Arquivos do Museu Nacional, Rio de Janeiro, v.61, n.4, p.241-244, out./dez.2003
ISSN 0365-4508

REPRODUCTIVE BEHAVIOR OF THE BRAZILIAN ANNUAL FISH *CYNOLEBIAS ALBIPUNCTATUS* COSTA & BRASIL, 1991 (TELEOSTEI, CYPRINODONTIFORMES, RIVULIDAE): A NEW REPORT OF SOUND PRODUCTION IN FISHES [1]

(With 6 figures)

DRAUSIO F. BELOTE[2, 3]
WILSON J. E. M. COSTA[2, 4]

ABSTRACT – The reproductive behavior of *Cynolebias albipunctatus* is described based on aquarium observations. The sequence of five distinct stages of reproductive behaviors defined for other rivulids was observed: 1) courtship displays; 2) invitation to dive; 3) submerging; 4) spawning/fertilization; 5) emerging. Some patterns are shared with several species of cynolebiatine annual fishes, such as courtship displays with lateral waving movements of male body and unpaired fins of male expanded during waving movements. Some unique behavioral patterns were also identified, such as distinctive movements of male head, producing a crack-like sound to attract the female, determination of a dominant female with exclusion of other female by the couple, dominant exhibiting of female that scrubs its snout in the urogenital region of male and exhibits brief courtship-like movements.

Key words: Cyprinodontiformes; Rivulidae; *Cynolebias*; annual fish; spawning; ethology; sound production; courtship.

RESUMO – Comportamento reprodutivo do peixe anual brasileiro *Cynolebias albipunctatus* Costa & Brasil, 1991 (Teleostei, Cyprinodontiformes, Rivulidae): um novo relato de produção de som em peixes.

O comportamento reprodutivo de *Cynolebias albipunctatus* é descrito baseado em observações em aquário. A seqüência de cinco estágios distintos de comportamento reprodutivo definidos para outros rivulídeos foi observada: 1) exibições de corte; 2) convite para submergir; 3) submersão; 4) desova/fertilização; 5) emersão. Alguns padrões são compartilhados com várias espécies de peixes anuais, como corte com movimentos ondulantes laterais do corpo do macho e nadadeiras ímpares expandidas durante os movimentos ondulantes. Alguns comportamentos únicos foram observados, como os movimentos distintivos da cabeça do macho, produzindo um som semelhante a um estalo para atrair a fêmea, escolha de uma fêmea dominante com exclusão da outra fêmea pelo casal e algumas exibições dominantes da fêmea que esfrega o focinho na região urogenital do macho e exibe breves movimentos parecidos com os de corte.

Palavras chave: Cyprinodontiformes; Rivulidae; *Cynolebias*; peixes anuais; desova; etologia; produção de som; corte.

INTRODUCTION

Cynolebias Steindachner, 1876 includes 12 species of neotropical annual fishes, endemic to northeastern and central Brazil, in the upper Tocantins, middle São Francisco, and lower Jaguaribe rivers basins, and smaller coastal drainages of northeastern Brazil (COSTA, 2001). *Cynolebias albipunctatus* Costa & Brasil, 1991 is a large species, reaching about 100mm SL, endemic to the middle São Fransisco basin. Although the reproductive behavior of rivulids being elaborate and diversified among distinct familial clades (COSTA, 1990, 1998; BELOTE & COSTA, 2002), no data is available for most species of *Cynolebias*. The only exceptions are the few notes included in the original description of *C. griseus*, Costa, Lacerda & Brasil, 1990). In the present study, the reproductive behavior of *C. albipunctatus* is described and compared to other rivulids.

MATERIAL AND METHODS

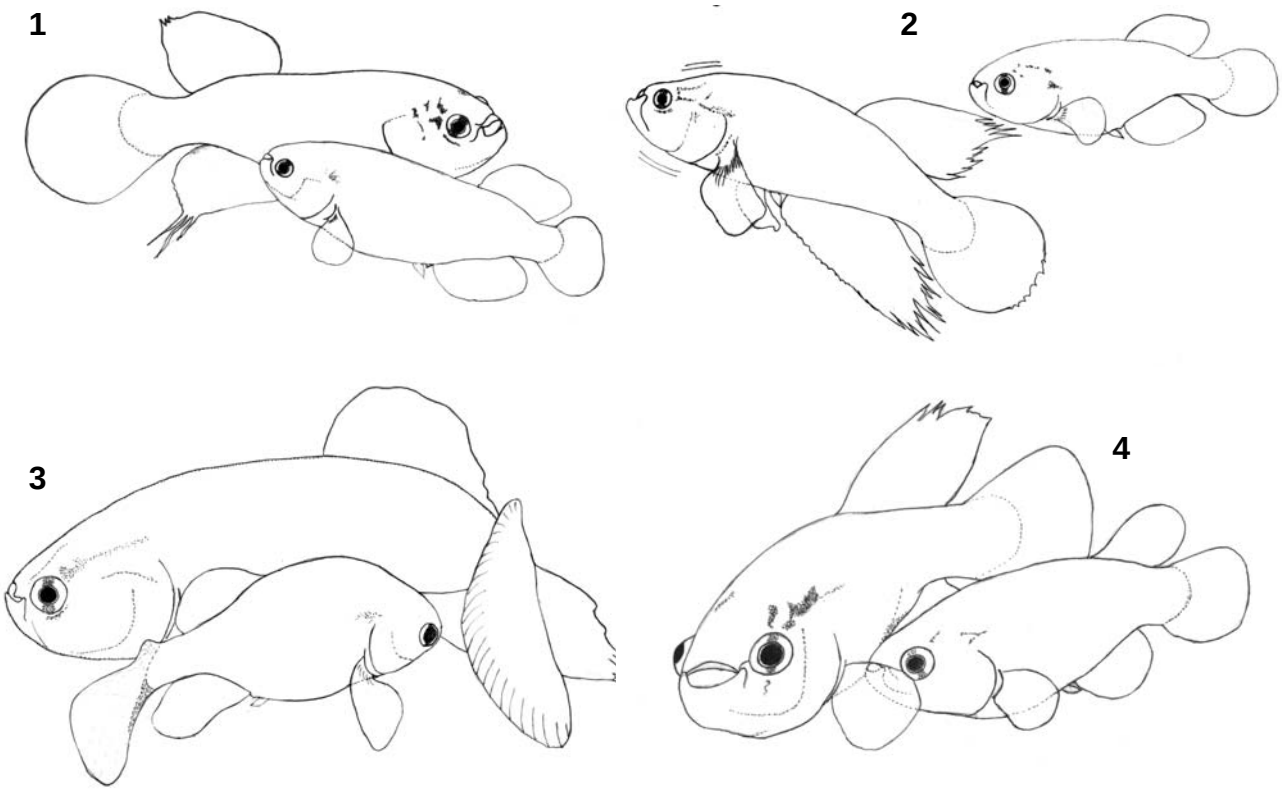
Specimens of *C. albipunctatus* (male 115mm SL and two females, both 85mm SL) used in this study were collected near Juazeiro, Bahia, northeastern Brazil. Direct and indirect observations were made during three months after collection, in aquaria sizing 1000´500´500mm containing gravels, logs and vegetation, and a smaller aquarium (200´150´150mm) with substrate for spawning,

[1] Received on July 24, 2002. Accepted on June 23, 2003.
[2] Museu Nacional/UFRJ, Programa de Pós-Graduação em Ciências Biológicas/Zoologia. Quinta da Boa Vista, São Cristóvão, 20940-040, Rio de Janeiro, RJ, Brasil. Universidade Federal do Rio de Janeiro, Laboratório de Ictiologia Geral e Aplicada. Caixa Postal 68049, Cidade Universitária, 21944-970, Rio de Janeiro, RJ, Brasil. Fellow of Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).
[3] E-mail: dbelote@ig.com.br.
[4] E-mail: wcosta@acd.ufrj.br.

pricked and boiled *Sphagnum* sp. (Bryophyta, Musci). Some observations were made without substrate to analyze details during spawning. The sampling methods used were all occurrence and sequence sampling (Lehner, 1998). For indirect observations, the reproductive behavior was recorded to provide a more detailed description. Videotape recordings started after the pair union and stopped after interest of female ending. The behavior patterns described were observed at least 100 times. Specimens were preserved and deposited in the Laboratório de Ictiologia Geral e Aplicada, Universidade Federal do Rio de Janeiro (UFRJ 5273). Reproductive behavior patterns were confirmed in videotapes provided by Dalton Nielsen and André Carletto (breeders, São Paulo, Brazil), with recordings made on specimens of *C. albipunctatus* collected in the same region. The description of the reproductive behavior of *C. albipunctatus* was divided into five distinct stages following BELOTE & COSTA (2002).

RESULTS

STAGE 1 – Courtship displays: Male begins courtship displays with lateral waving movements of body, showing unpaired fins expanded (Fig.1). Female remains near male following him through the aquarium. Male shakes the head up and downwards, producing a crack-like sound that attracts the female (Fig.2). Female also scrubs its snout around genital region of male (Figs.3, 4), sometimes exhibiting brief and subtle courtship-like waving movements. At this time, female is more active than male. When more than one female is present, one of them become dominant, the other female being excluded by the dominant female and male through some aggressive behaviors (chases and bites). The aggressive behavior displayed by the dominant female comprised courtship-like movements and approaches with S-shaped body and expanded opercle followed by bites and chases.



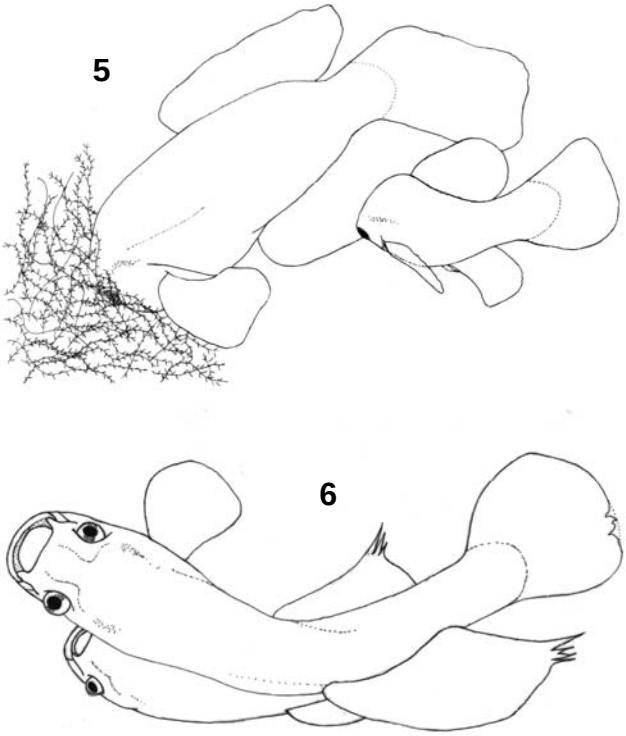
Cynolebias albipunctatus Costa & Brasil, 1991: fig.1- ♂, exhibiting the unpaired fins expanded during the courtship displays (stage 1); fig.2- ♂, shaking the head and producing the crack-like sound that attracts female (stage 1); fig.3- ♀, scrubbing the snout in the urogenital region of male (stage 1); fig.4- another view of female scrubbing (stage 1).

STAGE 2 – Invitation to submerge: Male swims near the bottom trying picking the site to dig under, always followed and scrubbed by female. Male put its snout down in substrate making an angle approximately between 30º and 90º, quivering body and fins (Fig.5).

STAGE 3 – Submerging: Female coupled male at any side, and both dug under substrate coupled, quivering their bodies.

STAGE 4 – Spawning/fertilization: Submerged into substrate, spawning and fertilization occur while male presses female against the bottom with its body (Fig.6). Male lies over female with body curved and fins gently folded over it. Male presses its body against female quivering and with opened mouth.

STAGE 5 – Emerging: After spawning, they emerge randomly at different times and places. Male leaves female, which looks for eggs around the area of the spawn. Female eats any found egg. Sequentially, female continued following male until a new courtship cycle is started, when courtship displays might be absent, but remaining head shakes.



Cynolebias albipunctatus Costa & Brasil, 1991: fig.5- the invitation to submerge (stage 2). The male with head down into substrate waiting the female to dig under; fig.6- the male lied over female, pressing female against the bottom with its body (stage 4).

DISCUSSION

The reproductive behavior of *C. albipunctatus* presents some unique patterns that make it different from other cynolebiatines such as *Simpsonichthys* Carvalho, 1959 (BELOTE & COSTA, 2002), *Austrolebias* Costa, 1998 and *Cynopoecilus* Regan, 1912 (VAZ-FERREIRA & SIERRA, 1973), *Campellolebias* (VAZ-FERREIRA & SIERRA, 1974). Since data on reproductive behavior are unavailable for most species of *Cynolebias*, it is not possible at the present to adequately assign the origin of the peculiar behavior patterns described for *C. albipunctatus*.

In *C. albipunctatus,* the male courtship display comprises few and slow lateral waving movements, which may be restricted to the first courtship cycles just after initial meeting. Slow waving movements were also recorded for *C. griseus* (COSTA, LACERDA & BRASIL, 1990). In other studied cynolebiatine genera, only quick lateral waving movements occur during male courtship displays, which are repeated at the first stage of all spawning cycles (*e.g.*, BELOTE, 1998; BELOTE & COSTA, 2002; VAZ-FERREIRA & SIERRA, 1973).

Female of *C. albipunctatus* display an active role during courtship behavior, an ethological pattern not found elsewhere among aplocheiloid fishes. Female scrubs the snout around urogenital region of male (Figs.3, 4), which seems to act as invitation for spawning. In all other cynolebiatines, females are limited to observe male courtship displays and to follow male to spawn.

In rivulids, when more than one female is present, they may fight as in *Simpsonichthys whitei* (Myers, 1942), or they may be indifferent to each other as in *Austrolebias cyaneus* (Amato, 1987) and *A. charrua* Costa, 2001 (CARVALHO, 1957; BELOTE, 1998; BELOTE, 2001), or even two females may try to dig under substrate with a single male at the same time, as in *Austrolebias nigripinnis* (Regan, 1912) (BELOTE, 2001). In contrast, in *C. albipunctatus* there is a dominant female which, together male, chase and bite the other female, avoiding its approach, and consequently only dominant female spawns. In other cynolebiatines male does never exclude a female.

The crack-like sound produced by the male head shaking to attract the female, in *C. albipunctatus* (Fig.2), was never recorded for any cyprinodontiform fish. Sound production during courtship behavior is known for some fish families

such as Gadidae, Batrachoididae, Centrarchidae, Haemulidae, Sciaenidae, Pomacentridae, and Gobiidae (HELFMAN, COLLETTE & FACEY, 1997), but there are no records for cyprinodontiform fishes. The exact mechanism for sound production by the males as well as for sound reception by female of *C. albipunctatus* are unknown at the present. However, synchronic head and mouth opening suggest that sound is produced within pharyngo-oral cavity. Reinforcing this hypothesis, the bony support of gill arches in a clade within *Cynolebias*, including *C. albipunctatus*, is highly modified (COSTA, 2001). In this assemblage, the dorsal surface of the fifth ceratobranchial presents a deep concave adjacent to large teeth, which are opposite to large teeth on the third pharyngobranchial. The ventral surface of the fifth ceratobranchial bears a pronounced pyramidal process forming a deep posterior fossa. In addition, anteriorly to fifth ceratobranchial, there is an ossification on the fourth basibranchial cartilage, which is attached to strong ligaments. All these osseous traits are unique among cyprinodontiform fishes, and may be related to sound production (*e.g.*, through friction of teeth) and sound amplification (*e.g.*, through dorsal concavity and pyramidal ventral fossa of fifth ceratobranchial). This same *Cynolebias* clade exhibits a strongly elaborate latero-sensory system on the head. Numerous exposed neuromasts, small papillate sensorial organs used to detect vibrations in the water, are arranged in multiple cephalic rows (COSTA, 2001). This uniquely specialized system may be related to sound reception.

ACKNOWLEDGEMENTS

To A.Belote, J.Freitas , T.Borges, and F.Belote (Rio de Janeiro, Brazil), for the logistic support, and to D.Nielsen and A.Carletto (São Paulo, Brazil) for the videotapes of *C. albipunctatus* in aquarium. Collecting trips were made during a project supported by the Fundação O Boticário de Proteção à Natureza, with permits by Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) – Ministério do Meio Ambiente, dos Recursos Hídricos e da Amazônia Legal - 02001.001660/98. A previous version of the manuscript benefited from the criticisms of R.Paz and G.Nunan (Museu Nacional - Rio de Janeiro). This study was supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico – Ministério da Ciência e Tecnologia (CNPq).

LITERATURE CITED

BELOTE, D.F., 1998 – **Comportamento reprodutivo do gênero *Simpsonichthys* Carvalho (Cyprinodontiformes - Rivulidae)**. Rio de Janeiro. 65p. Monografia (Bacharelado em Ciências Biológicas), Departamento de Ciências Naturais, Universidade do Rio de Janeiro.

BELOTE, D.F., 2001 – **Estudo da evolução dos padrões de comportamento reprodutivo da tribo Cynolebiatini (Cyprinodontiformes: Rivulidae)**. Rio de Janeiro. 130p. Dissertação (Mestrado em Ciências Biológicas/Zoologia), Museu Nacional, Universidade Federal do Rio de Janeiro.

BELOTE, D.F. & COSTA, W.J.E.M., 2002 – Reproductive behavior patterns in the neotropical annual fish genus S*impsonichthys* Carvalho, 1959 (Cyprinodontiformes, Rivulidae): description and phylogenetic implications. **Boletim do Museu Nacional**, **Nova Série**, **Zoologia**, Rio de Janeiro (489):1-10.

CARVALHO, A.L., 1957 – Notas para o conhecimento da biologia dos peixes anuais. **Revista Brasileira de Biologia**, Rio de Janeiro, **17**:459-466.

COSTA, W.J.E.M., 1990 – Análise filogenética da família Rivulidae (Cyprinodontiformes, Aplocheiloidei). **Revista Brasileira de Biologia**, Rio de Janeiro, **50**:65-82.

COSTA, W.J.E.M., 1998 – Phylogeny and classification of Rivulidae revisited: origin and evolution of annualism and miniaturization on rivulid fishes (Cyprinodontiformes: Aplocheiloidei). **Journal of Comparative Biology**, Ribeirão Preto, **3**:33-92.

COSTA, W.J.E.M., 2001 – The neotropical annual fish genus *Cynolebias* (Cyprinodontiformes: Rivulidae): phylogenetic relationship, taxonomic revision, and biogeography. **Ichthyological Exploration of Freshwaters**, München, **4**:333-383.

COSTA, W.J.E.M.; LACERDA, M.T.C. & BRASIL, G.C., 1990 – Description de deux nouvelles espèces. du genre *Cynolebias* du bassin du Rio Tocantins (Cyprinodontiformes, Rivulidae). **Revue Française d¢Aquariologie et Herpetologie**, Nancy, **17**:9-14.

HELFMAN, G.S.; COLLETTE, B.B. & FACEY, D.E., 1997 – **The Diversity of Fishes**. Massachusetts: Blackwell Science. 528p.

LEHNER, P.N., 1998 – **Handbook of Ethological Methods**. 2.ed., Cambridge: University Press. 672p.

VAZ-FERREIRA, R. & SIERRA, B., 1973 – Caracteres etológicos genéricos y específicos en los peces del genero *Cynolebias* Steindachner, 1876. **Boletín de la Sociedad Zoológica**, Montevideo, **2**:22-35.

VAZ-FERREIRA, R. & SIERRA, B., 1974 – *Campellolebias brucei* n.gen. n.sp., cyprinodontido con especialización de la papila genital y de los primeros radios de la aleta anal. **Comunicaciónes Zoológicas de Museo del Historia Natural**, Montevideo, **10**:1-21.