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Two new Rhabdocoels (Platyhelminthes) from the Peruvian Amazon floodplain

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Abstract. Two new Rhabdocoel species from the Peruvian Amazonia are described: *Sergia calae* n. sp. (Dalyelliidae) and *Mesostoma ucamara* n. sp. (Typhloplanidae). Both species were captured in the Pacaya-Samiria National Park, Loreto, Peru, with plankton-nets dragged several times through the abundant littoral floating plant-community. This is the first record of micro-turbellarians in this region. The discovery of these new species in the Pacaya-Samiria National Park suggests the high diversity of this area, which up to now has remained largely unknown, increases the general knowledge of the fauna of Neotropical turbellarians.

Introduction

The taxonomy, ecology and distribution of the Microturbellaria of Peruvian inland-waters are virtually unknown. Beauchamp (1939) referred to three species captured in Lake Titicaca, in southern Peru: *Mesostoma ehrenbergi* (Focke 1836), *Strongylostoma radiatum* (Müller 1774) and *Gieysztoria complicata* (Fuhrman 1914). In the 1950s, Du Bois-Reymond Marcus (1958) reported *Yagua lutheri* Bois-Reymond Marcus 1958, from Lima, in Central Peru. Here we describe two new species from the Peruvian Amazonia: *Sergia calae* n. sp. (Dalyelliidae) and *Mesostoma ucamara* n. sp. (Typhloplanidae). This is the first record of turbellarians in this region. Both species were captured during an expedition in the Pacaya-Samiria National Park, Loreto, Peru.

The genus *Sergia* (Nassonov 1923), is characterized mainly by the lack of cuticle structures in the male copulatory organ (Nassonov 1923; Luther 1955), and is therefore clearly distinguishable from other genera of the Family Dalyelliidae. Only two species comprise the genus *Sergia*, i.e., *S. sergia* (Beklemischev, 1918) Nassonov 1923 and *S. mancala* (Marcus and Marcus, 1957). *Sergia sergia* is restricted to the northern Hemisphere, while *S. mancala* has only been found in Zaire (Africa).

In contrast, *Mesostoma* Örsted, 1844, is a broadly distributed genus, with more than 44 well-known species (Noreña Janssen and Faubel 1992; Tyler and Bush 2003). It is important to note that while some species are highly cosmopolitan [e.g., *M. ehrenbergi* (Focke, 1836), *M. lingua* (Abildgaard, 1789)], other species have been captured only in restricted areas (e.g., *M. africanum* Kolasa, 1976, *M. extremeniensis* Noreña et al., 1999, *M. tubiseminalis* Smith 1998).

The discovery of these new species in the Pacaya-Samiria National Park in Peru suggests the existence of a high diversity of turbellarians in this area, which up to now has remained largely unknown, and increases the general knowledge of the fauna of Neotropical turbellarians (Noreña et al. 2003). Although such a diversity has gone unnoticed, we expect it to be one of the highest in South America. The discovery of these new species calls for further assessment of the specific richness of this group of platyhelminths in the area.

Materials and methods

The material was collected during an expedition carried out to the Pacaya-Samiria National Park in September 2002. The park lies within the department of Loreto and covers an area of 2 080 000 hectares. It is the largest reserve in Peru, the second largest in the Amazon basin and the fourth largest in South America (Figure 1).

The sampling stations are located in the region delimited by the Marañon and Ucayali Rivers. This area is covered with several connection channels, called ‘caños’ (secondary beds), and lagoons and pools of different size, called ‘cochas’ (abandoned beds) (Figure 1). The sediments of these different water-bodies are very dark and muddy. Samples were collected with plankton-nets (60 μm mesh). The nets were trawled several times through the abundant littoral floating plant-community (including *Pistia* sp., *Eichhornia* sp., *Azolla* sp.) along the riverbanks or lagoon edges, which are about 50–100 cm thickness. The material was transferred to plastic containers for transport to the laboratory aboard a ship. In the laboratory the worms were counted and studied alive (pigmentation, body-shape, etc) under a stereomicroscope. Some specimens were fixed in Polyvinil-lactofenol (whole-mounts) while some individuals were fixed in Bouin’s fluid and blocked in paraplast wax. Four micrometers sections were stained in Azan (Romeis 1989), and mounted in DPX. Type specimens were deposited in the Museo Nacional de Ciencias Naturales (MNCN), Madrid, Spain.

Results and discussion

Order Rhabdocoela Graff, 1904
Family Dalyelliidae Graff, 1908
Genus *Sergia* Nassonov 1923

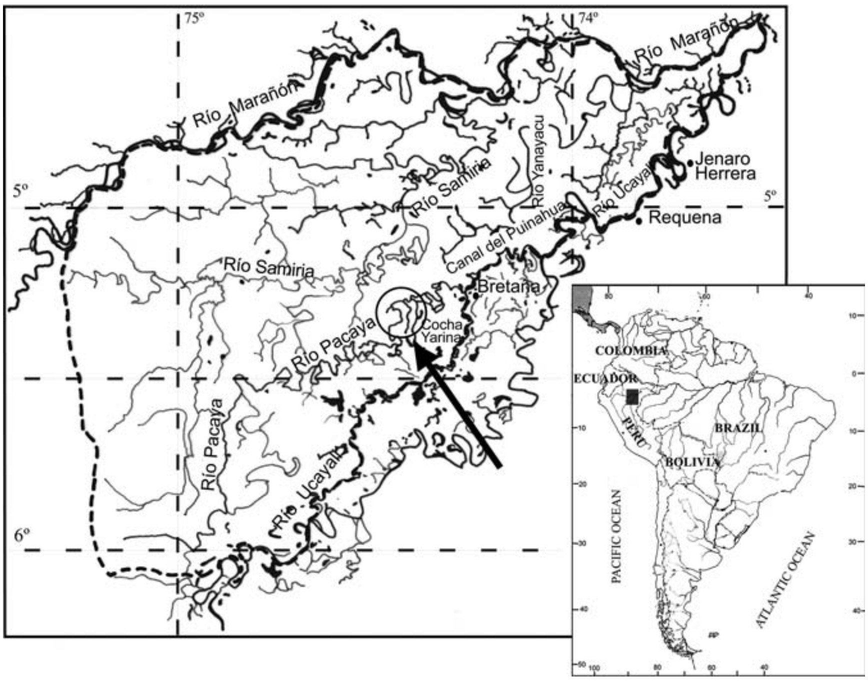

Figure 1. Pacaya-Samiria National Park, Loreto, Peru. The circle and the arrow indicate the location of the sampling place.

Sergia calae n. sp. (Figures 2 and 3)

Type locality: Pacaya-Samiria National Park, Loreto, Peru. Pool located in the semi-dry connection channel between the Cocha Zapote (05°20′16″ S, 74°29′40″ W) and the secondary arm of the Ucayali River called 'caño' Yarina. Date: 19.08.02.

Holotype: mature specimen sagittally sectioned (4 μm) deposited in the Museo Nacional de Ciencias Naturales (MNCN 4.01/47).

Further material: 1 mature individual studied alive.

Etymology: specific name dedicated to Inmaculada Calzado 'Cal', one of the best pianists of Spanish music in the present time.

Description

Body 1 mm in length. Anterior end rounded, very mobile and containing numerous glands; slight lateral narrowing behind the eyes. Maximum width behind pharynx. Posterior end elongated, forming small tail. Pigmentation dark brown, more irregular on anterior and posterior regions. Medial region orange; proximally and caudally transparent. One pair of black, rounded, clearly separated eyes in the anterior part of the body. Brain with anterior and posterior extensions surrounding eyes.

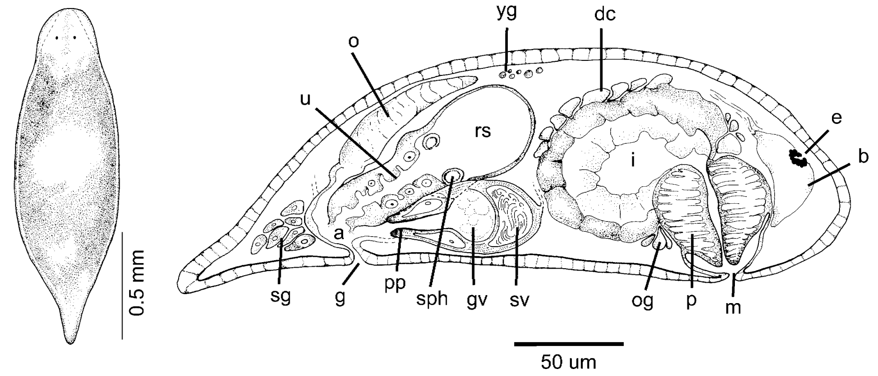

Figure 2. Dorsal view and sagittal reconstruction of *Sergia calae* n. sp. *Abbreviations*: a, atrium; b, brain; dc, dark cells; e, eye; g, genital pore; gv, granular vesicle; i, intestine; m, mouth; o, ovary; og, oesophageal glands; p, pharynx; pp, peneal papilla; rs, receptaculum seminis; sph, sphincter; sg, shell glands; sv, seminal vesicle; u, uterus; yg, yolk glands.

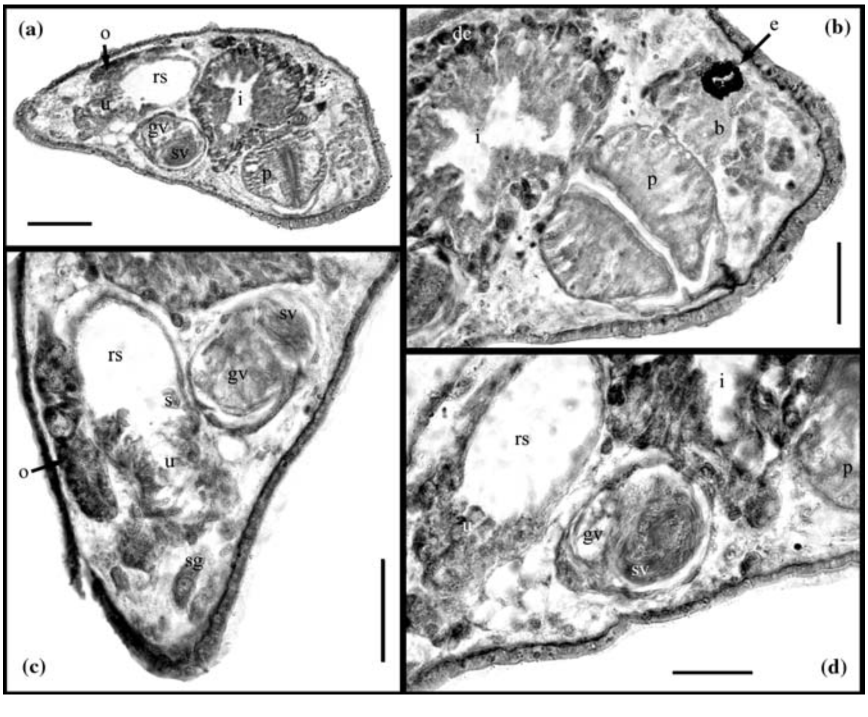

Figure 3. Sagittal sections of *Sergia calae* n. sp. (a) General view. (b) Anterior region. (c) Posterior region. (d) Detail of seminal and granulorum vesicles. *Abbreviations*: b, brain; dc, dark cells; e, eye; gv, granular vesicle; i, intestine; o, ovary; p, pharynx; rs, receptaculum seminis; s, sphincter; sg, shell glands; sv, seminal vesicle; u, uterus. Scale bar: (a) 50 μm; (b–d) 25 μm.

Mouth subterminal. Pharynx small and barrel-like. Well-developed oesophageal glands lying between pharynx and gut. Intestine externally covered by dark cells and internally by cubic vacuolated epithelium.

Corporal musculature thin, only slightly developed, composed by longitudinal, circular and diagonal muscles. Basal membrane ventrally thicker. Epithelium ciliated, very well-developed, wide, with grains of pigment. Rhabdites in groups of two, scarce and distributed over entire body.

Testes located caudally, very small, almost residual. Vas deferentia not observed but – given position and shape of seminal vesicle – possibly with common, proximal entrance into copulatory organ. Pear-shaped copulatory organ well-developed. Seminal vesicle proximal, rounded and compact. Vesicula granulorum distal and spongy. Proximal musculature of copulatory organ barely developed, but its thickness increasing gradually to form thick, muscular penial papilla. As typical for *Sergia*, no stylet, needles, or cuticular belt present. Penial papilla ending distally and entering directly into genital atrium. Absence of male genital canal. Yolk glands placed dorsally, very small with only slightly appreciable granular remains, and forming elongated germinal area at posterior end. Ovary narrow, very small, with only few ovocytes. Ovary continuing into ductus communis, which ends dorso-laterally in the caudal region of atrium. Shell glands open along ductus communis. Bursa copulatrix very tiny, only small sinuosity of genital atrium. Uterus with high and spongy epithelium and opening near male copulatory organ. Proximal region of uterus displaying conspicuous and elongated dilation operating as receptaculum seminis. Transition between receptaculum seminis and uterus regulated by sphincter of strong circular muscles. Size of the uterus and receptaculum seminis as large or larger than male copulatory organ. Eggs not observed in examined specimens.

Biology

Sergia calae n. sp. swims among the root system of various water plants (*Eichhornia* sp., *Salvinia* sp., *Azolla* sp.). Therefore, the principal habitats of *S. calae* n. sp. are ponds or pools with high plant richness. *S. calae* n. sp. was found with other microturbellarians of the genera *Stenostomum* sp., *Macrostomum* sp., *Gieysztoria* sp., *Gyratrix hermaphroditus* and with representatives of the Order Tricladida.

Other invertebrates also captured with *Sergia calae* n. sp. include Amphipoda, Rotifera, Cnidaria (*Hydra* sp.), Copepoda, Acari, Chironomidae, Ostracoda, Protozoa and Nematoda.

Discussion

Like *Sergia sergia* and *S. mancala, S. calae* n. sp. lacks cuticle structures but shows other clear specific differences. *S. calae* n. sp. differs from *S. sergia* and *S. mancala* mainly in the form of the male copulatory organ, which is much more muscular and more developed in *S. calae* n. sp. owing to the location of spermatic and prostatic products. In *S. calae* n. sp. the spermatic secretion does not form two spermatic balls as it does in *S. sergia* and *S. mancala*; nor does the prostatic secretion form distal sheets (Luther 1955, Marcus and Marcus 1957). Unlike *S. sergia* and *S. mancala, S. calae* n. sp. lacks a male canal.

Sergia calae n. sp. differs from *S. mancala* by the presence of a sphincter between the receptaculum seminis and the uterus.

In the specimen of *S. calae* n. sp. studied here, the testes and vitellaria were too small to describe, a feature of this species that was previously described also for *S. mancala* by Marcus and Marcus (1957). The yolk glands have a papillary aspect in both *S. sergia* and *S. mancala* (Luther 1955; Marcus and Marcus 1957).

Other minor differences among these species can be noted in the development of the muscle layers, size of the pharynx and in the pigmentation. In *S. calae* n. sp. all the muscle layers are equally thick, while in *S. sergia* the diagonal muscle layer is more developed than both the circular and the longitudinal layers. The pharynx is smaller in *Sergia calae* n. sp. than in the other two species of this genus. The pigmentation is reddish yellowish in *S. sergia*, yellowish with small dark spots in *S. mancala*, while *S. calae* n. sp. has a dense, dark, mostly irregular pigmentation that is slightly orange in the midsection of the body.

As in *S. mancala* (Marcus and Marcus 1957), the distal portion of the uterus of *S. calae* n. sp. is developed as the receptaculum seminis. The shape and size of the eggs are not known for either the new species or for *S. mancala*, but are known to be triangle-shaped in *S. sergia*. *Sergia calae* n. sp. is the first record of the genus on the American continent.

Family Typhloplanidae Graff, 1909
Subfamily Mesostominae Luther, 1904
Genus *Mesostoma* Örsted, 1844

Mesotoma ucamara n. sp. (Figures 4 and 5)

Type locality: Pacaya-Samiria National Park, Loreto, Peru. Cocha Tamara: abandoned meander of the 'caño' Yarina, connected through a channel to the caño during times when waters are low (5°16′28″ S, 74°29′55″ W). Date: 21.09.02.

Other localities: 'Cocha' (lagoon) Yarina: lagoon connected with the 'caño' Yarina (5°24′42″ S, 74°30′23″ W), Loreto, Peru. Date: 17.09.02.

Material: a few individuals studied alive and two of them sagittally sectioned (4 μm).

Holotype: A sagittally sectioned specimen deposited in the Museo Nacional de Ciencias Naturales (MNCN 4.01/46).

Etymology: the specific name refers to the acronym of the project Aquatic Faunal Survey of Peruvian Amazon floodplain 'UCAMARA'.

Description

Mature animals 0.5–0.8 mm length. Body fusiform, anterior and posterior end tapered. Epithelium transparent or translucent. Living specimens pigmentation

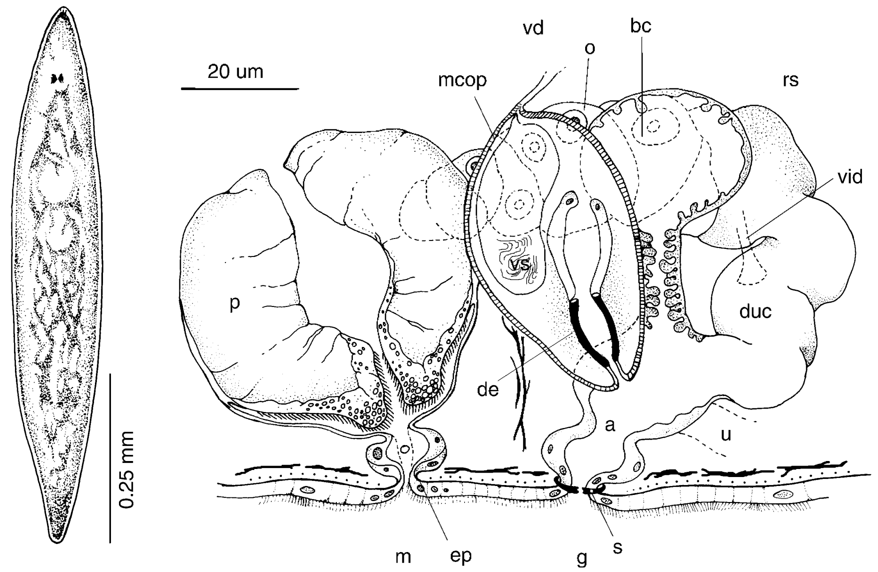

Figure 4. Dorsal view and sagittal reconstruction of *Mesotoma ucamara* n. sp. *Abbreviations*: a, common genital atrium; bc, bursa copulatrix; de, ductus eyaculatorius; duc, ductus communis; ep, excretory pore; g, genital pore; m, mouth; mcop, male copulatory organ; o, ovary; p, pharynx; rs, receptaculum seminis; s, sphincter; u, uterus; vd, vas deferens; vid, vitelline ducts; vs, seminal vesicle.

irregular brownish, reddish on the dorsal half line. Anterior end crossed by numerous nerve terminations and by rhabdites-rod tracts. Body musculature formed by longitudinal, transverse and diagonal muscles, typical of genus. Basal membrane more developed ventrally than dorsally. Two black eyes, with anastomoses, lying close to each other. Pharynx at end of first anterior third of body length.

Oral and genital pores clearly separated. Protonefridiums opening into prepharyngeal pouch. Opening of genital pore regulated by strong sphincter. Common genital atrium separated into two regions: ventral region covered by well developed epithelium with large nuclei, dorsal region with thin epithelium. Uteri opening caudally and bursa copulatrix dorsally into dorsal region of common genital atrium. Bursa copulatrix composed of bursa itself and long, thick stalk, lined by inner epithelium with numerous dilations. Bursa slightly oval and covered by fine, asymmetrical epithelium with irregular internal dilations. Male copulatory organ opening fronto-laterally into atrium, while ductus communis opens caudally, above uterus.

Testes extending along dorsal region from medial region to caudal end of body. The vasa eferentia emerging distally from testes and opening along with vas deferens into apical end of male copulatory organ. Copulatory organ ovoid, with longitudinal muscle layers internally and circular muscle layers

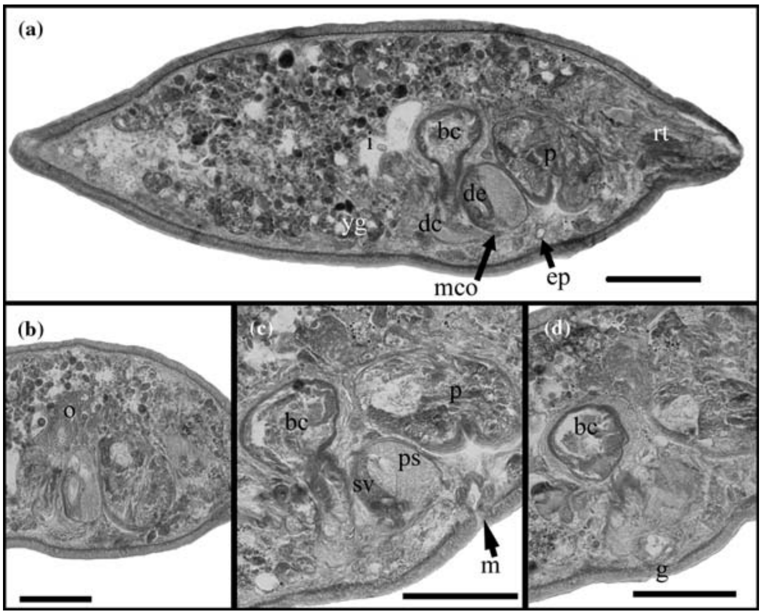

Figure 5. Sagittal sections of *Mesotoma ucamara* n. sp. (a) General view. (b) Anterior region with ovary. (c) and (d) Details of the male genital system. *Abbreviations*: bc, bursa copulatrix; de, ductus eyaculatorius; dc, ductus communis; ep, excretory pore; g, gonopore; i, intestine; m, mouth; mco, male copulatory organ; o, ovary; p, pharynx; ps, prostatic secretion; rt, rhabdite tracts; sv, seminal vesicle; yg, yolk glands. Scale bars 25 μm.

externally. Interior of organ with vesicula seminalis located proximally and prostatic secretions laterally. Ductus ejaculatorius forming small bladder distally and lined with fine cuticle. Proximally, ductus eyaculatorius strongly muscular and occupying first third of the copulatory organ. Opening of prostatic glands not observed but – because of disposition of prostatic secretions – possibly lateral and independent from opening of vas deferens.

Large ovary with rounded protuberances and extending behind pharynx, immediately followed by well-developed receptaculum seminis. Yolk glands lying along medial corporal region and ventral to testes. Glands forming compact follicles, but not clusters. Vitellaria and testes extending caudally from behind the pharynx. Complete trajectory of yolk ducts not observed, but opening in the ductus communis is common. Shell glands located in the distal region of ductus communis. Eggs not observed in examined specimens.

Biology

Mesostoma ucamara n. sp. was found in a pool of the ‘cocha’ (lagoon) Tamara. The littoral areas of this region were covered with abundant vegetation. Shore-vegetation consists mainly of *Polygonum* sp., while *Eichhornia* sp., *Pistia* sp. and *Salvinia* sp. form the free-floating plant community. *M. ucamara* n. sp. was also found in the 'cocha' Yarina, lagoon among the abundant shore-vegetation (*Scirpus* sp.) and free-floating plants (*Pistia* sp. and *Eichhornia* sp.). Cochas are lagoons with dark waters and profuse suspended silt. *Geocentrophora* sp. (aff. *applanata*) and representatives of the order Tricladida, along with abundant Gastropoda, Oligochaeta, Cladocera, Ostracoda, Copepoda, Amphipoda, Ephemeroptera and Coleoptera were also captured with *Mesostoma ucamara* n. sp.

Mesostoma ucamara n. sp. and its related species (see discussion below) prefer lentic waters with high temperatures and abundant floating vegetation. Smith (1998) reported similar predilections for *M. tubiseminalis* from Puerto Rico.

Discussion

Mesostoma ucamara n. sp. is closely related to *Mesostoma productum* (Schmidt, 1848), primarily due to its tapered shape; its dark and irregular pigmentation; the shape, size and position of its pharynx; the conspicuous rhabdites-rods; and the presence of a cuticularized ductus ejaculatorius (Noreña Janssen and Faubel 1992).

M. productum is differentiated from *M. ucamara* n. sp. by the absence of a sphincter in the genital pore and by an elongated stalk in the bursa copulatrix. Other differences can be observed in the cuticular lining of the ductus ejaculatorius. The proximal end of the ductus ejaculatorius of *M. productum* is completely cuticulariced (Noreña Janssen and Faubel 1992), whereas the proximal end of *M. ucamara* n. sp. forms a muscular 'chalice'.

Other species similar to *Mesostoma ucamara* n. sp. are: *M. ewerum* Du Bois-Reymond Marcus, 1951; *M. magnum* Kolasa and Schwartz, 1988 and *M. georgianum* Darlington, 1959. Like *M. ewerum, Mesostoma ucamara* n. sp. has a stalked bursa copulatrix, a separate genital and oral pore and a common entrance of the vas deferens. However, unlike *M. ucamara* n. sp. *M. ewerum* has a sphincter in the distal region of the atrium masculinum, a noncuticularized ductus ejaculatorius, also lacking a sphincter in the genital pore (Du Bois-Reymond Marcus 1951).

Mesostoma ucamara n. sp. shares a similar cuticularized ductus ejaculatorius and shape of the bursa copulatrix with *M. magnum*, but differs from this species in the opening of the genital and oral pore – common in *M. magnum* but separate and sphinctered in *M. ucamara* n. sp.

Additionally, *Mesostoma georgianum* and *M. ucamara* n. sp. share the following similarities: separate opening of the genital and oral pores, comparable shape of both the bursa copulatrix as well as the male copulatory organ, a cuticularized ductus ejaculatorius and a combined opening of the vas deferens. *M. georgianum* differs from *M. ucamara* n. sp. by the presence of a flap-like constriction in the ductus ejaculatorius and the lack of a sphincter in the genital pore. The ductus ejaculatorius and bursa copulatrix both lead into a common genital atrium in *M. ucamara* n. sp., a character which also distinguishes it from *M. georgianum* (Noreña Janssen and Faubel 1992).

Ecology

The most important feature of many of the water bodies in tropical floodplains is the high density of macrophytes and the lack of a thermic gradient (MacIntyre and Melack 1984, 1988; Tundisi 1993). Therefore, the main objective of the Project 'Aquatic survey of a Peruvian Amazon floodplain' was to study floating meadows. *Sergia calae* n. sp. and *Mesostoma ucamara* n. sp. were captured in habitats where one of the most conspicuous features was the macrophyte cover.

Vegetation covering exerts a strong influence on both biotic and abiotic factors. It creates various thermic microgradients and affects turbidity of the water through the release of root-detritus. Payne (1986) observed four types of plant-associations in tropical lakes:

(a) Shore-vegetation with root-systems firmly established in the flooded shore. Shoots and leaves rise above the water surface.

(b) Floating plant communities rooted to the bottom, but with their leaves floating on the surface (e.g., different species of water lilies and *Paspalum* sp.). A gradual rise of water levels activates growth regulators and the air-parts of the plants remain above the surface. This rapid growth produces plants with overlong sprouts. During extensive inundations, however, growth-rates do not correspond to the rapid increase of water-level and parts of the floating community decay and decompose within a short period of time, forming a bed of detritus. Some species like *Paspalum* sp. are rooted at the base of the shoreline and send longs shoots along the surface. High water levels cause these species to form floating root-complexes. During the visit to the Pacaya-Samiria National Park, (when water levels were low) *Paspalum* sp. formed 'floating meadows', which are typical macrophyte formations in these regions. Floating meadows were described by Schulz (1961), Junk (1970), Tur (1972), Neiff (1982, 1986) and Wolf (1990) who emphasized the great influence these plant-associations had on the ecosystems of the Neotropical area. Floating meadows include true floating plants, such as species of *Pistia*, *Eichhornia* and *Salvinia*. Sometimes these free-swimming complexes become very dense and form floating islands, which can be sufficiently well established to offer a protected medium for the migration of different invertebrate and vertebrate taxa (Sioli 1975).

(c) Submerged plant-communities: these communities consist of plant-species rooted principally to the bottom of water-bodies, whose shoots only emerge at the surface during the reproductive phase. The presence of these communities is mainly governed by the depth of the lake and the contents of suspended matter. This community was not studied in this occasion because the great depth of the cochas, which would require other collecting methods.

(d) Free-floating plant communities are mainly composed of species of *Eichhornia*, *Salvinia*, *Pistia* and *Azolla*. Plant species of this community can partially or completely cover the surface of water bodies, and have a strong influence on the efficiency of the abiotic factors and the abundance and diversity of the invertebrate fauna. A daily thermic (polymictic) stratification can be detected under these floating meadows in Neotropical lakes. During the night, the water column is mixed vertically and the thermic stratification disappears (Barbosa and Tundisi 1980). These plant associations were present in the study area, with the exception of the submerged plant community.

The dominant plant species within the floating meadows in the research area were *Eichhornia* sp. and *Paspalum* sp. In areas covered by these species, temperature fluctuations, oxygen concentrations and pH-values are generally lower than in regions with uncovered surfaces. In contrast, the CO_2-concentrations are very high. These differences are caused by the intensive aerobic processes occurring within the dead vegetation and detritus, and the increase of respiration and decrease of photosynthesis-rates (Rai and Munschi 1979).

During high water levels, the physiognomy of the research area changed dramatically, because the lake and cocha basins were partially washed out and only firmly rooted water plants remained.

The free-floating plant community exerted influence on the turbidity of the water, especially during months with extensive vegetative cover. Large parts of the suspended matter of the root-system within the water column were released due to the turbulences caused by the wind.

The total macrophyte complex, especially the floating and the free-floating plants with their root-system, offer an excellent habitat (food and protection) and distribution possibilities for many invertebrate-taxa (Junk 1973). Most of the turbellarians described in this study were captured here.

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