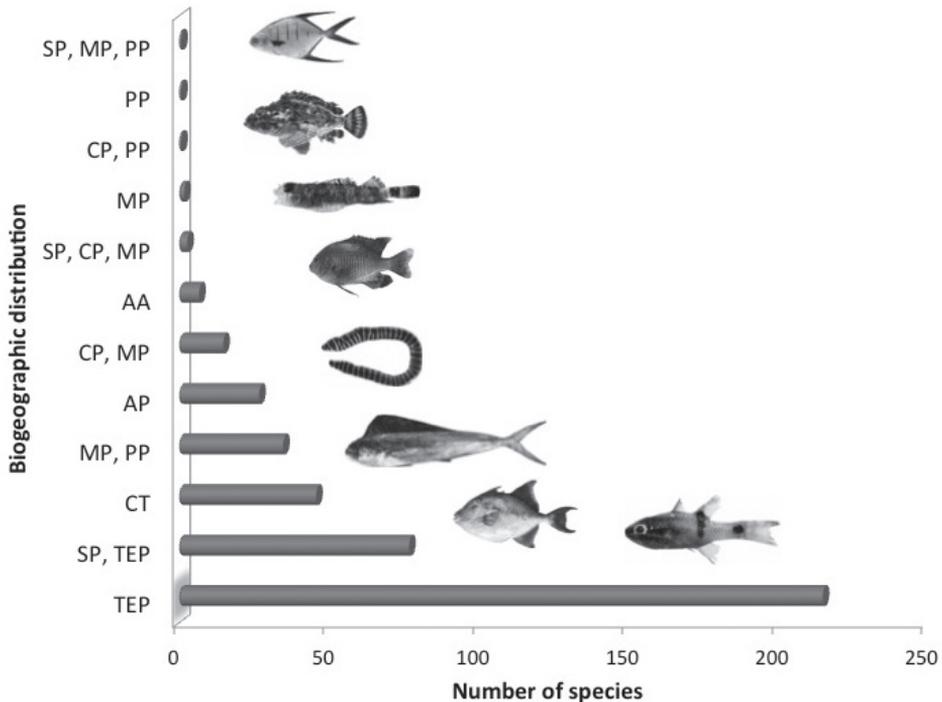


Figure 4. Biogeographic affinity of the fish fauna recorded on the Michoacán Coast. TEP, Tropical Eastern Pacific; CT, Circumtropical; AP, Transpacific species; AA, Amphi-American species; SP, San Diegan province; CP, Cortez province; MP, Mexican province; PP, Panamic province.

(3%) were restricted to the Cortez and the Mexican provinces; 35 (8%) were limited to the Mexican and Panamic provinces; and 2 (0.5%) were endemic to the Mexican province (Fig. 4). Six species collected in the estuarine ecosystems occurred in fresh or brackish water habitats and were not included in the marine biogeographical affinity categories: *Gobiomorus polylepis* Ginsburg, 1953 (brackish), *Sicydium multipunctatum* Regan, 1905, *Gobiesox mexicanus* Briggs & Miller, 1960, and *Poecilia butleri* Jordan, 1889 (fresh water). The introduced species *Pterygoplichthys disjunctivus* (Weber, 1991) and *Cyprinus carpio* Linnaeus, 1758 were also omitted.

Discussion

The present checklist represents the most updated and comprehensive systematic list of fishes recorded from the coast of the Mexican State of Michoacán. Of the species cataloged, 30% were first records for this State. The highest proportion of cataloged species was collected in reefs (40%). The pelagic zone accounted for 24% of the species collected, indicated a requirement for future studies of the demersal and pelagic

zones with increased sampling effort (Fig. 2). The highest number of new records for Michoacán was found in reefs, chiefly species exhibiting cryptic behavior (Table 1). This could be related to the sampling methods employed, which had not been previously used; the few previously reported species with cryptic behavior were primarily bycatch (Madrid-Vera 1998, Castro-Aguirre et al. 2006, Moncayo-Estrada et al. 2006, Chávez-Comparan 2008, Márquez-Espinoza 2012). Another source of new species records from Michoacán was the intertidal zone (Table 1), for which no published records are available. In general, the number of species in the area may be increased if sampling effort is expanded and records from shrimp and tuna bycatches are included. A new record was obtained for Mexico, two specimens of *C. janthinoptera* (Bleeker, 1855) were collected from Barco Hundido del Faro de Bucerias (CPUM 4532, N 18°21'8.82"W -103°31'18.71'), which identification was corroborated by BLAST (<http://www.ncbi.nlm.nih.gov/genbank>) and by boldsystems (<http://www.boldsystems.org>), searches showing 99% similarity in the cytochrome oxidase subunit 1 gene (COX-1) to specimens identified as *C. janthinoptera* from the south Tropical Eastern Pacific and the Indo-Pacific Ocean (GenBank accession numbers: KX505745 and KX505746). One specimen of *Bathygobius andrei* (Sauvage, 1880) (Gobiidae) was also reported in the Chuta estuary (CPUM 3296, 18°2'1"N and 102°33'33"W), representing an extension of its previously known northern distribution limit of the coast of Chiapas (Gómez-González et al. 2012). One specimen of *Calotomus carolinus* (Valenciennes, 1840) was collected from rocky reef in Faro de Bucerias location (18°20'50"N and 103°30'37"W), extending its extension range in the TEP.

In artisanal fishing (Fig. 3), the species considered to have the highest economic value belong chiefly to Carangidae (e.g. *Alectis ciliaris*, (Bloch, 1787)), Lutjanidae (e.g. *Lutjanus guttatus*, (Steindachner, 1869)), Paralichthyidae (e.g. *Cyclosetta querna*, (Jordan & Bollman, 1890)), Centropomidae (e.g. *Centropomus armatus*, Gill, 1863), and Serranidae (e.g. *Epinephelus labriformis*, (Jenyns, 1840)) (Table 1). Most of the elasmobranch capture, with the exception of the fins, is considered of low economic value. A high number of neonatal and juvenile hammerhead sharks (*Sphyrna* sp.), were captured, as well as pregnant *Rhinobatos glaucostigma* Jordan & Gilbert, 1883, *Gymnura marmorata* (Cooper, 1863), and *Urotrygon* spp. In general, the elasmobranchs, due to their unique biological and ecological characteristics, present low population growth and are considered highly vulnerable (Frisk et al. 2005, Hutchings et al. 2012). We accordingly recommend review and enforcement of the relevant legislation.

Bycatch in commercial fishing is frequently used for personal consumption, bait (-50%), or discarded (Fig. 3). Species with no current market value may have high nutrient value; hence the number of species with potential to be commercialized is underestimated. In offshore fisheries, these species often have commercial value. For instance, *Scorpaena mystes* (Jordan & Starks, 1895) reaches 35.6 cm and is marketed in regions such as Baja California. *Trichiurus nitens* Garman, 1899 supports a small fishery in the central portion of the littoral zone of Ecuador (pers. obs. Romero-Gallardo), whereas, in Michoacán, this species is not used for human consumption.

It was observed that 49% of the listed species are reported as also occurring throughout the three TEP provinces, with 8% of the species reported only in the Panamic and Mexican provinces, being mostly of tropical affinity, agreeing with previous fish fauna surveys in the area (Castro-Aguirre et al. 2006, Moncayo-Estrada 2006). The presence of 81 species (19%) with affinity to the San Diegan province (Fig. 4), a temperate-warm zone, reflects the dynamics of the current flow system of the Michoacán coast, reaffirming this region as a transition zone.

Although visual censuses and photo identification of fish species is widely used for the study of richness, diversity, and ecology of marine habitats (Aguilar-Palomino 2002, Palacios-Salgado 2005, Galván-Villa 2016), it is necessary to rely on reference organisms for taxonomic corroboration. A high proportion of small, nocturnal, or ecologically cryptic species may not be counted in a visual census, especially when the fish fauna of the area under study is not well known, as is the case for the Michoacán State.

The collections obtained in the present study enriched the records of the CPUM collection by 19%, since the majority of marine species previously collected remain in collections outside of Michoacán. Many species reported in this study as new records (Table 1) were included by Robertson and Allen (2015), although these authors listed them in the littoral zone of Michoacán coastline only as potential distribution based on habitat suitability. We have confirmed the distribution of such fish, as exemplified by the first formal record of 24 ecologically cryptic species. Our work expanded on the most complete fish fauna checklist previously available for the area by 32.5% (Madrid et al. 1998) and will undoubtedly represent important input for decisions about conservation and management of the coastal area of Michoacán State.

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An inventory of coastal freshwater fishes from Amapá highlighting the occurrence of eight new records for Brazil

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Abstract

The Amazon Basin occupies a vast portion of northern South America and contains some of the highest species richness in the world. The northern Brazilian state of Amapá is delimited by the Amazonas River to the south, the Oyapock River to the northern boundary with French Guyana, and the Atlantic northeastern coast to Amazon estuary. Despite several expeditions to the Amazon in recent decades, little is known about the freshwater ichthyofauna from Amapá, with records limited to local inventories and species descriptions. This paper presents a compilation of the freshwater fish diversity sampled in fifteen sites covering two major Amapá ecoregions during the dry season of 2015. 120 species representing eight orders and 40 families are reported upon in this work. Eight species appear for the first time in the Brazilian territory providing new information for future conservation status evaluations.

Keywords

Amazon, French Guyana, Neotropical, South America, Teleostei

Introduction

At the northern limit of Brazil, the state of Amapá occupies the lower portion of the Amazon River basin at the border between Brazil, French Guyana, and Suriname. With more than 14 million hectares, ca. 90% of its native surface is still intact and ca. 73% is legally protected as either federal/state conservation units or indigenous territories (Bernard 2008). As example, the Tumucumaque National Park is the largest Brazilian protected unit and the largest continuous tropical forest national park in the world (Bernard 2008). Consequently, Amapá harbors a striking portion of the Neotropical fauna and flora in the Guiana Shield. That region along with the adjacent coastal ecosystems certainly needs further biological research.

Amapá includes three major Neotropical freshwater ecoregions (*sensu* Abell et al. 2008). The first is the Guianas containing the Oyapock River that has its headwaters in the Tumucumaque National Park. The second is the Amazonas Guiana Shield containing the Rio Jari and Rio Iratapuru, and the upper portions of the Rio Araguari basin including the large Rio Amapari. Third ecoregion is the Amazonas Estuary and Coastal Drainages that contains small rivers reaching the lower Amazonas such as Rio Cajari and Rio Preto as well as several independent coastal rivers reaching the east coast, including the middle/lower Rio Araguari, Rio Flexal, Rio Amapá Grande and its associated lakes, Rio Calçoene, Rio Cunani, Rio Cassiporé and Rio Uaçá (Fig. 1) (Jégu and Keith 1999).

Checklists of freshwater fishes have been continually published for French Guyana (Planquette et al. 1996; Keith et al. 2000; Le Bail et al. 2000, 2012), Suriname (Mol et al. 2012) and the Guiana Shield in general (Vari et al. 2009; Sidlauskas and Vari 2012). Likewise, biogeographic questions have been addressed to that region (Jégu and Keith 1999; Lujan and Armbruster 2011) as well as species descriptions (e.g. Jégu and Santos 1990; Vari 1992; Zarske and Géry 1998; Lucena and Gama 2007; Ottoni et al. 2012). However, the diversity and composition of freshwater fishes from the Amapá and consequently the eastern limit of the Guiana Shield are limited to a concise and well-sampled inventory of fishes from the Tumucumaque National Park (Gama 2008) that is situated in the Amazonas Guiana Shield ecoregion (upper Oyapock River). Our aim is to present a survey of the ichthyofauna from Amapá sampled in the other two ecoregions: the Guianas (lower Oyapock River) and the Amazonas Estuary and Coastal Drainages. New records of freshwater fishes for Brazil should contribute to our understanding of the Neotropical ichthyofauna as well as to future evaluations of their conservation status.

Material and methods

Fifteen sites were sampled including small streams, river channels and large/lentic lagoons covering two ecoregions from Abell et al. (2008): Guianas (lower Oyapock River) and Amazonas Estuary and Coastal Drainages (Table 1; Fig. 1). Collection sites

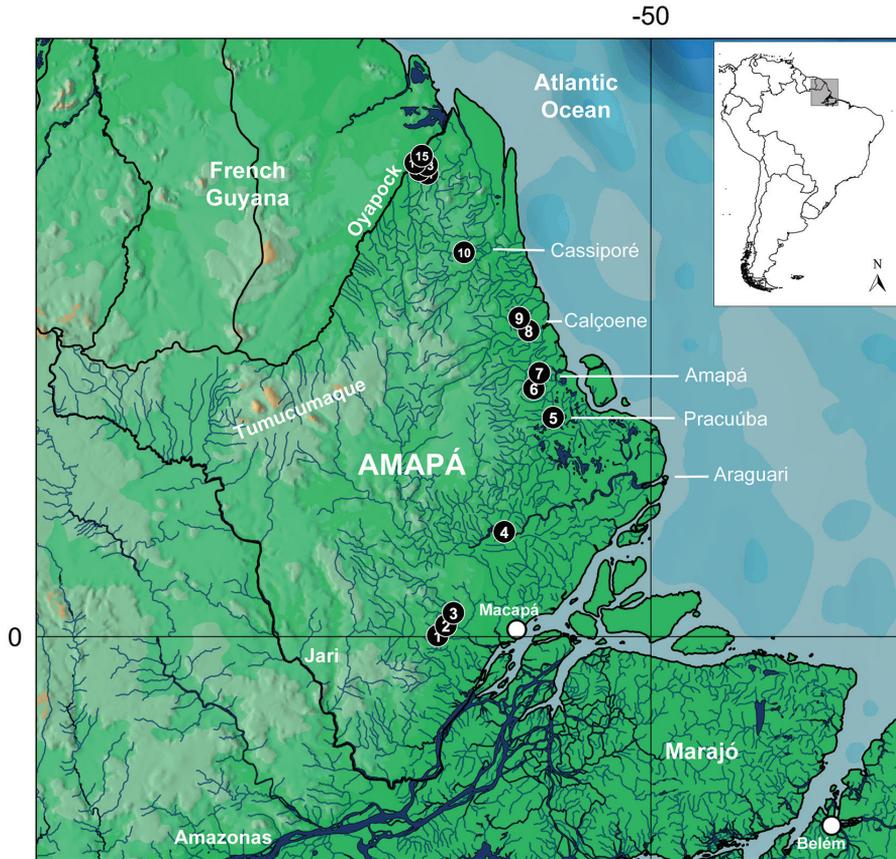


Figure 1. Map of Amapá in northern Brazil, lower Amazon basin showing each collecting site (black circles). Numbers match those in Table 1.

(Fig. 2) cover variable environments including small streams, rivers and lagoons and are near the main state road BR-156, which connects Laranjal do Jari to Oiapoque municipalities. Mazagão, Ferreira Gomes, Tartarugalzinho, Amapá and Calçoene are the intervening cities. Sampling efforts occurred during dry season in September and late November/early December 2015, mostly during daylight. Specimen collection involved tows of dipnets along the vegetated margins, a 5-meter bottom trawl and cast-netting in large streams or lagoons. Collection in the Lago Pracuúba comprised gillnets blocking fish passage overnight.

Specimens were anesthetized in a solution of clove oil, preserved in 96% ethanol (for molecular studies) or fixed in 10% formalin solution (for morphological studies) and then preserved in 70% ethanol. Muscle tissues were collected and preserved in 96% ethanol. Vouchers are deposited in the Laboratório de Biologia e Genética de Peixes at the Universidade Estadual Paulista, Botucatu, São Paulo, Brazil (LBP).

Table 1. Sampled localities in the Amapá and their placement in Figure 1.

Site	Locality	Major drainage	Municipality	Coordinates	Ecoregion
1	Rio Preto	Rio Amazonas	Mazagão	00°00'34.6"S 51°40'11.3"W	Amazonas Estuary and Coastal Drainages
2	Igarapé do Bispo	Rio Amazonas	Mazagão	00°01'45.5"N 51°38'05.6"W	Amazonas Estuary and Coastal Drainages
3	Unnamed lagoon	Rio Amazonas	Mazagão	00°05'11.3"N 51°37'58.1"W	Amazonas Estuary and Coastal Drainages
4	Unnamed stream	Rio Araguari	Ferreira Gomes	00°50'44.7"N 51°10'15.7"W	Amazonas Estuary and Coastal Drainages
5	Lago Pracuúba	Rio Amapá	Pracuúba	01°44'49.8"N 50°46'59.3"W	Amazonas Estuary and Coastal Drainages
6	Igarapé Balneário St. Bárbara	Rio Amapá	Amapá	02°03'42.8"N 50°54'15.1"W	Amazonas Estuary and Coastal Drainages
7	Igarapé Balneário Raso	Rio Amapá	Amapá	02°05'25.6"N 50°53'19.8"W	Amazonas Estuary and Coastal Drainages
8	Igarapé Pau Pintado	Rio Calçoene	Calçoene	02°28'47.7"N 50°58'47.2"W	Amazonas Estuary and Coastal Drainages
9	Igarapé Asa Aberta	Rio Calçoene	Calçoene	02°31'08.9"N 51°00'52.9"W	Amazonas Estuary and Coastal Drainages
10	Igarapé Faz. Campo Alegre	Rio Cassiporé	Oiapoque	03°04'49.7"N 51°28'50.7"W	Amazonas Estuary and Coastal Drainages
11	Igarapé do Quatorze	Oyapock River	Oiapoque	03°45'10.4"N 51°46'57.3"W	Guianas
12	Rio Pantanari	Oyapock River	Oiapoque	03°48'47.6"N 51°48'31.6"W	Guianas
13	Igarapé Cortiço	Oyapock River	Oiapoque	03°49'05.5"N 51°47'21.4"W	Guianas
14	Lagoa Mr. Rona	Oyapock River	Oiapoque	03°50'31.5"N 51°50'28.7"W	Guianas
15	Oyapock River	Oyapock River	Oiapoque	03°50'33.5"N 51°50'25.7"W	Guianas

Expeditions had permission to collect wild species in Brazil under ICMBio license number 13.843-1 to Claudio Oliveira. Species identifications to the lowest taxonomic level were conducted consulting the taxonomic literature and identification keys (Géry 1977; Planquette et al. 1996; Keith et al. 2000; Le Bail et al. 2000; Lucena and Malabarba 2010; Sidlauskas and Vari 2012; Peixoto et al. 2015) and updated with Eschmeyer et al. (2016). Classification follows the current phylogenetic arrangement of bony fishes (Betancur-R et al. 2014). We used checklists (Reis et al. 2003; Le Bail et al. 2012), SpeciesLink (<http://www.splink.org.br/>) and FishNet2 (<http://www.fishnet2.net/>) to search previous records of the species listed herein.

Results and discussion

The fish survey in the freshwater rivers of Amapá resulted in 120 species representing eight orders and 40 fish families that range from obligate freshwater to marine organisms (Table 2). Orders comprising the highest percentage of species richness were Characi-



Figure 2. Sampled localities in the Amapá, northern Brazil. Numbers follow Table 1 and Fig. 1. Photographs by B.F. Melo and C. Oliveira. Photo 2 credits: Alan Kardec available at Google Earth.

formes (55%), Cichliformes (16.6%), Siluriformes (14.1%) and Gymnotiformes (7.5%) as expected in Neotropical freshwaters (e.g. Langeani et al. 2007; Vari et al. 2009; Polaz et al. 2014). These four orders represent 93.3% of the total species richness. Clupeiformes (*Anchovia*), Cyprinodontiformes (*Fluviphylax* and *Melanorivulus*), Gobiiformes

Table 2. List of freshwater fish species collected in the state of Amapá, northern Brazil.

CLASS/ORDER/FAMILY/SPECIES	
CLASS ACTINOPTERYGII	
CLUPEIFORMES	
Engraulidae	
<i>Anchovia</i> aff. <i>surinamensis</i> (Bleeker, 1866)	LBP 20632
CHARACIFORMES	
Curimatidae	
<i>Curimata cyprinoides</i> (Linnaeus, 1766)	LBP 20629, LBP 20634, LBP 20645
<i>Curimatopsis</i> sp.	LBP 20480, LBP 21011, LBP 21031, LBP 21052, LBP 21079, LBP 21113, LBP 21191, LBP 21212, LBP 21240
<i>Cyphocharax gouldingi</i> Vari, 1992	LBP 21032, LBP 21078, LBP 21133, LBP 21189, LBP 21211
<i>Cyphocharax belleri</i> (Steindachner, 1910)	LBP 21140
Anostomidae	
<i>Leporinus friderici</i> (Bloch, 1794)	LBP 20633
<i>Leporinus gossei</i> Géry, Planquette & Le Bail, 1991	LBP 20626, LBP 21114
<i>Leporinus nijseni</i> Garavello, 1990	LBP 21163
<i>Leporinus parae</i> Eigenmann, 1908	LBP 20653
<i>Schizodon fasciatus</i> Spix & Agassiz, 1829	LBP 20656
Chilodontidae	
<i>Chilodus zumevei</i> Puyo, 1946	LBP 21129, LBP 21137, LBP 21177
Crenuchidae	
<i>Characidium zebra</i> Eigenmann, 1909	LBP 21016, LBP 21033, LBP 21051, LBP 21082, LBP 21149, LBP 21161, LBP 21195, LBP 21210
<i>Crenuchus spilurus</i> Günther, 1863	LBP 21107, LBP 21237
<i>Melanocharacidium</i> cf. <i>blennioides</i> (Eigenmann, 1909)	LBP 21185
<i>Melanocharacidium dispilomma</i> Buckup, 1993	LBP 21160
<i>Microcharacidium eleotrioides</i> (Géry, 1960)	LBP 21159, LBP 21190
Hemiodontidae	
<i>Hemiodus gracilis</i> Günther, 1864	LBP 21186
<i>Hemiodus quadrimaculatus</i> Pellegrin, 1908	LBP 21151
Characidae	
<i>Astyanax bimaculatus</i> (Linnaeus, 1758)	LBP 20637, LBP 21004, LBP 21008, LBP 21080, LBP 21125, LBP 21167, LBP 21234
<i>Astyanax</i> sp.	LBP 21005, LBP 21024, LBP 21026
<i>Bryconamericus</i> sp.	LBP 21171
<i>Charax niger</i> Lucena, 1989	LBP 21086, LBP 21217
<i>Hemigrammus boesemani</i> Géry, 1959	LBP 20484, LBP 20983, LBP 21099, LBP 21112, LBP 21128, LBP 21200, LBP 21225, LBP 21250, LBP 21589
<i>Hemigrammus levis</i> Durbin, 1908	LBP 20983, LBP 21006, LBP 21027, LBP 21043, LBP 21222
<i>Hemigrammus ocellifer</i> (Steindachner, 1882)	LBP 21069, LBP 21100, LBP 21244
<i>Hemigrammus rodwayi</i> Durbin, 1909	LBP 21226
<i>Hemigrammus</i> cf. <i>schmarda</i> (Steindachner, 1882)	LBP 21022, LBP 21045, LBP 21201, LBP 21224, LBP 21246
<i>Hemigrammus unilineatus</i> (Gill, 1858)	LBP 21094
<i>Hemigrammus</i> sp.	LBP 21001, LBP 21025, LBP 21046, LBP 21047, LBP 21068, LBP 21071, LBP 21227

<i>Hyphessobrycon copelandi</i> Durbin, 1908	LBP 21036, LBP 21064, LBP 21103, LBP 21138, LBP 21241
<i>Hyphessobrycon</i> sp.	LBP 20483, LBP 21002, LBP 21003, LBP 21101, LBP 21196, LBP 21199, LBP 21221
<i>Jupiaba abramoides</i> (Eigenmann, 1909)	LBP 21095
<i>Jupiaba keithi</i> (Géry, Planquette & Le Bail, 1996)	LBP 21122, LBP 21169
<i>Jupiaba meunieri</i> (Géry, Planquette & Le Bail, 1996)	LBP 21007
<i>Jupiaba ocellata</i> (Géry, Planquette & Le Bail, 1996)	LBP 21088
<i>Jupiaba</i> sp.	LBP 21247
<i>Moenkhausia chrysargyrea</i> (Günther, 1864)	LBP 21070, LBP 21097, LBP 21121, LBP 21146
<i>Moenkhausia collettii</i> (Steindachner, 1882)	LBP 21010, LBP 21044, LBP 21066, LBP 21096, LBP 21198, LBP 21223, LBP 21248
<i>Moenkhausia georgiae</i> Géry, 1965	LBP 21093
<i>Moenkhausia gracilima</i> (Eigenmann, 1908)	LBP 21243
<i>Moenkhausia lepidura</i> (Kner, 1858)	LBP 21085, LBP 21145
<i>Moenkhausia oligolepis</i> (Günther, 1864)	LBP 21077, LBP 21124, LBP 21139
<i>Moenkhausia surinamensis</i> Géry, 1965	LBP 21009, LBP 21102, LBP 21245
<i>Moenkhausia</i> sp.	LBP 21098, LBP 21249
<i>Odontostilbe gracilis</i> (Géry, 1960)	LBP 21228
<i>Phenacogaster wayana</i> Le Bail & Lucena, 2010	LBP 21218
<i>Poptella brevispina</i> Reis, 1989	LBP 21014, LBP 21056, LBP 21104, LBP 21127, LBP 21141, LBP 21168, LBP 21194, LBP 21220
<i>Pristella maxillaris</i> (Ulrey, 1894)	LBP 21037
Acestrorhynchidae	
<i>Acestrorhynchus falcatus</i> (Bloch, 1794)	LBP 21173
<i>Acestrorhynchus microlepis</i> (Schomburgk, 1841)	LBP 21142
Erythrinidae	
<i>Hoplerhythrinus unitaeniatus</i> (Agassiz, 1829)	LBP 21209
<i>Hoplias malabaricus</i> (Bloch, 1794)	LBP 21084, LBP 21110, LBP 21115, LBP 21175, LBP 21233
Lebiasinidae	
<i>Copella</i> aff. <i>arnoldi</i> (Regan, 1912)	LBP 20982
<i>Copella carsevennensis</i> (Regan, 1912)	LBP 21111, LBP 21131, LBP 21148, LBP 21162
<i>Nannostomus beckfordi</i> Günther, 1872	LBP 20477, LBP 20478, LBP 20981, LBP 21023, LBP 21034, LBP 21055, LBP 21091, LBP 21192, LBP 21216, LBP 21238
<i>Nannostomus bifasciatus</i> Hoedeman, 1954	LBP 21590
<i>Pyrrhulina filamentosa</i> Valenciennes, 1847	LBP 21015, LBP 21030, LBP 21054, LBP 21083, LBP 21193, LBP 21215, LBP 21239
Iguanodectidae	
<i>Bryconops affinis</i> (Günther, 1864)	LBP 21050, LBP 21132
<i>Bryconops caudomaculatus</i> (Günther, 1864)	LBP 20979, LBP 21089, LBP 21178, LBP 21219, LBP 21242
<i>Bryconops melanurus</i> (Bloch, 1794)	LBP 21143, LBP 21170
<i>Bryconops</i> sp.	LBP 20998, LBP 21013, LBP 21035
Serrasalminidae	
<i>Acnodon oligacanthus</i> (Müller & Troschel, 1844)	LBP 21012
<i>Metynnis lippincottianus</i> (Cope, 1870)	LBP 20647, LBP 20648, LBP 20999, LBP 21057, LBP 21172, LBP 21213
<i>Mylesinus paraschomburgkii</i> Jégu, Santos & Ferreira, 1989	LBP 20628

<i>Myleus ternetzi</i> (Norman, 1929)	LBP 20980, LBP 21144
<i>Pygocentrus nattereri</i> Kner, 1858	LBP 20651
<i>Serrasalminus humeralis</i> Valenciennes, 1850	LBP 20649, LBP 20650, LBP 20652, LBP 21187, LBP 21188, LBP 21214
SILURIFORMES	
Aspredinidae	
<i>Bunocephalus</i> sp.	LBP 21029
Callichthyidae	
<i>Megalechis thoracata</i> (Valenciennes, 1840)	LBP 21076
Loricariidae	
<i>Ancistrus</i> sp.	LBP 21147, LBP 21164
<i>Curculionichthys</i> sp.	LBP 21166
<i>Farlowella reticulata</i> Boeseman, 1971	LBP 21208, LBP 21230
<i>Guyanancistrus brevispinis</i> (Heitmans, Nijssen & Isbrücker, 1983)	LBP 21165, LBP 21183
<i>Hypostomus plecostomus</i> (Linnaeus, 1758)	LBP 20644
<i>Hypostomus ventromaculatus</i> Boeseman, 1968	LBP 20635
<i>Lithoxus</i> sp.	LBP 21184
<i>Loricaria cataphracta</i> Linnaeus, 1758	LBP 20636
Heptapteridae	
<i>Heptapterus bleekeri</i> Boeseman, 1953	LBP 21181
<i>Rhamdia quelen</i> (Quoy & Gaimard, 1824)	LBP 21072
Pimelodidae	
<i>Brachyplatystoma filamentosum</i> (Lichtenstein, 1819)	LBP 20630
<i>Hypophthalmus edentatus</i> Spix & Agassiz, 1829	LBP 20654
<i>Pimelodus</i> sp.	LBP 20627
Auchenipteridae	
<i>Ageneiosus inermis</i> (Linnaeus, 1766)	LBP 20655
<i>Trachelyopterus coriaceus</i> Valenciennes, 1840	LBP 20988
GYMNOTIFORMES	
Gymnotidae	
<i>Gymnotus</i> gr. <i>anguillaris</i> Hoedeman, 1962	LBP 21081, LBP 21156
Sternopygidae	
<i>Eigenmannia antonioi</i> Peixoto, Dutra & Wosiacki, 2015	LBP 21117, LBP 21182
<i>Eigenmannia waiwai</i> Peixoto, Dutra & Wosiacki, 2015	LBP 21118, LBP 21155
<i>Steatogenys elegans</i> (Steindachner, 1880)	LBP 20997
Apteronotidae	
<i>Apteronotus bonapartii</i> (Castelnau, 1855)	LBP 21591
Rampichthyidae	
<i>Gymnorhampichthys rondoni</i> (Miranda Ribeiro, 1920)	LBP 21232
<i>Rhampichthys rostratus</i> (Linnaeus, 1766)	LBP 21120, LBP 21154
Hypopomidae	
<i>Brachyhypopomus pinnicaudatus</i> (Hopkins, 1991)	LBP 21130
<i>Microsternarchus bilineatus</i> Fernández-Yépez, 1968	LBP 20996, LBP 21053, LBP 21235
GOBIIFORMES	
Gobiidae	
<i>Dormitator maculatus</i> (Bloch, 1792)	LBP 21090

SUBSERIES OVALENTARIAE	
Polycentridae	
<i>Polycentrus schomburgkii</i> Müller & Troschell, 1849	LBP 21039, LBP 21109
<i>Monocirrhus polyacanthus</i> Heckel, 1840	LBP 20989, LBP 21028, LBP 21202
CICHLIFORMES	
Cichlidae	
<i>Acaronia nassa</i> (Heckel, 1840)	LBP 20985, LBP 21048
<i>Aequidens</i> gr. <i>tetramerus</i> (Heckel, 1840)	LBP 20994, LBP 21136, LBP 21231
<i>Apistogramma agassizii</i> (Steindachner, 1875)	LBP 20479
<i>Apistogramma gossei</i> Kullander, 1982	LBP 20993, LBP 21040, LBP 21062, LBP 21092, LBP 21236
<i>Apistogramma</i> sp. 'Amapá'	LBP 21157
<i>Cichla monoculus</i> Spix & Agassiz, 1831	LBP 20625
<i>Cichla</i> sp.	LBP 21180, LBP 21205
<i>Crenicichla</i> cf. <i>multispinosa</i> Pellegrin, 1903	LBP 20991, LBP 21158
<i>Crenicichla saxatilis</i> (Linnaeus, 1758)	LBP 21038, LBP 21073, LBP 21207
<i>Geophagus surinamensis</i> (Bloch, 1791)	LBP 20638, LBP 20986, LBP 21074
<i>Guianacara geayi</i> (Pellegrin, 1902)	LBP 21116, LBP 21152
<i>Heros</i> cf. <i>efasciatus</i> Heckel, 1840	LBP 20646, LBP 20995, LBP 21042
<i>Hypselecara temporalis</i> (Günther, 1862)	LBP 21061, LBP 21067, LBP 21075, LBP 21135
<i>Krobia</i> aff. <i>guianensis</i> (Regan, 1905)	LBP 21017, LBP 21063, LBP 21108, LBP 21123, LBP 21153, LBP 21179, LBP 21203
<i>Laetacara flamannellus</i> Ottoni, Bragança, Amorim & Gama, 2012	LBP 21049
<i>Mesonauta guyanae</i> Schindler, 1998	LBP 20992, LBP 21018, LBP 21041, LBP 21059, LBP 21087, LBP 21119, LBP 21176, LBP 21204
<i>Nannacara aureocephalus</i> Allgayer, 1983	LBP 21065, LBP 21126
<i>Retroculus septentrionalis</i> Gosse, 1971	LBP 21019
<i>Satanoperca jurupari</i> (Heckel, 1840)	LBP 21058, LBP 21174
<i>Satanoperca rhynchitis</i> Kullander, 2012	LBP 21020
CYPRINODONTIFORMES	
Rivulidae	
<i>Melanorivulus schuncki</i> (Costa & De Luca, 2011)	LBP 20427, LBP 20987, LBP 21134, LBP 21197, LBP 21229, LBP 21251
Poeciliidae	
<i>Fluviophylax palikur</i> Costa & Le Bail, 1999	LBP 20481, LBP 20984, LBP 21021
BELONIFORMES	
Belonidae	
<i>Potamorhaphis guianensis</i> (Jardine, 1843)	LBP 20990, LBP 21060, LBP 21206
SERIES PERCOMORPHARIA	
Sciaenidae	
<i>Micropogonias furnieri</i> (Desmarest, 1823)	LBP 20631

(*Dormitator*), Beloniformes (*Potamorhaphis*), Sciaenidae (*Micropogonias*) and Polycentridae (*Monocirrhus* and *Polycentrus*) complete the list with one or two species each. The most highly represented family was Characidae (25% of total species), followed by Cichlidae (16.6%) and Loricariidae (6.6%). Previous fish survey from Tumucumaque

National Park listed 207 species from five expeditions (Gama 2008) and found a new species record in the Brazilian territory, the cichlid *Cleithracara maronii*. It is noteworthy, however, that some species are common in both lists despite sampling distinct ecoregions (e.g. *Ageneiosus inermis*, *Apistogramma gossei*, *Bryconops caudomaculatus*, *Leporinus gossei*, *Microsternarchus bilineatus*).

Eight species were identified from Brazilian territory previously thought to inhabit only the Guianas region. Herein, these species are formally recorded for Brazil and are *Leporinus gossei*, *Chilodus zunevei*, *Melanocharacidium* cf. *blennioides*, *Jupiaba keithi*, *Phenacogaster wayana*, *Odontostilbe gracilis*, *Acnodon oligacanthus* and *Nannacara aureocephalus* (Fig. 3). Among them, *L. gossei*, *C. zunevei* and *N. aureocephalus* were recently reported to Oyapock River in the Brazil-French Guyana boundary (Le Bail et al. 2012). *Leporinus gossei* was described from Marowijne river (Géry et al. 1991) and subsequently reported to many rivers of French Guyana (Planquette et al. 1996; Sidlauskas and Vari 2012) including the Brazilian section of the Oyapock River reported herein. *Chilodus zunevei* is recorded for the northeastern Suriname along the coastal rivers of French Guyana to Oyapock (Sidlauskas and Vari 2012) and now in the Rio Amapá. *Melanocharacidium blennioides* was described from the Potaro River in Guyana and ranges from Guyana to French Guyana (Buckup 2003). Herein, we report the species to the Rio Amapá. *Jupiaba keithi* is recorded from the Marowijne and Mana rivers of French Guyana (Zanata 1997); we found *J. keithi* in the Oyapock River. The recently described *Phenacogaster wayana* from Corantijn to Approuague rivers (Lucena and Malabarba 2010) is formally reported to Rio Amapá in Brazil. *Odontostilbe gracilis* occurs in a few places of the French Guyana (Planquette et al. 1996); we collected only a single specimen in the Rio Amapá. *Acnodon oligacanthus* is known only from the Guianas (Jégu 2003) and we found several specimens in the Rio Calçoene. Finally, *Nannacara aureocephalus* occurs in the Approuague river in French Guyana (Kullander 2003) and we found nine specimens in the Oyapock River. These new records should be incorporated in future evaluations of Brazilian threatened species conducted by the Ministério do Meio Ambiente/IUCN.

The following species are known to occur in Brazil but are now first reported for coastal rivers of Amapá. *Leporinus parae* occurs in the lower Amazon basin, state of Pará, Brazil as well as in the Orinoco basin in Venezuela (Britski and Birindelli 2008). We collected *L. parae* in the Lago Pracuúba, an oxbow lake adjacent to the Rio Amapá Grande, leading to the first formal record of the species to Amapá. *Jupiaba abramoides* was previously known from the Rio Negro and we have now extended its range to the Oyapock River. Specimens of *Curculionichthys*, small armored catfishes distributed mostly throughout La Plata, São Francisco, Tapajós and Xingu basins (Roxo et al. 2015) were found in the Rio Cassiporé and Rio Jari and represent an undescribed species.

Besides *Curculionichthys*, three other taxa represent putative undescribed species: *Curimatopsis* sp., a member of the cryptic lineage *Curimatopsis* aff. *crypticus* (Melo et al. 2016), *Lithoxus* sp. from Rio Amapá and *Apistogramma* sp. 'Amapá' from the Oyapock River, commonly misidentified as *A. gossei*. These specimens are subject of ongoing taxonomic investigation in our laboratory. Furthermore, some taxa could only be iden-



Figure 3. Species reported for the first time in Brazil. **a** *Leporinus gossei*, LBP 21114, Oyapock River **b** *Chilodus zunevei*, LBP 21129, Oyapock River **c** *Melanocharacidium* cf. *blennioides*, LBP 21185, Rio Amapá **d** *Jupiaba keithi*, LBP 21122, Oyapock River **e** *Phenacogaster wayana*, LBP 21218, Rio Amapá **f** *Odontostilbe gracilis*, LBP 21228, Rio Amapá **g** *Acnodon oligacanthus*, LBP 21012, Rio Calçoene **h** *Nannacara aureocephalus*, LBP 21065, Oyapock River. Scale bars: 1 cm.

tified at genus level, such as *Astyanax* sp., *Bryconops* sp., *Bryconamericus* sp., *Bunocephalus* sp., *Hemigrammus* sp., *Hyphessobrycon* sp., *Pimelodus* sp., among others (Table 2), and additional studies will be necessary to further classify these specimens. Overall, our survey increases our knowledge on the freshwater ichthyofauna of Amapá and of northern Brazil and provides new information for future conservation status evaluation. However, as other regions of the state remain unexplored, future inventories will likely reveal additional fish species in that part of the Guiana Shield.

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A new deep-reef scorpionfish (Teleostei, Scorpaenidae, *Scorpaenodes*) from the southern Caribbean with comments on depth distributions and relationships of western Atlantic members of the genus

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Abstract

A new species of scorpionfish, *Scorpaenodes barrybrowni* Pitassy & Baldwin, **sp. n.** which is described, was collected during submersible diving in the southern Caribbean as part of the Smithsonian's Deep Reef Observation Project (DROP). It differs from the other two western Atlantic species of the genus, *S. caribbaeus* and *S. tredecimspinosus*, in various features, including its color pattern, having an incomplete lateral line comprising 8–10 pored scales, tending to be more elongate, usually having the 11th–12th pectoral-fin rays elongate, and by 20–23% divergence in the cytochrome c oxidase I (COI) DNA barcode sequences. It further differs from one or the other of those species in head spination and in numbers of soft dorsal-fin rays, pectoral-fin rays, and precaudal + caudal vertebrae. Inhabiting depths of 95–160 m, the new species is the deepest western Atlantic member of the genus (*S. caribbaeus* occurs at depths < 35 m and *S. tredecimspinosus* from 7 to 82 m). DNA barcode data do not rigorously resolve relationships among the ten species of the genus for which those data are available.

Keywords

Manned submersible, Smithsonian Deep Reef Observation Project (DROP), Substation Curaçao, ocean exploration, integrative taxonomy, phylogeny

Introduction

Scorpionfishes of the genus *Scorpaenodes* occur circumglobally on rocky or reef substrates in tropical to temperate waters (Eschmeyer 1969, Poss and Eschmeyer 2003). Eschmeyer et al. (2016) recognize 29 valid species, 23 from the Pacific, four from the eastern Atlantic, and *S. caribbaeus* Meek and Hildebrand and *S. tredecimspinosus* (Metzelaar) from the western Atlantic. Both western Atlantic species are widely distributed, *S. caribbaeus* throughout the Caribbean to Brazil and north to the northern Gulf of Mexico and Bermuda, *S. tredecimspinosus* throughout the Caribbean to Brazil and north to North Carolina. Recent submersible diving off Curaçao in the southern Caribbean as part of the Smithsonian's Deep Reef Observation Project (DROP) resulted in the collection of five specimens of *Scorpaenodes* that are morphologically and genetically distinct. Here we describe them as a new species and comment on depth distributions and relationships of western Atlantic members of the genus. More recent submersible collecting as part of DROP resulted in the collection of two additional specimens of the new species from Dominica Island in the eastern Caribbean.

Methods and materials

Specimens of the new species were collected using Substation Curaçao's (<http://www.substation-Curaçao.com>) manned submersible *Curasub*. The sub has two flexible, hydraulic arms, one of which is equipped with a quinaldine/ethanol-ejection system and the other with a suction hose. Anesthetized fish specimens were captured with the suction hose, which empties into a vented plexiglass cylinder attached to the outside of the sub. At the surface, the specimens were photographed, tissue sampled, and preserved. Preserved specimens were later photographed to document preserved pigment pattern and X-rayed with a digital radiography system. Counts and measurements follow Eschmeyer (1965). The last ray of both the dorsal and anal fins is split completely to the base, but each is serially supported by a single pterygiophore, and we therefore consider it a single fin ray (in contrast to Poss et al. [2010], who counted the split dorsal and anal rays as one and a half fin rays). Measurements were made weeks to months after fixation in 10% formalin and subsequent preservation in 75% ethanol and were taken to the nearest 0.1 mm with digital calipers. USNM = Smithsonian Institution National Museum of Natural History, CAS = California Academy of Sciences.

Tissue samples for DNA Barcoding were stored in saturated salt-DMSO (dimethyl sulfoxide) buffer (Seutin et al. 1991). Extraction of DNA, PCR, sequencing cytochrome c oxidase subunit I (COI), and editing COI sequences were performed as outlined by Weigt et al. (2012a). A neighbor-joining tree (Saitou and Nei 1987) was generated using PAUP*4.1 (Swofford 2002) on an analysis of Kimura two-parameter distances (Kimura 1980) for the purpose of constructing a genetic-distance table. The neighbor-joining analysis reveals genetic distances in COI among individuals and clusters them into genetically distinct lineages, which, in teleost fishes, correspond

well with species (e.g. Baldwin and Weigt 2012, Weigt et al. 2012b). Interspecific phylogenetic relationships were hypothesized for western Atlantic *Scorpaenodes* and several species from other oceans (from public sequences available on GenBank) based on maximum parsimony analysis of the COI sequences using heuristic searches (100 replicates) in PAUP*4.1 (Swofford 2002). Characters were equally weighted and left unordered. The resulting equally parsimonious trees were summarized using the strict consensus method, and nodal support was estimated from 1,000 replicates of the bootstrap, utilizing random addition sequence and TBR branch swapping (Swofford 2002). The tree was rooted on *Scorpaena plumieri* Bloch, a member of the genus recovered as the sister group to *Scorpaenodes* by Smith and Wheeler (2004).

GenSeq nomenclature (Chakrabarty et al. 2013) and GenBank accession numbers for DNA sequences derived in this study are presented along with museum catalog numbers for voucher specimens in the Suppl. material 1. GenBank accession numbers for other scorpaenid sequences included in the genetic analysis are *Scorpaenodes guamensis* (Quoy and Gaimard) HQ945882, *S. parvipinnis* (Garrett) JQ350352, *Scorpaenodes* sp. KJ968262, *S. varipinnis* Smith JF494468, *S. kelloggi* (Jenkins) KF489747, *S. rubrivinctus* Poss et al. GU357570, *S. corallinus* Smith JQ432120, *S. minor* (Smith) JQ432127, and *Scorpaena plumieri* JQ8402070. BOLD accession number for *S. albaiensis* is DSLAF552-08.

Taxonomy

Stellate Scorpionfish

Scorpaenodes barrybrowni Pitassy & Baldwin, sp. n.

<http://zoobank.org/7511A771-86F4-46D2-8CBF-2B3C28755C94>

Figs 1–2A

Type locality. Curaçao, eastward of Substation Curaçao downline, 12.0832°N, 68.8991°W, D. R. Robertson, B. Brandt, A. Driskell, R. Loendersloot, K. Stewart, 30 May 2011.

Holotype. USNM 406390, Smithsonian DNA number CUR11390, 37.1 mm SL, *Curasub* submersible, sta. 11-5, Curaçao, eastward of Substation Curaçao downline, 12.0832°N, 68.8991°W, 95–160 m, 30 May 2011, D. R. Robertson, B. Brandt, A. Driskell, R. Loendersloot, K. Stewart.

Paratypes. USNM 406138, Smithsonian DNA number CUR11138, 30.4 mm SL, *Curasub* submersible, sta.11-02, Curaçao, off Substation Curaçao downline, 12.0832°N 68.8991°W, 137–146 m, 23 May 2011, C. Baldwin, D. R. Robertson, A. Schrier, B. Brandt; CAS 241446, Smithsonian DNA number CUR13257, 38.1 mm SL, *Curasub* submersible, sta. 13-14, Curaçao, off Substation Curaçao downline, 12.0832°N, 68.8991°W, 135 m, 9 August 2013, C. Baldwin, D. R. Robertson, A. Driskell, B. van Bebber; USNM 430028, Smithsonian DNA number CUR13322,



Figure 1. *Scorpaenodes barrybrowni* sp. n., holotype, USNM 406390, Smithsonian DNA number CUR 11390, 37.1 mm SL – before preservation (**A** photo by C. Baldwin and R. Robertson) and after preservation (**B** photo by D. Pitassy).

30.7 mm SL, *Curasub* submersible, sta. 13-31, Curaçao, west of Substation Curaçao downline, 12.0832°N, 68.8991°W, 223–235 m, 1 November 2013, C. Baldwin, D. R. Robertson, B. Brandt, C. Castillo; USNM 426717, Smithsonian DNA number CUR13179, 46.6 mm SL, *Curasub* submersible, Dive 2, Kralendijk, Bonaire City Dock, 12.1500°N, 68.2829°W, 114 m, 30 May 2013, C. Baldwin, A. Schrier, B. van Bebber, T. Christiaan.

Non-type specimens. USNM 438436, Smithsonian DNA number DOM16034, 50.0 mm SL, *Curasub* submersible, sta. 16-11, Dominica, Prince Rupert Bay, 15.5551°N, 60.4641°W to 15.5624°N, 61.4745°W, 146 m, 7 March 2016, C. Baldwin, B. Van Bebber, A. Schrier, B. Hoeksema; USNM 438437, Smithsonian DNA number DOM16086, 45.0 mm SL, *Curasub* submersible, sta. 16-15, Dominica, Prince Rupert Bay, 15.5551°N, 61.4746°W, depth not recorded, 10 March 2016, A. Schrier, B. Van Bebber, D. Felder, A. Collins.

Diagnosis. A species of *Scorpaenodes* distinguished by the following combination of characters: dorsal-fin soft rays 8; pectoral-fin rays 16–17, rays 11–12 (from uppermost ray) noticeably longer than rest in smallest four type specimens; caudal-fin rays 25–27; vertebrae 24 (8 precaudal + 16 caudal); spines on suborbital ridge 4 (rarely 5);

secondary suborbital ridge spines absent; two prominent round to oblong pores in suborbital sensory canal immediately ventral to suborbital ridge; coronal, interorbital, upper post temporal and postorbital spines absent; lateral line incomplete, 8-10 pored scales extending from behind supracleithral spine to mid body; cirri associated with nasal, supraocular, and parietal spines and present on posteroventral projection of lacrimal and upper left quadrant of orbit; no cirri associated with postocular, tympanic, supracleithral, and lower posttemporal spines; body relatively elongate, depth at origin of dorsal fin 30–32% SL, depth at caudal peduncle 9–10% SL. Color in life bright orange-red with several reddish-brown bars on posterior portion of trunk; pectoral fin with vivid yellow spots interspersed with bright orange-red spots.

Description. Dorsal fin XIII, 8, last soft ray split to base but supported in serial association by a single pterygiophore. Anal fin III, 5, last soft ray split to base but serially supported by single pterygiophore. Pectoral-fin rays 16–17, 17 (left)/17 (right) in holotype and three paratypes, 17/16 in one paratype. Upper-limb gill rakers 5–6 (2 rakers and 3–4 rudiments), lower limb 9–12 (8–9 rakers and 1–3 rudiments) = 14–18 total, 6 + 12 = 18 in holotype. Vertical scale rows 34–45, 41 in holotype. Pored lateral-line scales 8–10, 9 in holotype, scales extending from behind supracleithral spine to mid body. Vertebrae 8 + 16 = 24.

Morphometric data for type material given in Table 1. In the following, condition in holotype given in parentheses. Head large, length 44–48% SL (48% SL). Snout length 12–14% SL (12%), slightly shorter than orbit diameter, 14–15% SL (14%). Posterior portion of lacrimal with two somewhat rounded, ventrally directed projections. Suborbital ridge usually with 4, rarely 5, laterally directed spines (4), first at level of anterior rim of eye, second just posterior to center of eye, third and fourth posterior to orbit; spines positioned close together, with fourth spine at terminal end of suborbital ridge. Fifth spine, when present, appearing supplemental to fourth suborbital spine. Secondary suborbital ridge or spines absent. The two, large, suborbital pores positioned just below bases of second and third suborbital spines. Preopercle with 4 or 5 spines on posterior margin (5); uppermost spine largest, directed posteriorly, and in line with spines present on suborbital ridge. A conspicuous supplemental spine located immediately anterior to uppermost preopercular spine, and shafts of the two spines may appear merged with more or less distinct points; second preopercular spine sharp, located immediately ventral to first, and noticeably smaller than first and third spines; third spine more triangular in appearance, less sharp, directed posteroventrally; fourth spine similar in size or smaller than third, both directed ventrally; fifth spine rudimentary. Opercle with two pointed spines. Postocular, tympanic, parietal, nuchal, supracleithral, lower posttemporal, pterotic, and cleithral spines present, strongly developed, and with sharp points. Nasal, preocular, supraocular, and sphenotic spines distinct and pointed but diminutive relative to aforementioned spines. Interorbital ridges miniscule, lacking spines. Coronal, upper temporal, and postorbital spines absent. Cirri associated with nasal, supraocular, and parietal spines and present on posteroventral projection of lacrimal and upper left quadrant of eye. Cirri present or absent in association with preocular, nuchal, and second suborbital spines, and

Table 1. Morphometric characters of *Scorpaenodes barrybrowni*, sp. n., expressed as percentages of standard length. Means (in parentheses) include values of the holotype.

	HOLOTYPE	PARATYPES
	USNM 406390	n = 4
Standard length (mm)	37.1	30.4–46.6
Head length	47.7	44.4–46.0 (45.9)
Snout length	12.1	11.5–13.6 (12.4)
Orbit diameter	14.0	13.5–14.5 (13.9)
Interorbital width	4.7	4.3–5.4 (4.8)
Body depth	31.0	30.0–32.2 (31.1)
Caudal peduncle depth	9.9	8.9–10.0 (9.6)
Caudal peduncle width	14.5	13.9–16.6 (14.9)
Upper jaw length	24.0	21.9–23.4 (22.9)
Pre-Pelvic length	41.0	37.7–39.8 (39.3)
Pre-Dorsal length	45.1	42.9–46.4 (44.8)
Pre-Anal length	76.3	71.5–76.2 (74.5)
First dorsal spine length	6.2	5.7–6.5 (6.1)
Second dorsal spine length	7.8	8.3–11.3 (9.8)
Longest dorsal spine length	16.2	15.2–18.1 (16.3)
Twelfth dorsal spine length	3.2	4.0–6.6 (4.6)
Thirteenth dorsal spine length	11.1	10.7–11.8 (11.2)
Longest soft dorsal ray	14.6	15.6–16.6 (15.9)
First anal spine length	9.4	8.3–10.9 (9.9)
Second anal spine length	16.4	17.4–19.8 (18.4)
Third anal spine length	14.0	14.9–15.3 (14.9)
Longest soft anal ray	18.3	17.1–20.6 (19.0)
Caudal fin length	29.4	25.7–30.1 (28.4)
Pectoral fin length	31.8	29.7–35.3 (32.9)
Pelvic spine length	18.9	17.4–19.4 (18.7)
Pelvic fin length	23.7	23.7–24.9 (24.3)

anteriormost of the two ventral lacrimal projections. Cirri branched or unbranched at distal tips. Supraocular cirrus noticeably longer than others. Various fleshy lappets may be present on body, especially adjacent to lateral line. No cirri on ventral surface of mandible. Anterior nostril in short tube with broad, well-developed nasal flap/cirrus on posterior margin. Posterior nostril in short tube formed posteriorly by orbit and anteriorly by sheath of transparent skin.

Dorsal fin originating above upper edge of opercle, fourth or fifth spines longest; penultimate shortest; fin membranes between spines incised. Anal fin with 3 spines, second longer, more robust than first or third. Uppermost pectoral-fin ray unbranched, second branched or unbranched (branched in holotype), next 7–9 rays branched (8 in holotype), ventralmost 7–8 rays unbranched (7 in holotype). Longest pectoral-fin rays usually in position 11–12 from uppermost ray and usually conspicuously longer than surrounding rays (rays in ventral half of fin broken on left side of holotype, 11th

and 12th rays on right side conspicuously elongate). In largest type specimen (USNM 425717, 46.6 mm SL), 10th pectoral-fin ray longest and 11th and 12th rays not distinctly longer than neighboring rays. Pectoral fin may terminate anterior to anal fin or reach past origin of anal-fin spines. Pelvic fin terminating well anterior to anal-fin insertion, pelvic spine shorter than soft pelvic rays. Caudal fin with 25–27 total rays (25), dorsal lobe with 7 unbranched + 6 branched rays, ventral lobe with 5–6 branched + 7–8 unbranched (5+7).

No prominent knob at symphysis of lower jaw. Four distinct mandibular pores, the first very small and situated immediately posterior to symphysis. Gill rakers relatively short but slender.

Pseudobranch present but with poorly formed lamellae. Premaxilla and dentary each with band of small teeth in multiple rows, bands broadest near symphysis. Vomer with chevron-shaped patch of teeth in 3–4 rows. No teeth on palatine, pterygoids, or tongue. Swimbladder present.

Color description based on image of a living specimen in an aquarium brought to the surface alive from 114 m (USNM 426717, Fig. 2A) and from color images of recently deceased type material (e.g., USNM 406390, Fig. 1A). Body mostly orange to pinkish orange, paler on underside of head and belly; lower portion of body with diffuse areas of translucent yellow pigment; body lappets pink to white. Nasal and supraorbital cirri pink to orange; pupil black, encircled successively distally by thin cream ring, ring of short dark brown or grey bars on whitish or orange background, and ring of reddish-brown to orange bars on pink to grey background; two dark markings below ventral portion of eye forming part of red/orange bar that extends ventrally across mouth; this bar followed posteriorly by short red/orange bar or marking on lower jaw; in living specimen, another two dark markings (anterior one part of outer orbital ring of pigment) forming part of oblique, reddish-brown bar extending from posteroventral portion of orbit to posteroventral edge of operculum; snout, anterior portions of jaws, and dorsal portion of cheek pink to orange; posterior portions of jaws and ventral portion of remainder of head pink to clear; series of indistinct, narrow reddish-brown bars present across dorsal portions of head and nape; lappets on jaws creamy yellow. Body with five orange-brown to brown blotches, posteriormost three forming well-defined bars: anteriormost blotch on nape above rear corner of opercle and extending posteriorly beneath first three dorsal-fin spines; second blotch broadest, irregular in shape, with pale center, situated mostly beneath dorsal spines 6–10 and narrowing ventrally but extending anteriorly to rear edge of opercle along lateral line; third marking a bar beneath anterior half of soft dorsal fin; fourth the narrowest and most indistinct, located on caudal peduncle immediately behind bases of dorsal and anal fins; and fifth strong, narrow, and situated on posterior edge of caudal peduncle. Spinous dorsal fin mostly orange with scattered pale or pale pink streaks and usually a blackish-brown ovoid blotch across bases of spines 7–10; this dark blotch poorly defined in 46.6-mm SL specimen (USNM 426717, Fig. 2A) and appearing as several smaller spots; soft-dorsal fin with broad, bright orange stripe at base, sometimes with a few dark spots near the base; remainder of fin mainly clear with two to several irregular

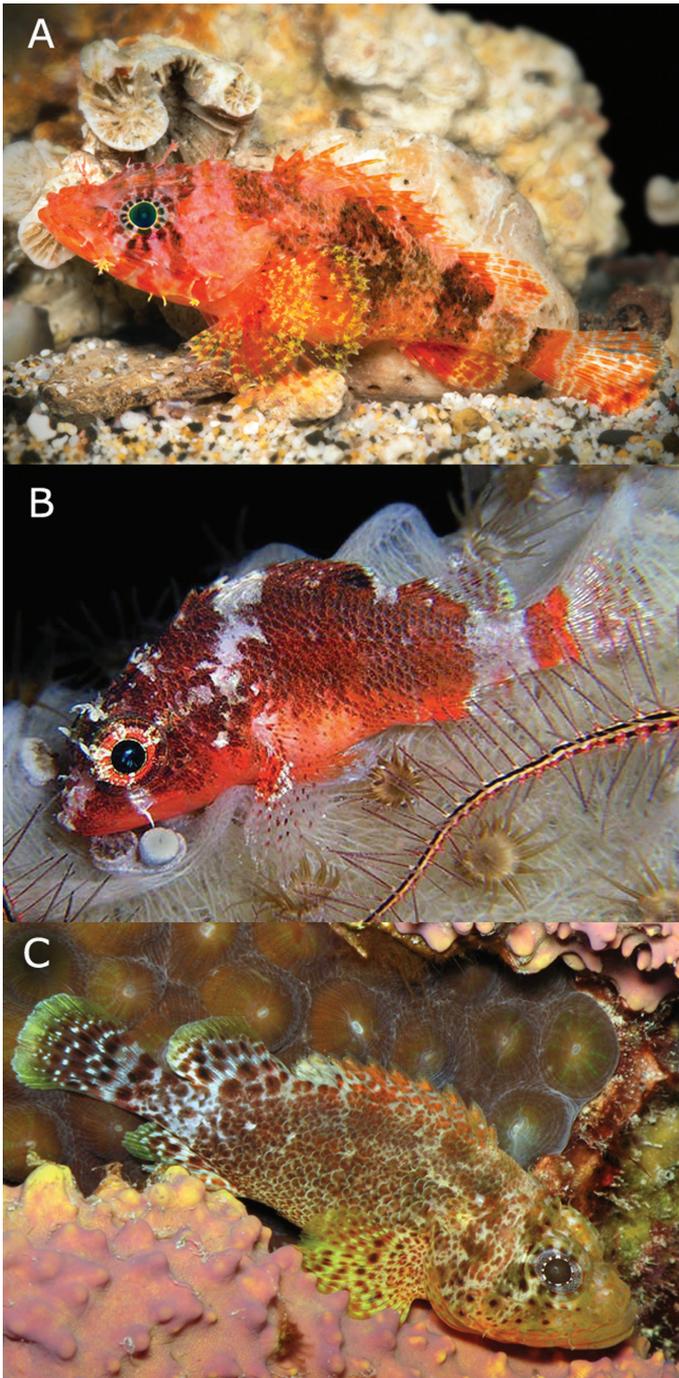


Figure 2. Comparison of living specimens of **A** *Scorpaenodes barrybrowni* sp. n., paratype, USNM 426717, 38.1 mm, with its two western Atlantic congeners: **B** *Scorpaenodes tredecimspinosus* and **C** *Scorpaenodes caribbaeus*. Photos: *S. barrybrowni* Barry Brown, *S. tredecimspinosus* Ellen Muller, *S. caribbaeus* Brian Mayes.

rows of orange spots; smallest specimen (30.4 mm SL) without dark body blotches or bars and without broad stripe of orange at base of soft dorsal fin. Base of caudal fin with strong orange bar immediately behind posteriormost peduncular bar, rest of fin with translucent membranes and irregular rows of elongate orange spots. Anal fin with broad orange stripe at base, distal portion of fin with translucent membranes and 2–3 irregular rows of orange spots; orange stripes at bases of soft dorsal and anal fins connected to third body blotch (anteriormost of the three well-defined bars), giving the appearance of a single orange (fins) to orangish-brown (body) bar. Pelvic fin spine whitish, basal half of soft-pelvic fin pale orange, fading distally to translucent/yellowish. Pectoral fin base pale pinkish, base of fin orange, orange extending posteriorly along several rays in ventral portion of fin; remainder of fin paler and with irregular pattern of orange and yellow spots; yellow xanthophores appearing as expanded, stellate pigment markings in living specimen (Fig. 2A).

Color of holotype in alcohol (Fig. 1B). Ground color light tan. Head with dark grey eye with varying numbers of short, radiating, dark brown lines or bars, some of these extending onto portions of head adjacent to orbit; a dark blotch beneath eye above posterior end of upper jaw; another dark blotch extending from posterior edge of orbit obliquely to rear edge of preopercle; snout, maxilla, operculum, and nape with scattered dark spots, a dark blotch above posterodorsal region of orbit. Body with five dark blotches or bars described in fresh specimens retained in preservative. Dorsal fin translucent with scattered dark specks and an oval black blotch on bases of spines 7–10 in all type specimens except the largest (46.6 mm SL), which has scattered dark markings on spines 6–10 as well as a bit of dark pigment at bases of spines 1–3; soft dorsal with dark blotch at base above dark body bar; remainder of fin clear. Caudal fin translucent. Anal fin translucent, usually with dark smudge on fin continuous with dark body bar. Pelvic fins translucent. Pectoral fins translucent, with one or more irregular dark spots on central fin rays.

Distribution. Known from Curaçao and Bonaire in the southern Caribbean, and Dominica in the Windward Islands, eastern Caribbean.

Habitat. Collected off Curaçao at 95–160 m on rocky substrata. Off Dominica, USNM 438436 was collected on a vertical rock wall.

Etymology. Named in honor of Barry Brown, Substation Curaçao and free-lance photographer (www.coralreefphotos.com), who has patiently, diligently, and expertly taken photographs of hundreds of fishes and invertebrates captured alive by DROP investigators. He has generously shared his photographs, and they have enhanced numerous scientific and educational publications. An example of his work is here featured in Fig. 2A.

Common name. Stellate Scorpionfish, in reference to the yellow, stellate chromatophores on the pectoral fin in life and the radiating pigment markings accentuating the eye. Spanish common name: Escorpión Estrellado.

Genetic comparisons. Figure 3 shows the results of the maximum parsimony analysis of the COI sequences, which clearly support recognizing *S. barrybrowni* as a species distinct from western Atlantic *S. caribbaeus* and *S. tredecimspinosus*. Table 2

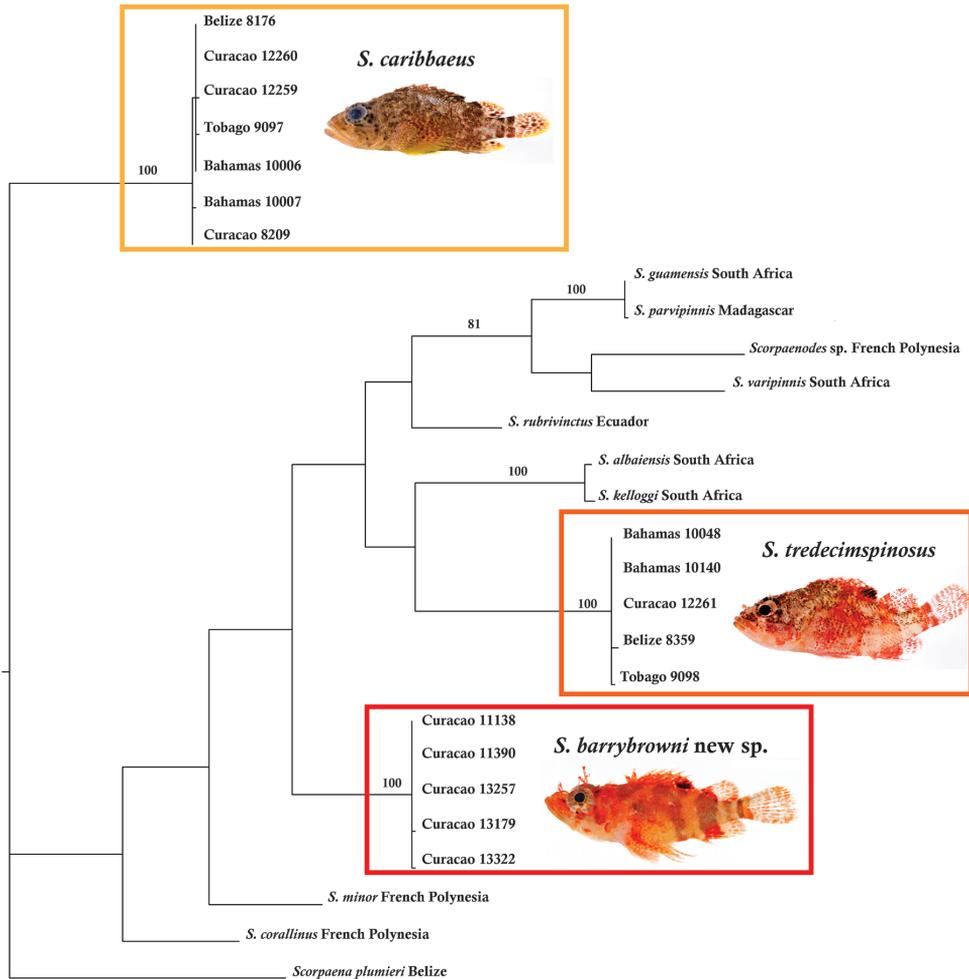


Figure 3. The strict consensus of a maximum parsimony analysis of the COI region of 26 individuals of *Scorpaenodes*. The tree was rooted on *Scorpaena plumieri*. Numbers above branches represent bootstrap support values > 50.

shows genetic distances within each species and between pairs of species included in the analysis. Intraspecific genetic variation is 0.0–0.2% for *S. barrybrowni* and 0.0–0.5% for both *S. caribbaeus* and *S. tredecimspinosus*, whereas interspecific divergences among the ten members of the genus for which data are available, including *S. barrybrowni*, are 14.5–23.2%. The COI data are insufficient to resolve most relationships among *Scorpaenodes* species with any confidence (only bootstrap values >50 are shown on the tree). A clade comprising *S. guamensis*, *S. parvipinnis*, *S. varipinnis*, and an unidentified *Scorpaenodes* from French Polynesia has a bootstrap value of 81. Note that *S. guamensis* from South Africa and *S. parvipinnis* from Madagascar appear to be the same species (0.2% divergence), which either indicates that they are synonymous or one of the

Table 2. Range and average Kimura two-parameter distance summary for species of *Scorpaenodes* based on cytochrome c oxidase I (COI) sequences analyzed genetically in this study. Intraspecific values are in bold.

	<i>S. caribbaeus</i>	<i>S. guamensis</i>	<i>S. parvipinnis</i>	<i>Scorpaenodes</i> sp.	<i>S. varipinnis</i>	<i>S. barrybrouni</i> sp. n.
<i>S. caribbaeus</i>	0.0–0.5 (0.2)					
<i>S. guamensis</i>	20.0–20.3 (20.2)	NA				
<i>S. parvipinnis</i>	20.1–20.3 (20.2)	0.2	NA			
<i>Scorpaenodes</i> sp.	21.8–22.0 (21.9)	15.1	15.1	NA		
<i>S. varipinnis</i>	19.4–19.8 (19.6)	14.3	14.3	14.8	NA	
<i>S. barrybrouni</i>	21.5–23.2 (21.8)	15.5–15.7 (15.6)	15.2–15.3 (15.3)	19.6–19.8 (19.7)	19.5–19.7 (19.6)	0.0–0.2 (0.1)
<i>S. albatensis</i>	18.3–18.5 (18.4)	18.8	18.5	20.7	18.2	16.3–16.5 (16.4)
<i>S. kelloggi</i>	18.7–19.1 (18.9)	18.6	18.3	20.9	18.6	16.1–16.3 (16.2)
<i>S. rubrivinctus</i>	18.7–19.0 (18.9)	14.7	14.5	18.5	15.9	14.5–14.7 (14.6)
<i>S. corallinus</i>	18.5–18.9 (18.7)	19.3	19.5	20.5	18.4	16.3–16.5 (16.4)
<i>S. minor</i>	21.1–21.6 (21.3)	17.2	17.4	18.4	17.7	15.1–15.3 (15.2)
<i>S. tredecimspinosus</i>	18.8–19.7 (19.2)	17.5–18.1 (17.6)	17.7–18.3 (17.8)	18.7–19.0 (18.9)	20.2–20.4 (20.2)	18.4–19.0 (18.8)
	<i>S. albatensis</i>	<i>S. kelloggi</i>	<i>S. rubrivinctus</i>	<i>S. corallinus</i>	<i>S. minor</i>	<i>S. tredecimspinosus</i>
<i>S. caribbaeus</i>						
<i>S. guamensis</i>						
<i>S. parvipinnis</i>						
<i>Scorpaenodes</i> sp.						
<i>S. varipinnis</i>						
<i>S. barrybrouni</i>						
<i>S. albatensis</i>	NA					
<i>S. kelloggi</i>	0.8	NA				
<i>S. rubrivinctus</i>	14.7	14.9	NA			
<i>S. corallinus</i>	21.5	21.7	19.2	NA		
<i>S. minor</i>	17.2	0.2	15.4	15.6	NA	
<i>S. tredecimspinosus</i>	19.4–19.7 (19.7)	19.8–20.3 (20.1)	18.2–18.6 (18.3)	18.8–19.4 (19.0)	19.9–20.2 (19.0)	0.0–0.5 (0.2)

specimens from which the sequences in GenBank were derived is misidentified. Likewise, *S. albaiensis* and *S. kelloggi* from South Africa are very similar (0.8% divergence). If one constructs a neighbor-joining tree online at BOLD (<http://www.boldsystems.org/>) for *Scorpaenodes*, there are numerous misidentifications or taxonomic issues that need to be resolved. For example, *S. varipinnis*, *S. parvipinnis*, and *S. guamensis* all appear in at least three genetic lineages. Additional analyses are needed, but our preliminary COI data would not appear to support a monophyletic clade of western Atlantic *Scorpaenodes*.

Morphological comparisons. The presence of thirteen dorsal-fin spines and absence of palatine teeth support the placement of the new species in the genus *Scorpaenodes* (Poss and Eschmeyer 2003). The combination of features provided in the diagnosis distinguishes *S. barrybrowni* from all congeners. Characters that distinguish *S. barrybrowni* from one or both of its western Atlantic congeners, *S. caribbaeus* and *S. tredecimspinosus*, are tabulated in Table 3 and summarized below. *Scorpaenodes barrybrowni* usually has a shallower body (depth at dorsal-fin origin 30–32% SL vs. 32–41% SL in *S. caribbaeus* and *S. tredecimspinosus*), usually a shallower caudal peduncle (depth 9–10% SL vs. 10–12% SL), two large round pores below the suborbital ridge (vs. several small pores), an incomplete lateral line comprising 8–10 pored scales (vs. a complete lateral line comprising 22–25 pored scales), and more caudal-fin rays (25–27 vs. usually 23–24). Interorbital, coronal, and upper posttemporal spines were not observed in *S. barrybrowni*, but all three are generally present in *S. caribbaeus* and the interorbital and coronal (and sometimes the upper posttemporal) are present in *S. tredecimspinosus*. Furthermore, *S. barrybrowni* has more slender gill rakers than the short, stubby elements of *S. caribbaeus* and *S. tredecimspinosus*; and the pseudobranch of *S. barrybrowni* is poorly formed, with fat, sausage-like lamellae vs. a very well-organized, comb-like pseudobranch in *S. caribbaeus* and *S. tredecimspinosus*. Color pattern of *S. barrybrowni* is distinct from that of *S. caribbaeus* and *S. tredecimspinosus* in many aspects (Fig. 2), but notably from the former in generally being bright orange (vs. mostly brown to reddish-brown) and from the latter in having yellow pigment on the pectoral fin. Finally, *S. barrybrowni* inhabits depths of 95–160 m vs. < 35 m for *S. caribbaeus* and 8–82 m for *S. tredecimspinosus* (Robertson and Van Tassell 2015).

Additional characters that differentiate *S. barrybrowni* from *S. caribbaeus* include fewer soft dorsal-fin rays (8 in *S. barrybrowni* vs. 9 in *S. caribbaeus*); usually fewer pectoral-fin rays (16–17 vs. 17–20); absence of secondary suborbital spines (vs. usually 1 or more), different vertebral counts (8 precaudal + 16 caudal vs. 9 + 15), fewer spine-associated cirri on head (*S. barrybrowni* lacks cirri associated with postocular, tympanic, supraclethral, and lower posttemporal spines, *S. caribbaeus* has cirri associated with most spines on the head). *Scorpaenodes barrybrowni* is smaller, reaching approximately 47 mm SL vs. 85 mm SL in *S. caribbaeus*.

Additional characters that distinguish *S. barrybrowni* from *S. tredecimspinosus* include more suborbital spines (4–5 in *S. barrybrowni* vs. usually 2, occasionally 1 or 3, in *S. tredecimspinosus*) and fewer soft dorsal-fin rays (8 vs. 9). Both species reach a similar maximum size (47 vs. 45 mm SL).

Table 3. Comparison of morphological characters in *Scorpaenodes barrybrowni*, sp. n., *S. caribbaeus*, and *S. tredecimspinosus*.

	<i>Scorpaenodes barrybrowni</i> sp. n. n = 5	<i>Scorpaenodes caribbaeus</i> n = 15	<i>Scorpaenodes tredecimspinosus</i> n = 13
Maximum SL (mm)	< 50	> 60	< 50
Body depth/ SL	30–32%	33–39%	32–41%
Caudal peduncle depth/ SL	9–10%	10–12%	11–12%
Soft dorsal-fin rays	8	9	9
Pectoral-fin rays	16–17	18–20	16–17
Caudal-fin rays	25–27	23–24	23–24
Pre-caudal + caudal vertebrae	8+16	9+15	8+16
Pored lateral line scales	8–10	22–25	22–23
Suborbital spines	4–5	3–6	1–3
Secondary suborbital spines	Absent	Present	Absent
Suborbital ridge pores	2, large	Multiple, small	Multiple, small
Coronal spines	Absent	Usually present	Usually present
Interorbital spines	Absent	Usually present	Usually present
Upper posttemporal spines	Absent	Usually present	Sometimes present
Gill raker shape	Slender	Stout	Stout
Pseudobranch lamellae	Stout	Slender	Slender
Pectoral fin color	Orange-red and yellow	Brownish red and yellow	Dark red and pink

Comparative material examined. *Scorpaenodes caribbaeus*, 15 specimens, 20.1–63.7 mm. BAHAMAS: USNM 415441, Smithsonian DNA number BAH 10006, 43.3 mm SL, BAH 10-01, Berry Islands, Great Stirrup Cay, 25.8261°N, 77.9189°W, 6–9 m, 7 August 2010, C. Baldwin, A. Driskell, L. Lang; USNM 415442, Smithsonian DNA number BAH 10007, 29.4 mm SL, BAH 10-01, Berry Islands, Great Stirrup Cay, 25.8261°N, 77.9189°W, 6–9 m, 7 August 2010, C. Baldwin, A. Driskell, L. Lang. BELIZE: USNM 404029, Smithsonian DNA number BLZ10029, 25.5 mm SL, CB10-02, Shallow spur and groove off north side of Carrie Bow Cay, 16.8007°N, 88.0783°W, 0–12 m, 11 November 2010, C. Baldwin, M. Fagan-Halloran; USNM 415314, Smithsonian DNA number BLZ 8313, 27.1 mm SL, CB 08-29, Sand bores ~ 3 miles southwest of Carrie Bow Cay, 16.7718°N, 88.1117°W, 0–9 m, 24 May 2008, C. Baldwin, Z. Foltz, D. Smith; USNM 415248, Smithsonian DNA number BLZ 8176, 32.9 mm SL, CB 08-17, Whale Shoals, South Cut, in and out of reef, 16.7598°N, 88.0761°W, 0–5 m, 20 May 2008, C. Baldwin, Z. Foltz, L. Weigt; USNM 415016, Smithsonian DNA number BLZ 7156, 33.5 mm SL, CB 07-14, Outer ridge east of Carrie Bow Cay, 21–23 m, 16 January 2007, D. Miller, J. Mounts; USNM 421926, Smithsonian DNA number BLZ 8358, 48.1 mm SL, CB 08-32, Tobacco Cay, 16.8899°N, 88.0649°W, 0–5 m, 25 May 2008, C. Baldwin, Z. Foltz, D. Smith, L. Weigt. CURAÇAO: USNM 413616, Smithsonian DNA number CUR 8209, 46.8 mm SL, CUR 08-04, Boca Sami, 12.1487°N, 68.9994°W, 0–3 m, 13 March 2008, C.

Baldwin, L. Weigt; USNM 414799, Smithsonian DNA number CUR 12259, 25.6 mm SL, CUR12-03, Klein Curaçao, northwest tip of island, 6–15 m, 11 August 2012, C. Baldwin, A. Driskell; USNM 413818, Smithsonian DNA number CUR 12260, 20.1 mm SL, CUR12-03, Klein Curaçao, northwest tip of island, 6–15 m, 11 August 2012, C. Baldwin, A. Driskell. PANAMA: USNM 81619, Holotype, 63.7 mm SL, Toro Point, Canal Zone, Atlantic at Colon, 19 May 1911, S. Meek, S. Hildebrand. TRINIDAD AND TOBAGO: USNM 413274, Smithsonian DNA number Smithsonian DNA number TOB 9097, 50.8 mm SL, TOB 09-04, Tobago, Store Bay, 11.1558°N, 60.8423°W, 5–9 m, 16 March 2009, C. Baldwin, L. Weigt, D. Smith; USNM 413273, Smithsonian DNA number TOB 9096, 55.1 mm SL, TOB 09-04, Tobago, Store Bay, 11.1558°N, 60.8423°W, 5–9 m, 16 March 2009, C. Baldwin, L. Weigt, D. Smith. TURKS AND CAICOS ISLANDS: USNM 414116, Smithsonian DNA number TCI 9394, 41 mm SL, TCI 09-09, South Caicos, East Bay, 21.5374°N, 71.4801°W, 0–5 m, 9 October 2009, J. Williams, C. Castillo, M. Fagan-Halloran, B. Holt, B. Matulis; USNM 414115, Smithsonian DNA number TCI 9393, 45 mm SL, TCI 09-09, South Caicos, East Bay, 21.5374°N, 71.4801°W, 0–5 m, 9 October 2009, J. Williams, C. Castillo, M. Fagan-Halloran, B. Holt, B. Matulis.

Scorpaenodes tredecimspinosus, 13 specimens, 20.7–44.8 mm. BAHAMAS: USNM 415463, Smithsonian DNA number BAH 10048, 35.3 mm SL, BAH 10-07, Berry Islands, Great Stirrup Cay, 25.8261°N, 77.9189°W, 9 m, 9 August 2010, C. Baldwin, A. Driskell, J. Lang; USNM 415512, Smithsonian DNA number BAH 10140, 26.7 mm SL, BAH 10-11, Berry Islands, Chub Cay, 25.3993°N, 77.8909°W, 21–24 m, 11 August 2010, C. Baldwin, A. Driskell. BELIZE: USNM 415200, Smithsonian DNA number BLZ 8037, 24.7 mm SL, CB 08-02, Curlew, outer ridge, 16.7900°N, 88.0781°W, 5–8 m, 15 May 2008, C. Baldwin, Z. Foltz, L. Weigt; USNM 415331, BLZ 8359, 29.3 mm SL, CB 08-32, Tobacco Cay, 16.8899°N, 88.0649°W, 0–5 m, 25 May 2008, C. Baldwin, Z. Foltz, D. Smith, L. Weigt. BONAIRE: USNM 216451, Paralectotype, 36.1 mm SL, Dutch West Indies, Bonaire, 1904, J. Boeke. CURAÇAO: USNM 413408, Smithsonian DNA number CUR 8204, 28.1 mm SL, CUR 08-04, Boca Sami, 12.1487°N, 68.9994°W, 0–3 m, 13 March 2008, C. Baldwin, L. Weigt; USNM 413812, Smithsonian DNA number CUR 12261, 25.3 mm SL, CUR12-03, Klein Curaçao, northwest tip of island, 11.9985°N, 68.6513°W, 6–15 m, 11 August 2012, C. Baldwin, A. Driskell; USNM 413836, Smithsonian DNA number CUR 12178, 20.7 mm SL, CUR12-02, Klein Curaçao, southwest tip of island, 11.9758°N, 68.6462°W, 0–3 m, 11 August 2012, D. R. Robertson, C. Castillo, P. Mace. TRINIDAD AND TOBAGO: USNM 319121, 37.7 mm SL, JTW 90-10, Tobago, Buccoo Reef, outer reef slope, 11.1850°N, 60.8228°W, 14 m, 10 September 1990, J. Williams, J. Howe, G. Johnson, S. Blum, M. Nizinski, T. Munroe; USNM 413271, Smithsonian DNA number TOB 9098, 33.7 mm SL, TOB 09-04, Tobago, Store Bay, 11.1558°N, 60.8423°W, 5–9 m, 16 March 2009, C. Baldwin, L. Weigt, D. Smith. TURKS AND CAICOS ISLANDS: USNM 411912, Smithsonian DNA number TCI 9036, 22.8 mm SL,

TCI 09-01, South Caicos, East Bay, 21.4919°N, 71.5176°W, 0–2 m, 7 October 2009, C. Baldwin, J. Williams, L. Weigt, C. Castillo, M. Fagan-Halloran, B. Holt, B. Matulis. UNITED STATES, FLORIDA: USNM 108875, 38.3 mm SL, South of Tortugas, 82 m, 14 July 1915, W. Longley; USNM 108876, 44.8 mm SL, South of Tortugas, 82 m, 14 July 1915, W. Longley.

Discussion

Poss et al. (2010) noted that the limits of *Scorpaenodes* are uncertain. Historically, shallow-water species such as *S. albaiensis* (Evermann and Seale) and *S. minor* (Smith), in which the uppermost unbranched rays of the pectoral fin are elongate, have been placed in *Hypomacrus*. Eschmeyer (1969) relegated *Hypomacrus* to the synonymy of *Scorpaenodes*, Mandrytsa (2001) recognized *Hypomacrus* as valid, and Poss et al. (2010) followed Eschmeyer's classification. We tentatively follow Eschmeyer (1969) and Poss et al. (2010) in placing the new species in *Scorpaenodes* but note that the smallest four type specimens of *S. barrybrowni* (30.4–38.1 mm SL) have the uppermost unbranched rays of the pectoral fin (11th and 12th from the top) elongate. The largest type specimen, 46.6 mm SL, lacks elongate pectoral-fin rays, but the two specimens from Dominica are large (45.0 and 50.0 mm SL) and have the 11th and 12th rays elongate. Further study is needed to determine if factors other than evolutionary history influence this morphological character.

Scorpaenodes barrybrowni is the ninth new fish species described from deep reefs of the southern Caribbean and discovered through manned submersible diving as part of the Smithsonian's Deep Reef Observation Project – DROP (Baldwin and Robertson 2013, 2014, 2015; Baldwin and Johnson 2014; Tornabene et al. 2016a). The new species range in depth from 70–240 m, and they all belong to genera that also comprise species inhabiting shallower reef depths. Relationships between shallow- and deep-reef congeners are poorly understood, as scarce access to or no knowledge of the deep-reef species has hindered inclusive phylogenetic analyses. In a recent molecular phylogenetic analysis incorporating new deep-reef goby species from the southern Caribbean, Tornabene et al. (2016b) found multiple, co-occurring but independent transitions from shallow to deep reefs with subsequent species radiations on deep reefs in some genera. Considerably more molecular data and better taxon sampling are needed to conduct similar investigations of depth transitions in *Scorpaenodes*.

Numerous other new fish and invertebrate species already discovered through exploratory submersible diving by DROP await description, and ongoing submersible diving in the southern and other parts of the Caribbean will almost certainly result in the continued discovery of new marine life. Globally, tropical deep reefs, which are below depths accessible with conventional scuba gear and above depths typically frequented by deep-diving submersibles, are diverse, underexplored ecosystems.

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Appendix

Table Links between DNA voucher specimens, GenBank accession numbers, and cytochrome c oxidase subunit I (COI) sequences of *Scorpaenodes* derived for use in this study. Other GenBank accession information is provided in the Materials and methods section. CUR = Curaçao, BAH = Bahamas.

Catalog Number/DNA Number	GenBank No.	GenSeq Designation
<i>Scorpaenodes barrybrowni</i> n. sp.		
USNM 406390, CUR 11390, Holotype	KX419779	genseq-1 COI
USNM 406138, CUR 11138, Paratype	KX419778	genseq-2 COI
CAS 241446, CUR 13257, Paratype	KX459119	genseq-2 COI
USNM 430028, CUR 13322, Paratype	KX459120	genseq-2 COI
USNM 426717, CUR 13179, Paratype	KX459118	genseq-2 COI
<i>Scorpaenodes tredecimspinosus</i>		
USNM 415463, BAH 10048	KX419789	genseq-4 COI
USNM 415512, BAH 10140	KX419786	genseq-4 COI
USNM 413812, CUR 12261	KX419788	genseq-4 COI
<i>Scorpaenodes caribbaeus</i>		
USNM 415441, BAH 10006	KX419783	genseq-4 COI
USNM 415442, BAH 10007	KX419785	genseq-4 COI
USNM 414799, CUR 12259	KX419782	genseq-4 COI
USNM 413818, CUR 12260	KX419781	genseq-4 COI