

## *Anablepsoides hoetmeri*, a new rivulid (Cyprinodontiformes: Rivulidae) from Rio Purus drainage, western Amazon basin, Brazil

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### Abstract

*Anablepsoides hoetmeri*, new species, is described from middle rio Acre, a tributary of the rio Purus, Amazon drainage, Brazil. It is the first species of *Anablepsoides* described from that basin and the second species belonging to the *Anablepsoides limoncochae* species group described from Brazil. The remaining species belonging to the *A. limoncochae* group are mainly found in Peru, but also occur in Colombia and Ecuador. *Anablepsoides hoetmeri* n. sp. differs other members of the *A. limoncochae* group by having two longitudinal rows of 18-20 minute contact organs per row on the sides of the body, and by the coloration patterns of both males and females.

### Zusammenfassung

Die neue Art *Anablepsoides hoetmeri*, wird vom mittleren Rio Acre beschrieben, einem Nebenfluss des Rio Purus, im Einzugsgebiet des Amazonas, Brasilien. Es ist die erste Art der Gattung *Anablepsoides*, die von diesem Becken beschrieben wird, und die zweite Art der *Anablepsoides-limoncochae*-Artengruppe, die aus Brasilien beschrieben wird. Die übrigen Arten der Gruppe kommen hauptsächlich in Peru vor, aber auch in Kolumbien und Ecuador. *Anablepsoides hoetmeri* n. sp. unterscheidet sich von den anderen Angehörigen der Gruppe durch zwei Längsreihen von 18-20 winzigen Kontaktorganen pro Reihe an den Flanken sowie durch die andersartigen Farbmuster sowohl bei den Männchen als auch bei den Weibchen.

### Resumo

*Anablepsoides hoetmeri*, espécie nova, é descrita do médio Rio Acre, um afluente do rio Purus, na bacia amazônica brasileira. É a primeira espécie de *Anablepsoides* descrita da bacia do rio Purus e a segunda pertencente ao grupo de espécies *Anablepsoides limoncochae* descrita do Brasil. As outras espécies no grupo *A. limoncochae* são encontradas principalmente no Peru, mas também ocorrem na Colômbia e no Equador. *Anablepsoides hoetmeri* n. sp. difere de outros

membros do grupo *A. limoncochae* por ter duas fileiras longitudinais compostas por 18-20 diminutos órgãos de sobre os lados do corpo, e pelos padrões de coloração de machos e fêmeas.

### Résumé

*Anablepsoides hoetmeri*, nouvelle espèce, est décrit provenant du moyen Rio Acre, un tributaire du rio Purus, bassin de l'Amazonie, Brésil. C'est la première espèce d'*Anablepsoides* décrite issue de ce bassin et la seconde espèce faisant partie du groupe *Anablepsoides limoncochae* décrite du Brésil. Le restant des espèces du groupe *A. limoncochae* proviennent surtout du Pérou, mais surviennent aussi en Colombie et en Equateur. *Anablepsoides hoetmeri*, nouvelle espèce, diffère des autres membres du groupe *A. limoncochae* par la présence de deux rangées longitudinales de 18-20 petits organes de contact par rangée sur les flancs et par le patron de coloration des mâles comme des femelles.

### Sommario

*Anablepsoides hoetmeri*, nuova specie, viene descritta dal medio Rio Acre, un affluente del Rio Purus, Amazonia, Brasile. È la prima specie di *Anablepsoides* descritta da quel bacino e la seconda specie appartenente al gruppo di specie *Anablepsoides limoncochae* descritte in Brasile. Le restanti specie appartenenti al gruppo *A. limoncochae* si trovano principalmente in Perù, ma si rinvencono anche in Colombia ed Ecuador. *Anablepsoides hoetmeri* n. sp. si differenzia dagli altri membri del gruppo *A. limoncochae* per avere due file longitudinali di 18-20 minuscoli organi di contatto per riga sui lati del corpo, e dai modelli di colorazione sia dei maschi che delle femmine.

### INTRODUCTION

The genus *Anablepsoides* was originally described as a subgenus of *Rivulus* by Huber (1992). Along with its description, Huber (1992) proposed two

groups within this subgenus: the *Anablepsoides urophthalmus* species group and the *Anablepsoides limoncochae* species group.

The systematics of the genus *Rivulus* Poey, 1860 has substantially changed in the last few years (Huber 1992, Costa 1998, 2006, 2007, 2010). Costa (2006) recognized seven subgenera of *Rivulus* based on a morphological phylogeny and previous molecular analyses: *Rivulus*, *Cynodonichthys*, *Anablepsoides*, *Benirivulus*, *Laimosemion*, *Owiyeeye*, and *Melanorivulus*. Costa (2008) proposed an eighth subgenus: *Atlantirivulus*.

Although the subgenera of *Rivulus* are supported both by morphological and genetic features (Costa, 2006), some less inclusive species groups within subgenera may not comprise monophyletic units. This is most likely the reason why Huber (1992) proposed the *Anablepsoides urophthalmus* species group, diagnosed by a combination of character states of uncertain polarity. Six species were included in the *A. urophthalmus* group: *A. stagnatus*, *A. mazaruni*, *A. lungi*, *A. deltaphilus*, *A. taeniatus*, and *A. rubrolineatus*.

Huber (1992) also proposed the *Anablepsoides limoncochae* group, comprised of species from the western Rio Amazon basin, including *A. christinae*, *A. limoncochae*, *A. iridescens* and *A. erberi*. Both the *A. urophthalmus* species group and *A. limoncochae* species group were diagnosed by a combination of similar character states: longitudinal rows of red spots on flanks, frontal squamation E-patterned, short dorsal and anal fins, (i.e., dorsal fin with 6-9 rays, anal fin with 12-15 rays), long pre-dorsal distance, and a large caudal spot in females. The *A. limoncochae* group differs from the *A. urophthalmus* species group by having three rows of red spots or stripes posteriorly extending to caudal-fin base (vs. 6-8 in the *A. urophthalmus* group). However, as discussed by Costa (2006), species of the *A. urophthalmus* species group may also have only three rows of red spots. Species of the *A. urophthalmus* species group (excluding *A. taeniatus* and *A. rubrolineatus*) may be further distinguished from species of the *A. limoncochae* species group (also including *A. christinae*, *A. rubrolineatus* and *A. christinae*) by males having contact organs on scales on the flanks (vs. absence of contact organs), an oblique transverse stripe on the middle of the dorsal fin (vs. absence of such color marking), and by the absence of similar light yellow to orange patches on dorsal and ventral margins of the caudal fin (vs. presence).

Costa (2011) raised to generic level the subgenera

*Anablepsoides*, *Atlantirivulus*, *Cynodonichthys*, *Laimosemion* and *Melanorivulus*, retaining *Owiyeeye* as a subgenus of *Laimosemion* and *Benirivulus* as subgenus of *Anablepsoides*.

Costa (2013) described *A. urubuiensis* and redefined the characteristics of the *A. urophthalmus* and *A. limoncochae* species groups. Species in which the males have light yellow to orange patches on dorsal and ventral margins of the caudal fin belong to the *A. urophthalmus* species group, and the presence of contact organs on the flank scales and an oblique transverse stripe on the middle of the dorsal-fin define species of the *A. limoncochae* group. With this redefinition, some species exchanged groups. As of 2013 Costa defined species belonging to the *A. limoncochae* species group as: *A. elongatus*, *A. christinae*, *A. limoncochae*, *A. parlettei*, *A. rubrolineatus*, *A. taeniatus*, *A. urubuiensis*, and *A. lineasoppilatae*.

Such an assemblage is obviously heterogeneous and more studies are needed for a better assessment of the species groups within the genus (Huber, 2012). However, we herein follow the nomenclature proposed and used by Costa (2011, 2013).

The new species herein described was discovered in the rio Acre, a tributary of the rio Purus, western Amazon basin, state of Acre, Brazil. The genus *Anablepsoides* is well distributed across the Amazon basin, the Río Orinoco basin, coastal Guyanese basins, and extending into coastal basins of northeastern Brazil. The greatest diversity of *Anablepsoides* species occurs in the Amazon basin; with recent studies suggesting that the diversity of the genus *Anablepsoides* in the Amazonian area is larger than previously thought (Costa 2013).

## MATERIALS AND METHODS

Measurements were taken point-to-point under a stereomicroscope with a digital caliper to the nearest 0.1 mm on the left side of the specimen following Costa (1995). Measurements are expressed as percentages of standard length (SL), except subunits of the head, which are recorded as percentages of head length (HL).

Descriptions of color patterns were based on photographs of both sides of live individuals of each population taken in small aquaria one day after collection. Color patterns derived from distribution of melanophores on fins were also observed in all preserved specimens.

In the description, counts of vertebrae and pleural ribs were taken from cleared and stained (c&s) specimens of two males and two females paratypes,

prepared according to Taylor & Van Dyke (1985) Table 1. Two times number 16 in Horizontal scales around caudal peduncle. Frontal squamation followed Hoedeman (1958) and Costa (2006). For vertebral counts, the caudal compounded centrum was counted as a single element. Osteological features included in the description are those considered phylogenetically informative in recent studies of the species formerly assigned to the genus *Rivulus* (Costa 2006, 2011).

Institutional abbreviations are UNITAU (University of Taubaté, Taubaté, Brazil) and ZUEC (Museu de Zoologia da Universidade Estadual de Campinas, Campinas, Brazil). Comparisons with congeners were based primarily on the literature (Fels & De Rham 1981; Huber 1992, Costa 2006, 2007, 2010, 2013).

*Anablepsoides hoetmeri*, n. sp.  
(Figs 1-2; Table 1)

**Holotype:** ZUEC 12540, 1 male, 47.8 mm SL, Brazil, Estado do Acre, Porto Acre, rio Acre, tributary of rio Purus, 9°36'58"S 67°32'43"W; Leendert Van Den Berg, Jan Willem Hoetmer, Arsênio Caldeira Baptista Junior, 16 May 2013.

**Paratypes:** ZUEC 10788, 4 males 41.4-50.3 mm SL, 4 females 41.7-52.6 mm SL; 4 c&s, two males 43.7-45.7 mm and two females 48.2-48.7 mm, all collected with holotype.

**Diagnosis:** Distinguished from all other species of the *Anablepsoides limoncochae* species group by presenting, in males, two longitudinal rows of 18-20 minute contact organs per row along the flanks, located between second and third red lines, begin-



Fig. 1. *Anablepsoides hoetmeri*, ZUEC 12540, holotype, male, 47.8 mm SL. Photo by J. W. Hoetmer.



Fig. 2. *Anablepsoides hoetmeri*, ZUEC 10788, paratype, female, 52.6 mm SL. Photo by J. W. Hoetmer.

**Table I.** Morphometric and selected meristic data for the holotype (H) and paratypes of *Anablepsoides hoetmeri*.

	H	Paratypes	
	Male	Male n = 4	Females = 4
Standard length (mm)	47.8	41.4-50.3	41.7-52.6
<b>Percents of standard length</b>			
Body depth	21.5	19.3-22.8	20.5-23.7
Caudal peduncle depth	13.8	12.0-14.5	12.8-14.6
Pre-dorsal length	75.3	75.3-77.8	76.5-79.4
Pre-pelvic length	52.5	48.5-56.4	51.3-55.6
Length of dorsal-fin base	7.5	7.5-9.6	7.3-8.2
Length of anal-fin base	17.7	17.7-20.7	15.6-18.0
Caudal-fin length	28.4	20.7-28.4	23.5-31.1
Pectoral-fin length	17.2	14.7-17.9	16.5-18.2
Pelvic-fin length	8.5	7.2-9.3	7.8-10.2
Head length	24.7	19.5-24.7	21.5-23.9
<b>Percents of head length</b>			
Head depth	61.8	61.8-74.2	62.7-77.0
Head width	54.2	70.5-78.8	73.1-76.5
Snout length	17.9	16.5-18.1	14.9-17.8
Lower jaw length	25.3	25.1-27.3	25.6-27.4
Eye diameter	29.2	28.1-32.3	30.0-34.2
<b>Counts</b>			
Dorsal fin	8	8-9	8-9
Caudal fin	28	28	28
Anal fin	14	14	14
Pelvic fin	6	6	6
Pectoral fin	14	14	14
<b>Meristics</b>			
Scales in longitudinal series	42-44	42-44	
Scales in transversal series	10	10	
Horizontal scales around caudal peduncle.	16		

ning at the level of the tip of pectoral-fin and ending at the anal fin terminus; contact organs absent in pectoral fin (vs. present in pectoral-fin or 1-3 contact organs on antero-ventral part of flank or on each scale of midventral portion of flank), six rows of red spots present, almost forming complete lines, the uppermost row presenting red spots coalescing, nearly forming a line (vs. red dots coalescing forming lines); presence of six lines of red dots, three of which continuous along body sides to the caudal peduncle, whereas the remaining three ending at the level of the anal fin (vs. distinct number of red lines in *A. rubrolineatus*, *A. iridescens*, *A. elongatus*, *A. taeniatus*, *A. limoncochae*, *A. urubuiensis*, *A. parlettei*, and *A. lineasoppilatae* or 4-5 lines formed by small red dots in *A. christinae*); dorsal fin basal half with a patch of white pigmentation at

the basal portion of anteriormost rays, followed by a yellow-gold patch on the middle and last rays; dorsal fin upper half intensely metallic reddish-orange, separated from the basal half by a conspicuous red line (vs. pale yellow in *A. urubuiensis*, *A. parlettei*, *A. lineasoppilatae*, *A. iridescens*, *A. limoncochae*, pale brown in *A. rubrolineatus*, *A. taeniatus*, *A. elongatus*, and pale yellow to metallic orange in distal area in *A. christinae*), anal fin base bright blue-green with pink spots at interradian areas, followed a longitudinal row of red dots between the rays, distal portion bright orange without a black border (vs. pale greenish yellow, without red spots, and with a black border in *A. elongatus*, *A. urubuiensis* and *A. rubrolineatus* orange-red without spots in *A. taeniatus* light bright orange with red spots on the base or dark in *A. limoncochae* and

*A. christinae* pale gray with yellow base and red spots in *A. lineasoppilatae*, and pale yellowish with red spots on the posterior portion in *A. parlettei*, opercle metallic turquoise blue (vs. brown with few blue scales in *A. christinae*, *A. elongatus*, golden-brown in *A. rubrolineatus*, whitish-blue in *A. urubuiensis*, green-yellowish in *A. parlettei* and *A. lineasoppilatae*, and a dark lattice in *A. taeniatus*), venter metallic blue to pink (vs. light blue in *A. parlettei* or yellow in *A. christinae*, or whitish in the remaining species of *A. limoncochae* specie group).

Females of *A. hoetmeri* can be distinguished from females of all other species of the *Anablepsoides limoncochae* species group by the presence of four longitudinal lines formed by separated, conspicuous bright red dots along the flanks, three of which ending at the caudal peduncle region, interspersed

by lines of golden dots, which decrease in size towards the caudal peduncle (vs. distinct color patterns on flanks), caudal fin hyaline with small irregular red-brown lines, some S-shaped, at its dorsal area (vs. never a similar color pattern on caudal fin).

*Anablepsoides hoetmeri* can be distinguished from *A. christinae* by the pinkish lower lips (vs. strong red), pectoral fin reaching 62% of the distance between of the pectoral-fin base and the pelvic-fin base (vs. pectoral-fin long reaching up to the level of the beginning of anal fin), pelvic-fin bright orange (vs. yellow), ventral area purplish blue to pinkish with red small round spots (vs. whitish without red spots), from *A. rubrolineatus* (Fig. 3), *A. limoncochae*, *A. iridescens* and *A. taeniatus* by having the caudal-fin oval-shaped (vs. truncate), and by the absence of light yellow or orange light



Fig. 3. *Anablepsoides rubrolineatus*, male, 53.4 mm SL. Photo by J. W. Hoetmer.



Fig. 4. *Anablepsoides elongatus*, male, male 62.1 mm SL. Photo by J. W. Hoetmer.

orange stripe on the distal margin of the anal fin in males (vs. presence), from *A. elongatus* (Fig. 4), by having fewer numbers of scales on the longitudinal series (42-44 vs. 48-52), from *A. elongatus*, *A. rubrolineatus*, *A. urubuiensis* and *A. taeniatus* by the dorsal fin positioned more anteriorly at vertical through the base of the 8<sup>th</sup>-10<sup>th</sup> anal fin (vs. between the base of the 12<sup>th</sup> anal-fin rays or behind a vertical through last ray of anal-fin), in males.

**Description:** Measurement data are presented in Table I. Largest examined male 50.3 mm SL, largest examined female 52.6 mm SL. Dorsal and ventral profiles slightly convex from snout to posterior end of dorsal and anal fins, nearly straightly on caudal peduncle. Body slender, subcylindrical, slightly depressed on head, compressed posteriorly. Greatest body depth at mid-length between pectoral-fin base and anal-fin base origin. Jaw short, snout short and rounded. Dorsal fin very small,

rounded without filaments in both sexes. Caudal fin rounded. Pectoral fin rounded, tip of pectoral-fin posterior margin reaching vertical at about 62% of length between pectoral fin and pelvic-fin base. Tip of pelvic fin falling slightly short of reaching anus, pointed, base with interspace. Dorsal fin origin at level of base of 13<sup>th</sup> anal-fin rays and between neural spines of 16-17 vertebrae. Anal fin origin between neural spines of 23-24 vertebrae. Dorsal-fin rays 8-9; anal fin rays 14; caudal-fin rays 28; pectoral-fin rays 14; pelvic fin rays 6. Scales large, cycloid. No scales on dorsal fin and anal-fin base. Frontal squamation E-patterned.

Longitudinal series of scales 42-44; transverse series of scales 10; scale rows around caudal-fin peduncle 16. Two longitudinal rows with 18-20 minute contact organs, on each scale, beginning at the level reach by distal tip of the pectoral fin when addressed and ending at distal end of the anal fin,



Fig. 5. Geographical distribution of the species of the *Anablepsoides limoncochae* species group.



Fig. 6. Type locality of *Anablepsoides hoetmeri*, Acre, Brazil. Photo by J. W. Hoetmer.



Fig. 7. *Anablepsoides christinae*, male, 49.2 mm SL. Photo by J. W. Hoetmer.

between second and third longitudinal red lines. Contact organs absent in pectoral fins. Total vertebrae 32-33.

Cephalic neuromasts: supraorbital 3 + 3, parietal 1, anterior rostral 1, posterior rostral 1, infraorbital 15 +1, preorbital 2, otic 1, post-otic 2, supratemporal 1, medianopercular 1, ventral opercular 2, preopercular 2 + 4, mandibular 3 + 1, lateral mandibular 3, paramandibular 1. Two neuromasts on caudal-fin base. Five branchiostegal rays. Vomerine teeth 1.

**Coloration in life (Fig. 1): Males:** Side of body purplish-blue, with six longitudinal rows of continuous red spots, sometimes interrupted, and replaced by rows of yellow-gold dots, six dotted lines composed by large red dots, almost in contact but retaining their individuality, with exception of uppermost line where dots coalesce almost forming a continuous line out of the six red dotted lines, three continue into the caudal peduncle, whereas the other three end at the beginning of the caudal peduncle. Interspersed between the rows of red dots yellow golden scales are present. Dorsum brown, with irregular thick black lines. Venter metallic blue to pink, with little red dots. Side of head turquoise blue, opercular region metallic turquoise blue. Iris pale yellow. Dorsal-fin basal half with a patch of white pigmentation at the basal portion of anterior most rays, followed by a yellow-gold patch on the middle portion of fin and posterior most rays; dorsal fin upper half intense metallic reddish-orange, separated from the basal half by a strong red line. Anal-fin base bright blue-green with rosy spots at interradial membranes, followed by a longitudinal row of red dots, also at interradial membranes, distal portion bright orange, without black margin. Caudal fin orange, with its dorsal portion metallic orange. Pectoral-fin hyaline with an orange tint. Pelvic fin orange, with a small yellow metallic spot at its distal area.

**Coloration in life (Fig. 2): Females:** Sides of body light brown, with four longitudinal lines formed by conspicuous bright red dots, three of which ending at the caudal peduncle region, interspersed by lines of golden dots, which decrease in size towards the caudal peduncle. Sides of head brown, opercular region metallic green with light blue iridescent spots. Iris yellow. Dorsal-fin base whitish, distal portion translucent with scattered brown spots. Caudal-fin hyaline, with reddish-brown small, irregular lines, some S-shaped, in the dorsal area. Anal-fin basis with a light blue

patch of pigmentation, distal portion hyaline with brown irregular spots. Pectoral-fin hyaline. Pelvic-fin hyaline with metallic blue tint.

**Distribution:** (Fig. 5) Currently only known from the type-locality, a small first-order stream tributary of the Rio Acre, Acre state, Brazil.

**Habitat:** (Fig. 6) The type-locality is a small, artificial hole of about 1 meter by 1 meter, with a depth of 1 meter, dug in the spring of a small stream running into the Rio Acre. The water at the dug well was transparent, which trickled in from the higher layers in a shallow stream, but also had a secondary flow – barely visible among the fallen leaves – flowing slowly into the Rio Acre, which lies at a distance of 400 meters. The depth of the stream ranged between 1 cm and 5 cm at its widest, it was 1 meter in diameter. The substrate both from the bottom as from the walls of the well was river clay. The vegetation at the type locality and along the entire course of the stream is a secondary forest.

**Etymology:** The specific name *hoetmeri* is treated as a patronym in gratitude and recognition to Jan Willem Hoetmer, biologist and environmentalist, who discovered the species.

## DISCUSSION

Currently, the genus *Anablepsoides* is known from a vast geographical area spanning the Southern Lesser Antilles, the Orinoco river basin in Venezuela, the river basins of the Guianas as well adjacent portions of northeastern Venezuela and northern Brazil the Amazon basin in Colombia, Ecuador, Peru, Bolivia and Brazil, and isolated drainages in northeastern Brazil. However, there are still few records for the genus from the central Amazon (Costa 2013).

The *Anablepsoides limoncochae* species group occurs primarily in the western Amazon. The only species found outside this general area is *A. urubuiensis*, which occurs in Central Amazon, near Manaus. *Anablepsoides hoetmeri* is found at the Rio Purus basin, a right bank tributary of the Rio Amazon, not far from the Río Madre de Dios, where three species of the genus *Anablepsoides* can be found: *A. christinae* (Fig. 7), *A. parlettei*, and *A. lineasoppilatae*.

*Anablepsoides hoetmeri* is herein included within the *A. limoncochae* species group based on the presence of contact organs on the flanks (vs. absence of contact organs on the flanks), the presence of an oblique transverse stripe on the middle of the dor-



sal fin (vs. absence of such pigmentation marking), and the absence of light yellow to orange patches of pigmentation on the dorsal fin and ventral margins of the caudal fin (vs. presence) (Costa 2010).

Costa (2006) recorded the presence of *A. taeniatus* in the Acre state, at the Rio Acre basin, near the city of Rio Branco, about 60 km south of the type locality of *A. hoetmeri*. In the same paper, Costa (2006) recorded the presence of *A. taeniatus* in the town of Presidente Figueiredo, state of Amazonas, about 1.420 km from the type locality of *A. hoetmeri* in a straight line, and 1.790 km from the type locality of *A. taeniatus* in a straight line. He subsequently described the Presidente Figueiredo population as a distinct species, *A. urubuiensis* (Costa 2013). Presumably, the population referred as *A. taeniatus* from the Rio Acre by Costa (2006) belongs to *A. hoetmeri*.

The type locality of *A. taeniatus* lies at the town of Morelia, Colombia, in the Río Caqueta drainage (Fowler 1945), about 1550 km in a straight line from the type-locality of *A. hoetmeri*. *Anablepsoides taeniatus* as circumscribed by Costa (2006) consists of several populations scattered over central and western Amazon in the Brazilian states of Amazonas and Acre. Some probably refer to *A. urubuiensis*, some to *A. hoetmeri* and some may represent additional, undescribed species.

Annual fish often present contact organs located at the paired fins or at the sides of the body. The position of the contact organs on the body of annual fishes indicates the position in which the female approaches the male to make spawning and fertilization of eggs possible. The female approaches the male from behind, laterally to and below the male body, a position which makes it easy to identify the female position as one allowing the male to dive into the substrate to fertilize the eggs (Belote 2000).

The position of contact organs in *A. hoetmeri*, two longitudinal rows with 18-20 minute contact organs in each row, beginning just at the level of the tip of the pectoral fin when adpressed against the body, and ending at the anal fin, between the second and third red longitudinal lines, indicates a reproductive behavior involving the female being positioned laterally to the male body (Belote 2000). Aquarium observations of *Anablepsoides hoetmeri* demonstrated the approach of the female from behind the male, which curls the body into an "S", and the laying of eggs near the surface, probably indicating that in their natural habitat

plant roots or other structures near the top of the water column are used as substrate.

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