

Occurrence of early life stages of *Hirundichthys affinis* (Günther, 1866) and *Cheilopogon* sp. (Beloniformes, Exocoetidae) in a tropical estuary, northeastern Brazil

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Abstract. Exocoetidae is a family of predominantly epipelagic, oceanic fish, commonly known as flying fish. These small fish reach a maximum length of 450 mm and their occurrence is restricted in coastal waters. The material analyzed in the present study was collected in the Formoso River estuary complex on the southern coast of the state of Pernambuco in northeastern Brazil. The specimens of *Hirundichthys affinis* were caught in the post-flexion stage, with a standard length from 9 to 15 mm. Specimens were sampled in September, October and November 2001. Two larvae from the genus *Cheilopogon* were caught in November 2004, both in the post-flexion stage of the notochord, with standard lengths of 13.5 and 15.2 mm. This record of Exocoetidae larvae in the Formoso River estuary demonstrates its occurrence in estuarine environments, underlining the role these ecosystems play for both coastal as well as oceanic ichthyofauna.

Key-words: flying fish, estuary, Formoso River.

Resumo: Ocorrência de estágios iniciais de *Hirundichthys affinis* (Günther, 1866) e *Cheilopogon* sp. (Beloniformes, Exocoetidae) num estuário tropical, nordeste do Brasil. Exocoetidae é uma família de peixes predominantemente oceânicos e epipelágicos, comumente conhecidos como peixes-voadores. Estes peixes de pequeno porte alcançam um tamanho máximo de 450 mm e têm ocorrência restrita em águas costeiras. O material analisado no presente estudo foi coletado no complexo estuarino de rio Formoso, no litoral sul de Pernambuco, nordeste do Brasil. O espécimens de *Hirundichthys affinis* foram coletados no estágio de pós-flexão, com um comprimento padrão de 9 a 15 mm. Os espécimens foram coletados em setembro, outubro e novembro/2001. Duas larvas do gênero *Cheilopogon* foram coletadas em novembro/2004, ambos no estágio de pós-flexão da notocorda, com um comprimento padrão de 13,5 e 15,2 mm. Este registro da presença de larvas de Exocoetidae no estuário do rio Formoso demonstra sua ocorrência em ambientes estuarinos, ressaltando o papel destes ecossistemas tanto para a ictiofauna costeira como oceânica.

Palavras-chave: peixe-voador, estuário, rio Formoso.

INTRODUCTION

Flying fish from the family Exocoetidae are small fish, reaching a maximum length of 450 mm and are usually under 300 mm. They are easily identified through their well-developed pectoral fins, reaching

60 to 70 percent standard length. They are predominantly epipelagic and oceanic, and are less common in coastal waters (CRUZ, 1973; FIGUEIREDO & MENEZES, 1978; BARLETTA & CORRÉA, 1992). Exocoetids are commercially important in a number of regions around the world (BARROSO & MORAIS, 1968; MAHON, 1981; DALZEL, 1993; GOMES *et al.*, 1998; PARIN, 2002).

According to PARIN (2002), the following exocoetids occur in the western central Atlantic Ocean: *Cheilopogon cyanopterus* (Valenciennes, 1847), *C. exsiliens* (Linnaeus, 1771), *C. furcatus* (Mitchill, 1815), *C. heterurus* (Rafinesque, 1810), *C. melanurus* (Valenciennes, 1847), *C. comatus* (Mitchill, 1815), *Exocoetus obtusirostris* Günther, 1866, *E. volitans* Linnaeus, 1758, *Hirundichthys affinis* (Günther, 1866), *H. rondeletti* (Valenciennes, 1847), *H. speculiger* (Valenciennes, 1847), *Parexocoetus hillianus* (Gosse, 1851), *Prognichthys glaphyrae* Parin, 1999, and *Prognichthys occidentalis* Parin, 1999. All these, except *H. rondeletti*, *P. glaphyrae* and *P. occidentalis*, are differently distributed along the Brazilian coast down to 30° S. However, MENEZES *et al.* (2003) has only recorded *Cheilopogon* (= *Cypselurus*) *comatus*, *Cheilopogon cyanopterus*, *C. exsiliens*, *C. melanurus*, *Cheilopogon pinnatibarbatu* (= *P. hillianus*), *E. obtusirostris*, *E. volitans*, *H. affinis*, *H. rondeletii*, *H. speculiger*, *Parexocoetus brachypterus* (Richardson, 1846), and *Parexocoetus* (= *Prognichthys*) *gibbifrons* (Valenciennes, 1847) for Brazil.

H. affinis and *C. cyanopterus* are the most abundant flying fish in northeastern Brazil (MONTEIRO *et al.*, 1998). The former is most commonly captured off the state of Rio Grande do Norte, where large shoals are frequent (EL-DEIR, 1998). It is captured year round, but mainly between April and June, which corresponds to the annual recruitment peak in the region (LESSA & BEZERRA JR., 2004). *C. cyanopterus* is most commonly captured around seamounts and islands, mainly the São Pedro-São Paulo Archipelago, where large shoals concentrate for spawning between November and May (VASKE *et al.*, 2006). Their occurrence in estuarine waters in northeastern Brazil, however, has not been previously recorded.

MATERIAL AND METHODS

The material used in the present study came from two different surveys undertaken in the estuarine complex of Formoso River, located on the southern coast of the state of Pernambuco, Brazil (08° 35'

00''S and 035° 95' 00''W), approximately 90 km from the state capital Recife, northeastern Brazil (Fig.1). The former (CASTRO, 2005) was an ichthyoplankton survey carried out from January to December 2001, with bi-weekly sampling using a conical-cylindrical plankton net (0.5mm mesh) in diurnal and nocturnal rising and falling tides at ten different stations located throughout the estuary (Fig.1). The latter (MEDEIROS, 2005) was performed with the use of a light lift-net for fish larvae sampled at a fixed location in the same estuary (Station 8 of CASTRO, 2005) during weekly samplings over four successive phases of the moon in October-November 2003 as well as March-April, July-August and November 2004. Water temperature and salinity were measured in both studies with a portable multi-probe. The identification of Exocoetidae larvae was based on fin ray count; predorsal (PDL), preanal (PAL) and prepelvic (PP2L) lengths, expressed as percentage of standard length (SL), and other morphological characters presented by COTTEN & COMYNS (2006).

RESULTS

In the 39 samplings of the first survey, 399 towing events were carried out in which 2875 fish larvae, 4120 eggs and 691 juveniles of 30 different taxa were collected (CASTRO, 2005). Among these, three *H. affinis* individuals were collected, each during different

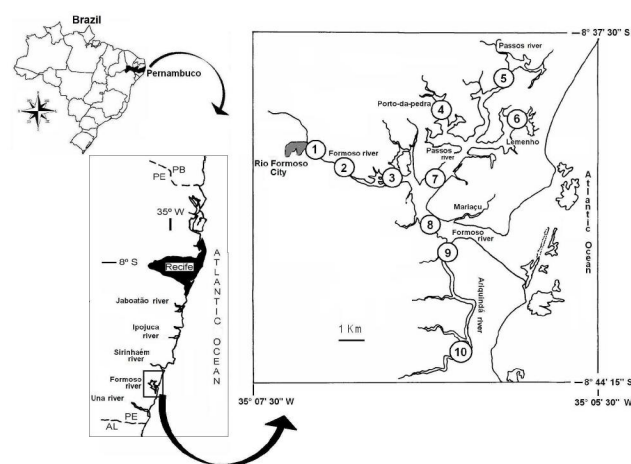


Figure 1. Map of the estuarine complex of Formoso River, with location of sampling stations.

samplings in September (station 8), October and November 2001 (station 3). These individuals measured 14 (Fig.2B), 9 (Fig.2A) and 15 mm standard length (SL), respectively, and were collected in water temperatures of 28.5, 28.5 and 29.0°C, respectively, and corresponding salinities of 19, 33 and 32.6. In the latter study, using a light lift-net (MEDEIROS, 2005), two post-flexion Exocoetidae were collected in November 2004 (29°C; salinity of 31.5), both belonging to *Cheilopogon* sp., with 13.5 (Fig.3) and 15.2 mm SL.

The 9.0 mm SL (Fig.1A) larva of *H. affinis* is in the post-flexion stage. The tip of the pectoral fin does not reach the base of the pelvic fins and the caudal fin does not yet exhibit the fork junction that is characteristic of the family, although the lower lobe of this fin is much more developed than the upper one. The dorsal fin is inserted vertically above the anal axis (an aspect that characterizes the genus

Hirundichthys). The dorsal fin has eight rays and the anal fin has nine. At 14 mm SL (Fig.2B), the larva exhibits significantly more developed fins, with definite number of rays in the pectoral (17), dorsal (12) and anal (13) fins, thus acquiring the characteristic appearance of the genus, similar to an animal with four wings. However, the caudal fin does not yet exhibit the characteristic fork juncture. The 14 mm SL specimen of *H. affinis* (Fig.2B) was quite dried out, possibly as a result of inadequate storage. It was therefore impossible to characterize its pigmentation, but that did not hinder its identification on the species level, based on the fin ray count and body proportions (70.9% SL for PDL, 67.7% for PAL and 54.8% for PP2L).

The two specimens of *Cheilopogon* are both in the post-flexion stage, and are sparsely pigmented, with dendritic chromatophores spread throughout the body. Their assignment to the genus was based on the number of pectoral (13), dorsal (13) and anal (9) fin rays. The pectoral and pelvic fins are already well developed in the 13.5 mm SL individual, taking on the family's characteristic appearance of four wings. The anal fin originates below the sixth ray of the dorsal fin. Although the pectoral fins may not be completely developed, they already present the definite number of rays, being already evident that the first ray is unbranched and shorter than the following ones. In the 15.3 mm SL specimen (Fig.3), there are a large number of chromatophores on the dorsal fin, forming a blackish spot, and both larvae exhibit a strong pigmentation on the pectoral fins, especially at the base and tips, indicating the formation of a pale transverse strip. The larvae have a pair of delicate structures of dermal tissue on the extremity of the mandible, which corresponds to the chin barbels. Conical teeth are present in the mandible and maxillary.

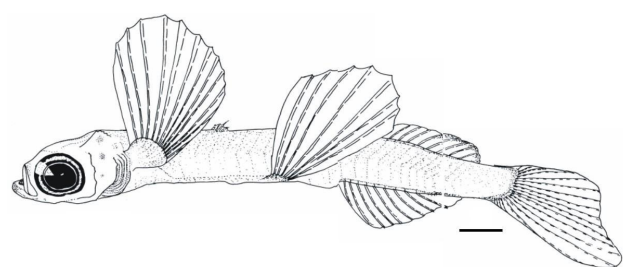
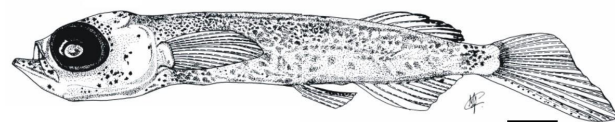


Figure 2. *Hirundichthys affinis* larvae in postflexion stage, with 9.0 (A) and 14.0 mm (B) SL. Bar equals 1mm.

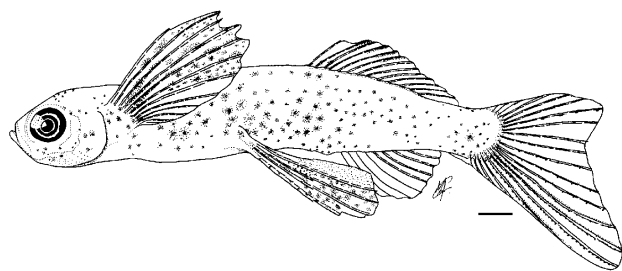


Figure 3. *Cheilopogon* sp. larvae in postflexion stage, with 15.3 mm SL. Bar equals 1 mm.

DISCUSSION

According to COTTEN & COMYNS (2006), larvae from fourteen exocoetid species have been described for the western central Atlantic Ocean, pertaining to *Cheilopogon*, *Cypselurus*, *Exocoetus*, *Hirundichthys*,

Parexocoetus, and *Prognichthys*, the larval development of which is summarized and larvae can also be separated through the identification key provided therein.

Exocoetid larvae eclose in the flexion stage (COTTEN & COMYNS, 2006), and exhibit varying pigmentation patterns on the body following those of the adults. The early stages of *H. affinis* present completely different morphological aspects than the adult stage. However, their larvae may be separated from *Cheilopogon* by their more densely pigmented body, a higher number of anal fin rays (11-13 against 8-11 in *Cheilopogon*) and a lower number for the dorsal one (10-12 against 11-15).

All *H. affinis* individuals were collected in the Formoso River estuary between September and November. EL-DEIR (1998) did not detect a characteristic temporal pattern for the reproductive period off Rio Grande do Norte and suggested its reproduction occurred throughout the year, although a peak between April and June has also been recorded.

Cheilopogon has an anal fin originating three or more rays behind the origin of the dorsal fin. The dorsal fin has between two and five more rays than the anal fin. The anal fin is therefore shorter and only the first ray of the pectoral fin is interrupted (COTTEN & COMYNS, 2006). As in *Hirundichthys*, *Cheilopogon* has long pelvic fins (the extremity of the longest rays surpassing the origin of the anal fin), located closer to the base of the caudal fin than the tip of the snout (FIGUEIREDO & MENEZES, 1978; PARIN, 2002).

The *Cheilopogon* larvae collected in the present study are possibly *C. exsiliens*, based on their short chin barbels (*C. cyanopterus* present longer barbels at the corresponding size), the pigmentation pattern of the dorsal fin, which suggests the formation of its characteristic dark spot, and a faint strip present on the pectoral fins. *Cheilopogon* larvae are abundant around the São Pedro-São Paulo Archipelago, where they comprise ca. 80% of the ichthyoneuston (LESSA *et al.*, 1999). Larvae have been collected in November, which corresponds to its reproductive period in off-shore environments in the region (VASKE *et al.*, 2006).

Records of *H. affinis* or *Cypselurus* spp. in estuarine areas in Brazil are scarce. These taxa have been reported as epipelagic and oceanic (FIGUEIREDO

& MENEZES, 1978; BARLETTA & CORRÉA, 1992). Exocoetidae larvae are also considered epipelagic, with wide distribution in oceanic waters off northeastern Brazil (MAFALDA JR. & SOUZA, 2004). EKAU *et al.* (2001) recorded two exocoetid larvae in the Santa Cruz Channel in the state of Pernambuco (Brazil), but these were *Hyporhamphus* sp. (Hemirhamphidae), a widely distributed species along the Brazilian coast. Exocoetids play an important role in pelagic food chains in tropical and subtropical oceans worldwide as a trophic link between zooplankton and larger predators (LIPSKAYA, 1987; COTTEN & COMYNS, 2006), which is similar to the role played by Atherinopsidae, Gobiidae, Gerreidae, Engraulidae, Clupeidae and Hemiramphidae in coastal and estuarine environments.

The Formoso River estuary is a diversified ecosystem, including mangroves, seagrass beds and coral reefs. It is subjected to low freshwater input, which makes it a suitable place for oceanic species to explore during their initial development. Ichthyoplankton studies in coastal areas, especially estuaries, are incipient in Brazil, which limits knowledge on the distribution and ecology of estuarine-dependent fish species. However, estuarine ecosystems provide a suitable ground where early life stages of several fish species may be found together, although adults may present rather diverse sizes, food habits, reproductive strategies and habitats. These environments have undergone increasing exploitation and human impact from urban areas and industrial development throughout the world. Therefore, there is an urgent need for further studies on the ichthyoplanktonic composition and early life fish ecology in estuaries along the Brazilian coast.

ACKNOWLEDGMENTS

The Associação dos Engenheiros de Pesca de Pernambuco (AEP/PE) and Superintendência do Desenvolvimento do Nordeste (SUDENE) are acknowledged for financial support during ichthyoplankton surveys in the Formoso River estuary. MFC, TNM and EJJ thank the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for providing scholarships for their graduate course.

REFERENCES

- BARLETTA, M. & CORRÊA, M.F.M. 1992. **Guia para identificação de peixes da costa do Brasil**. Curitiba, UFPR. 131p.
- BARROSO, A.C. & MORAIS, S.B. 1968. Prospecção de áreas de pesca de peixe-voador (*Cypselurus cyanopterus* Valenciennes, 1846) ao longo do litoral dos estados de Pernambuco e Paraíba. **Boletim de estudos de Pesca SUDENE** 8 (3): 9-16.
- CASTRO, M.F. 2005. **Abundância e distribuição das fases iniciais de peixes no estuário do Rio Formoso, Pernambuco – Brasil**. MSc. Dissertation. Universidade Federal Rural de Pernambuco. 72p. (available at <http://www.pgpa.ufrpe.br>).
- COTTEN, N. & COMYNS, B.H. 2006. Exocoetidae: Flyingfishes, pp. 955-989. *In*: RICHARDS, W.J. (ed.). **Early life stages of Atlantic fishes: an identification guide for the western central North Atlantic**. Vol. 1. Boca Raton, 1335p.
- CRUZ, J.F. 1973. **Fisioecologia do peixe-voador *Hirundichthys affinis* no Nordeste brasileiro. Crescimento, reprodução e índices de captura**. MSc. Dissertation. Universidade de São Paulo. 72p.
- DALZELL, P. 1993. The fisheries of flying fishes (Families: Exocoetidae and Hemiramphidae) from the Camotes Sea, Central Philippines. **Journal of Fish Biology** 43: 19-32.
- EL-DEIR, A.C.A. 1998. **Reprodução e caracterização morfológica e merística do peixe-voador *Hirundichthys affinis* (Gunther, 1866) em Caiçara – RN**. MSc. Dissertation. Universidade Federal de Pernambuco. 93p.
- EKAU, W., WESTHAUS-EKAU, P., MACÉDO, S.J. & DORRIEN, C.V. 2001. The larval fish fauna of the “Canal de Santa Cruz” estuary in Northeast Brazil. **Tropical Oceanography** 29 (2): 117–128.
- FIGUEIREDO, J.L. & MENEZES, N.A. 1978. **Manual de Peixes Marinhos do Sudeste do Brasil. II. Teleostei (1)**. São Paulo, Museu de Zoologia/Univ. São Paulo, 110p.
- GOMES, C., DALES, R.B.G. & OXENFORD, H.A. 1998. The application of RAPD markers in stock discrimination of the four-wing flyingfish, *Hirundichthys affinis* in the central western Atlantic. **Molecular Ecology** 7: 1029-1039.
- LESSA, R.P.; MAFALDA JR., P.; ADVÍNCULA, R.; LUCCHESI, R.B.; BEZERRA JR., J.L.; VASKE JR., T.; HELLENBRANDT, D. 1999. Distribution and abundance of ichthyoneuston at seamounts and islands off North-Eastern Brazil. **Archives of Fishery and Marine Research** 47 (2/3): 239-252.
- LESSA, R.P. & BEZERRA JR., J.L. 2004. *Hirundichthys affinis*, Exocoetidae, peixe-voador, pp. 39-50. *In*: LESSA, R.P., NÓBREGA, M.F. & BEZERRA JR., J.L. (org.). **Dinâmica de populações e avaliação dos recursos pesqueiros da região nordeste**. Vol. II. Recife, UFRPE/Programa Revizee – Score Ne. 246p.
- LIPSKAYA, N.Y. 1987. Feeding of flyingfish (Exocoetidae) larvae and fingerlings in the region of the Peruvian upwelling. **Journal of Ichthyology** 27 (3):108-116.
- MAFALDA JR., P. & SOUZA, C.S. 2004. Estrutura da comunidade de larvas de peixes da Zona Econômica Exclusiva do nordeste do Brasil. Salvador, CIRM/MMA/REVIZEE-Score NE. 60p.
- MAHON, R. 1981. Developing a management strategy for the flyingfish fishery of the eastern Caribbean. **Proceedings of the Gulf Caribbean Fisheries Institute** 34: 28–37.
- MEDEIROS, T.N. 2005. **Uso comparativo de atrator luminoso e rede de arrasto na captura de larvas de peixes no estuário do rio Formosos – Pernambuco – Brasil**. MSc. Dissertation. Universidade Federal Rural de Pernambuco. 58p. (available at <http://www.pgpa.ufrpe.br>).
- MENEZES, N.A.; BUCKUP, P.A.; FIGUEIREDO, J.L. & MOURA, R.L. (eds.). 2003. **Catálogo das espécies de peixes marinhos do Brasil**. São Paulo, Museu de Zoologia/USP, 160p.
- MONTEIRO, A.; VASKE JR., T.; LESSA, R.P.; EL-DEIR, A.C.A. 1998. Exocoetidae (Beloniformes) off north-eastern Brazil. **Cybiurn** 22 (4): 395-403.
- PARIN, N.V. 2002. Exocoetidae: flyingfishes, pp. 1116-1134. *In*: Carpenter, K.E. (ed.) **The living marine resources of the western Central Atlantic. Vol. 2. Bony fishes part 1 (Acipenseridae to Grammatidae)**. FAO Species Identification Guide for Fishery Purposes and American Society of Ichthyologists and Herpetologists Special Publication no. 5. Rome, FAO. p. 601-1374.
- VASKE JR., T.; NÓBREGA, M.F.; SANTANA, F.M.; LESSA, R.P.; RIBEIRO, A.C.B.; PEREIRA, A.A.; ANDRADE, C.D.P. 2006. Peixes, pp. 56-151. *In*: VASKE JR., T.; LESSA, R.P.; NÓBREGA, M.F.; AMARAL, F.M.D.; SILVEIRA, S.R.M. **Arquipélago de São Pedro e São Paulo: histórico e recursos naturais**. Olinda, Livro Rápido-Elógica. 191p.

Recebido: 13/09/2007
 Revisado: 21/03/2008
 Aceito: 27/04/2008

