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On the biology and ecology of *Valencia letourneuxi* (Sauvage, 1880) (Teleostei, Cyprinodontiformes) in the Aheron-Kokitos-River-Drainage in northwestern Greece

by

J. Das

Valenciennes (1846) described a new fish species from the northeastern part of Spain, and he named it *Hydrargyra hispanica*. It belongs to the order Cyprinodontiformes (sensu Parenti, 1981). Günther (1866) relocated this species to the genus *Fundulus* (Lacépède, 1803). Myers (1928) set up the new genus *Valencia* for *F. hispanicus*. In 1880, Sauvage described *Fundulus Letourneuxi* from the Ionian Island of Corfu. Oliva (1965) suggested that *F. letourneuxi* might at species level be identical to *V. hispanica*. But most recent results (Villwock, Scholl & Labhart 1982) indicate that *V. letourneuxi* seems to be a separate species. Whereas *V. hispanica* frequently has been mentioned in the literature on European fishes (e. g. Berg 1932; Ladiges & Vogt 1979; Maitland 1977), the Eastern European population of *Valencia* (= *V. letourneuxi*) has largely been overlooked (e. g. Berg 1932; Maitland 1977) or its existence has been questioned (Ladiges & Vogt 1979; Villwock 1970). The reason may be that up to 1975, *V. letourneuxi* only sporadically has been found in Southeastern Europe, e. g. on Corfu (Sauvage 1880; Oliva 1965), in the Louros- and Aheron-river-valleys in Greece (Stephanidis 1939; 1974), and in Lake Butrinto in Albania (Oliva 1961). During the last five years our knowledge about *V. letourneuxi* has largely been increased through the efforts of amateur ichthyologists and aquarists. They have searched for this fish species in Greece and reported their findings in aquaristic journals (Labhart 1980; Baun in Seegers 1980a; Woeltjes 1982). During a vaccation in the spring of 1982, Das (1983) found further habitats of this species and inspected a locality described by Stephanidis (1974). Some observations on the ecology, the biology, and the waterf chemistry will be portrayed in this paper. The distribution pattern of the habitats of *V. letourneuxi* (Greek name: "Zournas"; Stephanidis 1974) in Eastern Europe, which so far have been reported, are marked in fig. 1. In addition, the environments of the localities visited by the author are shown on a larger scale (fig. 1; A, B).

Materials and methods

The fishes were caught from the banks of the habitats with a spoon net (∅: 32 cm; lenght: 42 cm; mesh size: 0.3 cm; length of the shaft: 2.5 m). The contents of the net were inspected and subsequently the animals caught were released in the water (except the specimens mentioned in the text). The chemical parameters were determined by the "Aquamerck Wasserlabor 1102", Merck, Darmstadt, FRG. The temperature and the consistency (ϱ 18°C) were measured by a calibrated liquid thermometer, resp. areometer.

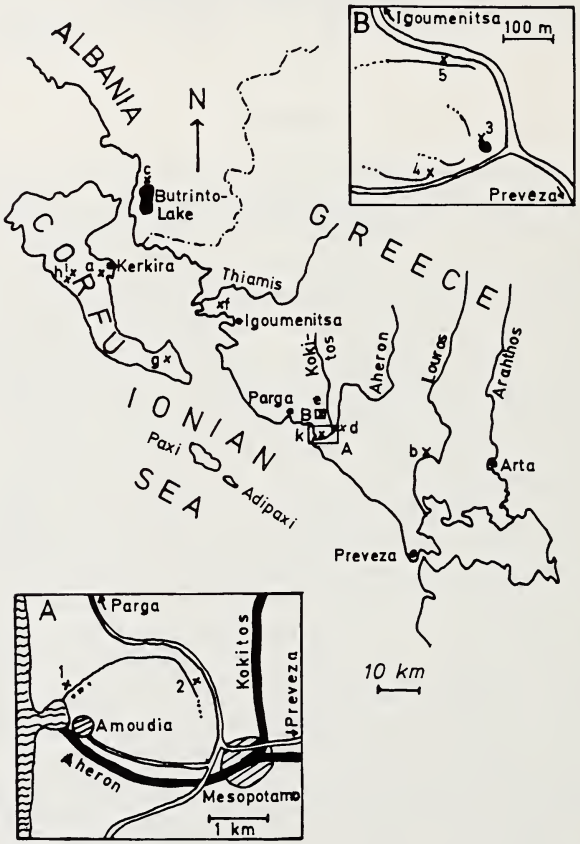

Fig. 1: Habitats of *Valencia letourneuxi* in South Eastern Europe. The small letters indicate the habitats in the order of their discovery: a: Sauvage (1880), Oliva (1965), Woeltjes (1982); b: Stephanidis (1939); c: Oliva (1961); d: Stephanidis (1974); e: Stephanidis (1974), Das (this paper); f: Labhart (1980); g: Baun (Seegers, 1980); h: and i: Woeltjes (1982): k: Das (this paper). Insert A: Flat at the mouth of the Aheron-river. Insert B: Valley west of Kipseli. (The numbers correspond to the habitats mentioned in the text.)

Results

The climate in Greece is of great influence on the water conditions. In maritime Greece, the weather is predominantly mild and rainy in the winter and hot and dry in the summer. The rainy season is on Corfu (Corfu may be vicarious for the opposite mainland) extending from October to March; the minimal rainfall occurs in July (Anonymous 1969). This climatic cycle may be modified in different ways: For instance, when the author entered Greece at April 16, the weather was warm and sunny (20—25°C). On April 20, the weather changed and became, with the exception of a few days, rainy and cool until May 1. The last days of April were characterized by heavy showers in the night and in the morning; in the afternoon, the weather cleared up. On May 2, the weather was overcast but dry. By May 3, the warm and sunny weather returned and lasted until on May 14 the author left Greece. It continued throughout the summer of 1982 and led to a heat wave and drought in Greece.

Habitats in the flat at the mouth of the Aheron-River (Fig. 1, A)

The Aheron is one of the great rivers which drain from the highlands of Epirus into the Ionian Sea. It springs forth near Mount Tomaros and flows into the sea after a course of about 60 km, south of Parga. The flat at the mouth of the Aheron river is almost circular and measures about 3 km in diameter. It opens in the west to a bay of a width of 500 m which in the north and in the south is bordered by rocky hills which extend in the sea. These hills enclose the flat like a horseshoe. Opposite to the bay, near the village of Mesopotamo at the road from Preveza to Parga, the hills are lowest. Here, the Aheron-river enters the flat. In the southwestern part near the beach at the right side of the mouth of the Aheron-river, the small village of Amoudia is situated. An

Fig. 2: Creek at the north of the bay near the mouth of the Aheron-River at habitat 1.

asphalt road of a length of 3 km leads from Mesopotamo to this site. The marshy flat is drained by some ditches. Where the marshy ground is sufficiently solid, the green flat is used as pastureland (horses, cattle, goats, pigs). In the environment of Mesopotamo, cotton is cultivated. The neighbouring hills are sparsely covered with Xerophytes which are grazed by sheeps and goats.

Fig. 3: Habitat 1. In the bights and in the stagnant water near the bank *V. letourneuxi* was found. At the slope of the hill in the background, the road from Preveza to Parga can be seen. At the bottom of the hill (X) habitat 2 is situated.

Habitat 1

(Fig. 1, A; fig. 2; fig. 3; table 1)

Only the characteristics of the habitats are given in the description. Further details are presented in table 1.

Northern end of the bay; a creek runs (velocity: 20 cm/sec.) alongside the rocks into the sea (fig. 2). Width of the creek: up to 10 m, depth: 1 m. About 50 m upstream small bights overgrown with *Myriophyllum* spec. and wads of

Chlorophyceae. In the bights *Valencia letourneuxi* (length: 2—4 cm) and *Gambusia affinis* (Baird & Girard, 1854). Salty taste of the water; consistency (ϱ18 ° C) smaller than 1.005. In the clear, reedy pools at the left side of the creek, connected in part with the same by small ditches, no *Valencia*, but *Gambusia affinis* in great number as well as toads and frogs (*Bufo viridis*, *Rana ridibunda*, *R. graeca*) which were in their spawning season.

The swimming *Valencia* could be easily distinguished from the accompanying and in the shape of the body similar *Gambusia* by observation of the white reflection of the eyes (Labhart 1980) from a position above the water.

Upstream, the current of the creek slowed down. After a few hundred meters, the salinity decreased until salt no longer could be tasted. The contents of minerals remained great. The source of brackish water in the lower course of the creek could not be detected. No surface affluent could be seen. Upstream, at decreasing flow, a thick layer of spherical (∅: 0.5—1.5 cm), crisped green algae covered the surface of the water. When at random pulling the spoon net through this layer of floating algae near the bank, up to 6 *V. letourneuxi* could be caught with the net. Females were more numerous (5 x) than males. The ratio of the number of *Gambusia* and the number of *Valencia* caught which was 3 near the mouth (habitat 1) decreased until, at habitat 2, no *Gambusia* was found.

Fig. 4: Habitat 2. The surface of the water is covered by a dense layer of crisped, spherical algae.

Habitat 2
(Fig. 1, A; fig. 4; table 1)

Same creek as habitat 1; 3 km upstream; below the road Preveza — Parga. Width: 5 m; depth: 1.5 m. Stagnant water.

From this locality, 8 living *V. letourneuxi* (3 males, 5 females; length: 2—3 cm) were brought to Germany. An accurate determination of these specimens revealed that the meristic dates agree with those of the *Valencia* from Corfu (Oliva, 1965), Three specimens have been left in the custody of the Museum Alexander Koenig, Bonn, FRG (Collection Numbers: ZFMK 12.901 — 12.903).

Live colouration of the male: body brownish-olive with up to 10 blue iridescent vertical bars on the flanks ranging from the vent to the tail head of the caudal fin; trunk with a few silver spots; belly silver or golden; opercula silver or golden metallic; dorsal and caudal fins with 3 to 4 rows of black dots between the fin rays semicircular around the bases of the fins; remaining fins colourless. Live colouration of the female: similar to the male, except all fins colourless, no vertical blueish bars, silver spots even at the tails (fig. 5 a, b). A coloured photograph of the fishes has been published (Das, 1984).

Habitats in a spring valley west of Kipseli
(Fig. 1, B)

Stephanidis (1974) reports about a finding of *V. letourneuxi* in "a spring west of the village Kypseli". Kipseli is situated in the Kokitos-river-valley (the Kokitos is the main tributary to the Aheron) at a by-road leading from the main road: Preveza — Igoumenitsa to the village of Gliki. Kipseli is located at the eastern slope of a rocky hill. The hilltop ist found directly west of Kipseli. The road: Preveza — Igoumenitsa by-passes the hill to the West. About 1 km after the bifurcation to Kipseli, in the airline west of this village, the road enters a marshy valley closely covered with vegetation (fig. 1, B). The valley begins in the East at the street line and winds some kilometers between hills to the West. The eastern part of the valley near the road is the source of a number of brooks flowing towards West. No signs of cultivation could be detected, but some cattle was seen in the lowland at habitat 5. Where the main road enters the valley, a small macadam road leads to a grave-pit in the West.

Habitat 3
(Fig. 1, B; fig. 6; table 1)

In the angle between asphalt road and macadam road a circular pool (∅: 10 m; depth: ?), covered with a dense layer of *Lemna trisulca. V. letourneuxi* (length: 2—3.5 cm) in a scrub of *Myriophyllum* spec. Around the pool, marshy ground and a girdle of reed. Pool only accesible from the North. About 20 m towards West: a brook (width: 3 m; depth: 1 m; current: 20 cm/sec.). Here, *Gasterosteus aculeatus* Linn., 1758, was caught. This brook originates in the girdle of reed at the south-western part of the pool. The pool must be spring

of the brook. Therefore, the author assumed that this pool must be the "spring West of ... Kypseli". This hypothesis has been confirmed by Stephanidis (letter from April 27, 1983).

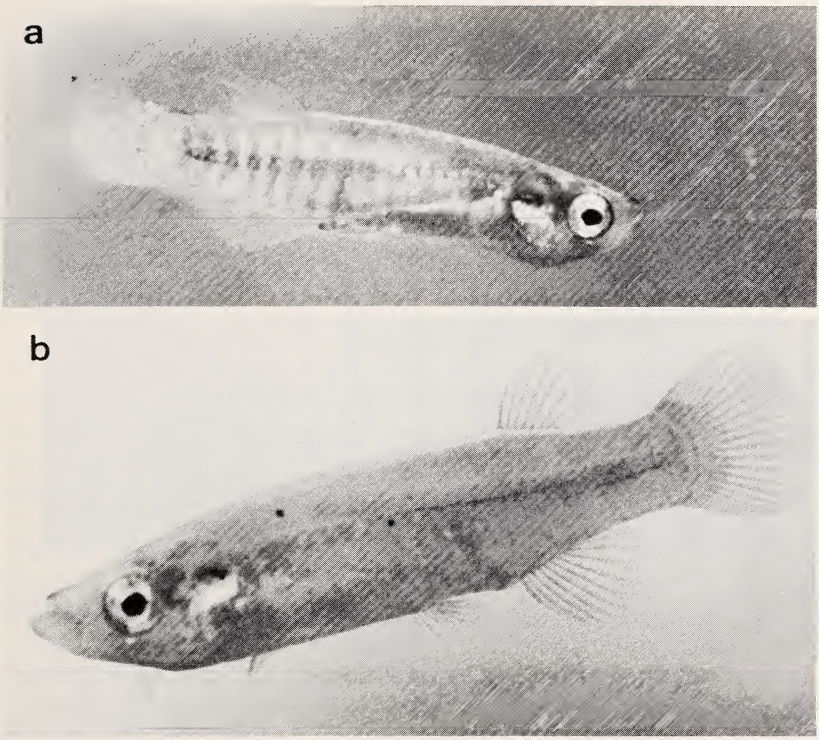

Fig. 5: *Valencia letourneuxi* from habitat 2; a: male; b: female.

Habitat 4
(Fig. 1, B; table 1)

About 200 m along the macadam road, a ditch beginning at the right hand, fed by some small springs gushing out of the earth below the slope of the roadway. Beside one of the springs lay a well coloured dead male (length: 4 cm) of *V. letourneuxi* on dry land. In the ditch further *Valencia* (length: 2—2.5 cm; 1 female: 6 cm).

Habitat 5
(Fig. 1, B; table 1)

On the other side of the valley where the mainroad leaves, a ditch in the valley overgrown densely by reed. In a small bight (depth up to 50 cm) separated by

a girdle of reed from the main water: *Valencia* (length: 2—3 cm). Ground covered with pebbles (∅: 5—15 cm).

In the habitats of this valley (3—5), no *Gambusia affinis* could be found.

Fig. 6: Habitat 3. A spring in the valley west of the village of Kipseli. The surface of the water is covered by a dense layer of *Lemna trisulca.*

Discussion

As most fishes of the order Cyprinodontiformes (Seegers 1980b) and its relative *Valencia hispanica* (Val., 1846) (Steindachner 1865), *Valencia letourneuxi* (Sauvage, 1880) inhabits quiet biotopes densely overgrown by plants. It prefers stagnant or slow running ditches (Labhart 1980; Seegers 1980a; Woeltjes 1982) and pools (Stephanidis 1939). When the fishes are living in larger waters (Butrinto Lake, Albania) they swim in shallow banks overgrown with plants, in most cases where ditches are ending in the lake (Oliva 1961). The mineral contents of the water is of little influence on the occurrence (table 1). The water may have a relativ low mineral contents (13 °DGH $\approx$ 230 ppm $CaCO_3$), it may be very hard ($>$ 70 °DGH $\approx$ $>$ 1250 ppm $CaCO_3$) or it may be slightly brackish. At any rate, *V. letourneuxi* could not, as e. g. its relative *Aphanius fasciatus* (Val., 1821), be found in lagoons and estuaries. The low concentrations of nitrite-, nitrate-, and ammonium ions indicate that the water does not contain much organic matter. *Valencia* spawns

in the plants (Seegers 1980b) and is not as some tropical Cyprinodontid fishes, e. g. *Cynolebias* (Lüling 1977), dependent upon any special kind of substrate. A thick layer of floating plants provides a shelter against predators from the air. The surface layer gives an efficient thermal insulation. The water did not noticeably cool down during the cold rainy period (April 16 — May 1, 1982) and did not warm up during the hot days (May 3 — 14, 1982). Perhaps the thermal constancy is mainly due to the thermal capacity of the large water reservoirs, represented by the marshy valleys at the end of the rainy season in April. In the course of the hot and rainless summer, a large proportion of the water will evaporate, but the central water localities must remain because *V. letourneuxi* has to survive in water habitats and is not dependent upon periodically desiccating localities, such as the "annuals" among the Cyprinodontiformes (e. g. *Cynolebias*; Lüling 1977). In the hot and dry summer the temperature of the water increases markedly. However, in the aquarium tank, *V. letourneuxi* endured temperatures of more than 30° C.

V. letourneuxi was associated with various small fishes, among them juveniles of larger ones, which also prefer thickets of plants or flee into them after disturbances. There also were large shoals of shrimps (*Palaemonetes*) as well as insects and their larvae. Some of these arthropods (*Dytiscus*, *Argulus*) could be dangerous to small fishes.

The live bearing tooth carp (Poeciliidae) *Gambusia affinis* (Baird & Girard, 1854) needs particular consideration as an associated fish species. This Meso-American fish has been released in the Mediterranean countries, e. g. at Corfu in 1930 (Stephanidis 1948), to combat the larvae of the malarial mosquito (*Anopheles*), and has spread over a wide area because of its high rate of reproduction. Since it generally inhabits the same ecological niche as its egglaying relatives (*Valencia*, *Aphanius*) native to this area, it frequently has ousted them (Altvater 1980). The rapid sequence of the generations and the comparatively large size of the new-born juveniles of a live-bearer in contrast with the small larvae hatched from eggs are of great advantage for Gambusia. *Aphanius fasciatus* and *A. iberus* (Val., 1846) escaped into hypersaline water habitats, where *Gambusia* could not follow (Altvater 1980). In contrast, *Valencia* which is not as tolerant to salinity could not leave the habitat. As a consequence *Valencia* is, especially in Spain, considered to be threatened by extinction. The situation seems to be analogous in Eastern Europe (Labhart 1980). In our search, it was striking that there were some biotopes which solely were inhabited by *Gambusia* and others by *Valencia*. *Gambusia* was e. g. found in a brackish lagoon at Igoumenitsa accompanying *Aphanius fasciatus* (habitat not shown). *Gambusia* also could be seen in such a large number that the water seemed to bubble at approaching in a small pool filled with mud and feces of cattle near the above mentioned lagoon; the visibility in this water was at best 1 cm (habitat not shown). Whereas both of these waters were unsuitable to

Table 1: Summary of all observed and measured parameters at the habitats of *V. letourneuxi*. * 1 ° DGH (German degree of total hardness) ≙ 17.8 ppm $CaCO_3$ ≙ 0.18 mmole Σ Ca^{2+} + Mg^{2+}/l; ** 1 °DKH (German degree of carbonate hardness) ≙ 0.18 mmole Σ $CaCO_3$ + $Ca(HCO_3)_2$ + $MgCO_3$ + $Mg(HCO_3)_2$/l.

Habitat	1	2
Date	4/30/82 4.30 p.m.	5/11/82 6.00 p.m
Weather	sunny	sunny
Temperature of the air	16 ° C	25 ° C
Temperature of the water at the surface	19 ° C	18 ° C
Quality of the water	colourless, translucent, no sediment after standing in a bottle, no odour	
Depth of the water	1 m	1.5 m
Current	in the stream: 20 cm/sec. at the bank: 0 cm/sec.	0 cm/sec.
Waterchemistry:		
pH	7.0	7.0
Total hardness*	>70 °DGH (>1250 ppm $CaCO_3$)	75 °DGH (1335 ppm $CaCO_3$)
Carbonate hardness**	13 °DKH	15 °DKH
NH_4^+	0.5—1 mg/l	0
NO_2^-	0	0
NO_3^-	0	10 mg/l
Consistency of the water (ϱ 18 ° C)	< 1.005	1.000
Salinity of the water	+	—
Substrate	mud	mud
Accompanying fish species	in the stream: Atherinidae (length: 20—30 cm) at the bank: *Gambusia affinis* juvenile Cyprinidae juv. Atherinidae juv. *Anguilla anguilla*	none seen
Accompanying fauna (except fishes)	*Palaemonetes* sp.	*Palaemonetes* sp.
Flora	*Phragmites* *Myriophyllum* wads of chlorophyceae *Juncus*	*Phragmites* *Typha* *Myriophyllum* spherical algae (∅: 0.5—1.5 cm)

3	4	5
5/1/82 0.30 p.m. sunny 20 ° C	5/1/82 1.00 p.m. overcast 18 ° C	5/1/82 2.30 p.m overcast 18 ° C
18 ° C same	16 ° C same	17 ° C same
? 0 cm/sec.	1 m 0 cm/sec.	0.5 m 0 cm/sec.
7.5 13 °DGH (231 ppm $CaCO_3$) 13 °DKH 0 0 10 mg/l	7.5 15 °DGH (267 ppm $CaCO_3$) 13 °DKH 0 0 10 mg/l	7.5 13 °DGH (231 ppm $CaCO_3$) 12 °DKH 0 0 mg/l 10 mg/l
1.000 — mud *Gobius ophiocephalus*(?)	1.000 — mud none seen	1.000 — pebbles *Gasterosteus aculeatus*
not seen	not seen	*Gammarus* sp. *Palaemonetes* sp. *Argyroneta* sp. *Dytiscus* sp. *Argulus* sp. parasitic on a juv. Cyprinid fish
Phragmites *Typha* *Ceratophyllum* *Lemna trisulca*	*Phragmites*	*Phragmites* *Lemna trisulca*

Valencia (high salinity, dirt), it remains to be explained, why *Valencia letourneuxi* could not be detected in the clean pools at habitat 1, where *Gambusia* was found. A few meters away in the creek of habitat 1, connected with the pools by ditches, both species were swimming. Similarly, inexplicable was the finding, that upstream the creek (habitat 2) and in the valley near Kipseli (habitats 3—5), no *Gambusia affinis* could be found. Whether *Gambusia* had not yet conquered these areas or whether some unknown factors exclude it there, it must be investigated.

For unknown reasons, with one exception only semi-adult *V. letourneuxi* (2—4 cm in length) could be caught. The adult specimens may swim in other regions of the water which could not be reached by the net or they may be quicker in avoiding the spoon net. Another possibility may be that only a small percentage of the fishes reach adulthood. Possible predators are larger fishes, the mentioned arthropods and their larvae, and the Dice Snake (*Natrix tesselatus*), which frequently was seen swimming in the waters, though not in any of the portrayed *Valencia* habitats. In that case, the risk must be greater for the striking and iridescent males. That may explain the fact that five times more females than males have been caught.

In conclusion, a few comments will be made to the geographic distribution of *Valencia letourneuxi* in Eastern Europe. The map (fig. 1) shows that *Valencia* could be found in each river valley at the west coast of the Balkan penisula from Butrinto Lake, Albania, in the North to the Louros-River, Greece, in the South. Further studies have to point out whether the area of distribution reaches even further to the North, whether other Ionian Islands besides Corfu (e. g. Paxi, Adipaxi) are colonized, and whether in the South this fish species can be found in the drainage basins of the Arahthos- and Archelos-rivers. In the Arahthos-valley, *Valencia letourneuxi* must be expected, since this valley is not separated by geographic barriers from the Louros-valley. In its area, *V. letourneuxi* inhabits the lowlands of the great rivers and lakes. These lowlands are compressed by the surrounding mountains a few kilometers upstream excluding the habitats for *Valencia*. It seems that *Valencia* has not crossed the mountains of the inland, Pindos mountains (altitude: $\approx$ 2000 m), because otherwise it should have been found in the plains of Thessalia which are 100—150 km away. Thus, *Valencia letourneuxi* is an inhabitant of the waters of the coastal area, but not in the sense that it lives in purely marine environments; it is largely a freshwater species.

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Summary

A survey is given of the distribution of the Cyprinodontiform fish species *Valencia letourneuxi* in the south-eastern part of Europe. The fish has been found in coastal biotopes of the great valleys from Butrinto Lake, Albania, in the North to the Louros-river, Greece, in the South and on the Ionian Island of Corfu. Furthermore, some biological and ecological life-conditions of *V. letourneuxi*, esp. in the Aheron-river-drainage, are presented. The fishers inhabit stagnant or slow streaming ditches and pools or flat banks of lakes. The habitats are characterized by translucent and clean water. The fishes live in or between thickets of plants. The water may be medium hard (230 ppm $CaCO_3$), very hard (> 1250 ppm $CaCO_3$), or slightly saline. In some habitats, *V. letourneuxi* is accompanied by the Poeciliid *Gambusia affinis*. In the future, this naturalized species from Central America may become a severe danger to the survial of *V. letourneuxi* because it lives as a superior competitor in the same ecological niche.

Zusammenfassung

Beiträge zur Biologie und Ökologie von *Valencia letourneuxi* (Sauvage, 1880) (Teleostei, Cyprinodontiformes) im Aheron-Kokitos-Flußsystem im nordwestlichen Griechenland.

Ein Überblick über das Verbreitungsmuster der cyprinodontiformen Fischart *Valencia letourneuxi* in Südosteuropa wird gegeben. Dieser Fisch wurde in küstennahen Biotopen in den größeren Tälern vom Butrinto See, Albanien, im Norden bis zum Louros-Fluß, Griechenland, im Süden sowie auf der Ionischen Insel Korfu gefunden. Weiterhin wird über einige ökologische und biologische Lebensbedingugnen von *V. letourneuxi,* besonders im Aheron-Flußsystem, berichtet. Er bewohnt stehende oder schwach strömende Gräben und Teiche bzw. flache Stillwasserbuchten von Seen. Die Habitate zeichnen sich durch glasklares, sauberes Wasser aus. Die Tiere leben in oder zwischen Pflanzendickichten. Das Wasser darf mittelhart (13 °DGH) bis sehr hart (> 70 °DGH) oder schwach salzhaltig sein. In einigen Gewässern ist *V. letourneuxi* mit dem Poeciliiden *Gambusia affinis* vergesellschaftet. Dieser aus Mittelamerika eingeführte lebendgebärende Zahnkarpfen kann als überlegener Konkurrent eine ernste Gefahr für das Überleben von *V. letourneuxi* werden.

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