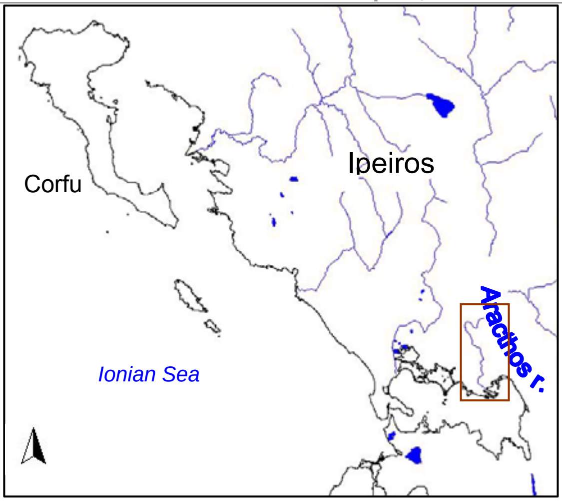
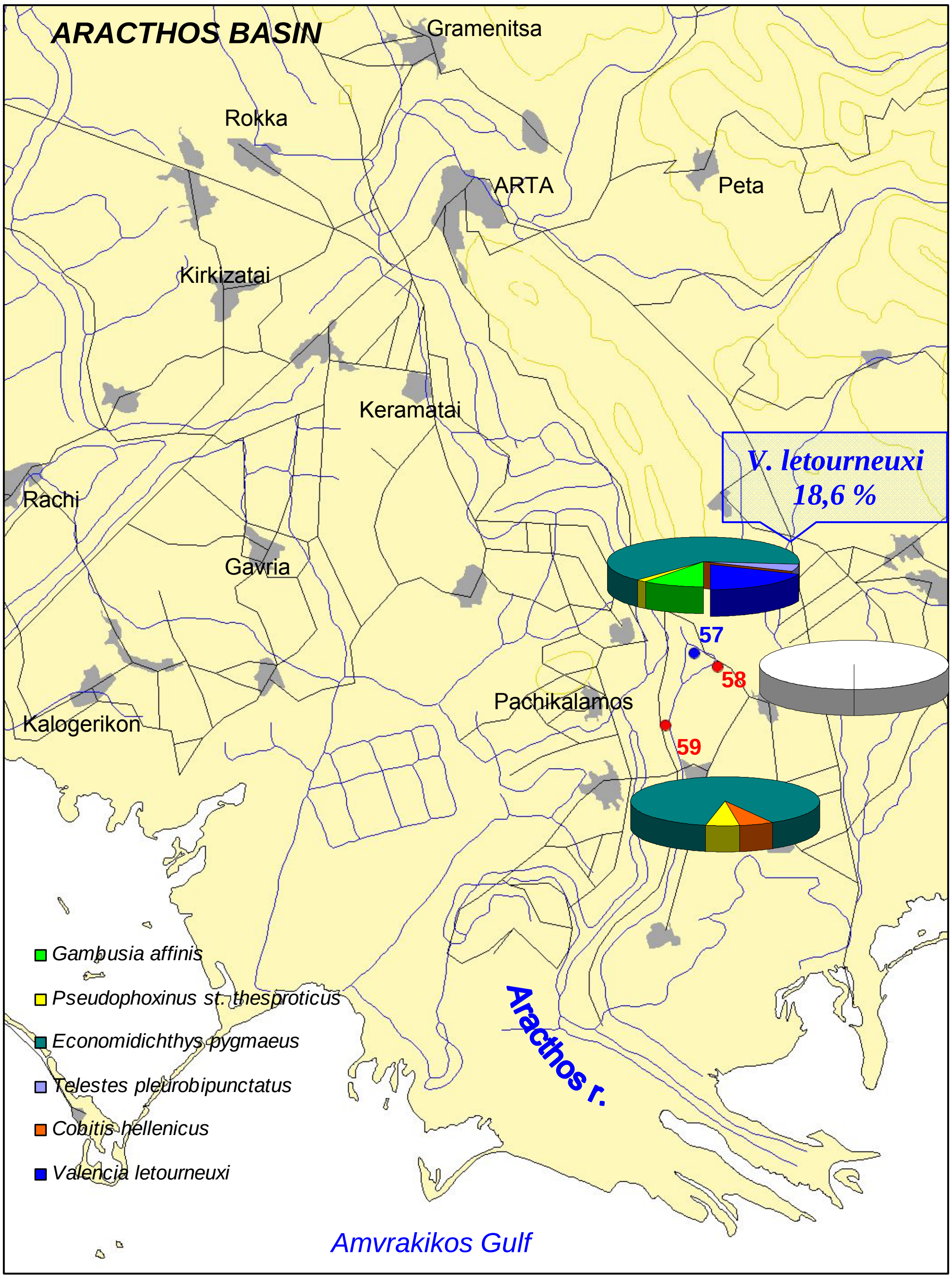
MAP II. Fish species composition at the Arachthos sampling sites. *V. letourneuxi* was recorded at one site (57) with a density of 18,6%.





CURRENT VERSUS HISTORICAL PRESENCE OF *V. LETOURNEUXI* IN THE ARACHTHOS SYSTEM

V. letourneuxi was first reported in the Arachthos system by *Daoulas* (2003) at the Agios Georgios springs, where *V. letourneuxi* presence was also confirmed in October 2005 during the current survey, at densities (18,6%), relatively high for this species (similar to those reported by *Daoulas*, 17,5%).

References	**V. letourneuxi *presence***
Daoulas (2003)	●
Current Survey	●

3.1.9 LOUROS RIVER

The Louros river originates from springs south of mount Tomaros and flows into the Amvrakikos Gulf (length 73 km, basin 983 km^2, average yearly discharge 900 hm^3). Along its course it is fed by springs at its banks and at the river bed from its aquifer, as well as from springs at the Arta valley. The main points of discharge of the Louros karstic system are at the following locations: Chanopoulo, Kampi, Priala (Mavri) and Skala. Due to the fact that along most of its course it flows through karstic limestone and its mostly spring-fed, its discharge does not exhibit pronounced seasonal fluctuation, in comparison to pluvio-nival rivers, such as Arachthos. At its outlet it forms a large delta (150 km^2) protected by a series of Greek and EU decrees.

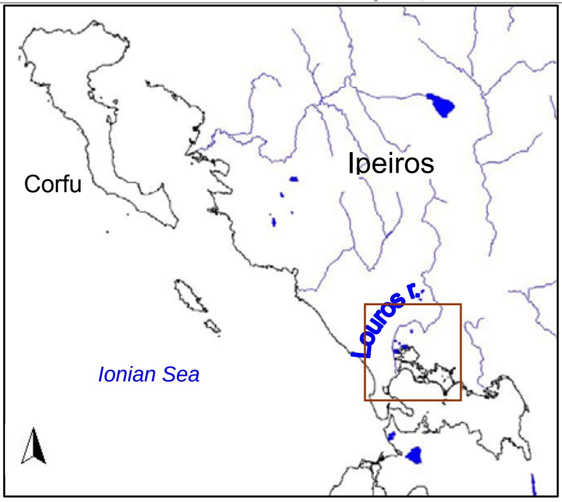
SAMPLING STATION DISTRIBUTION

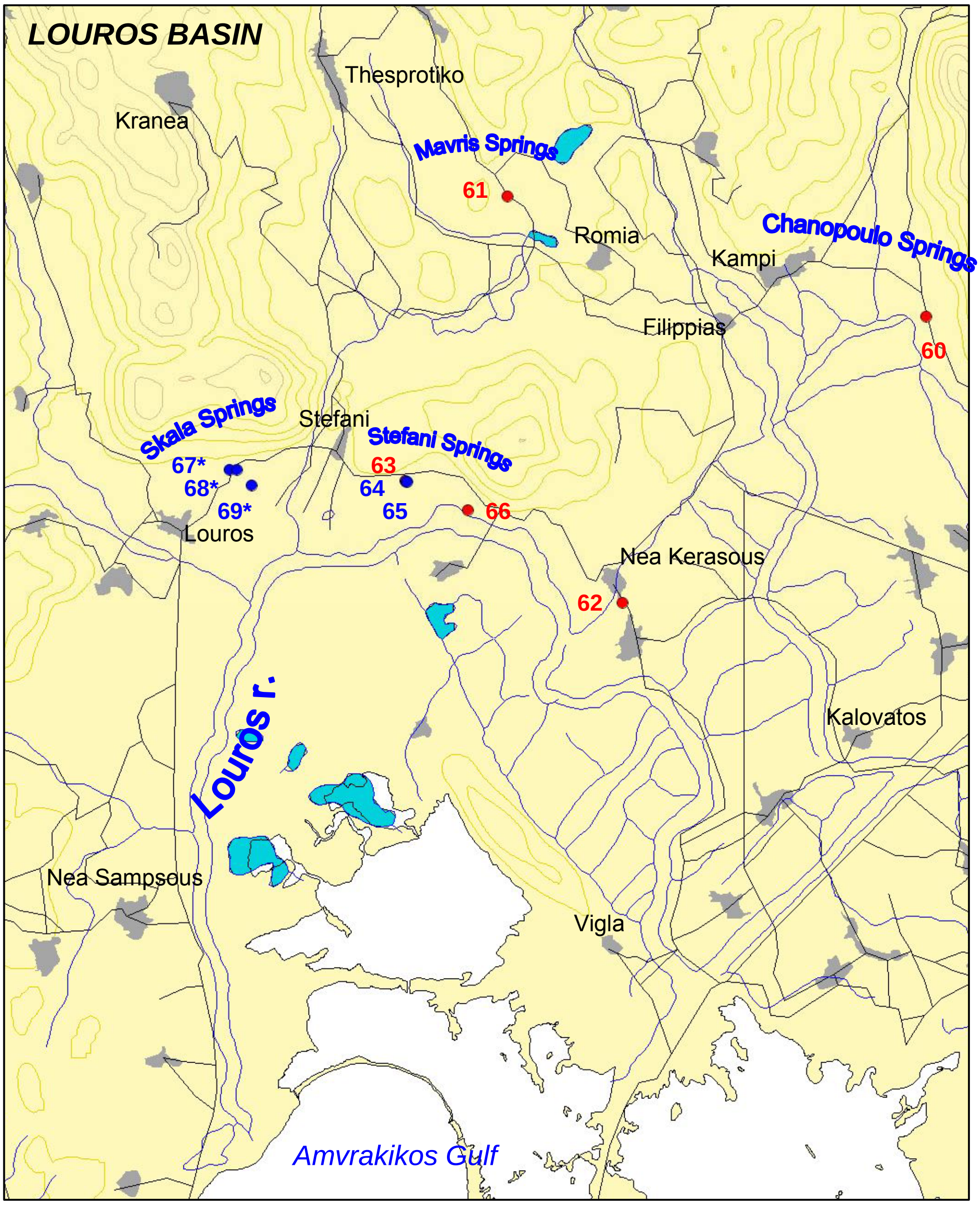
The current survey focused on a series of springs and associated canals at the lower area of the Louros system, with a total of 10 sampling sites. These included the Chanopoulo springs (site 60), the Mavri (Priala) springs (site 61) which in the past fed Mavri Lake, drained in the early 1970s, the Nea Kerasous springs (site 62), the Stefani springs (sites 63, 64 & 65), a section of the Louros river (site 66) and the Skala springs (sites 67,68 & 69).

TABLE 1. Sampling sites at the Louros system.

site	*location*	*water body type*	*pressures*
60	Chanopoulo springs	Spring fed canal	Animal husbandry, adjacent road
61	Mavri springs	Canal	Water abstraction, agriculture, wetland drainage
62	Nea kerasous springs	Spring-fed pool	Water abstraction, agriculture
63	Stefani springs- trout holding pond	Pond, human created	Water abstraction, adjacent road, tourist infrastructure
64	Stefani stream- outside gate	Spring fed stream	Water pumping, Adjacent road, restaurant
65	Stefani stream bank	Spring-fed stream	Water abstraction, agriculture
66	Louros river	River	Water abstraction, agriculture, organic pollution
67	Skala springs	Springs	Adjacent road, fish farm, roadworks
68	Skala stream –before fish farm	Spring-fed stream	Adjacent road, fish farm
69	Skala stream-after fish farm effluent site	Spring-fed stream	Adjacent road, fish farm

MAP I. Sampling sites at the Louros river basin. Localities where *V. letourneuxi* was recorded (●), sites 64 & 65 at Stefani springs and sites 67*, 68* & 69* at Skala springs – and not recorded (●) – sites 60, 61, 62, 63 & 66.
* First record





PRESSURES

The main pressures to the Louros system are the increasing water use for irrigation, the operation of animal husbandry units in or close to the riparian area, as well as the operation of a large number of trout farms. The latter probably contribute to the pollution of the system's waters with organic and inorganic material, while the effect of escaped trout on the local fish populations and generally on the local fauna and flora is yet unknown. There is also agricultural pollution from the extensive use of fertilizers and some point source organic pollution from husbandry units near the river's estuaries and some urban waste pollution from the small urban centers of the area.

HABITAT CHARACTERISTICS

Chanopoulo springs. The Chanopoulo springs are karstic springs. From these springs originates a canal with rich aquatic vegetation, the flow of which is controlled by sluices. After those, the aquatic vegetation diminishes. The dominant macrophytes are *Salix spp.* and *Typha spp.* with some *Ficus* trees and bramble. The aquatic vegetation is mostly mixed submerged plants. The water form these springs is diverted to Vossa Canal (Fig. 1-5).

Fig. 1. Chanopoulo springs with rich submerged vegetation.

Fig. 2. Station 60, slightly downstream from the Chanopoulo springs at the canal.

Fig. 3. The flow of the water is regulated by a system of sluices.

Fig. 4. The Chanopoulo canal, d/s from the sluices, with much less floating vegetation.

Fig. 5. The origin of the Vossa Canal near Chanopoulo springs.

Fig. 6. The Vossa Canal, about 6 km downstream from the Chanopoulo springs.

Mavri springs. The waters of the Mavri springs create a canal with very clear and relatively cool water, rocky substrate and many submerged and emergent aquatic plants (Fig. 7-10).

Fig. 7. The Mavri springs, at relatively high altitude (12 m).

Fig. 8. The Mavri canal (site 61).

Fig. 9. Site 61 with water cress and *Ceratophyllum spp.* aquatic plants.

Fig. 10. Site 61 with water cress-like plants and fallen dead reeds (top).

Nea Kerasous springs. These springs create a shallow ford with spring inlets through conglomerate rock fissures. The riparian vegetation is mostly bramble and grasses and the aquatic vegetation is mostly algae and moss. (Site 62, Fig. 11-12).

Fig. 11. Nea Kerasous springs. Site 62 with shallow ford.

Fig. 12. Spring inlets through rock fissures at site 62.

Stefani springs. These springs were in the past part of a big marsh, now partially filled to build a restaurant. The springs discharge into a human created trout holding pond (Site 63). Site 64 was right outside pond and site 65 at the banks of the Stefani stream (Fig. 13-18).

Fig. 13. Stefani springs. Human made pond (site 63).

Fig. 14. Pond (site 63) and gate to prevent the trout dispersal in the stream.

Fig. 15. Site 64 just outside the gate.

Fig. 16. The Stefani stream.

Fig. 17. The Stefani stream partially covered with *Lemna spp.*

Fig. 18. Site 65 at the bank of Stefani stream.

Louros river bank. Sampling site 66 was located at the Louros river bank just before its confluence with the Stefani stream. It is a wide riverine area with little riparian and aquatic vegetation.

Fig. 19. The Stefani stream just before its confluence with the main river.

Fig. 20. Site 66 at the Louros river bank.

Skala springs.
These springs, near Louros village, form a wide canal with rich aquatic vegetation.

Fig. 21. Skala springs, site 67, with water-cress like aquatic plants.

Fig. 22. Location further d/s, very close to site 68.

Fig. 23. Site 69, by the fish farm effluent.

Fig. 24. Site 69, effluent of fish farm.

TABLE 2. Data on the riparian and aquatic vegetation at the Louros sampling sites.

site	riparian vegetation	% r.v.	aquatic vegetation	% a.v.	surface cover
60	*Salix alba* *Typha spp.* *Bramble* *Ficus*	30 30 20 5	*Mixed submerged*	50	20
61	*Bramble*	50	*Water cress-like* *Ceratophyllum sp.*	40 10	80
62	*Salix alba* *Ficus tree* *Arundo spp.* *Bramble* *Grasses and perennial plants*	20 10 10 30 30	*Emergent lily-like* *Algae*	5 40	10
63	*Platanus orientalis* *Fraxinus sp*	40 10	*Algae* *Ranunculus lle plants*	20 15	10
64	*Platanus orientalis* *Fraxinus sp* *Phragmites aus.* *Grasses*	10 10 50 5	*Lemna spp.* *Ceratophyllum spp.* *Water cress-like*	30 5 5	50
65	*Salix alba* *Populus sp.* *Phragmites aus.* *Bramble*	5 2 70 20	*Lemna spp.*	80	80
66	*Salix alba* *Arundo spp.* *Iris spp.*	<2 15 20	*Water cress* *Ceratophyllum spp.* *Ulva algae*	10 <5 10	10
67*	*Scirpus sp.* *Annual and perennial weeds*	20 80	*Water cress-like*	50	80
68*	*Bramble* *Grasses*	40 30	*Lemna spp.* *Water cress*	80 20	95
69*	*Populus spp.* *Salix alba* *Bramble* *Iris sp.*	30 10 50 10	*Lemna spp.* *Water cress-like*	80 20	95

FISH SPECIES COMPOSITION

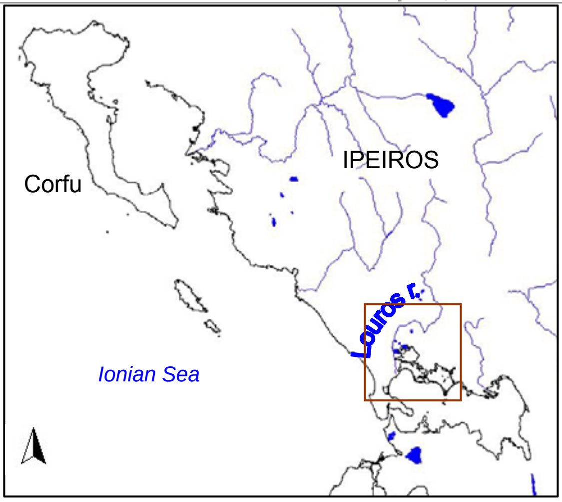
Table 3 summarizes the fish species composition at the Louros sampling stations and Map II their spatial distribution. The fish species encountered were *Pseudophoxinus st. thesproticus, Telestes pleurobipunctatus* and *Barbus peloponnesius* (Cyprinidae), *Economidichthys pygmaeus* (Gobiidae), *Cobitis hellenicus* (Cobitidae), *Gasterosteus aculeatus* (Gasterosteidae), *Gambusia affinis* (Poecillidae) and *Valencia letourneuxi* (Fig. 25-29).

V. letourneuxi was found in two systems, the Stefani stream and the Skala stream at densities that varied from 3,4 to 11,9%.

TABLE 3. Fish species composition at the Louros sampling sites.

site	*Sampling equipment*	*Fish species*	*%*	*No*	*V. letourneuxi*
60	electrofishing	*Pseudophoxinus st. thesproticus* *Telestes pleurobipunctatus* *Economidichthys pygmaeus* *Cobitis hellenicus* *Gasterosteus aculeatus*	31,5 11,0 48,6 4,1 4,8	146	●
61	scoop net	*Telestes pleurobipunctatus* *Barbus peloponnesius* *Economidichthys pygmaeus*	44,5 33,3 22,2	18	●
62	electrofishing dip net	*Pseudophoxinus st. thesproticus* *Telestes pleurobipunctatus* *Economidichthys pygmaeus*	3,1 9,4 87,5	64	●
63	scoop net	*Telestes pleurobipunctatus* *Economidichthys pygmaeus*	95,8 4,2	48	●
64	electrofishing scoop net	*Pseudophoxinus st. thesproticus* *Economidichthys pygmaeus* *Gambusia affinis* ***Valencia letourneuxi***	3,6 66,0 25,0 **5,4**	56	●
65	scoop net dip net	*Economidichthys pygmaeus* *Gambusia affinis* ***Valencia letourneuxi***	83,3 11,1 **5,6**	18	●
66	scoop net dip net	*Pseudophoxinus st. thesproticus* *Economidichthys pygmaeus* *Cobitis hellenicus* *Gambusia affinis*	1,6 82,0 13,1 3,3	61	●
67*	scoop net dip net	*Telestes pleurobipunctatus* *Economidichthys pygmaeus* *Cobitis hellenicus* *Gambusia affinis* ***Valencia letourneuxi***	0,9 82,7 0,9 7,7 **7,8**	116	●
68*	scoop net	*Economidichthys pygmaeus* *Gambusia affinis* ***Valencia letourneuxi***	75,9 20,7 **3,4**	29	●
69*	scoop net dip net	*Pseudophoxinus st. thesproticus* *Economidichthys pygmaeus* *Cobitis hellenicus* *Gambusia affinis* ***Valencia letourneuxi***	1,7 47,4 5,1 33,9 **11,9**	59	●

MAP II. Sampling sites at the Louros river basin. *V. letourneuxi* was found in two systems, the Stefani springs (sites 64 & 65) and the Skala springs (sites 67*, 68* & 69*). Densities varied from 3,4% to 11,9%.
* First record



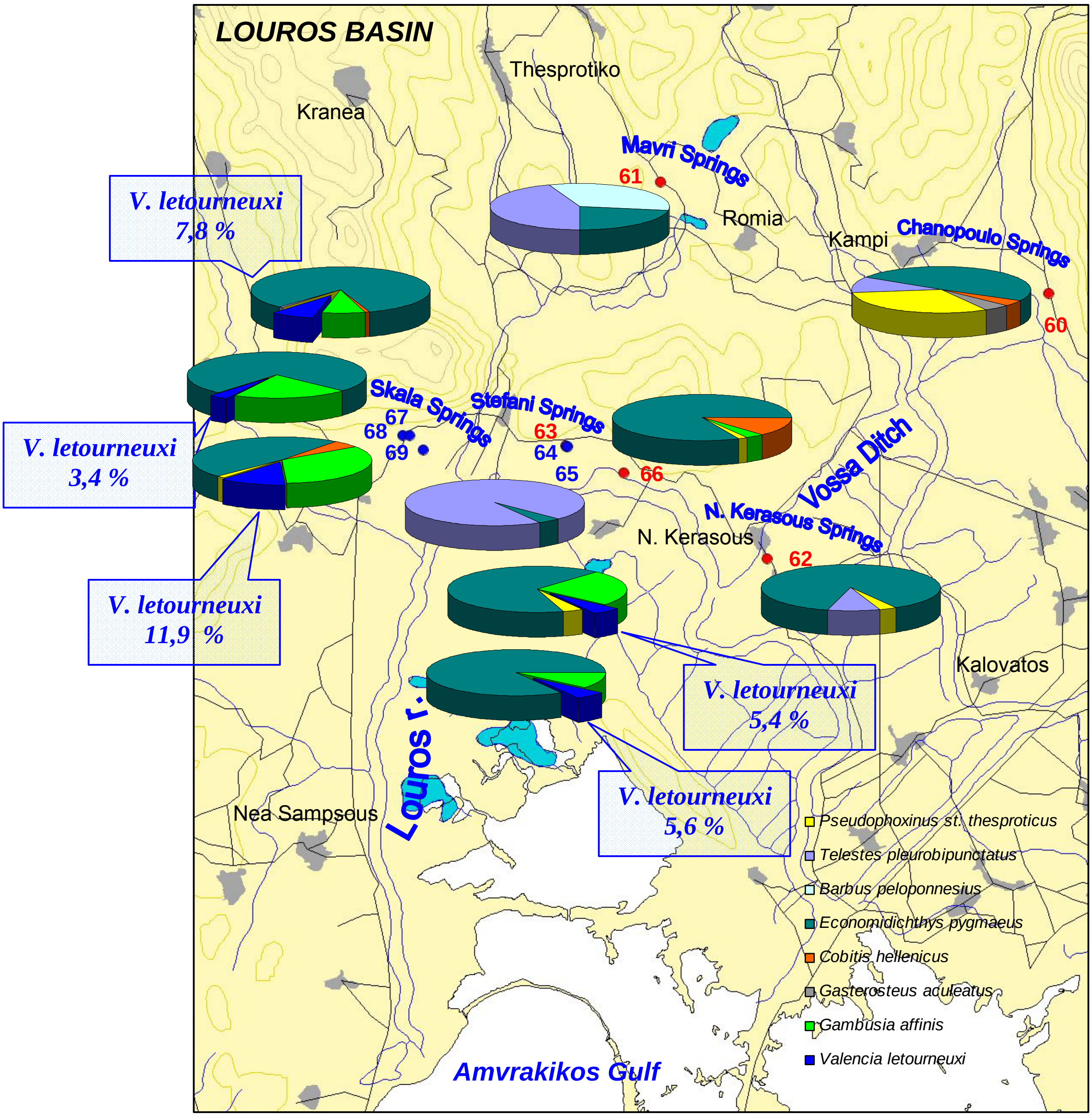


Fig. 25. *Telestes pleurobipunctatus* (Stefani springs, site 63).

Fig. 26. *Economidichthys pygmaeus* (Stefani stream, site 64).

Fig. 27. *Cobitis hellenicus* (Skala stream, site 68).

Fig. 28. *Valencia letourneuxi* (Stefani stream, site 64).

Fig. 29. *Valencia letourneuxi*.

CURRENT VERSUS HISTORICAL PRESENCE OF *V. LETOURNEUXI* IN THE LOUROS SYSTEM

V. letourneuxi was first reported by *Stephanidis* (1939) at the Stephani springs and later reported there too by *Economou et al.* (1991) and *Barbieri et al.* (2000). This location corresponds to site 64 of the current survey, where *V. letourneuxi* presence could be confirmed. *V. letourneuxi* was also found during this survey in a second spring-fed stream of the Louros system, the Skala stream (see Table below).

References	**V. letourneuxi *presence***
Stephanidis (1939)	●
Economou *et al.* (1999)	●
Barbieri *et al.* (2000)	●
Current Survey	●

POPULATIONS FIRST RECORDED HERE
Skala stream

3.1.10 ACHERON BASIN

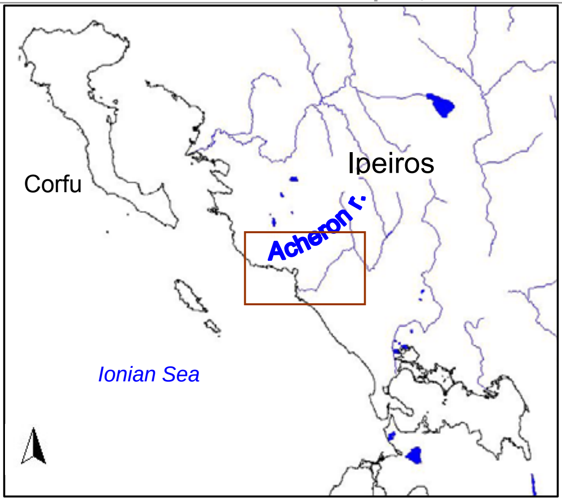
The Acheron river springs forth near mount Tomaros and, after a course of 52 km, drains into the Ionian sea close to the village of Ammoudia (basin 752 km^2, average yearly discharge 393 hm^3). It has two main tributaries, Kokkitos river and Dala stream. A series of karstic systems discharge along its course. The coastal plain at the mouth of the Acheron, almost circular in shape, is marshy and drained by some ditches. The Delta wetland (16 km^2) in under heavy pressure from anthropogenic activities.

SAMPLING STATION DISTRIBUTION

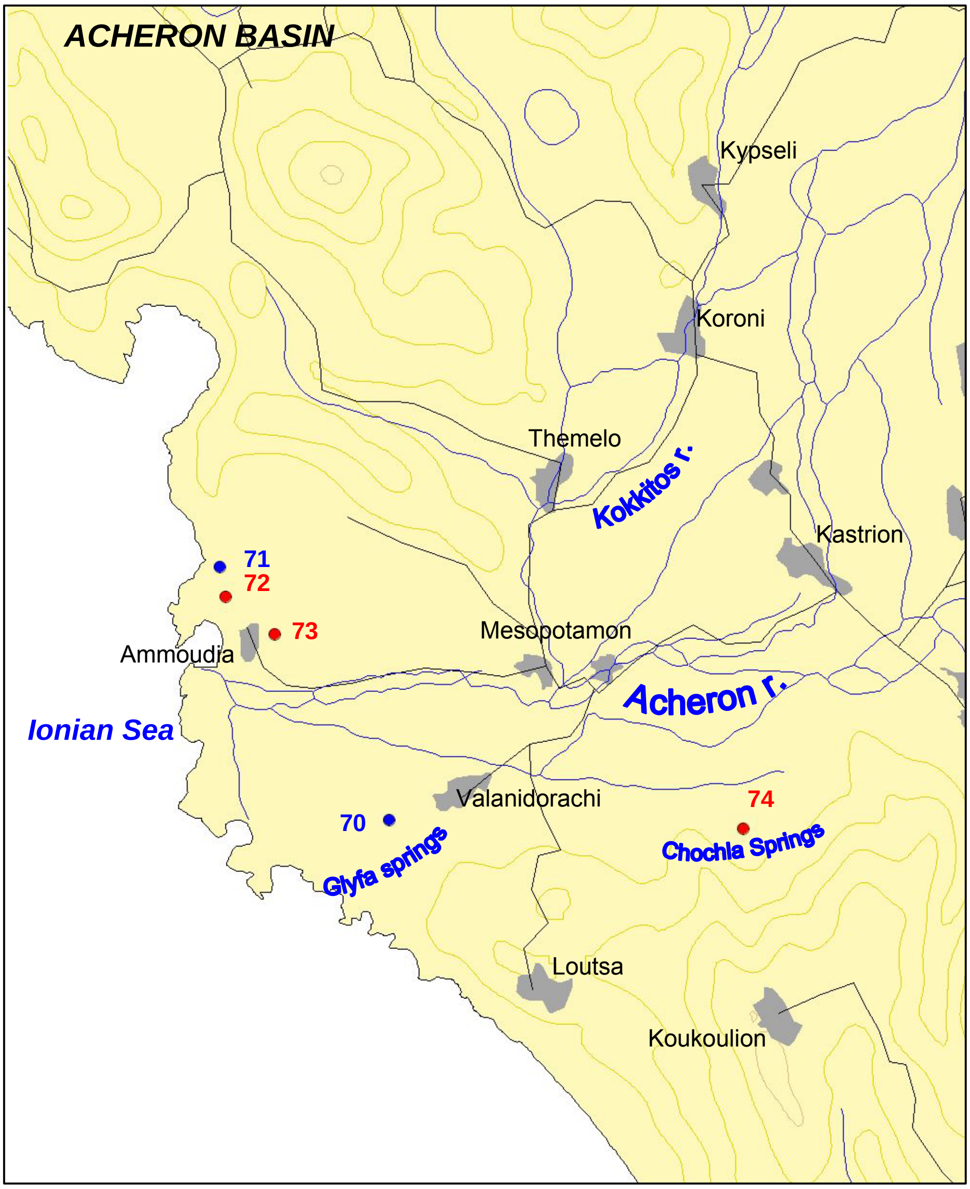
The current survey focused on a the Delta area of Acheron river. The sampling sites included a spring area at the southern edge of the Delta (Glyfa springs, site 70), a drainage ditch at the northern edge of the Delta (site 71,72), a marshy area in the swamp (site 73) and a spring area further inland discharging in a small stream near Chochla village (Chochla springs, site 74).

TABLE 1. Sampling sites at the Acheron basin.

site	*location*	*water body type*	*pressures*
70	Glypha springs	Canal joining Glyfa springs	Drainage works, canal building, vegetation clearing, grazing
71	Drainage ditch, pumping station	Ditch	Drainage works, animal husbandry unit, grazing, organic pollution, solid waste disposal
72	Drainage ditch, western side	Ditch, marshes	Drainage works, grazing, organic pollution
73	Acheron marsh	Marsh	Drainage works, grazing, organic pollution, construction works
74	Chochla springs	Springs	Urban site



MAP I. Sampling sites at the Acheron river basin. Localities where *V. letourneuxi* was recorded (●) – sites 70 & 71 - and not recorded (●) – sites 72, 73 & 74.



PRESSURES

The main threat to the Acheron Delta system are drainage works currently in progress to create pasture land, as well as land for touristic development.

HABITAT CHARACTERISTICS

Glyfa springs, associated canal. Glyfa springs are located at the southern edge of the almost circular Acheron Delta and together with a drainage ditch flowing from the north, create a wide canal flowing into the sea. The water of the springs was brackish (7,6 ‰), in contrast to that of the adjacent ditch (2,3 ‰). Both the spring area and the adjacent drainage ditch were sampled in this survey (site 70). This was a heavily disturbed site, with some *Phragmites* reeds and rich aquatic vegetation (Fig.1-6).

Fig. 1. The Acheron Delta photographed from the east. At the background can be seen the village of Ammoudia.

Fig. 2. The Glyfa springs, at the southern side of the river Delta, with dense floating vegetation.

Fig. 3. Drainage canal joining the Glyfa spring area.

Fig. 4. The point of convergence of the drainage canal with the Glyfa springs.

Fig. 5. Close up of site 70 (drainage canal) with Zanichelia-like aquatic plants.

Fig. 6. The wide canal formed by the Glyfa springs and the drainage canal, further downstream.

Northern drainage ditch, swamp area. Along the northern edge of the delta, runs a wide canal which then turns southward along the coastline. Two sites were sampled there (site 71 and 72). Site 71 was a section of the canal with brackish water (6,2 ‰) with *Phragmites* reeds and *Juncus spp.* along its banks and rich aquatic vegetation. Sites 72 and 73 were swamp-like sites (salinity 4,6 and 6,6‰ respectively) with *Phragmites* and *Juncus spp*. macrophytes (Fig. 7-12).

Fig. 7. Northern drainage canal (site 71) with *Phragmites* reeds and Juncus *spp.* at its banks.

Fig. 8. Site 71 with *Ceratophyllum spp.*, algae and grass-like *Potamogeton spp.*aquatic plants.

Fig. 9. *Ceratophyllum spp.* at site 71.

Fig. 10. Site 72 with ulva algae.

Fig. 11. Site 72 with *Phragmites* reeds and *Juncus spp.*

Fig. 12. Site 73, deep in the swamp, mostly with *Phragmites* reeds and *Ceratophyllum spp.* plants.

Chochla springs. The Chochla springs flow into the Vouvos stream at the southern edge of the river delta. The area of the springs has been built around to create a recreational area (Fig. 13-14).

Fig. 13. The Chochla springs (site 74).

Fig. 14. Site 74 with water cress aquatic plants.

TABLE 2. Data on the riparian and aquatic vegetation at the Acheron sampling sites.

site	riparian vegetation	% r.v.	aquatic vegetation	% a.v.	surface cover
70	*Phragmites aus.* *Annual plants*	50 <5	*Algae* *Ceratophyllum spp.* *Zanichelia like*	15 5 80	80
71	*Phragmites aus.* *Juncus spp.* *Grasses*	45 15 40	*Ceratophyllum spp.* *Algae mats* *Grass like* *Potamogeton spp.*	70 10 20	70
72	*Phragmites aus* *Juncus spp.*	30 20	*Ulva algae*	40	40
73	*Phragmites aus* *Juncus spp.*	70 20	*Ceratophyllum spp.*	40	40
74	*None*	0	*Grasses* *Water cress*	30 65	80

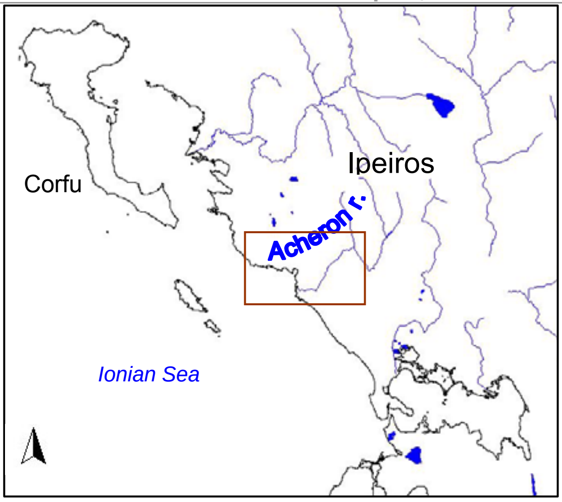
FISH SPECIES COMPOSITION

Table 3 summarizes the fish species composition at the Acheron sampling stations and Map II their spatial distribution. The fish species encountered were *Pseudophoxinus st. thesproticus* (Cyprinidae), *Knipowitschia sp.* (Gobiidae), *Anguilla anguilla* (Anguillidae), *Gambusia affinis* (Poecillidae), fishes of the Mugilidae family and *Valencia letourneuxi* (Fig. 15-17).

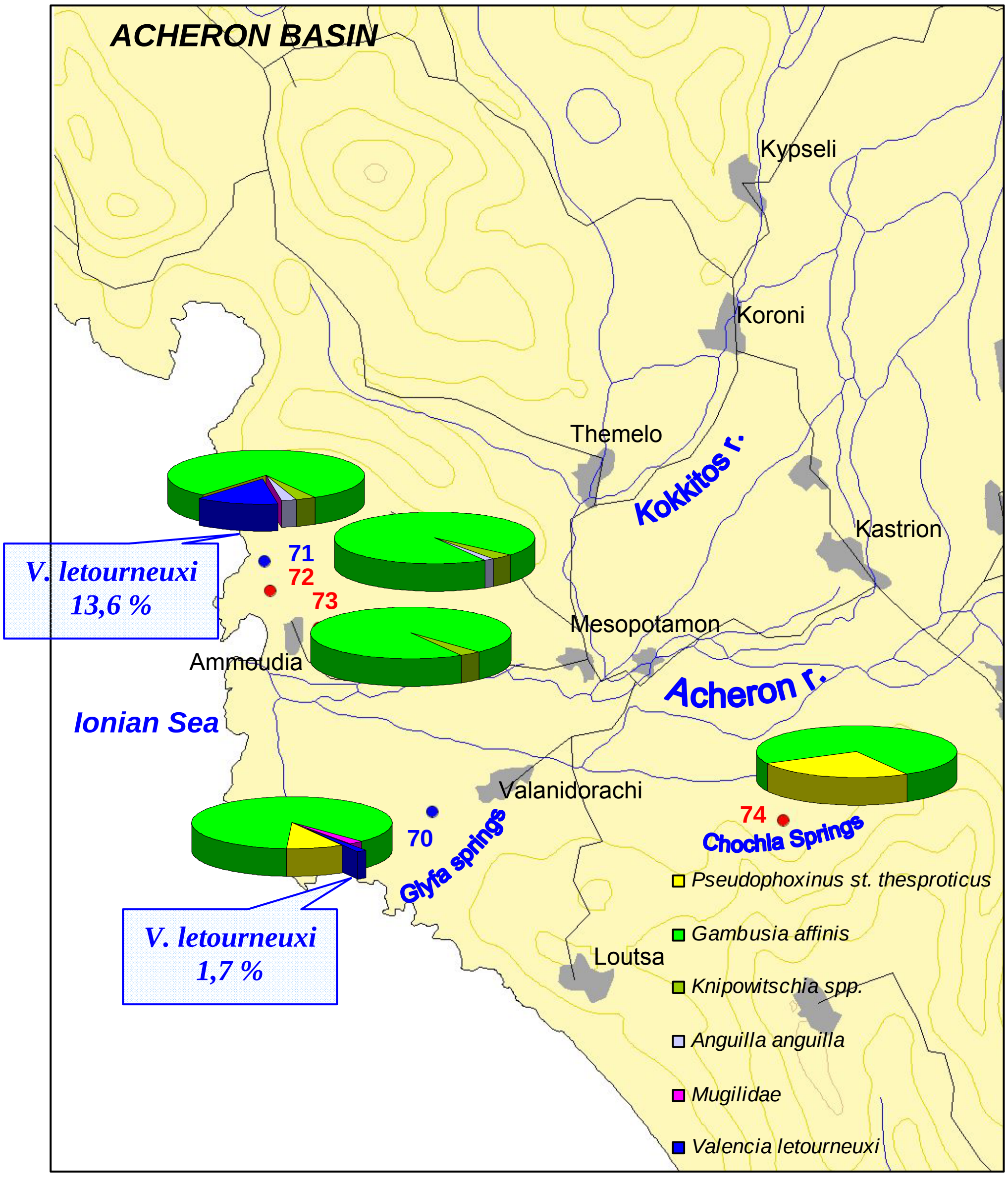
V. letourneuxi was found in the drainage canal close to the Glyfa springs (site 70) and in the northern drainage canal (site 71) at densities of 1,7 and 13,6% respectively.

TABLE 3. Fish species composition at the Acheron sampling sites.

site	***Sampling equipment***	***Fish species***	***%***	***No***	***V. letourneuxi***
70	Scoop net Dip net	*Pseudophoxinus st. thesproticus* *Gambusia affinis* *Mugilidae* ***Valencia letourneuxi***	9,1 86,9 2,3 **1,7**	176	●
71	scoop net	*Gambusia affinis* *Knipowitschia sp.* *Anguilla anguilla* ***Valencia letourneuxi***	80,5 3,4 2,5 **13,6**	118	●
72	scoop net	*Gambusia affinis* *Knipowitschia sp.* *Anguilla anguilla*	94,7 3,5 1,8	57	●
73	scoop net	*Gambusia affinis* *Knipowitschia sp.*	96,4 3,6	28	●
74	scoop net	*Pseudophoxinus st. thesproticus* *Gambusia affinis*	25,9 74,1	27	●



MAP II. Fish species composition at the Acheron sampling sites. *V. letourneuxi* was found in the drainage canal near the Glyfa springs (site 70) and in the drainage canal at the northern edge of the delta (site 71), at densities of 1,7% and 14,6% respectively.



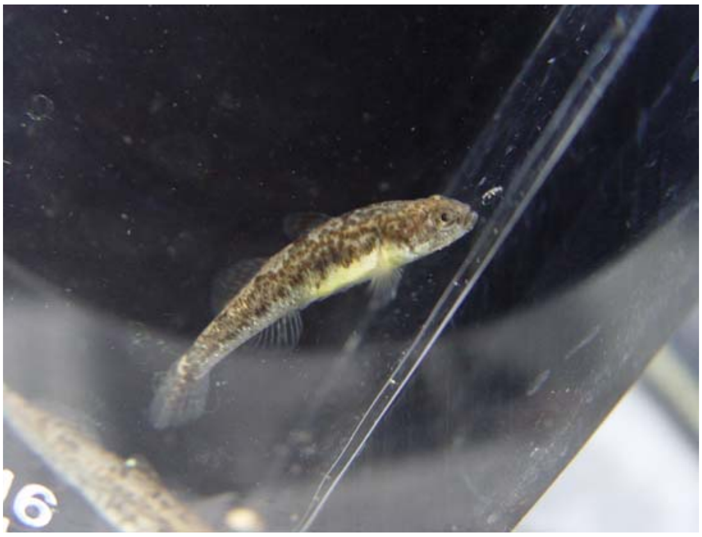


Fig. 15. *Knipowitschia spp.* (possibly *K. milleri*).

Fig. 16. Adult *V. letourneuxi.*

Fig. 17. Adult *V. letourneuxi,* approx. length 4 cm.

CURRENT VERSUS HISTORICAL PRESENCE OF *V. LETOURNEUXI* IN THE ACHERON BASIN

V. letourneuxi was first reported in Acheron by *Stephanidis* (1974) at the northern drainage canal (site 71 of the current survey) and subsequently by *Das* (1985), *Barbieri et al.* (2000) and *Economou et al.* (1999) technical report. It was also found by *Stephanidis* (1974) in springs near Kastri village and by *Stephanidis* (1974) and *Das* (1985) in a spring west of Kypseli village. Unfortunately, it was not possible to sample these sites in the frame of the current survey. Finally, *V. letourneuxi* was found by *Barbieri et al.* (2000) in a creek running through a marshy area (near Valanidorachi village) into the sea at the southern edge of the Acheron estuaries, corresponding to site 70 (drainage canal associated with Glyfa springs) of the current survey.

References	**V. letourneuxi *presence***
Stephanidis (1974)	●
Das (1985)	●
Economou *et al.* (1999)	●
Barbieri *et al.* (2000)	●
Current Survey	●

3.1.11 KALAMAS RIVER

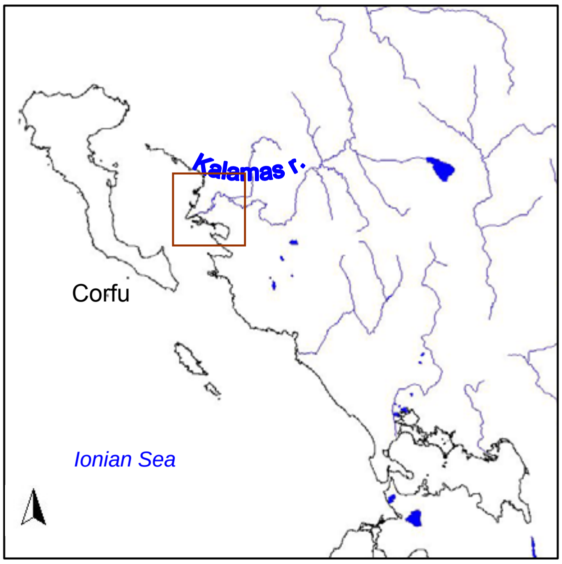
The Kalamas (or Thyamis) river springs forth from mount Dousko near the Greek-Albanian border and drains into the Ionian Sea (length 115 km, basin 1800 km^2, average yearly discharge 2048 hm^3). A series of karstic systems discharge along its course. Its Delta includes a rich variety of wetlands with the old and the new course of the river (created in 1949), irrigation and drainage canals, freshwater swamps, coastal marshes, springs, etc. The delta wetland (78 km^2) is under pressure from anthropogenic activities, such as drainage and irrigation works.

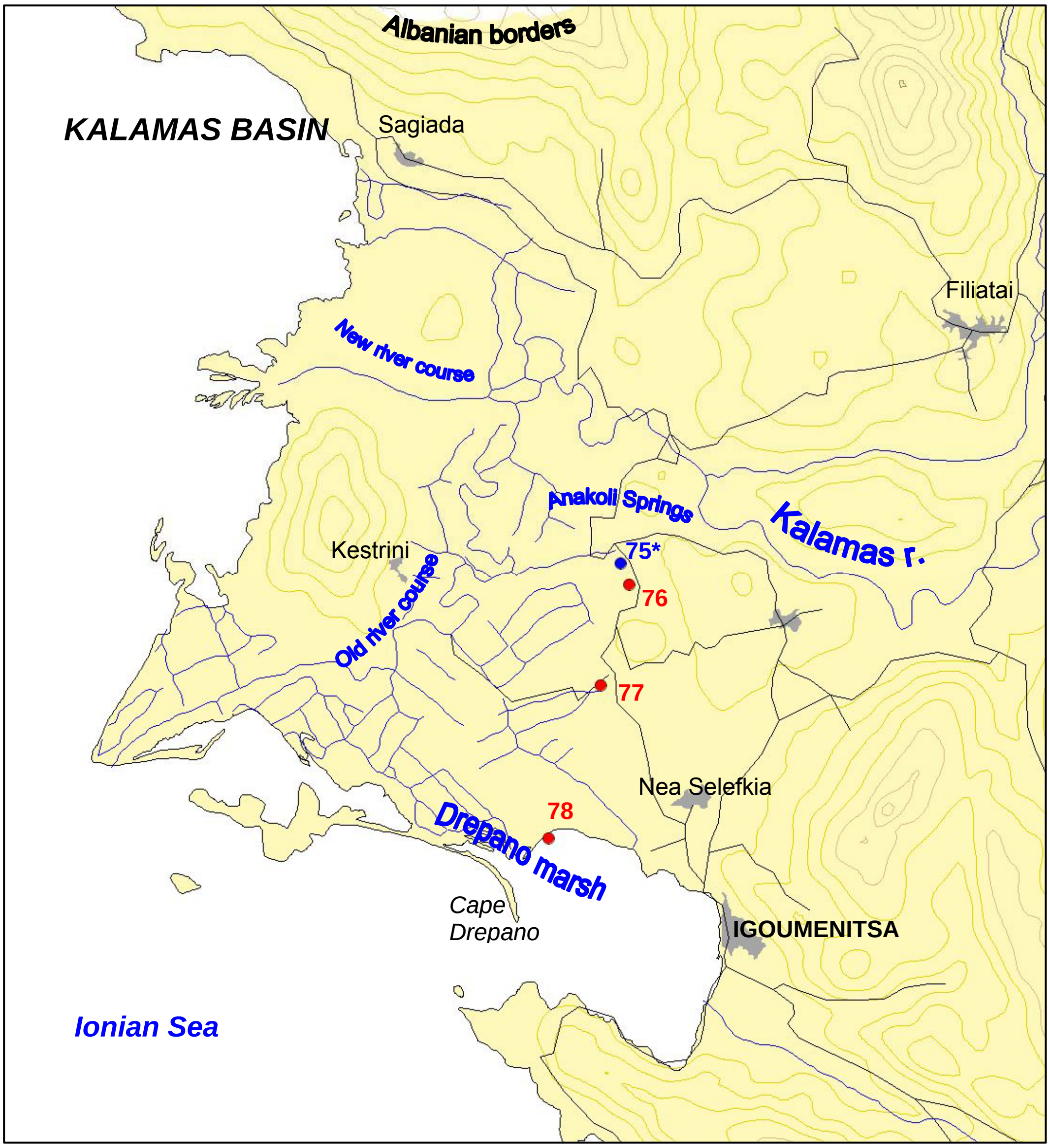
SAMPLING STATION DISTRIBUTION
In the frame of the current study, four sites at the river's Delta were sampled for *V. letourneuxi* presence, i.e. the Anakoli springs (site 75), the Anakoli ditch (sites 76 & 77) and Drepano swamp (site 78).

TABLE 1. Sampling sites at the Kalamas basin.

site	*location*	*water body type*	*pressures*
75*	Anakoli springs	Drainage ditch fed by spring	Agriculture, pasture
76	Anakoli ditch – d/s from springs	Spring fed ditch	Agriculture, pasture
77	Anakoli ditch- slaughter house	Spring fed canal	Agriculture, pasture
78	Drepano swamp	Marsh	Heavy organic pollution from animal husbandry

MAP I. Sampling sites at the Kalamas river basin. Localities where *V. letourneuxi* was recorded (●) – site 75* - and not recorded (●) – sites 76, 77 & 78.
* First record (site 75).





PRESSURES

The pressures to the Kalamas basin originate from the irrigation works for agriculture, while gravel extraction also takes place, negatively affecting the aquatic vegetation of the fish habitats. The main point-source pollution was the disposal of semi-untreated urban waste from the city of Ioannina which, through, the Lampsista ditch, ended up in the Kalamas river. Another source of pollution are also the trout farms operating in the area. Finally, fertilizers and pesticides used in the cultivation of approx. 110.000 square kilometers are washed out directly into the Kalamas river.

HABITAT CHARACTERISTICS

Anakoli springs. These are carstic springs which create a marshy area and a ditch running westwards, with cool, slow moving waters and dense vegetation at its banks (*Phragmites* reeds, *Juncus spp.,* bramble). Aquatic vegetation consists mainly from *Ceratophyllum spp*. (Fig.1-2)

Fig. 1. Marshy area at the Anakoli springs.

Fig. 2. Spring-fed ditch (site 75) with dense *Phragmites* reeds.

Anakoli spring-fed canals. Sites 76 and 77 are locations at a spring-fed canal running southwards along the foothills. One bank is covered by bracken fern and the other by a thick hedge of bramble. The water surface is covered by a thick layer of water cress (Fig. 3-5). Site 77, further downstream, is a much wider canal, with sparsely vegetated banks and a dense mat of *Lemna spp*. on the water surface (Fig.6).

Fig. 3. Site 76 with dense riparian vegetation (mostly bramble).

Fig. 4. A dense layer of water cress-like plants covers the water surface in site 76.

Fig. 5. Close-up of water cress-like aquatic plant at site 76.

Fig. 6. Site 77 (spring-fed canal) with less thickly vegetated banks and a dense mat of *Lemna spp.*

Drepano marsh. Drepano marsh, part of Drepano coastal lagoon, is located along the coastal road from Igoumenitsa to Cape Drepano. Site 78 is a thickly vegetated marshy area with patches of open, turbid water, covered by a thick peat-like organic sediment, with a strong hydrogen-sulphide odour (Fig.7-10)

Fig. 7. A thicky vegetated marshy area (site 78) in Drepano marsh.

Fig. 8. Drepano marsh is located on the other side of the coastal road to Cape Drepano.

Fig. 9. Open spot in Drepano marsh (site 78) with *Phragmites* reeds.

Fig. 10. Close-up of site 78 with organic sediment.

TABLE 2. Data on the riparian and aquatic vegetation at the Louros sampling sites.

site	riparian vegetation	% r.v.	aquatic vegetation	% a.v.	surface cover
75*	*Salix alba* *Phragmites aus.* *Juncus spp.* *Grasses*	5 70 20 30	*Ceratophyllum spp.* *Algae*	85 15	50
76	*Bracken fern* *Bramble* *Juncus spp.* *Grasses*	40 50 5 5	*Water cress-like* *Ceratophyllum spp.*	90 5	99
77	*Phragmites aus.* *Bracken fern* *Bramble* *Grasses*	30 20 20 30	*Lemna spp.* *Ceratophyllum spp.*	95 5	95
78	*Phragmites aus.* *Grasses* *Bramble* *Juncus spp.*	40 50 5 5	*Algae* *Ceratophyllum spp.*	10 30	30

FISH SPECIES COMPOSITION

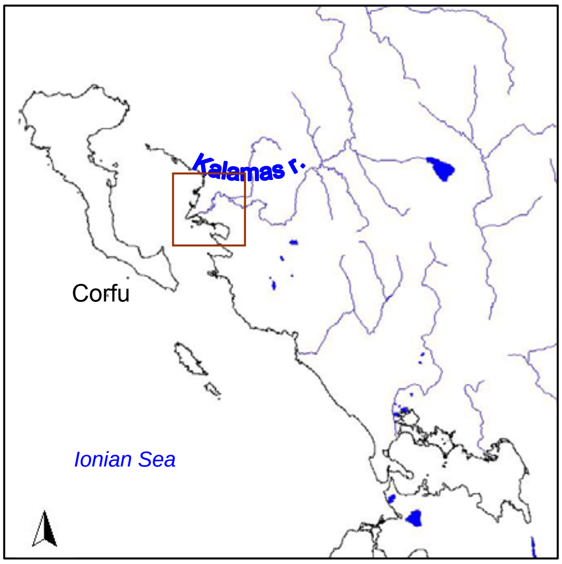
Table 3 summarizes the fish species composition at the Kalamas sampling stations and Map II their spatial distribution. The fish species encountered were *Pseudophoxinus st. thesproticus* (Cyprinidae), *Economidichthys pygmaeus* (Gobiidae), *Gambusia affinis* (Poecillidae) and *Valencia letourneuxi*.

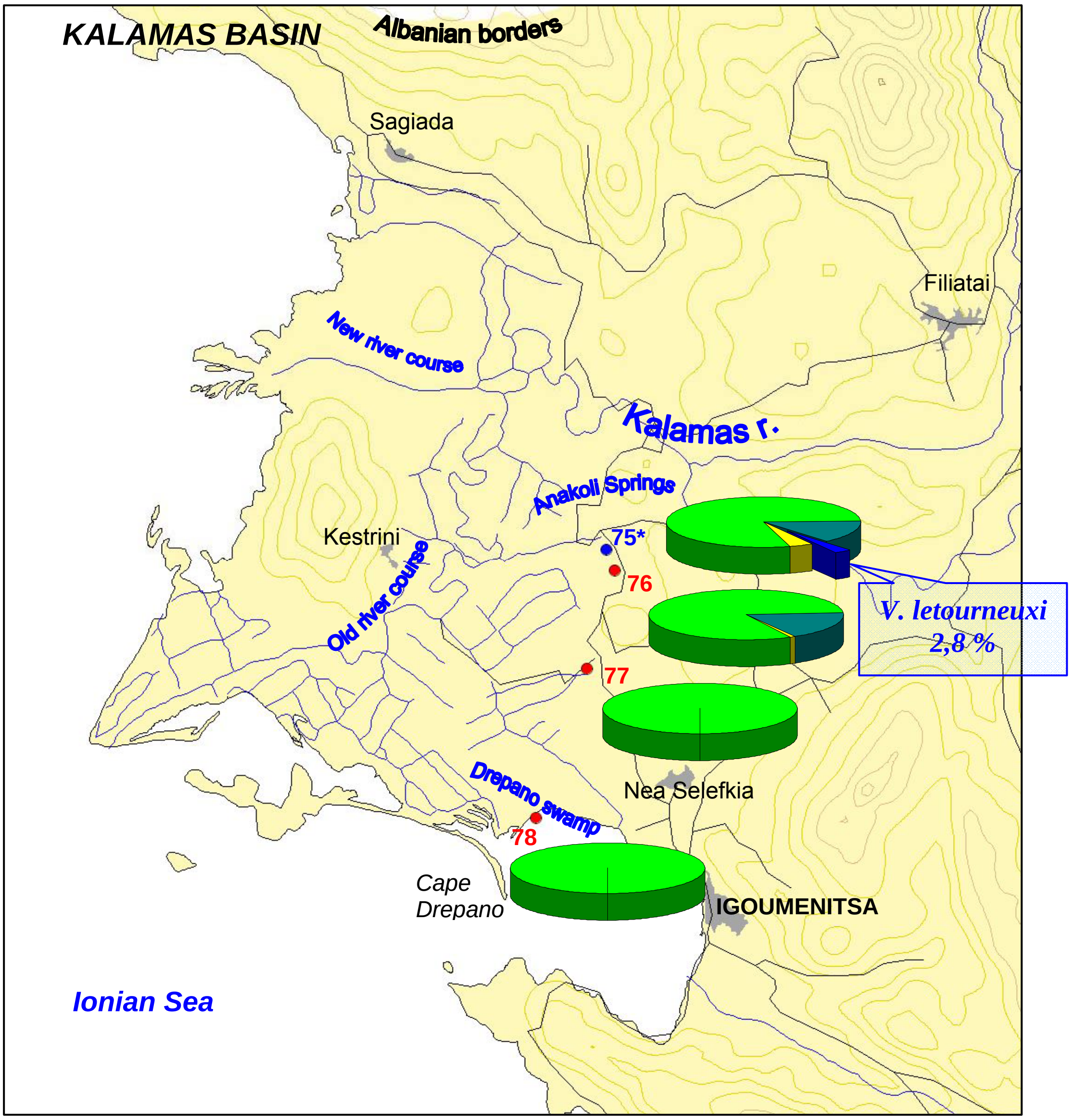
V. letourneuxi was found in one system, a ditch fed by the Anakoli springs, at a density of 2,8 %. First record of this population.

TABLE 3. Fish species composition at the Kalamas sampling sites.

site	*Sampling equipment*	*Fish species*	*%*	*No*	*V. letourneuxi*
75*	scoop net dip net	*Pseudophoxinus st. thesproticus* *Gambusia affinis* *Economidichthys pygmaeus* ***Valencia letourneuxi***	3,9 78,9 14,4 **2,8**	180	●
76	scoop net	*Pseudophoxinus st. thesproticus* *Gambusia affinis* *Economidichthys pygmaeus*	0,9 81,2 17,9	117	●
77	scoop net	*Gambusia affinis*	100,0	4	●
78	scoop net	*Gambusia affinis*	100,0	60	●

MAP II. Sampling sites at the Kalamas river basin. *V. letourneuxi* was found in one system, a ditch associated with the Anakoli springs (site 75*) at a density of 2,8%.
* First record (site 75).





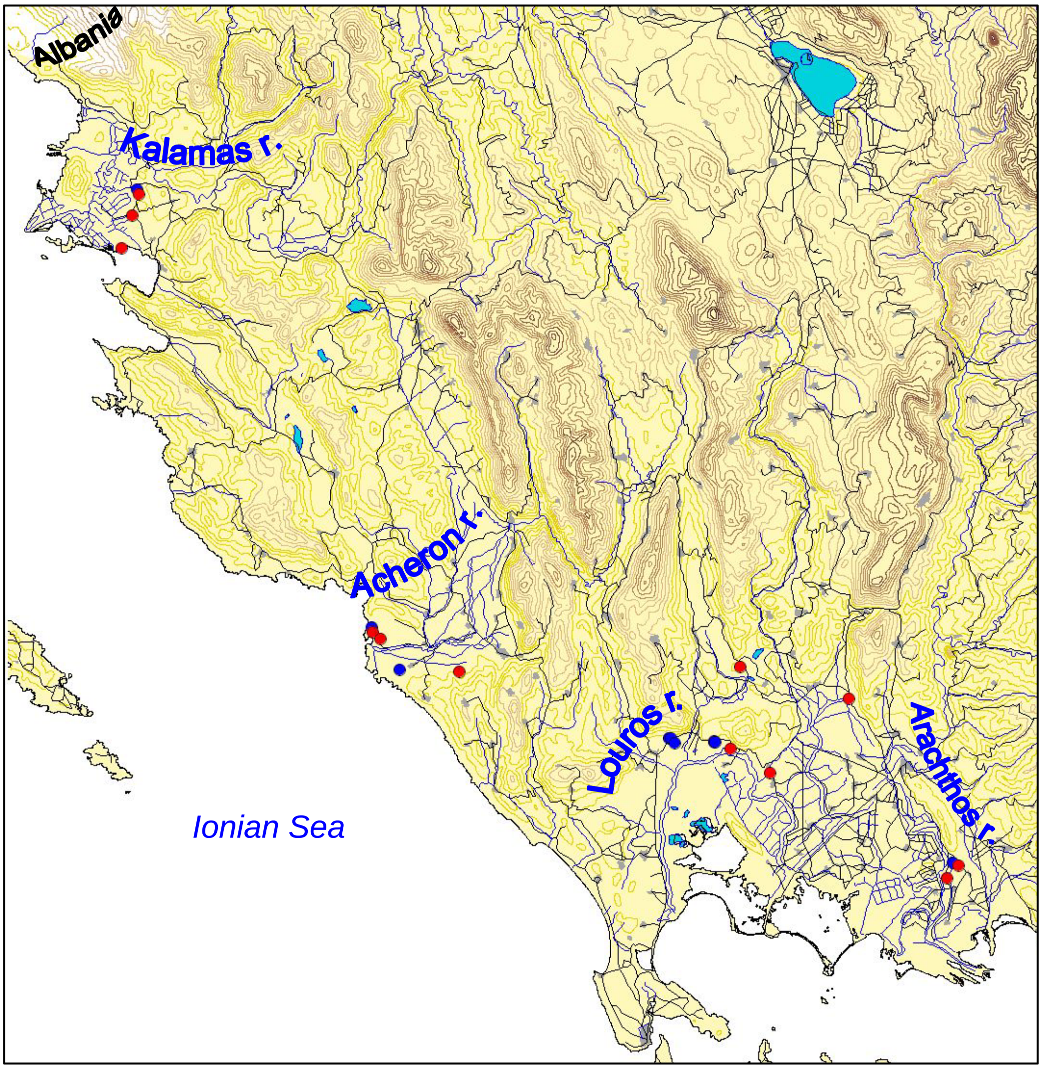
CURRENT VERSUS HISTORICAL PRESENCE OF *V. LETOURNEUXI* IN THE KALAMAS BASIN

V. letourneuxi has been found by *Labhart* (1980) and *Barbieri et al.* (2000) - also reported in *Economou et al.* (1999) technical report - in a marsh near Drepano village, corresponding to site 78 of the current survey. Despite extensive efforts it was not possible to confirm the presence of the species there. Its possible extinction from this lagoonal marsh may be related to the fact that in September 1997 the marsh became almost completely dry. However, in the frame of the current survey, a new population of the fish was found in a ditch associated with the Anakoli springs (site 75, see Table below).

References	**V. letourneuxi *presence***
Labhart (1980)	●
Barbieri *et al.* (2000)	●
Economou *et al.* (1999)	●
Current Survey	●

POPULATIONS FIRST RECORDED HERE
Anakoli springs

Current Population Status of *V. letourneuxi* in Ipeiros

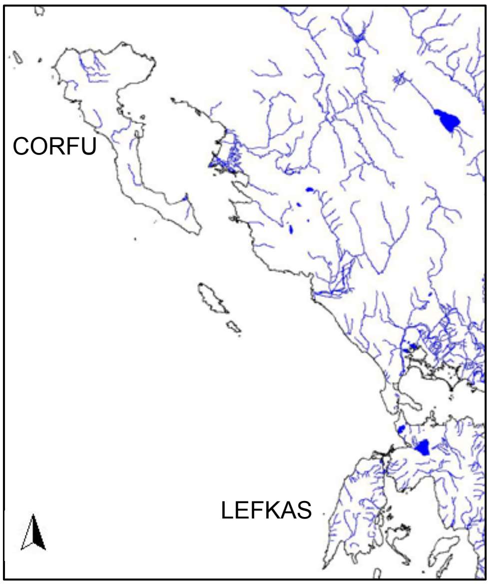


In the frame of the current survey, four river basins of Ipeiros were sampled for *V. letourneuxi* presence (i.e., Arachthos, Louros, Acheron and Kalamas basins). Out of a total of 22 sampling stations, *V. letourneuxi* presence was confirmed in 8 sites (●) in all four systems. More specifically, it was found in the Agios Georgios springs in Arachthos, in the Stefani springs and the Skala springs in Louros, in Glyfa springs and the northern drainage canal in Acheron and in the Anakoli springs in Kalamas.

Water Systems of the Ionian Islands

3.1.12 Corfu Island systems

3.1.13 Lefkas Island systems



3.1.12 CORFU SYSTEMS

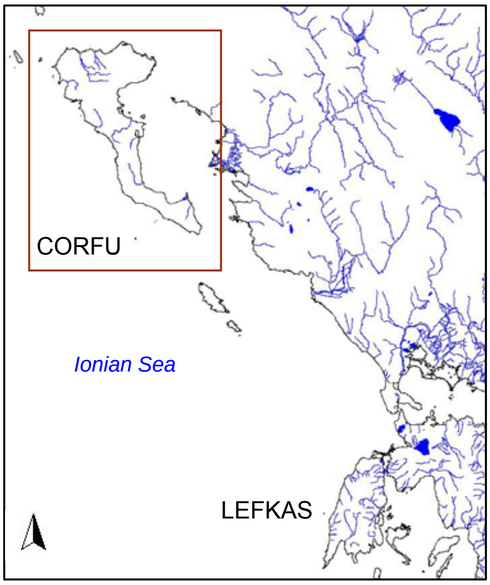
The Island of Corfu is the second largest island of the Ionian Sea. It is semi-mountainous, with mount Pantokratoras (906 m) dominating the northern part of the Island, while the southern part is covered by hills not exceeding 250m in height. Despite the area's heavy rainfall rate (1183 mm), there are mostly torrent streams in the Island.

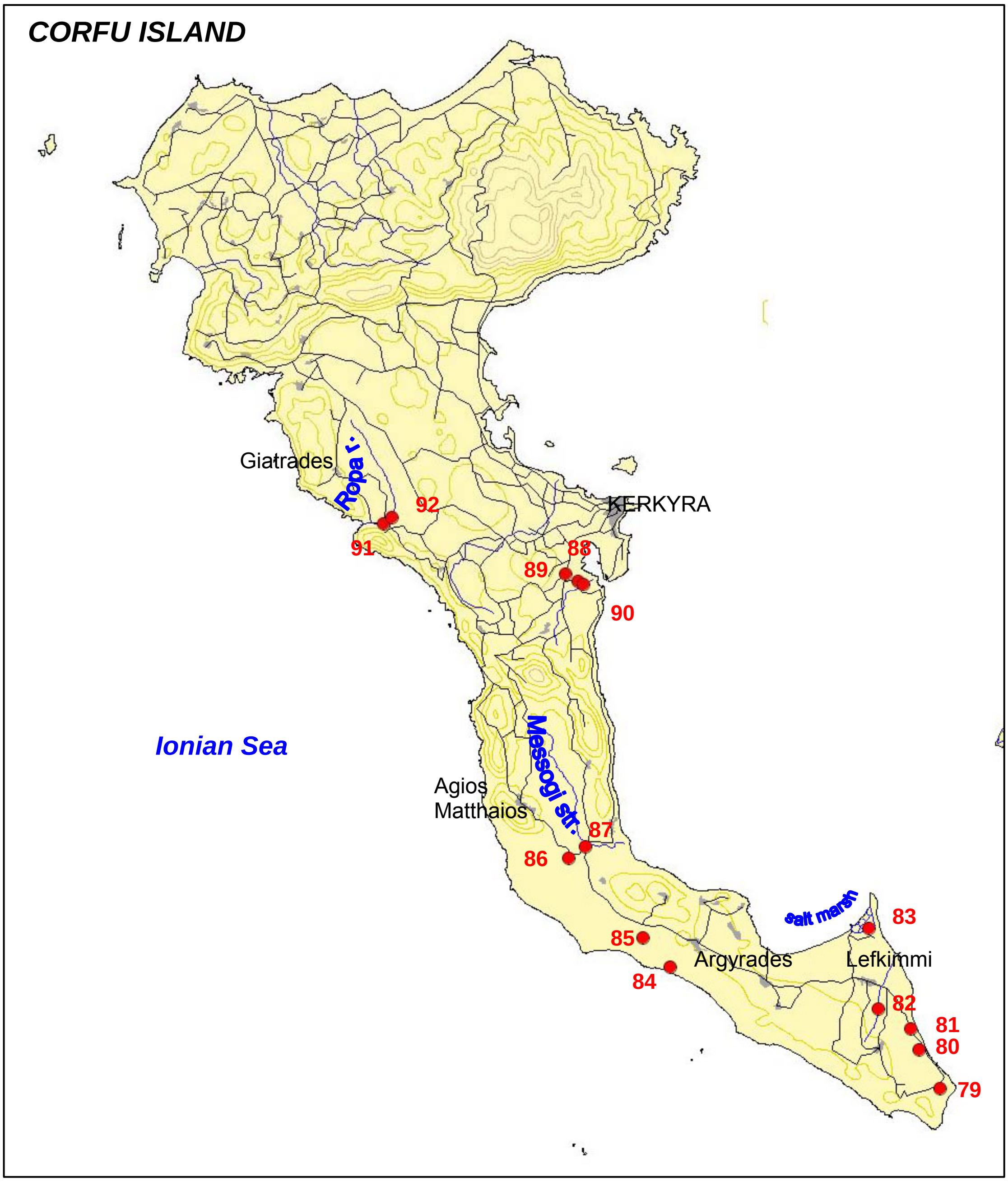
SAMPLING STATION DISTRIBUTION
In the frame of the current study, a total of 14 sites were sampled at different water systems in the Island of Corfu. These included mostly streams and spring areas at the southern and central part of the Island.

TABLE 1. Sampling stations at the Corfu Island.

site	***location***	***water body type***	***pressures***
79	Moschopoulou stream	springs	Dam construction, litter disposal
80	Agios Petros stream	stream	Litter disposal
81	Sotira stream	stream	Water flow regulation
82	Lefkimmi river	river	
83	Lefkimmi saltern	Saltern	Water pollution form sewage, tourism development
84	Agios Georgios stream	Stream	Tourism development
85	Pantokratoras stream	stream	Houses
86	Gyftoneri stream	stream	
87	Mesongi stream	stream	Roads
88	Chrissiis springs	springs	Tapped. Water abstraction
89	Lartourou stream		Litter disposal, houses, roads
90	Chalkiopoulou springs	springs	Organic pollution, water abstraction
91	Ropa river, road bridge	river	Vegetation clearing, wetland drainage
92	Ropa river, golf course	river	Golf course, vegetation clearing

MAP I. Sampling sites at Corfu Island. Localities where *Valencia letourneuxi* was recorded (●) – none - and not recorded (●) – sites 79 - 92.





PRESSURES

The main anthropogenic pressure on Corfu is water over-abstraction to cover the high demand for drinking water, especially during the summer tourist period. This problem is more acute at the central and southern part of the Island. This over-abstraction has caused groundwater salinization, apparent in the increase of chlorium ions at the coastal areas of the southern, northern and northeastern part of the Island. A secondary threat for the water systems of the Island is phosphate pollution from urban waste disposal. Finally, fringing wetlands have been drained at many sites.

HABITAT CHARACTERISTICS

Moschopoulou stream. Spring site (site 79) with extremely low water level, due to a dam construction. Also extremely polluted by litter disposal (Fig. 1, 2).

Fig. 1. Moschopoulou stream with very little water (site 79).

Fig. 2. Litter disposal at site 79.

Agios Petros stream. Stream with water only in heavy rainfall (Fig.3,4).

Fig. 3. Agios Petros stream (site 80).

Fig. 4. Agios Petros stream (site 80).

Sotira stream. Stream with turbid, brown water (site 81). Its flow is regulated to prevent the flooding of the surrounding area.

Fig. 5. Sotira stream (site 81).

Fig. 6. Sotira stream.

Lefkimmi river, Lefkimmi salt marsh. The Lefkimmi river is 8 m wide and has maximum depth 1 m. Polluted. The Lefkimmi salt marsh is a large area, formerly used for salt extraction.

Fig. 7. The Lefkimmi river (site 82)

Fig. 8. The Lefkimmi river (site 82)

Fig. 9. The Lefkimmi saltern (site 83).

Fig. 10. Site 83 with canal parallel to the coast with brackish water.

Agios Georgios stream, **Pantokratoras stream**. Both streams flow out at the west coast of the Corfu island. The area of the springs of the Agios Georgios stream is very densely vegetated, but with little water. The mouth of the stream is heavily polluted. The Pantokratoras stream has a shallow and narrow bed and its surface is covered with *Lemna spp.* (Fig. 11, 12).

Fig. 11. Agios Georgios stream, spring area (site 84), with dense vegetation and little water.

Fig. 12. Pantokratoras stream (site 85). Narrow stream covered with *Lemna spp.*

Gyftoneri stream. A small stream with narrow streambed and no floating aquatic vegetation (site 85). This small stream discharges into the Mesongi stream that flows out at the east coast of the island (Fig.13).

Fig. 13. Gyftoneri stream (site 86).

The site sampled at the **Mesongi stream** (site 87) was a section of the stream with alluvial gravelly wash and low water level. The water was covered by a thick film (Fig. 14, 15)

Fig. 14. Mesongi stream (site 87) with alluvial gravelly wash and low water level.

Fig. 15. Mesongi stream.

Chrissiis springs. This is the type locality site of the species. Now it is tapped and the site completely dry (site 88, Fig.16). The nearby **Lartourou stream** is a narrow stream with no fish life (site 89, Fig.17). Finally, some small springs, the **Chalkiopoulou springs**, situated close to the Chalkiopoulou lagoon, with heavy organic pollution, were also sampled (Fig.18-19).

Fig.16. Chrissiis springs (site 88).

Fig. 17. Lartourou stream (site 89).

Fig. 18. Chalkiopoulou springs (site 90), small ditch.

Fig. 19. Site 90, small spring area.

Ropa river. Two sites were sampled at this system, i.e. site 91 by the road bridge and a site further upstream (site 92) by the golf course. The first site was a wide section of the river (8 m wide, 80 cm max. depth) with thick *Myriophyllum spp.* aquatic plants (Fig. 20, 21). The second site, is also a wide part of the river, adjacent to a golf course. Its surface is covered with *Lemna spp.* (Fig.22-23).

Fig. 20. Ropa river (site 91) with thick *Phragmites* reeds at one bank.

Fig. 21. Close-up of site 91, with *Myriophyllum spp.* aquatic plants.

Fig. 22. Ropa river (site 92) adjacent to a golf course (top right).

Fig. 23. The banks of the river are cleared from their vegetation. Its surface is covered with *Lemna spp.*

TABLE 2. Data on the riparian and aquatic vegetation at the Corfu sampling sites.

site	**riparian vegetation**	**% r.v.**	**aquatic vegetation**	**% a.v.**	**surface cover**
79	*Arundo sp.*	30	*None*	0	0
	Phragmites aus.	10			
	Grasses	30			
	Forbs	60			
	Sparganium sp.	10			
80	*Arundo sp.*	60	*Water cress*	30	20
	Rubus sp.	10			
	Calistygia sp.	10			
81	*Arundo sp.*	30	*None*	0	0
	Ulmus sp.	10			
	Salix sp.	5			
	Rubus sp.	70			
	Fern	10			
82	*Phragmites aus.*	40	*None*	0	0
	Arundo sp.	10			
	Rubus sp.	50			
	Grasses	30			
83	*Arthrocnemum sp.*	15	*None*	0	0
84	*Quercus ilex*	20			

	Quercus sp. *Rubus sp.* *Humulus lupus* *Hedera helix*	20 50 80 20			
85	*Rubus sp.* *Arundo sp.* *Grasses*	40 10 20	*Lemna sp.* *Water cress*	30 40	70
86	*Carex sp.* *Forbs* *Rubus sp.* *Sparganium sp.* *Equicetum sp.*	15 30 30 5 5	*None*	0	0
87	*Rubus sp.* *Ulmus sp.* *Cupressus sp.* *Cercis siliquistrum* *Hedera helix* *Vitex agnus castus*	50 15 10 20 15 20	*Algae (submerged)*		0
88	*Grasses* *Forbs* *Ficus carica*	60 40 10	*None*	0	0
89	*Sparganium sp.*	40	*Lemna sp.* *Water cress*	5 10	15
90	*Grasses*	100	*Water cress* *Alysma sp.*	80 15	80
91	*Phragmites aus.* *Typha sp.*	100 5	*Myriophyllum sp.*	80	0
92	*Grasses* *Forbs* *Populus alba*	50 50 5	*Lemna sp.*	95	95

FISH SPECIES COMPOSITION

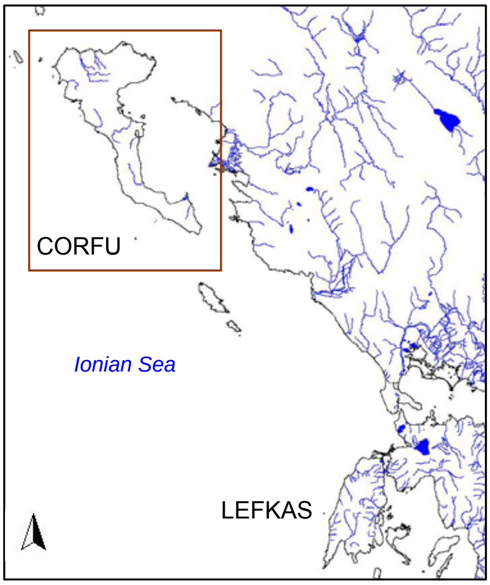
Table 3 summarizes the fish species composition at the Corfu Island sampling sites and Map II their spatial distribution. The fish species encountered were *Pseudophoxinus st. thesproticus* and *Telestes pleurobipunctatus* (Cyprinidae), *Gambusia affinis* (Poecillidae), *Aphanius fasciatus* (Cyprinodontidae) at the salt marsh and fish of the Mugilidae family.

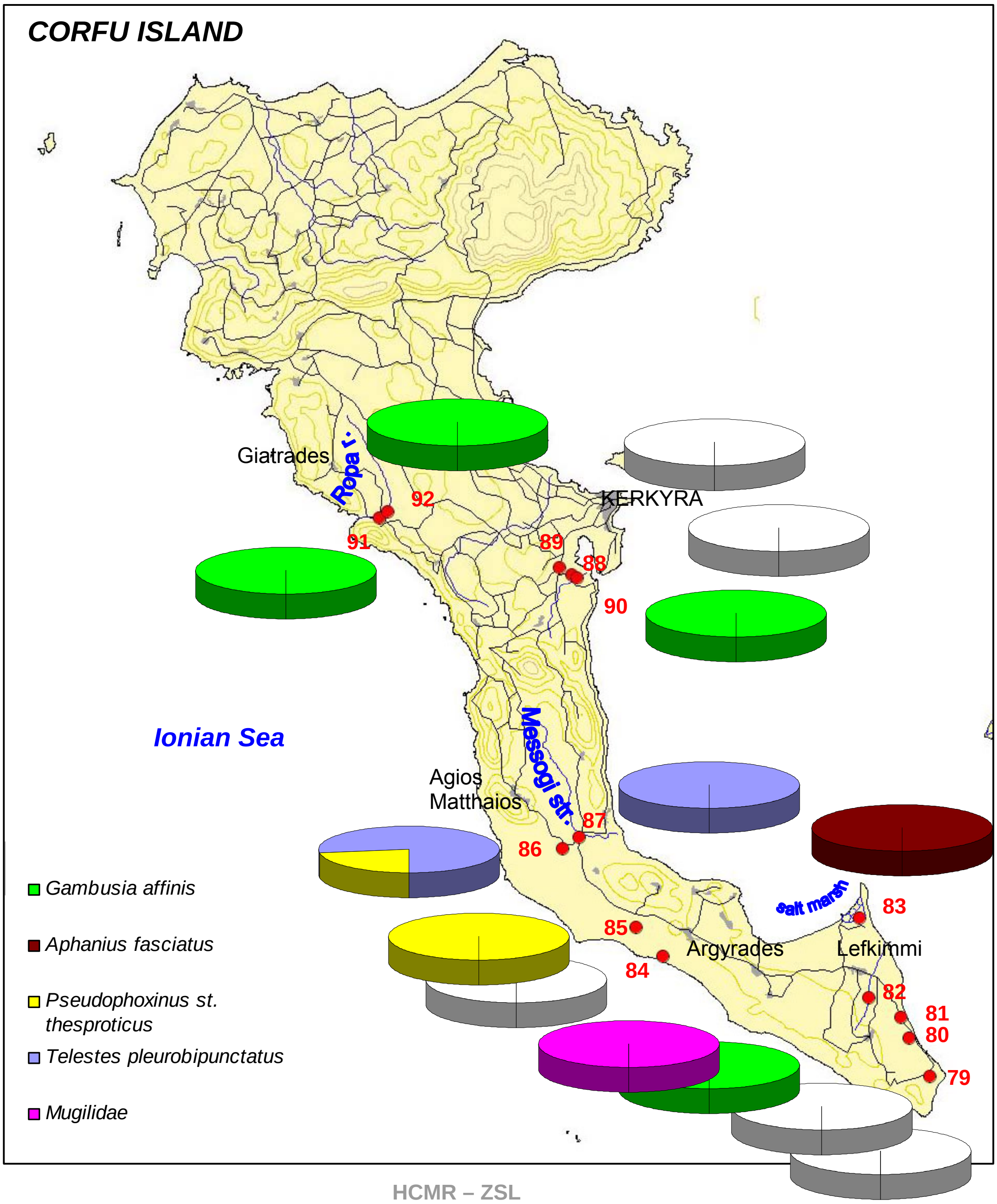
V. letourneuxi was not found in any of the 14 sites sampled.

TABLE 3. Fish species composition at the Corfu Island sampling sites.

site	Sampling equipment	Fish species	%	No	V. letourneuxi
79	-	*No fish*	-	0	●
80	-	*No fish*	-	0	●
81	scoop net	*Gambusia affinis*	100,0	5	●
82	scoop net	*Mugilidae*	100,0	10	●
83	dip net	*Aphanius fasciatus*	100,0	20	●
84		*No fish*		0	●
85	electrofishing	*Pseudophoxinus st. thesproticus*	100,0	62	●
86	scoop net	*Pseudophoxinus st. thesproticus* *Telestes pleurobipunctatus*	22,6 77,4	53	●
87	scoop net	*Telestes pleurobipunctatus*	100,0	5	●
88	-	*No fish (tapped)*	-	0	●
89	-	*No fish*	-	0	●
90	scoop net	*Gambusia affinis*	100,0	5	●
91	scoop net	*Gambusia affinis*	100,0	20	●
92	scoop net	*Gambusia affinis*	100,0	100	●

MAP II. Sampling sites at Corfu Island. *V. letourneuxi* presence could not be confirmed in any of the 14 sites sampled, including the type locality of the species (Chrissiis springs, site 88).





CURRENT VERSUS HISTORICAL PRESENCE OF *V. LETOURNEUXI* IN CORFU ISLAND

V. letourneuxi was first reported by *Sauvage* (1880) in the Chrissiis springs, Chalkiopoulou lagoon area, near the city of Kerkyra. At a later date it was found by *Oliva* (1965) at the same site. It was also found by *Seegers* (1980, in *Das* 1985) in one spring in the Lefkimmi area. *Woeltjes* (1988) found it in the Chalkiopoulou lagoon, Kavos-Lefkimmi, Mesongi, Benitses and River Ropa. However, later efforts to find the species in the Island were unsuccessful (*Bianco et al.,* 1996). According to *Economidis* (1995) the species is apparently extinct in Corfu. A similar conclusion can be drawn also from the results of the current study, as sampling of all known locations were the fish was previously found, yielded no results.

References	**V. letourneuxi *presence***
Sauvage (1880)	●
Oliva (1965)	●
Seegers (1980)	●
Woeltjes (1988)	●
Bianco *et al.* (1996)	●
Current Survey	●

3.1.13 LEFKAS SYSTEMS

The Island of Lefkas is the fourth largest island of the Ionian Sea (302,5 Km) of which 206 km are mountainous. There are few flat areas, only localized coastal valleys. Streams are mostly intermittent.

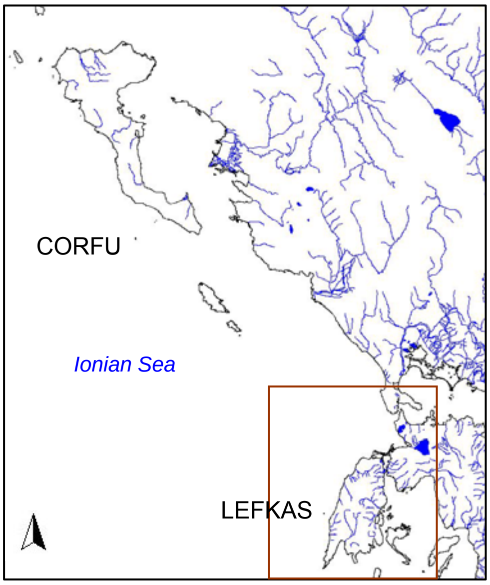
SAMPLING STATION DISTRIBUTION

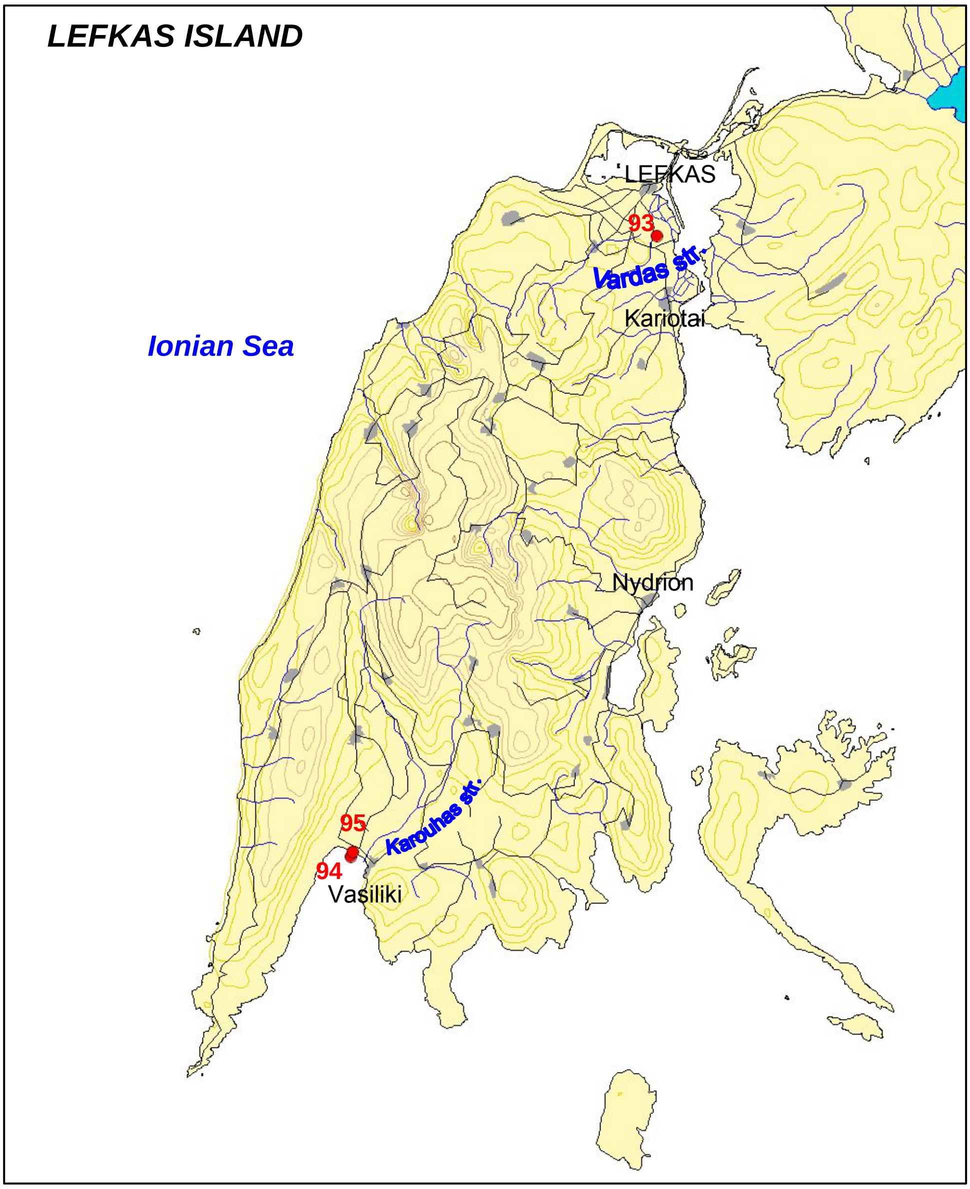
In the frame of the current study, a total of 3 sites were sampled at the Island of Lefkas. These included one stream at the northeastern (site 93) and two sites at a stream of the southern part of the Island. An additional site visited in the Island was the Zoodochos Pigi springs, where originally *V. letourneuxi* was caught, but the springs are now tapped for irrigation use.

TABLE 1. Sampling stations at the Lefkas Island.

site	***location***	***water body type***	***pressures***
93	Vardas stream	stream	Vegetation clearing, litter disposal
94	Karouhas stream - bouka	stream	Vegetation clearing, Olive grove, housing
95	Karouhas stream – road bridge	stream	Vegetation clearing, Olive grove, housing

MAP I. Sampling sites at Lefkas Island. Localities where *Valencia letourneuxi* was recorded (●) – none - and not recorded (●) – sites 93 - 95.





PRESSURES

The main problem in the Island of Lefkas is water over-abstraction to cover the demand for drinking water. An additional problem is the disposal of untreated urban waste. Lastly, former small wetlands have been drained through small drainage works and water diversions.

HABITAT CHARACTERISTICS

Vardas stream. Site 93 was a section of Vardas stream cleared from its riparian vegetation. Sampling was done in a pool (70 cm deep) immediately under a bridge, oxygenated from a cascade from the culvert.

Fig. 1. Vardas stream.

Fig. 2. Sampling site 93 under the bridge.

Karouhas stream. Two sites were sampled at this stream, one at the stream's outlet to the sea (site 94) and one at a location further upstream, by a road bridge (site 95).

Fig. 3. Karouhas stream outlet (site 94).

Fig. 4. Karouhas stream outlet to the sea.

Fig. 5. Site 95 at a location further upstream.

Fig. 6. Site 95.

TABLE 2. Data on the riparian and aquatic vegetation at the Lefkas sampling sites.

site	**riparian vegetation**	**% r.v.**	**aquatic vegetation**	**% a.v.**	**surface cover**
93	*None*		*Algae*	5	5
94	*Phragmites aus.* *Arundo sp.*	50 50	*Algae*	100	0
95	*Platanus orientalis* *Apple/pear tree* *Brumble* *Salix alba* *Arundo spp.* *Herbaceus plants*	10 20 40 10 10 10	*Algae*	90	5

FISH SPECIES COMPOSITION

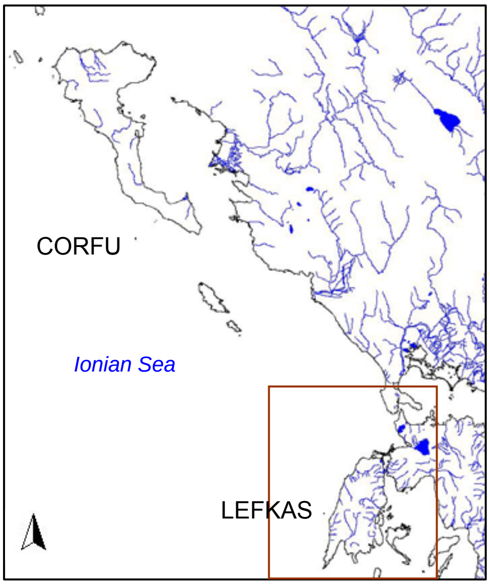
Table 3 summarizes the fish species composition at the Lefkas Island sampling stations and Map II their spatial distribution. The fish species encountered were *Pseudophoxinus stymphalicus* (Cyprinidae), *Economidichthys pygmaeus* (Gobiidae), *Anguilla Anguilla* (Anguillidae) and fish of the Mugilidae family.

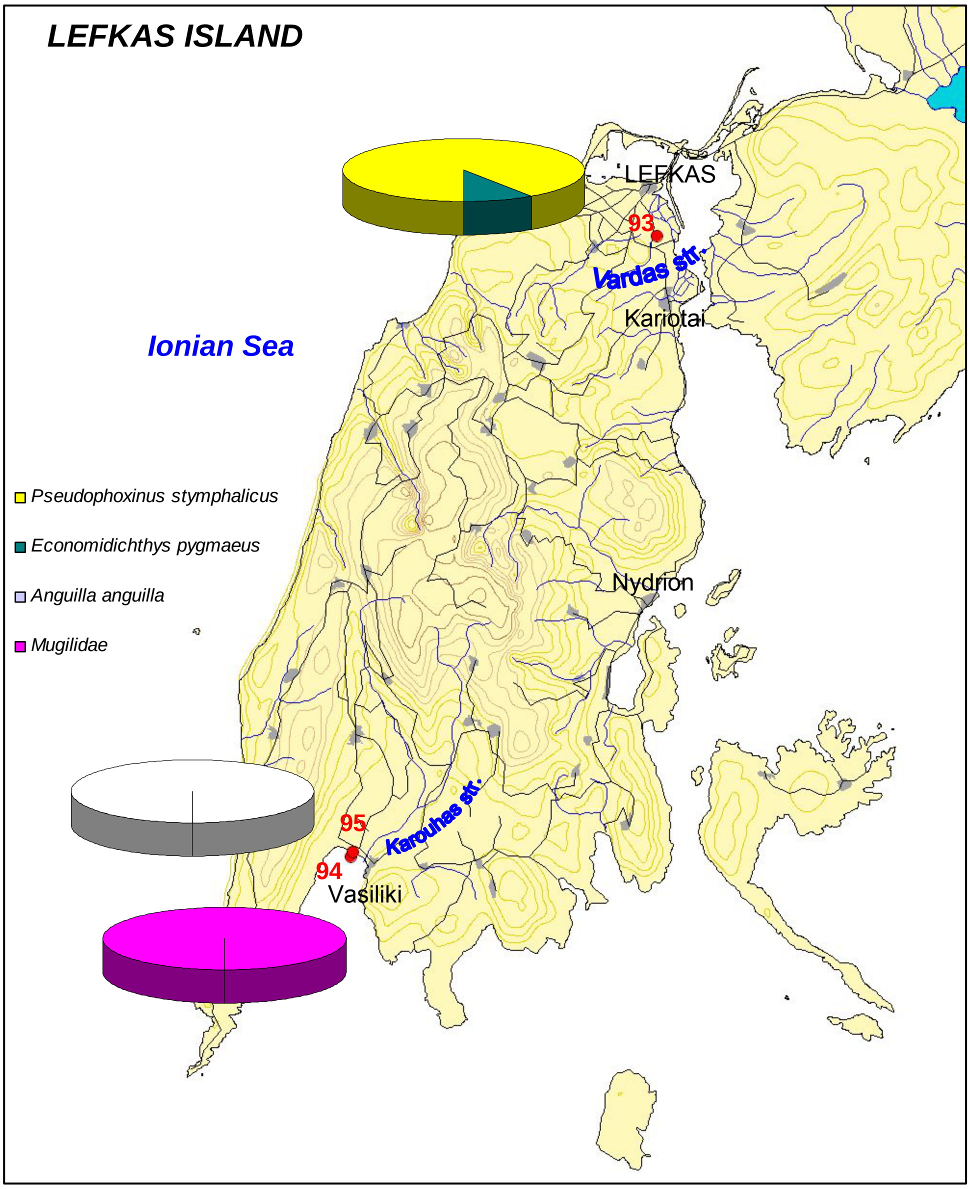
V. letourneuxi was not found in any of the sites sampled.

TABLE 3. Fish species composition at the Lefkas Island sampling sites.

site	***Sampling equipment***	***Fish species***	***%***	***No***	***V. letourneuxi***
93	electrofishing	*Pseudophoxinus stymphalicus* *Economidichthys pygmaeus* *Anguilla anguilla*	90,6 9,3 0,1	733	●
94	scoop net	*Mugilidae*	100,0	20	●
95	scoop net	*No fish*	0	0	●

MAP II. Species composition at the Lefkas sampling sites.





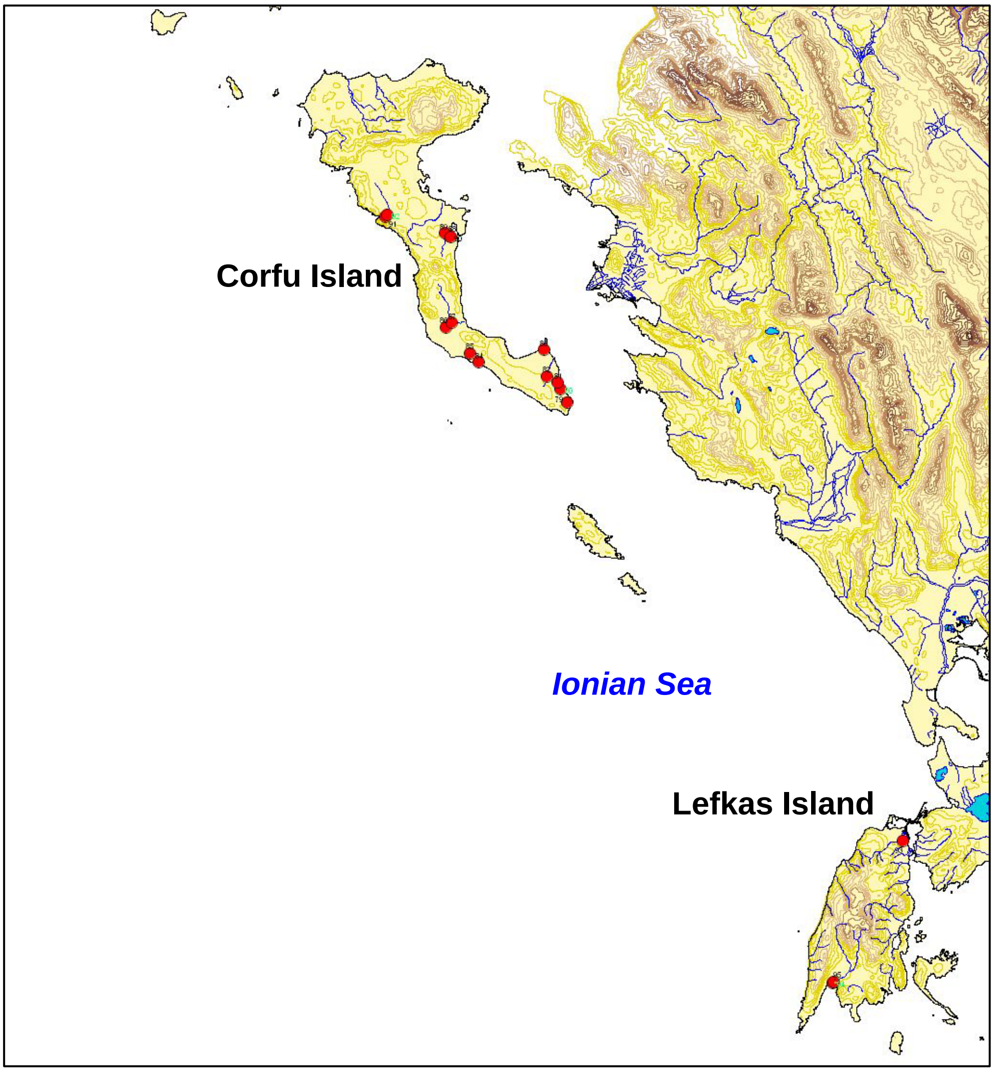
CURRENT VERSUS HISTORICAL PRESENCE OF *V. LETOURNEUXI* IN LEFKAS ISLAND

The species was found in the Zoodochos Pigi springs by Economidis in 1963 (reported in *Economidis* 1991 and 1995), but the springs are now dry and this population appears to be extinct. In the frame of the current study, no *V. letourneuxi* presence could be confirmed in the water systems of Lefkas (see Table below).

References	**V. letourneuxi *presence***
Economidis (1991,1995)	● (blue)
Current Survey	● (red)

Current Population Status of *V. letourneuxi* in the Ionian Islands

In the frame of the current survey, a total of 14 sites in Corfu (among them the type locality of the species) and 3 sites in Lefkas were sampled for *V. letourneuxi* presence. It appears, however, that the islandic populations of the species are now extinct.

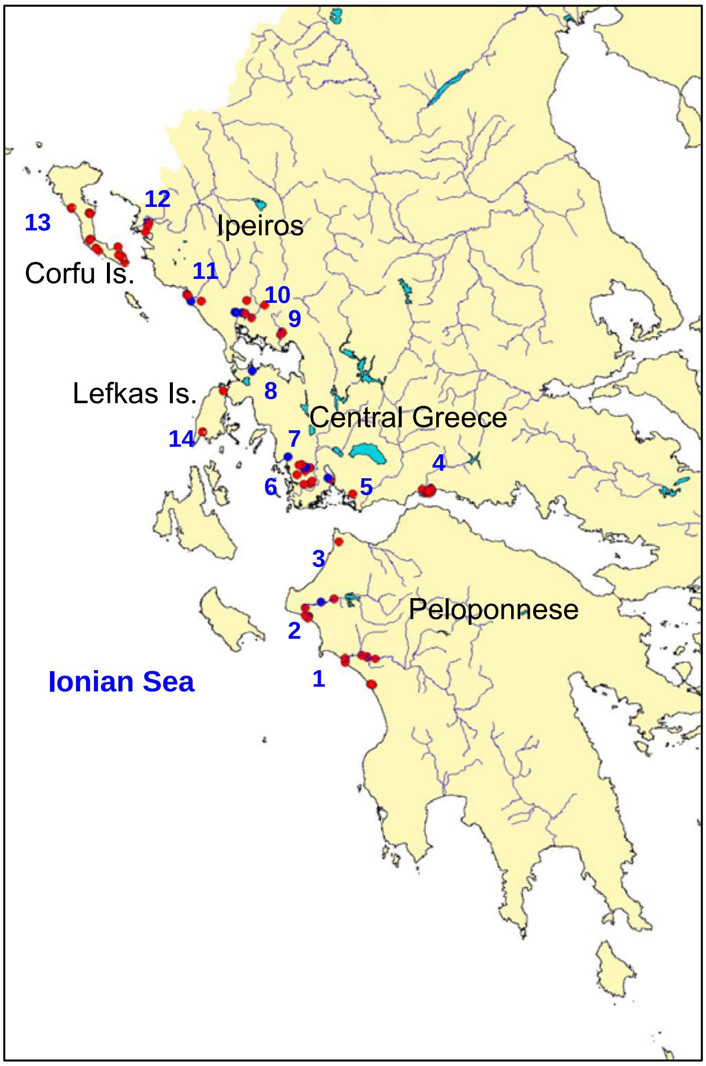


3.2 Summary Project Results

Geographical distribution, Abundance, Sympatric Fish Species, Length Classes and Ecology of *V. letourneuxi*

3.2.1 Geographical Distribution

Although the historical geographical range of the species was extended, covering the mainland of Western Greece and some of the Ionian Islands, its known localities were not numerous. The species is usually found in springs and riverine sections associated with springs, whereas it is absent from lake systems. In the course of the current survey 14 systems of Western Greece were sampled for *V. letourneuxi* presence. These comprised a total of 95 sampling sites in both known and suspected *V. letourneuxi* localities (Fig.1).
Prior to this investigation, its presence had been reported in 11 aquatic systems of the Western Greece mainland (Alfios r., Pinios r., Mornos r., Acheloos r., Agios Dimitrios r., Astakos springs, Vlychos springs, Arachthos r., Louros r., Acheron r. and Kalamas or Thyamis r.) and in two of the Ionian Islands, i.e. Corfu Island and Lefkas Island (see Table 1 and Fig. 2). The results of the 2005 survey show that the species' original geographical range has been restricted significantly, with the islandic populations of the Ionian (Corfu and Lefkas Islands) and those of the Peloponnese (rivers Alfios and Pinios) being extinct or near extinction and the remaining populations seriously recessing. Out of a total of 14 systems and 95 sites sampled, the species was found in 10 systems in 21 sites (blue dots, Fig.1).



1	Alfios R.
2	Pinios R.
3	Prokopos Lagoon
4	Mornos R.
5	Acheloos R.
6	Agios Dimitrios R.
7	Astakos spr.
8	Vlychos spr.
9	Arachthos R.
10	Louros R.
11	Acheron R.
12	Kalamas R.
13	Corfu Is. systems
14	Lefkas Is. systems

Fig.1. Sampling sites distribution in the 2005 survey. A total of 95 sites in 14 systems of Western Greece mainland and of the Ionian Islands were sampled for *V. letourneuxi* presence.

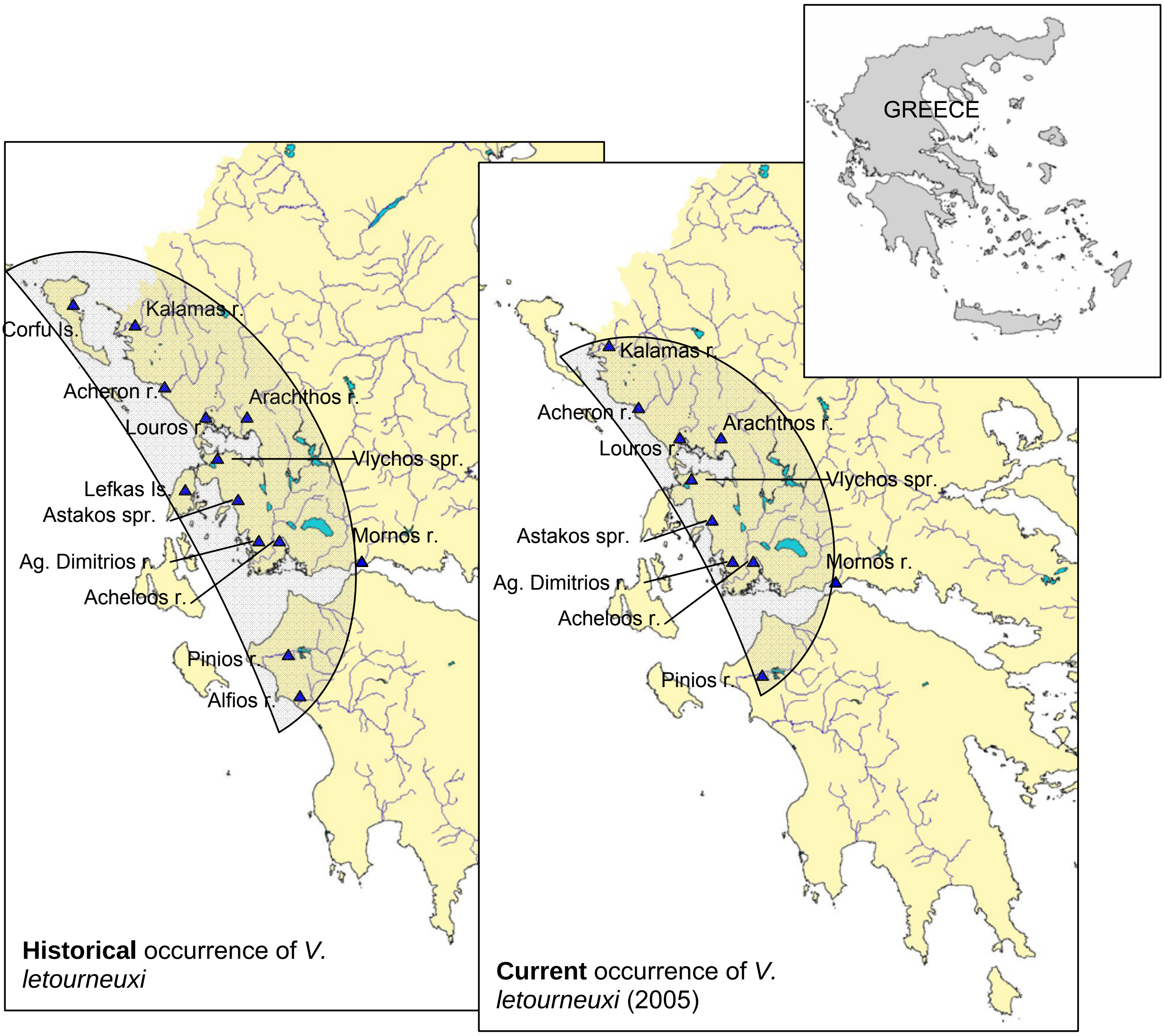


Fig.2. Historical *versus* current occurrence of *V. letourneuxi.*

The current study established a restriction of the species geographical range, with the extinction or near extinction of its westernmost and southernmost populations. More specifically, of the **13** systems in which *V. letourneuxi* presence has been historically reported, the Ionian Islands populations i.e. the islandic populations of Corfu and Lefkas appear to be extinct. In addition, in the Peloponnese, the Alfios and Pinios river populations appear to be extinct and near extinction respectively. In summary, *V. letourneuxi* appears to be extinct in 3 systems and close to extinction in one of the systems historically present.

Table 1. Records of historical occurrence of *Valencia letourneuxi* in Greece (1880-2005). Aquatic systems listed from south to north. Despite the discovery of some new populations in the 1990's in western Greece mainland, it appears that the islandic populations of the Ionian are extinct and those of the Peloponnese near extinction.

	Authorities														
Aquatic system	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	***Notes***
Alfios river										●	●	●		○	**a**
Pinios river										●	●	●		●	**b**
Mornos river *											●	●		●	**c**
Ag. Dimitrios river											●	●		●	**d**
Acheloos river *												●		●	**e**
Astakos springs													●	●	**f**
Vlychos springs												●		●	**g**
Arachthos river													●	●	**h**
Louros river *		●									●	●		●	**i**
Acheron river					●				●		●	●		●	**j**
Kalamas river *							●				●	●		●	**k**
Corfou systems	●			●		●		●						○	**l**
Lefkas systems			●											○	**m**

INDEX TO AUTHORITIES
1. Sauvage (1880)
2. Stephanidis (1939)
3. (Economidis 1995)
4. Oliva (1965)
5. Stephanidis (1974)
6. Seegers (1980, in Das, 1985)
7. Labhart (1980)
8. Woeltjes (1988)
9. Das (1985)
10.Bianco & Miller (1989)
11. Economou *et al*. (1999)
12. Barbieri *et al.* (2000)
13. Daoulas (2003)
14. Present investigation

*** First record of new populations**

NOTES ON THE DISTRIBUTION

(a) Found by [10] at a site near Epitalio village in 1987 and by [11] and [12] in 1992 at a deep creek discharging about 140 m upstream of the river mouth. Also found by [11] near the Alfios dam at a similar date, but not in subsequent efforts. **(b)** Found by [10] in 1987 under the bridge of Agia Mavra and by [14] at the same location, but at extremely low densities. Also found by [11] and [12] at a deep site of the river near Kalyvia village, d/s from Vartholomio bridge. **(c)** Found by [11] and [12] at the deep ditch discharging the Chiliadou springs and by [14] at the same site. Also found by [14] at three locations of the nearby Koufosouda stream. **(d)** Found by [11] in 1994 and [12] at the springs of Agios Dimitrios and at a site 200 m downstream. Found by [14] at the d/s site, and also at two additional sites, at Pentalofou springs and at Geroporos stream. **(e)** Found by [12] at two sites (near ancient Oiniades and at Fraxos forest) and by I. Leonardos in stream Ai Simios near the Technological Institute of Mesolongi. Found by [14] in a small stream near Aitoliko. **(f)** Found by [13] and [14] at a small stream near Astakos town. **(g)** Found by [12] and [14] at the ditch that discharges from the littoral Vlychos springs (Vonitsa). **(h)** Found by [13] and [14] at a ditch discharging of Agios Georgios springs, near Peranthi village. **(i)** Found first by [2] at the Stephani springs and later also by [11] and [12]. Found also recently by [14] at that site, and at Skala stream near Louros village. **(j)** Found by [5], [9], [11], [12] and [14] at the northern drainage canal of the Acheron delta, near Ammoudia village. Found by [5] in springs near Kastri village and by [5] and [9] in a spring west of Kypseli village. Also found by [11], [12] and [14] in a creek near Valanidorachi village at the southern edge of the Acheron delta. **(k)** Found by [7], [11] and [12] in a marsh near Drepano village, that has dried completely in 1997, but not in the current survey. Found by [14] in a ditch discharging of the Anakoli springs. **(l)** Found by [1], [4] and [8] in the Chrissiis springs (species type locality) at the Chalkiopoulou lagoon, by [6] and [8] at the southern Lefkimmi area, and by [8] in Mesongi, Benitses and Ropa river. These populations are now probably extinct. **(m)** Found in the Zoodochos Pigi springs by [3] in 1963, but the springs are now dry and this population appears to be extinct.

3.2.2 Abundance

One index of abundance of a target species is its relative abundance to all the other species, i.e. the number of *V. letourneuxi* individuals caught during the present investigation (June 2005 and October 2005) in comparison to the total number of fish caught. The sampling of a total of 95 sites yielded a total of 7024 fish out of which only 136 belonged to the *V. letourneuxi*. An additional indicator of rarity is the abundance of a target species in comparison to the abundance of other species having a similar geographical distribution. Thus, in the frame of the current investigation 136 individuals of *V. letourneuxi* were caught, in contrast to the 1641 individuals of the endemic *P. stymphalicus* and the 1991 specimens of the introduced *G. affinis* (Fig.1). Given the fact that *V. letourneuxi* was the exclusive target of this investigation, and thus the sampled localities were often typical of the species, the above data appear to be a true reflection of rarity.

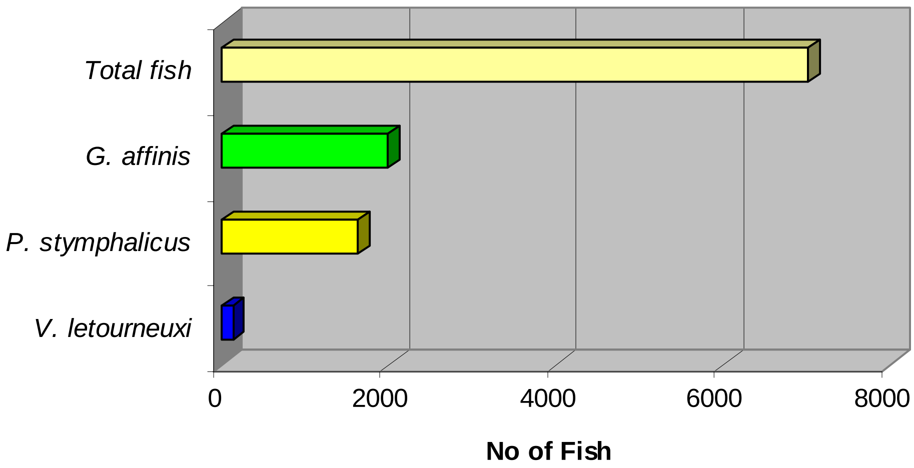


Fig. 1. Abundance (expressed in number of fish caught) of *V. letourneuxi* in comparison to the abundance of the endemic *P. stymphalicus*, the introduced *G. affinis* and the total fish caught in all the systems sampled.

Local densities can be an additional criterion of rarity, as a species can have a restricted distribution but be locally abundant. This is not however the case with *V. letourneuxi*, as its local density varied from 0,2 to 20,1 (one site showed 100% but N=1), estimated as the percentage of *V. letourneuxi* individuals in the total number of fish in each sampling station (Table 1 and Fig.2) At lowest densities, almost beyond detection, the species was encountered in the Pinios river and at highest densities in the Mornos river in Central Greece followed by the Arachthos and Acheron rivers in Ipeiros. In absolute terms, however, it was encountered at low densities in all systems sampled, and therefore it can be characterized as a "locally rare".

Table 1. Local densities of *V. letourneuxi* expressed as percentage (%N) in total fish caught.

Aquatic system	Site	No of *V.letourneuxi*	Total No Fish	Local density of *V. letourneuxi*
Pinios r.	18	2	891	0,2
Mornos r.	21	35	174	20,1
	22	8	71	11,3
	25	1	5	20,0
	27	1	7	14,3
Acheloos r.	40	1	39	2,6
Agios Dimitrios r.	47	1	1	100,0
	49	4	70	5,7
	51	1	36	2,8
Astakos springs	54	5	91	5,5
Vlychos springs	55	11	305	3,6
	56	10	325	3,1
Arachthos r.	57	11	59	18,6
Louros r.	64	3	56	5,4
	65	1	18	5,6
	67	9	116	7,8
	68	1	29	3,4
	69	7	59	11,9
Acheron r.	70	3	176	1,7
	71	16	118	13,6
Kalamas r.	75	5	180	2,8

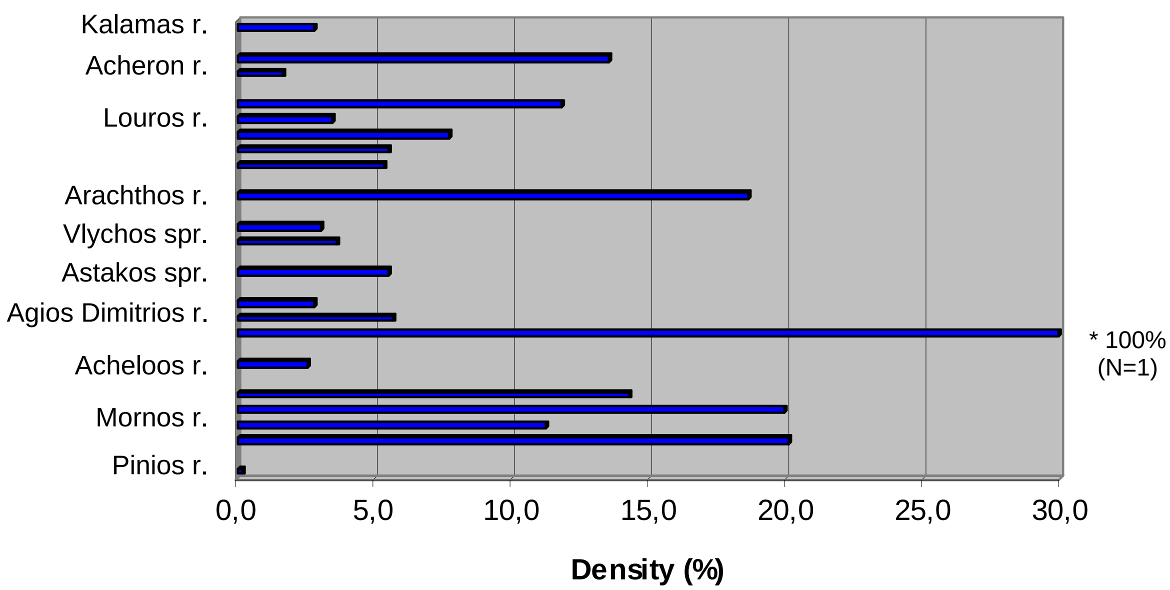


Fig. 2. *V. letourneuxi* relative local densities (%) per system and site sampled.

V. letourneuxi Density Comparison with Other Fish Species

A comparison of the percentage contribution at the fish community of the 19 fish species (in all systems sampled) confirms the low contribution of *V. letourneuxi* to the fish communities. Note especially its low contribution in contrast to the endemic *P. stymphalicus* and the introduced *G. affinis* that have a similar geographical distribution.

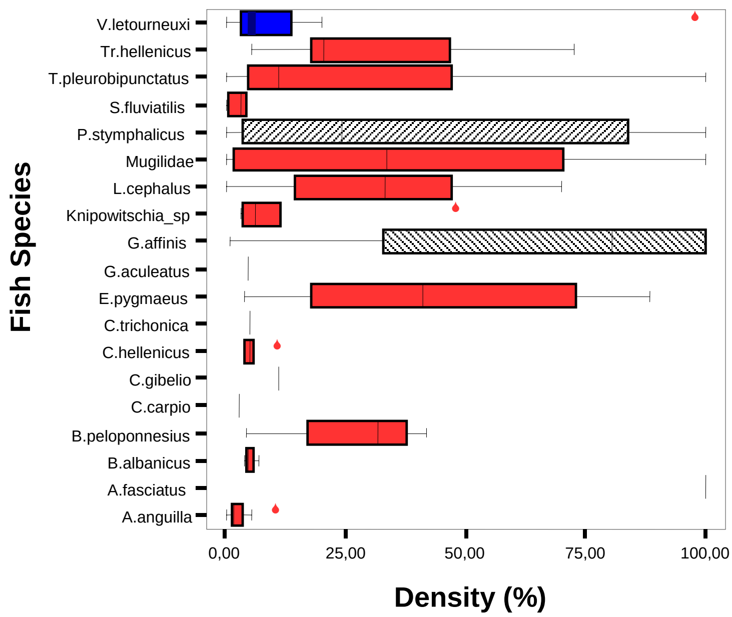


Fig. 3. Boxplot graph showing the percentage contribution of the 19 fish species in the 83 sites found with fish. Extreme values are marked with a drop. *V. letourneuxi* presented an extreme value (100%) at site 47 at Ag. Dimitrios river which actually refers to a single individual. Therefore, this sample was omitted at all further analyses.

A comparison of the percentage contribution to the fish community for *V. letourneuxi* and *P. stymphalicus* (per water system) confirms the local rarity *of V. letourneuxi*, as opposed to the density of *P. stymphalicus*.

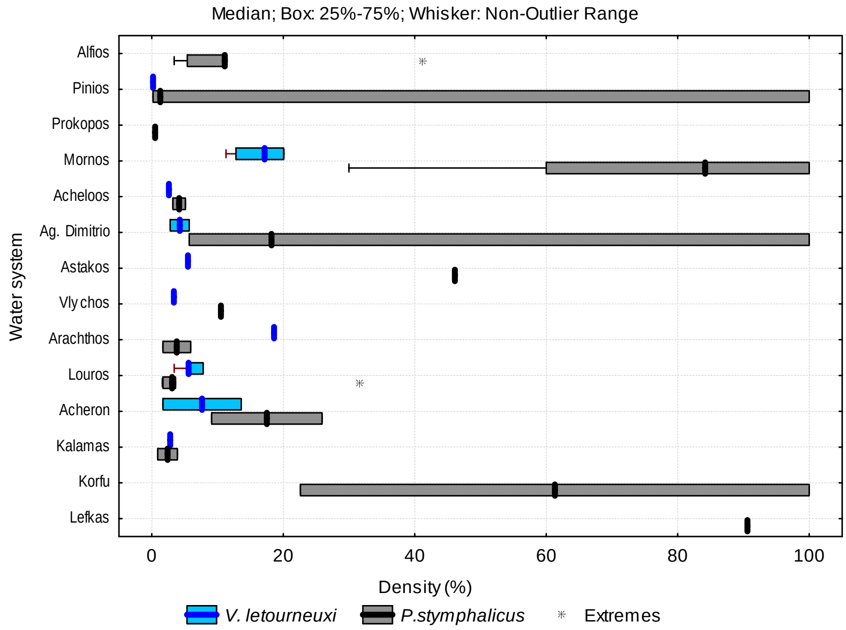


Fig. 4. Boxplot graph showing the percentage contribution of *V. letourneuxi* and *P. stymphalicus* per water system sampled. Extreme values are marked with an asterisk.

Similarly a comparison of the percentage contribution at the fish community of *Valencia letourneuxi* and *Gambusia affinis* confirms the local rarity *of V. letourneuxi*, as opposed to the density of *G. affinis*.

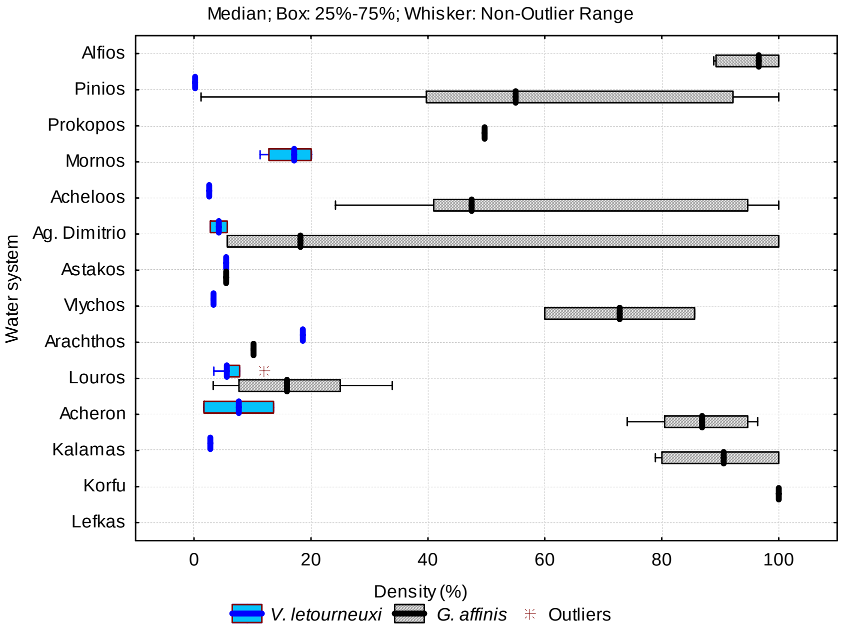


Fig. 5. Boxplot graph showing the percentage contribution of *V. letourneuxi* and *G. affinis* per water system sampled. Extreme values are marked with an asterisk.

3.2.3 Sympatric Fish Species

In the frame of the current study, *V. letourneuxi* occurred with a minimum of two and a maximum of seven sympatric species with a total of 11 associated species recorded in the 10 systems that *V. letourneuxi* presence was confirmed (Table 1). These included species of the Cyprinidae, Mugilidae, Poecilidae, Gobbidae, Cobitidae and Anguilidae families. The commonest cyprinid was the endemic minnow *Pseudophoxinus stymphalicus* (or *P. st. thesproticus*) which occurred in almost all systems, followed by the endemic goby *Economidichthys pygmaeus* (Gobiidae).
V. letourneuxi was found in association with a species of the Cyprinidae family (*Pseudophoxinus stymphalicus* (or *P. st. thesproticus*) in all systems examined, in 14 out of the 21 sampling sites. *V. letourneuxi* was found in association with a species of the Gobiidae family also in the majority of the systems examined, (in nine of the 10 systems sampled, and in a total of 18 out of the 20 sampling sites) with the sole exception of the Pinios river system in the Peloponnese. More specifically, it was found in association with *Knipowitschia sp*. in one system (Acheron r.) and in association with *Economidichthys pygmaeus* in the remaining eight systems (Mornos r., Acheloos r., Agios Dimitrios r., Astakos spr., Vlychos spr., Arachthos r., Louros r. and Kalamas r.). Extremely widespread was also the introduced species *Gambusia affinis* (Poecilidae), and *V. letourneuxi* was found in association with *G. affinis* in 9 of the 10 systems sampled, with the notable exception of the Mornos river system. In contrast, the loach *Cobitis hellenicus* (Cobitidae) occurred in association with *V. letourneuxi* only in one system, the Louros river.[*]

The highest species diversity was found in Pinios river in the Peloponnese, with the occurrence of 5 cyprinid species, of the introduced *G. affinis* and of fish of the Mugilidae family. The lowest species diversity was found in the Mornos river Delta in Central Greece, with the occurrence of only two species associated with *V. letourneuxi*, the minnow *P. stymphalicus* and the goby *Economidichthys pygmaeus.*

In summary, the species sympatric to *V. letourneuxi* occurring in Western central Greece and Ipeiros systems, were almost invariably the minnow *P. stymphalicus* (or *P.st. thesproticus*) and the introduced *Gambusia affinis*, together with the goby *E. pygmaeus* (with the notable exception of the Acheron river, where it is replaced by another goby, *Knipowitschia sp.*).

[*] Recent surveys revealed the co-occurrence of *V. letourneuxi* in association with a loach (*Cobitis arachthosensis*) also in Arachthos basin.

Table 1. Associated species in the sites where *V. letourneuxi* occurred.

	System	***site***	***Associated species***										
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
			Cyprinidae					**Mugilidae**	**Poecilidae**	**Gobiidae**		**Cobitidae**	**Anguilidae**
PELOPONNESE	***Pinios r.***	18	√	√	√	√	√	√	√				
WESTERN CENTRAL GREECE	***Mornos r.***	21	√								√		
		22	√					√			√		
		25	√								√		
		27	√								√		
	Acheloos r.	40	√			√			√		√		
	Ag. Dimitrios r.	47											
		49	√	√		√			√		√		√
		51		√							√		√
	Astakos spr.	54	√					√	√		√		
	Vlychos spr.	55							√		√		
		56	√					√	√		√		
IPEIROS	***Arachthos r.***	57	√	√					√		√		
	Louros r.	64	√						√		√		
		65							√		√		
		67		√					√		√	√	
		68							√		√		
		69	√						√		√	√	
	Acheron r.	70	√					√	√				
		71							√	√			√
	Kalamas r.	75	√						√		√		

Cyprinidae
(1) *Pseudophoxinus stymphalicus*
or *Pseudophoxinus st. thesproticus*
(2) *Telestes pleurobipunctatus*
(3) *Leuciscus cephalus*
(4) *Tropidophoxinellus hellenicus*
(5) *Barbus albanicus*

Mugilidae
(6) *sp.*

Poecilidae
(7) *Gambusia affinis*

Gobiidae
(8) *Knipowitschia* sp.
(9) *Economidichthys pygmaeus*

Cobitidae
(10) *Cobitis hellenicus*

Anguilidae
(11) *Anguilla anguilla*

In terms of abundance, species of the Mugilidae family were most abundant only in the Pinios river, in the Peloponnese (see Fig.1) The endemic minnow *P. stymphalicus* (or *P.st. thesproticus,* yellow bars) was relatively most abundant in two systems, the Mornos river and the Astakos springs. The goby *Ec. pygmaeus* (*dark* green bars) was the dominant species in three systems, the Agios Dimitrios river, the Aracthos river and the Louros river. Finally, the introduced *G. affinis* (bright green bars) was the most abundant species in four systems, i.e. the Acheloos river, the Vlychos springs, the Acheron river and the Kalamas river.

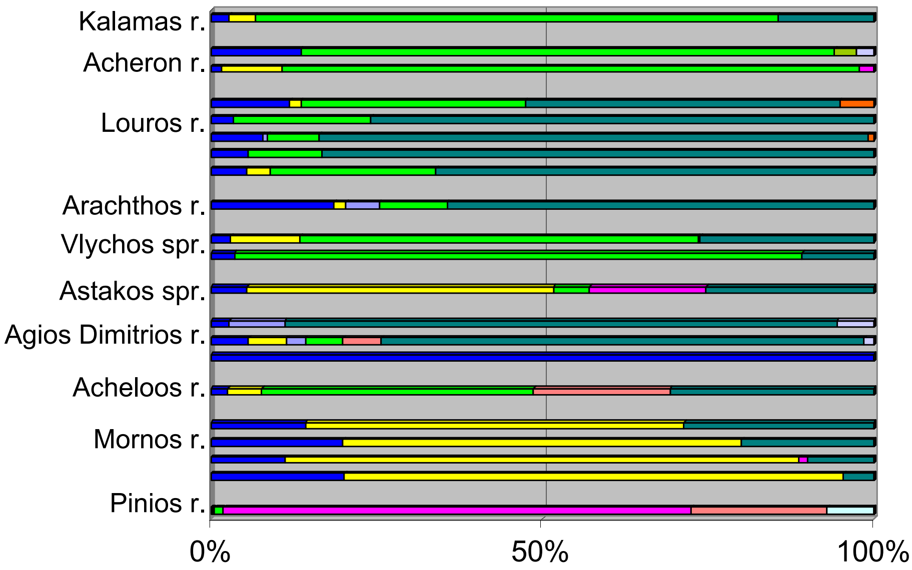
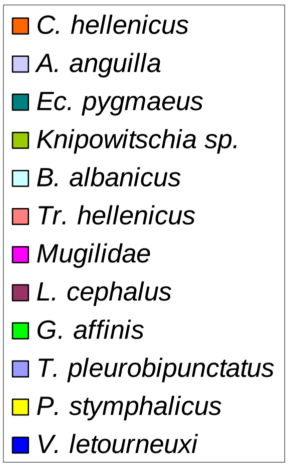


Fig. 1. Sympatric species composition and their relative abundance in the water systems of Greece, that *V. letourneuxi* occurred. Note the high species diversity in the Pinios river (7 species, all cyprinids) and the low species diversity in the Mornos river (only two sympatric species). Note also the presence of the introduced *G. affinis* (bright green bars) in all systems, with the sole exception of the Mornos river. Second commonest species was the goby *E. pygmaeus* (dark green bars).



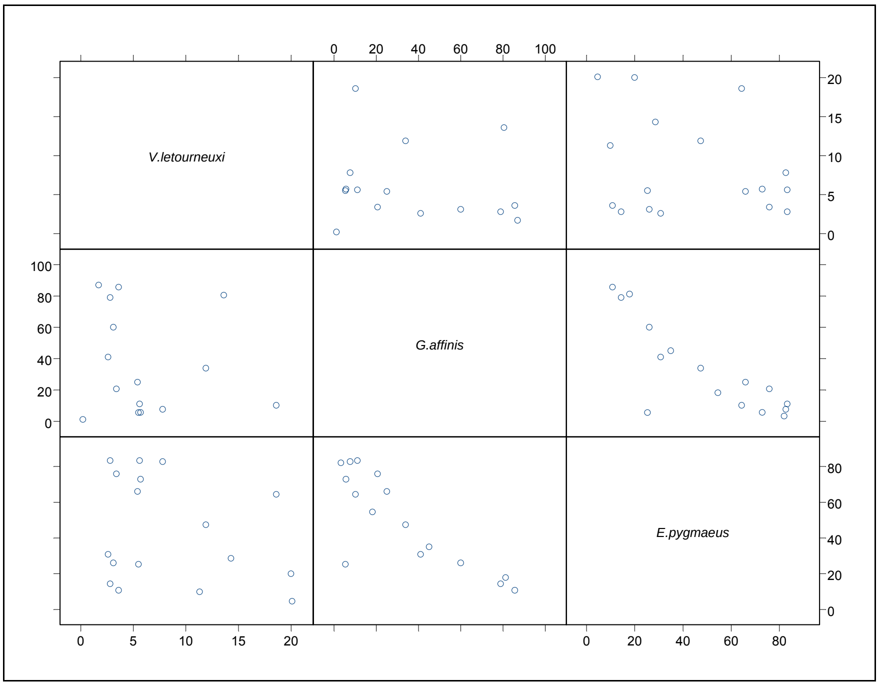
V. letourneuxi	*P. stymphalicus*	*T. pleurobipunctatus*	*G. affinis*	*L. cephalus*	*Mugilidae*	*G. aculeatus*	*Tr. hellenicus*	*B. peloponnesius*	*C. gibelio*	*C. carpio*	*B. albanicus*	*S. fluviatilis*	*Knipowitschia sp.*	*E. pygmaeus*	*A. anguilla*	*A. fasciatus*	*C. trichonica*	*C. hellenicus*	
1	0,108	0,042	-0,048	-0,100	0,051	-0,062	-0,027	-0,127	-0,062	-0,062	0,008	-0,157	**0,229***	**0,423****	0,067	-0,062	-0,062	0,102	*V. .letourneuxi*
	1	-0,052	**-0,568****	0,055	-0,028	0,106	-0,113	-0,054	0,032	0,032	-0,070	-0,080	0,102	-0,044	-0,043	-0,109	-0,109	0,041	*P. stymphalicus*
		1	**-0,387****	**0,281***	-0,103	**0,233***	-0,038	**0,353****	**0,240***	**0,240***	0,050	0,096	-0,194	**0,325****	0,216	-0,052	-0,052	0,114	*T.pleurobipunctatus*
			1	**-0,284****	-0,033	-0,115	0,119	**-0,235***	-0,115	-0,115	0,026	-0,082	-0,076	-0,135	-0,122	-0,115	0,127	-0,105	*G. affinis*
				1	0,131	-0,034	-0,002	**0,550****	**0,354****	**0,354****	0,161	**0,418****	-0,126	-0,192	**0,321****	-0,034	-0,034	-0,078	*L. cephalus*
					1	-0,044	-0,042	-0,089	-0,044	-0,044	0,132	0,039	-0,162	-0,122	-0,009	-0,044	-0,044	-0,100	*Mugilidae*
						1	-0,044	-0,025	-0,012	-0,012	-0,022	-0,031	-0,046	0,166	-0,039	-0,012	-0,012	**0,424****	*G. aculeatus*
							1	-0,089	-0,044	-0,044	**0,525****	**0,318****	0,049	0,037	0,075	-0,044	-0,044	-0,100	*Tr .hellenicus*
								1	**0,509****	**0,509****	-0,044	0,153	-0,093	-0,039	0,117	-0,025	-0,025	-0,058	*B. peloponnesius*
									1	1	-0,022	**0,379****	-0,046	-0,070	**0,333****	-0,012	-0,012	-0,028	*C. gibelio*
										1	-0,022	**0,379****	-0,046	-0,070	**0,333****	-0,012	-0,012	-0,028	*C. carpio*
											1	0,174	0,100	-0,123	0,119	-0,022	-0,022	-0,050	*B. albanicus*
												1	0,135	-0,177	**0,502****	-0,031	-0,031	-0,071	*S. fluviatilis*
													1	**-0,260****	0,153	-0,046	-0,046	-0,105	*Knipowitschia sp.*
														1	0,035	-0,070	-0,070	**0,452****	*E. pygmaeus*
															1	-0,039	-0,039	-0,089	*A. anguilla*
																1	-0,012	-0,028	*A. fasciatus*
																	1	-0,028	*C. trichonica*
																		1	*C. hellenicus*

A non parametric Spearman rho correlation has taken place in order to depict the relations among the different fishes that constitute the communities at the 82 samples. According to the correlation table *Valencia letourneuxi* was correlated positively to the *E. pygmaeus* abundance whereas the *G. affinis* was negatively correlated to the same fish but a direct relation among *V. letourneuxi* and *G. affinis* is not evident. *Mugilidae, A. fasciatus* and *C. trichonica* were not correlated to another species. *A. fasciatus* and *C. trichonica* were present solely in one sample. *C. gibelio* and *C. carpio* presented absolute correlation but they were found only in the same one sample.

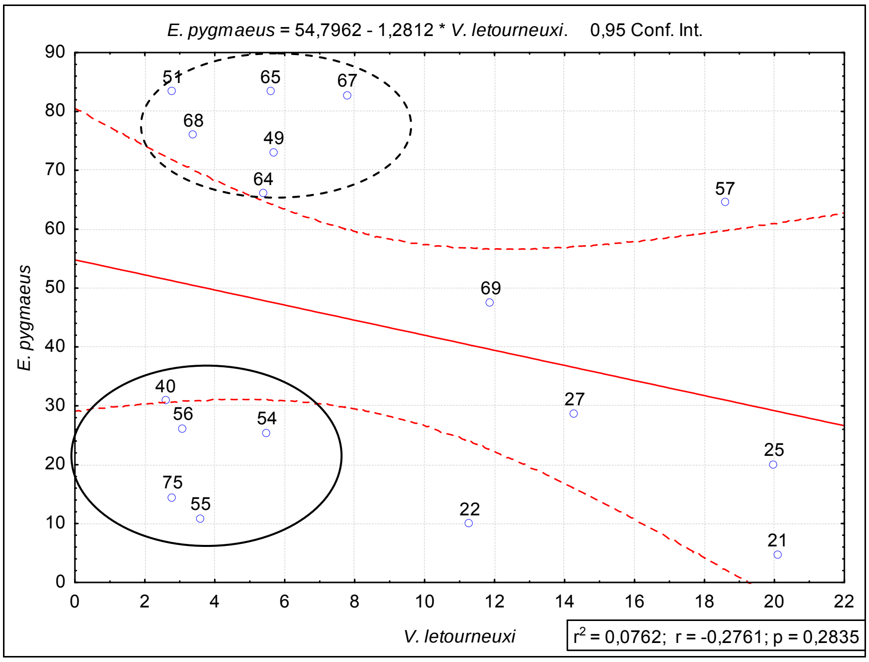
* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

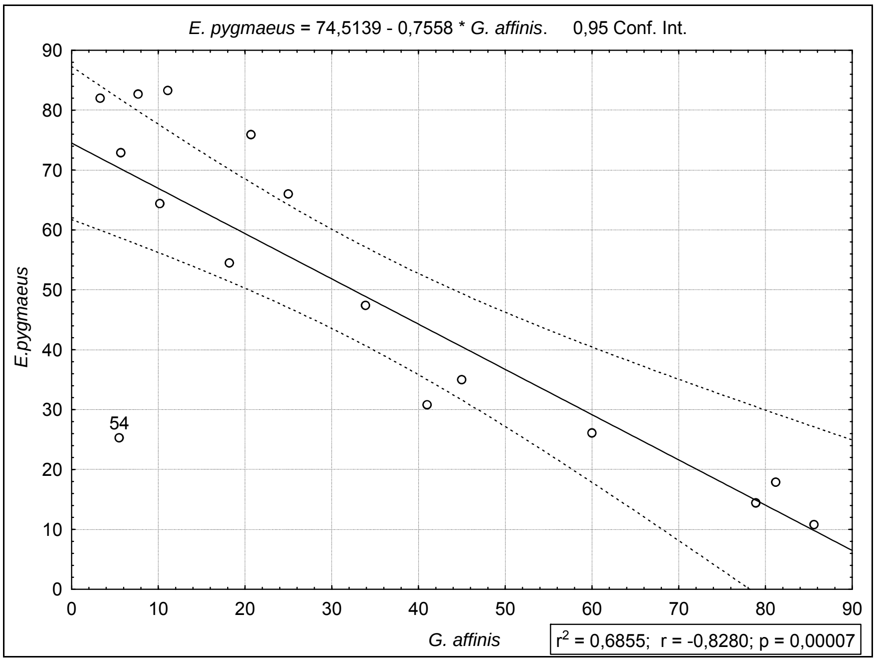
At the matrix plot below, the positive relation between *V. letourneuxi* and *E. pygmaeus* is not that evident as it is the negative relation among *E. pygmaeus* and *G. affinis.*



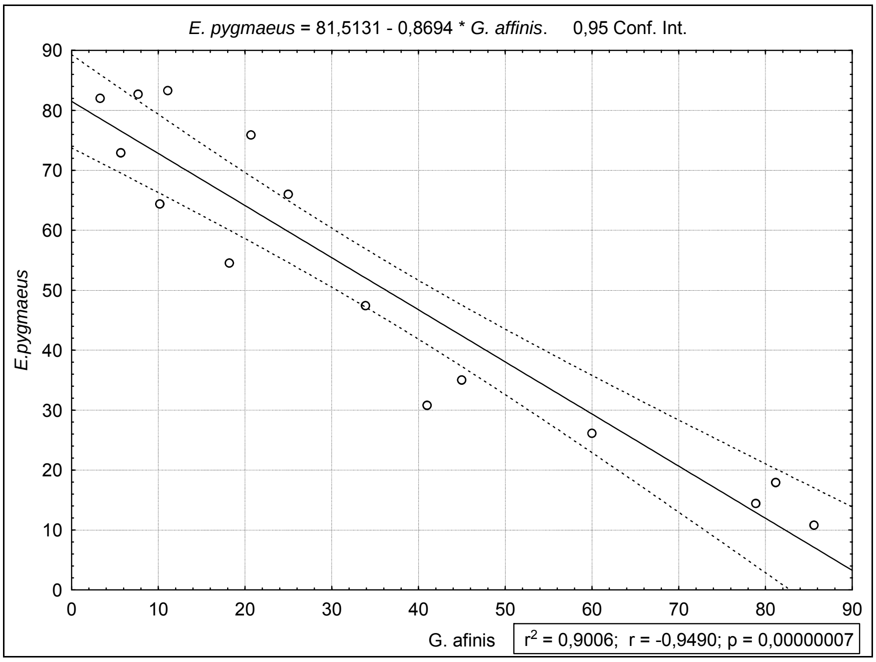
In a linear regression graph among *V. letourneuxi* and *E. pygmaeus* it is evident that they cannot meet the criteria of a valid quantitative relation because of two group of values: samples 49, 51, 64, 65, 67 and 68 that present low *V. letourneuxi* values and high *E. pygmaeus* ones; whereas samples 40, 54, 55, 56 and 75 present low values for both species.



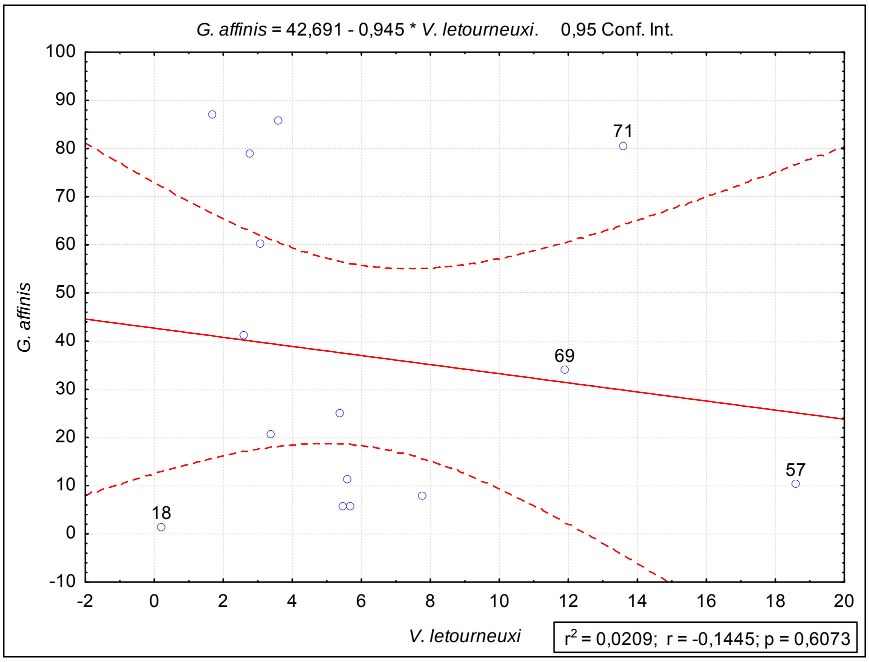
In a linear regression among *E. pygmaeus* and *G. affinis* despite the outlier sample 54, a strong quantitative relation is evident from the fact that the variability explained (r^2) is 68,55 %.



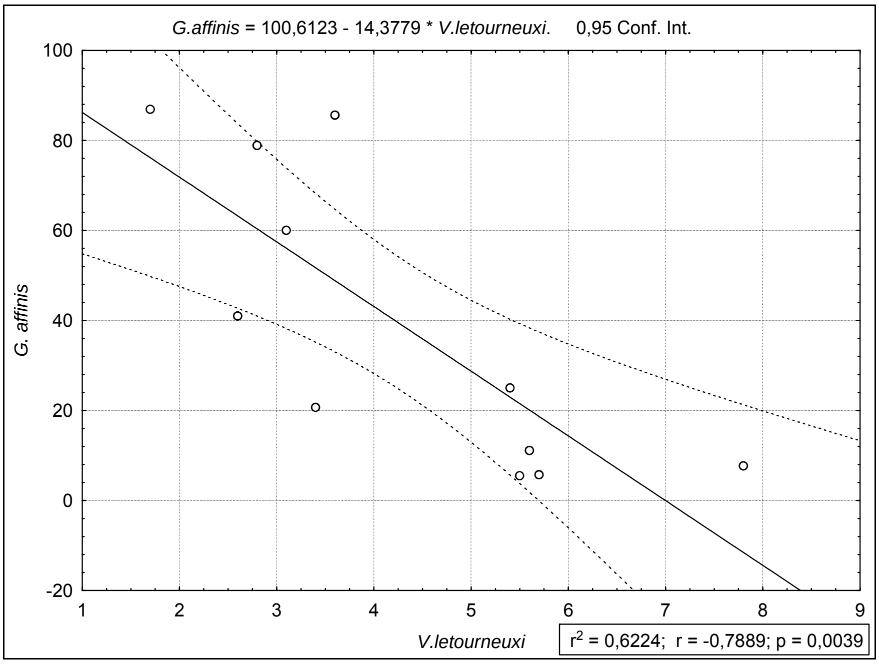
By removing sample 54 the variability explained reaches 90,06 %. The negative relation among *E. pygmaeus* and *G. affinis* is profound.



In a linear regression among *V. letourneuxi* and *G. affinis* no clear relationship can be seen unless if samples 18, 57, 69 and 71 are removed.

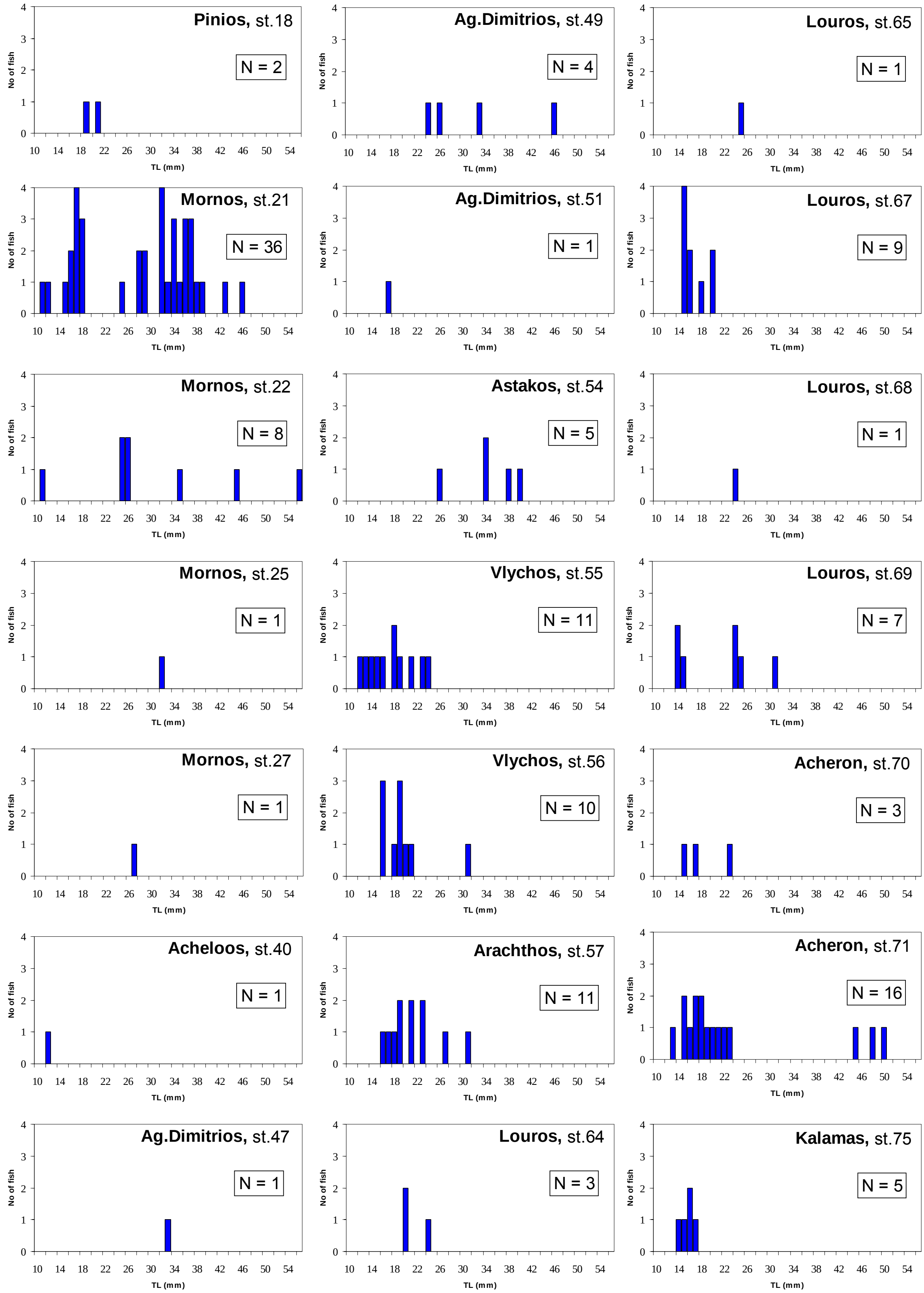


By removing samples 18, 57, 69 and 71, the produced linear regression explains the 62,24 % of the variability and a clear negative relation between *V. letourneuxi* and *G. affinis* becomes evident.



3.2.4 Length Classes.

Length-frequency distribution of *V. letourneuxi* in all sites where the species was found. Only sites 21 (Chiliadou springs, Mornos r.) and site 71 (Northern Canal, Acheron r.) yielded enough individuals for a biological examination. Nevertheless, the presence of small larvae in sites sampled in late October, such as site 71, indicate that spawning possibly extends to mid autumn.



3.2.5 Ecology

A common characteristic of all *V. letourneuxi* sites is their low altitude (0 altitude). With respect to flow regime, turbidity and temperature in the sites where *V. letourneuxi* occurred, the variance of these factors is low, indicating a dominant *V. letourneuxi* micro-habitat, with low current velocity, minimal turbidity and relatively low water temperature (varying from 14,5 to 21,4 ºC). The above, indicate a preference of the species for slow flowing, clear and relatively cool water. With respect, however, to depth and width site characteristics, there is a high variance between the different sites, with depth varying from 0,15 to >2 m and width varying from 1 to 30 m. The two extremes generally correspond to shallow and narrow spring areas (e.g. the Skala springs, Fig. 1) on the one hand and deep, wide spring-fed canals or streams (e.g. Skala stream, Fig. 3) on the other.

With respect to salinity, most of the habitats of the species are associated with freshwater springs, with most sites (Pinios r., Mornos r., Agios Dimitrios r., Louros r., Arachthos r. and Kalamas r.) having salinity values lower than 2 ‰ and conductivity values ranging from 418 to 1990 µS/cm. Three habitats, however (Astakos springs, Vlychos springs and Acheron r.), could be characterized as brackish, having significantly higher salinity values (ranging from 2,3 to 7,6 ‰) and conductivity values ranging from 3770 to 11800 µS/cm. Thus, although the species mostly occurs in freshwater habitats, it can also be found in brackish waters.

The habitat sediment in all stations was either exclusively silt or a combination of silt, sand, pebble and cobble. The riparian vegetation consisted mostly of *Phragmites australis*, *Arundo spp,*.*Typha spp.* and *Juncus spp.* The most conspicuous feature however of the species habitats was the high surface cover by aquatic vegetation, the composition of which varied between the different sites. The commonest was a thick layer of predominantly *Lemna spp.* (e.g. in Skala and Stefani streams. Fig. 3,4 and Arachthos river, Fig. 5), of *Ceratophyllum spp*. (e.g. in Vlychos ditch, Fig. 6), floating algae (e.g. in Mornos river, Chiliadou spr., Fig. 7,8), of *Zanichelia spp.* (Astakos springs, Fig. 9,10) of *Potamogeton spp.* (Acheron river, Fig. 11,12). Aquatic plant also commonly found in these habitats, at various percentages, were water cress-like plants, often found in combination with other floating and submerged aquatic plants (Vlychos springs, Geroporos stream, Fig. 13-16).

Fig. 1. Skala springs, shallow spring area.

Fig. 2. Vlychos springs.

Fig. 3. Skala stream (Louros system).

Fig. 4. Stefani stream (Louros system).

Fig. 5. Arachthos river with *Lemna spp.*

Fig. 6. Vlychos ditch with *Ceratophyllum spp.*

Fig. 7. Mornos river, Chiliadou springs.

Fig. 8. Mornos river, Chiliadou springs (algae).

Fig. 9. Astakos springs.

Fig. 10. Astakos springs with *Zanichelia spp*.

Fig. 11. Acheron r.

Fig. 12. *Potamogeton spp.* from Acheron r.

Fig. 13. Vlychos springs with water cress, *Lemna spp.* and submerged algae.

Fig. 14. Water cress-like plants.

Fig. 15. Geroporos str. with *Potamogeton spp.* and water cress-like plants.

Fig. 16. *Potamogeton spp.* in Geroporos str.

Comparative Species Abundance Correlation to Abiotic Parameters
A non parametric Spearman rho correlation has taken place in order this time to depict the relations among *V. letourneuxi*, *G. affinis* and *E. pygmaeus* abundance and the abiotic parameters measured at 34 samples (sites with fish and full abiotic data sets), i.e. Depth, Flow, Conductivity, pH, DO, Temperature, Turbidity and Vegetation Surface Cover (Field *et al.,* 1982).

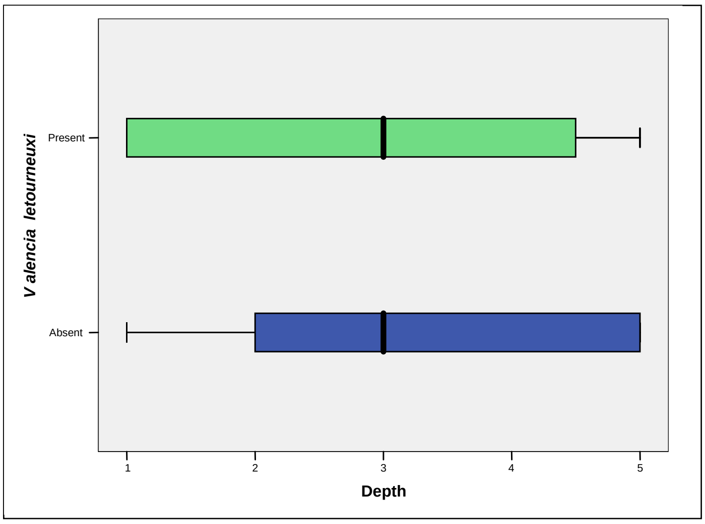
	V. letourneuxi	*G. affinis*	*E. pygmaeus*
V. letourneuxi	1,000	-,081	**,356(*)**
G. affinis	-,081	1,000	**-,417(*)**
E. pygmaeus	**,356(*)**	**-,417(*)**	1,000
% Veg Surf Cover	**,510(**)**	,210	,229
Depth	,117	,284	,108
Flow	-,019	**-,467(**)**	,233
Conductivity	-,035	,298	-,166
PH	-,234	,088	-,159
D.O.	,282	-,128	,304
Temperature	,166	-,035	-,220
Turbidity	-,316	,246	**-,488(**)**

For *V. letourneuxi,* a correlation was observed only for surface vegetation cover.

V. letourneuxi abundance correlation to abiotic parameters

Water Depth

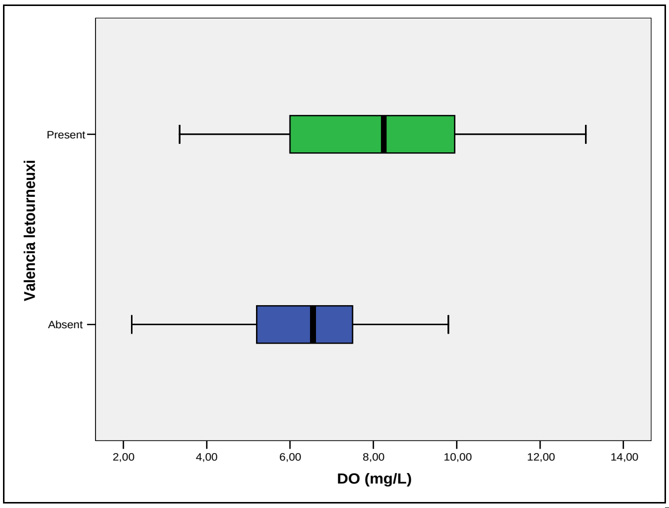
From the comparison of the depth classes in the samples where *Valencia letourneuxi* was present versus the samples where it was absent it cannot be extracted a clear pattern of preference, regarding the depth class.

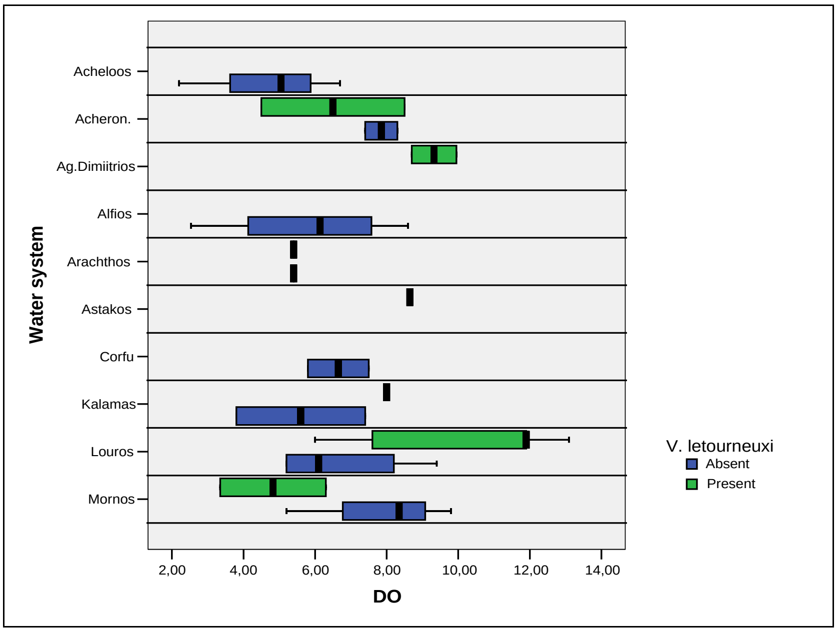


Depth	m
1	0,00 - 0,3
2	0,31 -0,6
3	0,61- 1,2
4	1,21- 2,00
5	2,01 -

Dissolved Oxygen

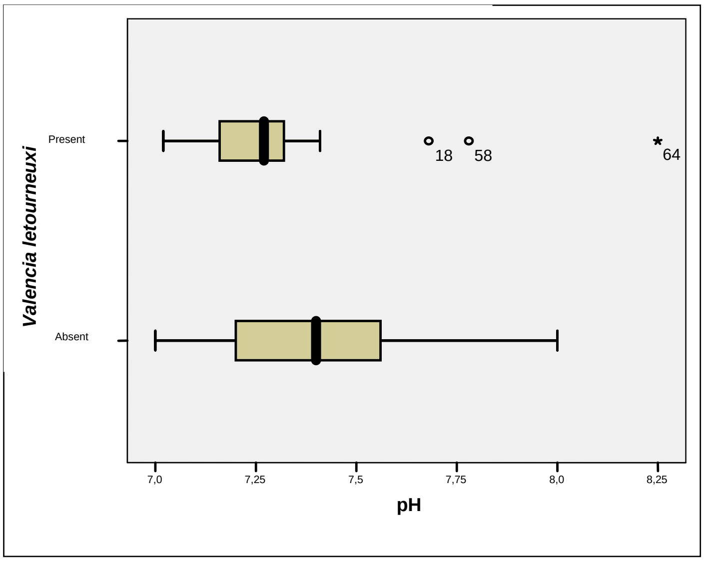
From the comparison of the DO values in the samples where *V. letourneuxi* was present versus the samples where it was absent it cannot be extracted a clear pattern for the dissolved oxygen level preference.





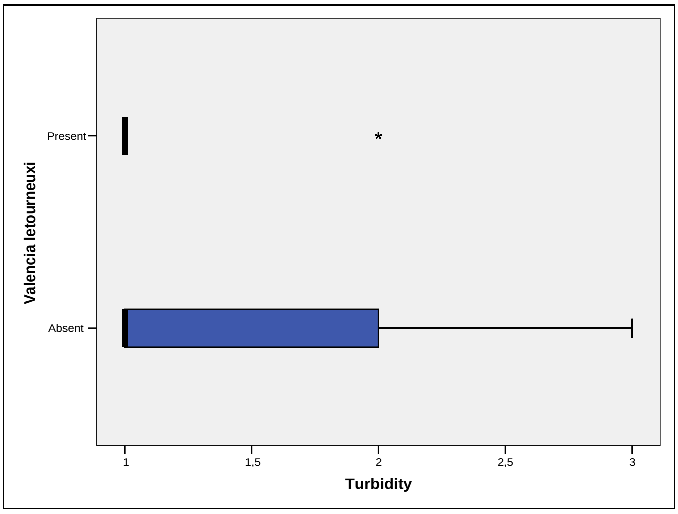
pH

From the comparison of the pH values in the samples where *V. letourneuxi* was present versus the samples where it was absent it cannot be extracted a clear pattern for the pH level preference. Nevertheless, the samples where it was found produced lower pH than those that it was absent. The outlier values 18 and 58 refer respectively to sites 18 and 65 belonging to Pinios and Louros rivers respectively, and the extreme value 64 belongs to site 71 (Acheron r.). Site 18 (Pinios, Agia Mavra) was the only site in the Peloponnese where *V. letourneuxi* was found, but at very low densities (2 individuals in a total of 891 fish caught).

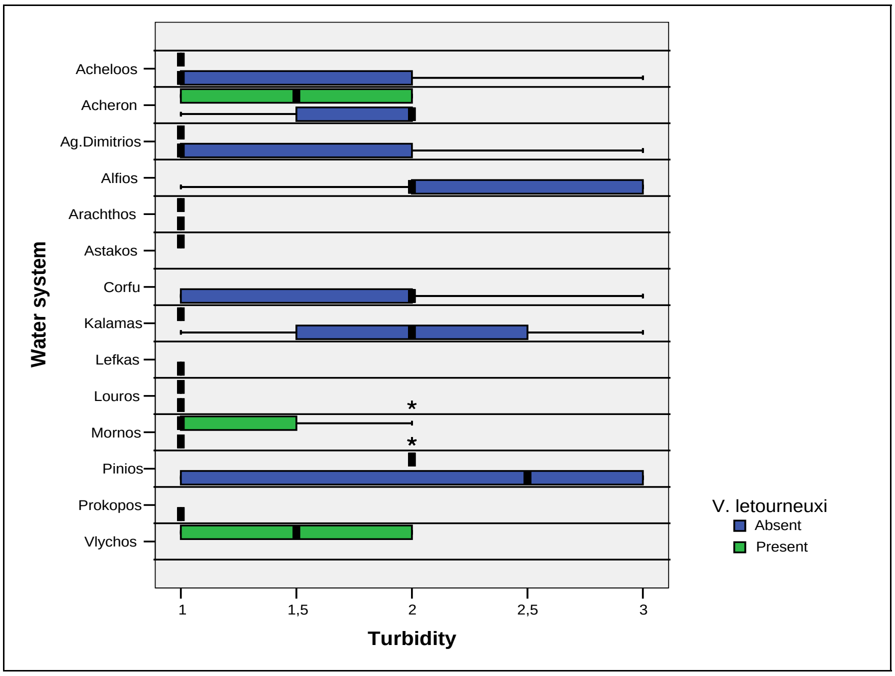


TURBIDITY

By a comparison of the turbidity classes in the samples where *V. letourneuxi* was present, versus the samples it was absent, it is evident that the fish demonstrated a preference to the less turbid sites. The only exception (extreme value) is presented for sample 18 in Pinios river.

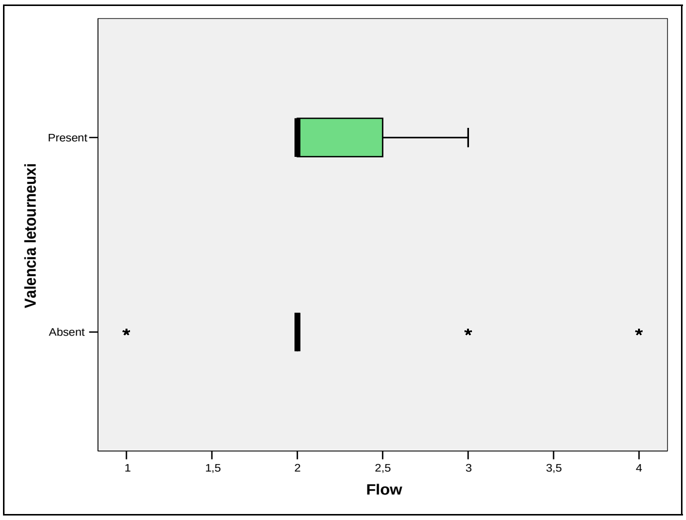


Turbidity	
1	Clear
2	Turbid
3	Very turbid



Flow

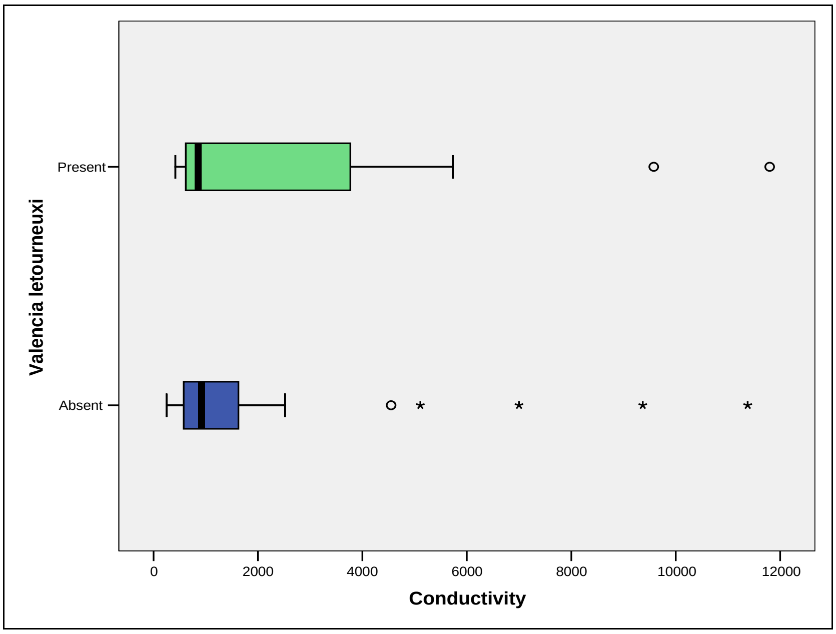
From the comparison of the flow classes in the samples where *V. letourneuxi* was present, versus the samples it was absent, a preference for low flow was evident.

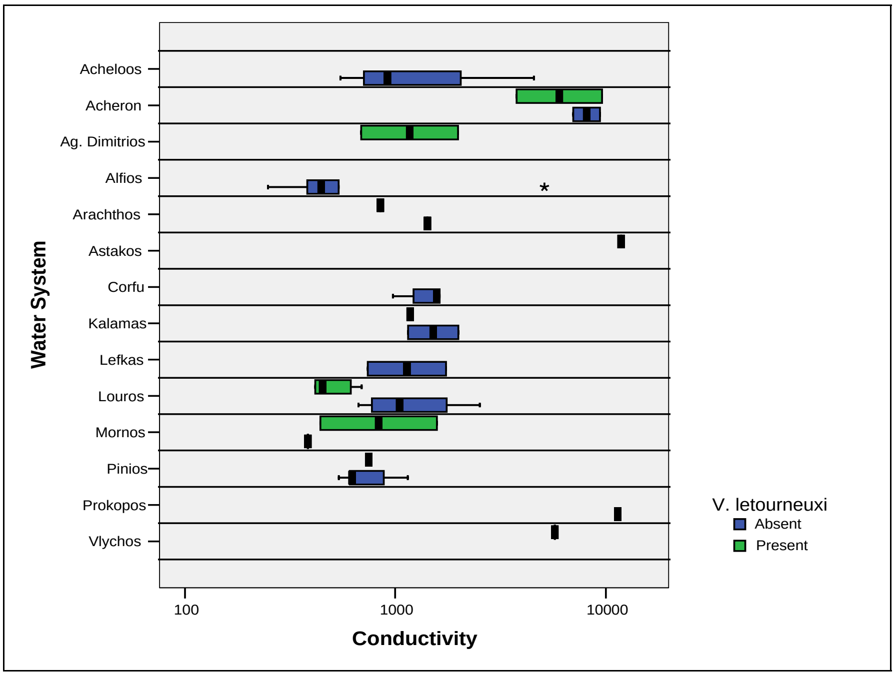


Flow	
1	No flow
2	Low
3	Medium
4	Fast

Conductivity

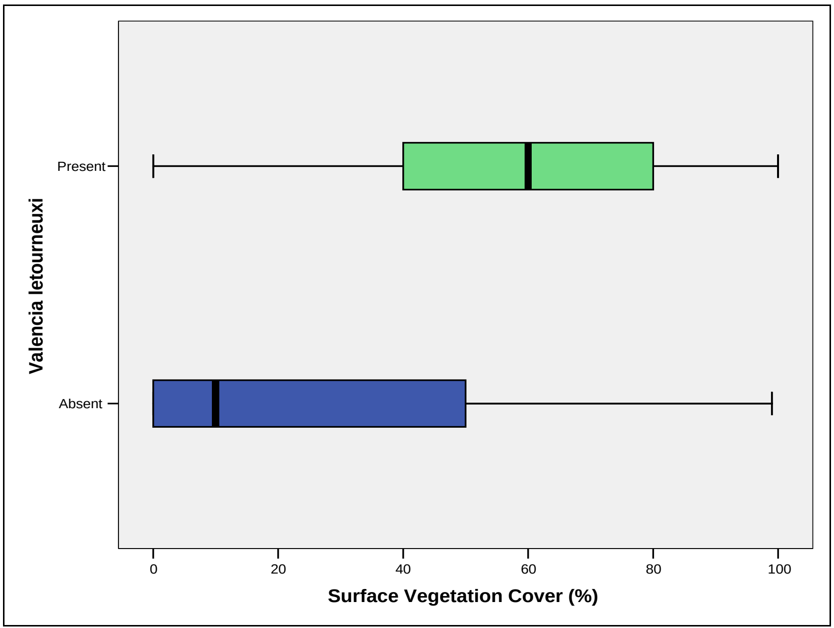
From the comparison of the conductivity values in the samples where *V. letourneuxi* was present, versus the samples it was absent, it cannot be extracted a clear pattern for the conductivity preference. Nevertheless, it is evident that the species can be found in various conditions regarding the conductivity levels. The outliers in the boxplot of *V. letourneuxi* presence refer to sites 71 and 54 belonging to sites very close to the sea in the Acheron r. and Astakos spr. respectively.



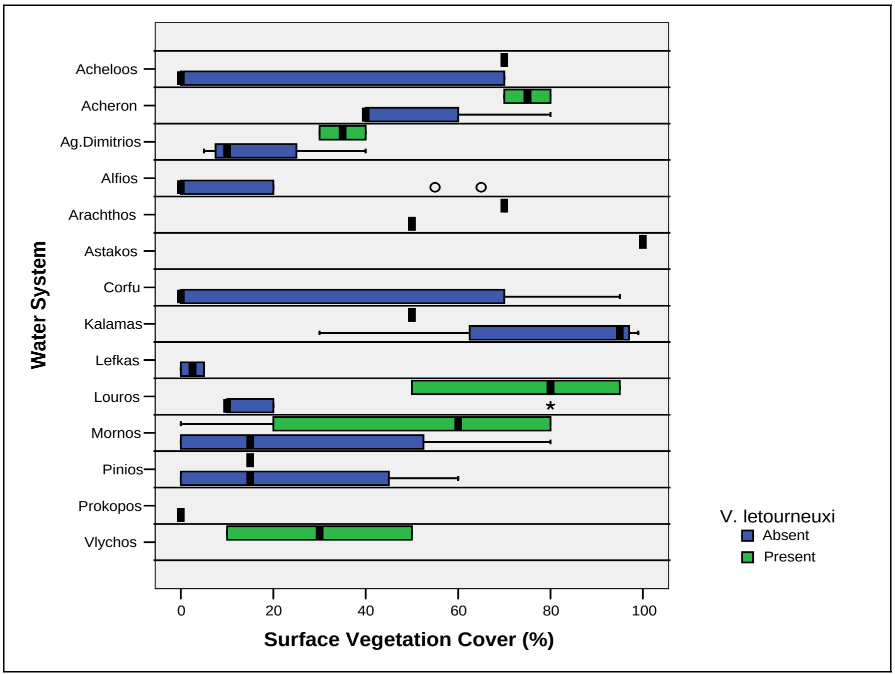


Vegetation Surface Cover

By a comparison of the vegetation surface percentage cover in the samples where *V. letourneuxi* was present, versus the samples it was absent, it is evident that although the species was found in different degrees of vegetation cover, it preferred the richly vegetated sites.



The previous conclusion is even clearer by checking the same thing for every water system, in the following graph. The only exceptions to this preference for richly vegetated habitats can be found in Kalamas and Pinios rivers.



4. DISCUSSION

Many freshwater Mediterranean fishes with special habitat requirements are under pressure by climatic variability and anthropogenic habitat modification (Maitland & Crivelli, 1995; Maitland, 1995; Cote *et al.*, 1999). There are about 40 freshwater fishes endemic to Greece and/or adjacent countries, many of which are included in the IUCN International Red List and are assigned a threatened conservation status (Economidis, 1995).

V. letourneuxi is a freshwater fish, endemic to western Greece and south-western Albania, listed as critically endangered in the IUCN Red List. Available evidence suggests that both the species' range and the number and abundance of its populations are declining (Economidis, 1995, Barbieri *et al.*, 2000). However, there has been paucity of appropriate distributional data needed to evaluate the rate of the species' decline, the reasons of its decline, and the status of the extant populations. Furthermore, biological and ecological knowledge, upon which conservation actions could be based, is fragmentary or lacking.

This report presents the results of the first complete baseline survey specifically targeting this species. Research was carried out in June and October 2005, with a total of 22 days spent in the field, and represents the most thorough study of *V. letourneuxi* and its habitats so far undertaken. In total, 95 sites were visited, and 7024 fish were caught, of which 136 belonged to this species. The data obtained contribute: (a) to the better understanding of the biology, life-history and ecology of *V. letourneuxi*, (b) to the delineation of its current distribution and the evaluation of the status of its populations and (c) to assessments of the habitat quality and vulnerability of the species to extrinsic (environmental) or intrinsic (biological traits) factors.

The projects' results on the biology, ecology and distribution of *V. letourneuxi*, including a description of its habitat conditions, are summarized below and the implications of these data on conservation assessments and management are discussed.

4.1 Biology and ecology

Length-frequency distribution data from the sampled localities indicate that *V. letourneuxi* is a small-bodied and relatively short-lived fish. It grows to a maximum size of 57 mm TL and lives two to three years. However, most populations were comprised of only one or two age-classes. Studies on the food habits and the gonadal maturation cycle of this species have been undertaken, but the results are not yet available. Preliminary data, however, seem to confirm previous studies (Barbieri *et al.*, 2000) according to which *V. letourneuxi* is a serial spawner, matures in the first year of life and feeds predominantly on aquatic insects. The breeding period, as assessed from the appearance of newly-emerged larvae, starts in May and continues throughout the summer. The presence of larvae in sites sampled in late October, indicate that spawning possibly extends even to mid autumn. We were not able to observe the reproductive behaviour of *V. letourneuxi* in the field. Limited data provided by previous authors indicate that this fish deposits large spherical adhesive eggs on aquatic plants (Das, 1985; Bianco & Miller, 1989; Barbieri *et al.*, 2000; Economou *et al.*, 1999).

Most populations were found in entirely freshwater habitats. However, three extant populations (Northern Acheron Canal, Vlychos springs, Astakos stream) and some extinct populations (Drepano marsh, Corfu wetlands) have been reported from slightly brackish waters, indicating that this species is able to tolerate saline conditions. Otherwise, *V. letourneuxi* exhibits narrow ecological preferences and can be regarded as a habitat specialist. It lives in clean, slow-running and relatively cool waters (up to 21,4 ^{0}C) and is confined to sections with rich aquatic vegetation, avoiding open areas. Throughout its life-cycle, *V. letourneuxi* displays cryptic colouration and behaviour, spending most of its time among submerged or floating plants. These life-history characteristics facilitate life in vegetated habitats and may represent adaptations against predation risk.

Strict habitat specialisation poses constraints on the species' distribution and population size or growth, accounting for its sporadic and fragmented occurrence. The distributional data indicate that *V. letourneuxi* shows a strong affinity towards low altitude springs and spring-fed wetlands. When this species occurs in rivers and marshes, it is predominantly found in portions of them close to, or influenced by, springs. One explanation for the preference of *V. letourneuxi* for spring-fed habitats is based on the observation that this fish was mostly found in sites with relatively cool water. A possible dependency of the species on low water temperature may be inferred from this observation. Springs are supplied by groundwater tables, and since groundwater is cooler than stream water during summer, spring-fed systems provide to *V. letourneuxi* suitable thermal regimes which could not be found in adjacent runoff systems or marshy habitats. However, this explanation is contradicted by the fact that Cyprinodontids are generally warm-water species and there is no reason to believe that *V. letourneuxi* is an exception. An alternative explanation is that the occurrence of *V. letourneuxi* in spring-fed habitats is the consequence of its requirement for conditions of environmental stability. If this is the case, the preference of the species for spring-fed systems can be explained in relation to the semi-arid and hot climate of Greece, characterised by deficient rainfall and an often prolonged summer drought. Under such climatic conditions, runoff systems and marshes are unstable environments, with the hydrological and physicochemical conditions fluctuating markedly on an annual, seasonal or even daily basis. Instability is caused both by natural factors (e.g. seasonal fluctuations of temperature and low summer flow) and by human activities (water abstraction, agricultural pollution, etc.) and generates poor habitat conditions for this species. Spring-fed systems, by contrast, are hydrologically, thermally and chemically more predictable environments than runoff systems. In addition, flow stability enables the development of perennial aquatic vegetation upon which the species relies for shelter, spawning substrate and foraging habitat.

Our survey strategy was confined in lowland areas and involved sampling only in small aquatic systems, where *V. letourneuxi* was most likely to be found. Rivers and large streams were not covered by our investigation, with the exception of the Agios Dimitrios river and some vegetated sections of the rivers Alfios and Pinios in the Peloponnese. Extensive surveys undertaken by the HCMR over the past 20 years (Economou *et al.,* 1999, Economou *et al.,* 2001) have shown that the species is absent or extremely rare in such riverine environments, most probably because of turbid flow, high annual temperature fluctuations and poor surface aquatic vegetation generate prohibitive conditions for it. This is not the case with the Agios Dimitrios r., which is entirely spring-fed. Due to sampling difficulties only few individual were caught in this river but it is known from previous surveys that *V. letourneuxi* occurs in various parts of this river, even in localities away from the spring area. Upland rivers also seem to be hostile environments for the species because they have a flashy and erosive behaviour that prevents the formation of quiet sections with vegetative beds.

Food limitation does not appear to be a limiting survival factor in the restricted but energy-rich species' habitats. Being a low-level predator that feeds on insects and microcrustaceans, *V. letourneuxi* has access to the abundant and relatively stable food resource which is usually available at the low levels of the trophic hierarchy. Predation constitutes a potentially more important threat. Being small in size and low in the food chain, *V. letourneuxi* is vulnerable to predation by larger animals, such as fishes, reptiles, amphibians and birds. Although this species is behaviourally adapted to avoid predator attacks by means of its concealment behaviour, we believe that predation remains a major source of mortality, and in fact it is a major reason for the evolution of its phytophilic life-history style.

Throughout its range, *V. letourneuxi* occurs in association with certain other small-bodied species, mainly the endemic minnow *Pseudophoxinus stymphalicus*, the goby *Economidichthys pygmaeus* and the alien *Gambusia affinis*. These, in contrast to *V. letourneuxi*, are habitat generalists, also occurring in adjacent rivers, streams and marshes. It has been hypothesised that *G. affinis*, which has been introduced in most aquatic systems of western Greece for mosquito control, influences the survival of *V. letourneuxi,* predominantly through competition (Economidis, 1995). Moreover, the mosquitofish is known to predate on the young developmental stages of other species (Meffe, 1985; Hayes & Rutledge, 1991). Our data provide some evidence, though not conclusive, to support this hypothesis. In addition, studies are underway to test the hypothesis of a possible dietary antagonism between *G. affinis* and *V. letourneuxi*. Here it is important to note that the healthiest and more abundant population of *V. letourneuxi* was found in the Chiliadou springs (Mornos delta), which is the only known aquatic system of western Greece where introduction of *G. affinis* has not been recorded.

4.2 Distribution and abundance

The historical range of *V. letourneuxi* includes the area between the rivers Alfios in the Peloponnese and Thyamis (Kalamas) in mainland Greece, the Lake Butrinto in south Albania and the islands Corfu and Lefkas (summarised by Barbieri *et al.*, 2000). It is considered extinct in the Ionian Islands. There is no recent information about the status of the Albanian population in lake Butrinto.

In the frame of the current survey, almost all known and many localities likely to harbour *V. letourneuxi* in Greece were sampled. The species was not found in the islands Corfu and Lefkas, neither in the Drepano marsh (Kalamas delta), despite considerable sampling effort. Likewise, it could not be located in wetland habitats of the Alfios drainage in Peloponnese, which marks the southern edge of the species' range in mainland Greece. *V. letourneuxi* still occurs in the adjacent Pinios river, but the status of this population seems to be deteriorating rapidly. Extensive sampling in this river yielded only two individuals (out of 891 fish totally caught). The disappearance of the Corfu, Lefkas and Alfios populations and the recession of the Pinios population provides evidence suggesting that the species range is contracting northwards and eastwards.

The localities currently occupied by *V. letourneuxi* vary in their capacity to support this species. Only the Chiliadou stream population (Mornos drainage) can be characterised as abundant, in terms of local densities and geographical extent. The populations of the Stephani springs (Louros drainage) and Northern canal (Acheron drainage) are moderate in abundance. All other populations can be regarded as rare, while some historically known populations are extinct. Meanwhile, the species was detected in some not previously known localities (Koufosouda stream in the Mornos drainage, Aetoliko stream in the Acheloos drainage, Geroporos stream and Pentalofou springs in the Agios Dimitrios drainage, Skala stream in the Louros drainage and Anakoli springs in the Kalamas drainage).* It is notable in this context that most of the currently known populations of *V. letourneuxi* have been discovered in the last 30 years [Rivers Alfios and Pinios in Bianco & Miller (1989); Rivers Mornos and Agios Dimitrios and Vlychos springs in Economou *et al.,* (1999); River Arachthos and Astakos stream in Daoulas, (2003), River Acheron in Stephanidis, (1974); River Kalamas in Labhart, (1980)]. Only one of the remaining extant populations (in the river Louros) has been known from earlier times (Stephanidis, 1939). These recent discoveries seem to be a consequence of intensified sampling effort and imply that the historical data on the distribution and abundance of the species are incomplete. Hence, it is possible that the species had existed in more localities in the past, but the respective populations became extinct before being detected.

Since the historical range of *V. letourneuxi* has not been precisely documented, it is difficult to make a sound estimate of the rate of population decline. However, it is possible to make a rough assessment of the decline based on the total number of historically recorded populations and the number of populations that are still extant today, according to our recent survey. As the data of the table below indicate, there have been records (historical and recent) of 32 local populations. Today there are only 15 confirmed localities harbouring the species (5 other localities in four systems were not sampled).

Aquatic system	*Historical*	*2005 confirmed*
Alfios river	3	0
Pinios river	2	1 (+1 not sampled)
Mornos river	2	2
Ag. Dimitrios river	4	3 (+1 not sampled)
Acheloos river	4	1
Astakos springs	1	1
Vlychos springs	1	1
Arachthos river	1	1
Louros river	2	2
Acheron river	4	2 (+2 not sampled)
Kalamas river	2	1
Corfou systems	5	0 (+1 not sampled)
Lefkas systems	1	0
Total	*32*	*15 (20)*

This gives an overall decline of 37,5% over the past 70 years (a percentage that becomes even higher, 53,1%, if the not sampled populations are also extinct). This is a conservative assessment because, as mentioned before, some populations existing in small aquatic systems may have been extirpated before being discovered. An alternative estimate can be based on trends of the status of historically known populations. Up to 1980, there were three known populations scattered in localities of the islands Corfu and Lefkas and five known populations in the drainages of the rivers Louros, Acheron and Kalamas (total 8 populations). Only four (regarding the not sampled populations as still extant) of these localities continue to provide habitat to this species, which gives an estimated number of population loss of 50% (A percentage that becomes even higher, 75%, if the not sampled populations are also extinct). Although examining population trends only at historically known (and presumably 'optimal') locations is likely to generate erroneous conclusions with

* Recently, an individual was caught also at the Vossa canal in Louros drainage.

regard to population trends, we can infer a species decline in terms of population extinctions of approx. 50% over the last 35 years.

The 15 confirmed and new "species' habitat sites" belong to 10 independent drainages. By the term "habitat site" we refer to a specific location where suitable habitat for the species exists and within which the abiotic and biotic environmental conditions permit interaction between individuals. The dimensions of habitat sites may differ depending primarily on the morphological, hydrological and biological characteristics of the aquatic systems accommodating these sites. For example, the species' habitat sites in the Agios Dimitrios river and the Chiliadou stream may extend along a route of several hundred meters (in the sense that the physical and environmental conditions permit connections among suitable habitat patches within the site). By contrast, the habitat sites of the Stephani springs and the Skala stream in the Louros drainage may occupy just a few dozen square meters each. Although these two habitat sites are hydrologically connected via the Louros river, the hydraulic, physicochemical and biological conditions of the riverine environment between them do not seem to provide suitable habitat conditions for the species. In this sense, the populations inhabiting these two sites can be regarded as isolated from each other. However, we cannot exclude the possibility that the species utilises the Louros river as a corridor for dispersal. Needless to say that there is no connection between populations occupying sites belonging to different drainages. This lack of connectivity contributes to the populations' decline because, once a local population is depleted, there is little chance that the population will be re-established by migration from other sites. This might not have been the case in earlier geological epochs, as in the Pleistocene, when the drop of the sea level due to the glacial events would have enabled drainage connections through the confluence of the lower reaches of rivers (Banarescu, 1989). The species' broad tolerance limits to salinity would also have facilitated dispersal through brackish waterways in the river estuaries. In the post-glacial period, the rising of the sea level separated the drainages permanently, limiting the dispersal opportunities. A genetic study is currently being undertaken to assess genetic distances of *V. letourneuxi* populations inhabiting different drainages and, in the case of the Louros drainage, of two different habitat sites within the same drainage.

In developing a scenario for the biogeographic history of *V. letourneuxi*, it has to be taken into account that the glacial events of the Pleistocene can account only for short-distance dispersal, i.e. dispersal among rivers that came into confluence during periods of sea lowering. They are not sufficient to account for long-distance dispersal and differentiation from *V. hispanica*, which inhabits the Iberian Peninsula. Therefore, we are inclined to accept that the establishment of *V. letourneuxi* in the western Balkans, and its separation from *V. hispanica*, occurred at an earlier time, perhaps in the Miocene. One hypothesis postulates that important radiation of freshwater fishes may have occurred across the present Mediterranean during the Messinian brackish or freshwater (Lago Mare) phase of the Mediterranean Sea (Bianco, 1990). We hypothesise that, during that phase, faunal exchange between the ancestral populations of *V. letourneuxi* and *V. hispanica* could occur. After the end of the Messinian salinity crisis, dated at 5.5. million years ago, the two populations would have been separated by the filling-up of the Mediterranean, and become permanently isolated.

4.3 Vulnerability to threats

The ecology of *V. letourneuxi* makes it especially vulnerable to demographic and environmental stochasticity. Being a habitat specialist, narrowly adapted to specific hydraulic and vegetative conditions, this species is highly susceptible to modifications of its habitat, whether these modifications are induced by natural causes or by human activities. Natural causes include the frequently occurring summer droughts and seasonal temperature fluctuations in Greek systems. Anthropogenic habitat changes are directly or indirectly linked with rural developments and include, among others, summer abstractions of water, wetland drainage, agricultural pollution, dam operation and introduction of alien species (particularly *G. affinis,* Stephanidis, 1964).

We assert that the most severe impacts on the species' habitats have been caused by a combination of summer drought and water abstraction for irrigation and/or urban needs. Water is a limited resource in Greece, and all surface and groundwater water resources are intensely or fully exploited. Agriculture is the main consumer of water. In the last 50 years the rate of water abstraction has been accelerated, following the adoption of intensive cultivation practices, supported by industrial irrigation. Irrigation takes place in the summer, which is the toughest time for water-obligate organisms, and thus acts additively to droughts in exhausting the aquifers that feed karstic springs. Reduced spring water supply has affected the habitat quality of *V. letourneuxi* in a dual manner: by causing a deterioration of the flow conditions or shrinkage of wetland surface, and by lowering the heat regulating capacity of water bodies due to lower water volume, thus allowing more rapid warming of the spring water in the summer. Larger springs, such as in the Chiliadou, Vlychos and Stephani, have been less affected, continuing to support healthy populations of the species. The groundwater table in the Chiliadou springs, however, is already heavily exploited for domestic needs. Local plans to advance the exploitation of the groundwater to cover irrigation needs as well, may endanger the local population of *V. letourneuxi*. Smaller springs have been affected more severely and some are now intermitted in activity or completely desiccated. Springs known to have supported populations of V. *letourneuxi*, such as existed on the Corfu and Lefkas islands, are now completely tapped for their water supply and the local populations of the species have disappeared.

Other major impacts on the species' habitats have been generated by land reclamation. Extensive reclamation works have taken place in the lower parts of the Rivers Acheloos, Alfios, Evinos and Pinios, where enormous marshy areas have been drained for farming. In these areas, the transformation of many wetlands to agricultural fields has caused a substantial loss of natural habitat types and the biodiversity they support. Of the few spring-fed wetlands that have been left in these areas, most have been affected by water abstraction, pollution and the expansion of the agricultural activities to the wetland area. The *V. letourneuxi* population detected in Aitoliko stream near the Acheloos estuary may well be a remnant of a previously more abundant population that inhabited spring-fed inland and littoral marshes that once existed in this area. Again, lack of appropriate data on the distribution of the species in the pre-reclamation period prevents us drawing any firm conclusions about the consequences of land reclamation on the *V. letourneuxi* populations. Scheduled reclamation plans in the Ammoudia marsh (Acheron river delta) involve the drying of about two thirds of the current marshy area for the creation of agricultural land. Realization of these plans is likely to have very adverse effect on the now abundant and prosperous population in the Northern Drainage Canal of the Acheron delta. Likewise, the increase of irrigation in the Arta plains using water abstracted from the Louros river and the underlying aquifers is likely to have similar adverse effects on the Louros populations of *V. letourneuxi*.

There are evident signs of agricultural pollution over many of the areas investigated, such as the lowlands of Alfios r. in the Peloponnese and Acheloos r. in Western

Central Greece, but the precise impacts on the species are difficult to evaluate. Small aquatic systems have been affected more adversely than larger ones, due to their limited capacity to buffer the effects of increased nutrient and toxicant inputs, especially in areas where agriculture is coupled with animal husbandry activities, such as the small Aitoliko stream. The operation of hydroelectric and irrigation dams, as in the rivers Alfios, Acheloos, Arachthos and Pinios, appears to have had a negative effect on the species, causing disturbance of the flow conditions, increased sedimentation and damage of the aquatic vegetation.

Finally, alien species constitute a potential threat to *V. letourneuxi*, as potential predators or competitors. Especially in Greece, the widespread introduction of *G. affinis* for anti-mosquito control has been postulated as a probable reason for the decline of *V. letourneuxi* (Bianco & Miller, 1989). In Spain, there is evidence that the presence of *G. holbrooki* causes increased agonistic interactions, decreased feeding rates and disruption of reproductive behaviour on adults and young of the year of *V. hispanica* (Rincon *et al.,* 2002). Although we also have some evidence of behavioral interference, at this stage we lack appropriate data to test for possible competitive or predatory impacts of *G. affinis* on *V. letourneuxi*. An investigation of the feeding ecology of both species is also under way and we are awaiting its results in order to reach more definite conclusions.

4.4 Conservation status and management strategy

V. letourneuxi has been precautionary classified as "Critically Endangered" in the IUCN list of threatened species (2005 update) based on a suspected decline in extent of occurrence and area of occupancy of at least 50% in the last 10 years and a projected severe decline in the next 10 years. Although sufficient information to make a precise evaluation of the species decline is lacking, a similar decline based on population extinctions within the last 35 years has been inferred from our data (see above). We acknowledge that this assessment is based on incomplete historical data sets and there is not an independent method to test the precision of the estimates. Moreover, the assessment is based on population extinctions, rather than on trends in extent of occurrence and area of occupancy, which could not be estimated with the data available to us.

Nonetheless, the species meets at least the criteria to be termed "Endangered" and the best available evidence suggests that there is a high likelihood of going extinct in the near future. In addition to its declining range, the species exhibits several limiting demographic characteristics and ecological attributes that increase the probability for extirpation events to occur (e.g., fragmented distribution, few populations, low population densities, low fecundity due to large egg size and high habitat specialization).

In summary, main threats arise from habitat loss or deterioration associated with agricultural intensification. The specialised aquatic habitats of *V. letourneuxi* are especially at risk from water abstraction. The increase in irrigation, in particular, lowers the groundwater tables and thereby affects the water supply of springs which provide the best habitat to the species. Important impacts are also generated by reduced water quality because of agricultural pollution, stream canalisation and the expansion of agricultural land into wetland areas. There is a long-standing hypothesis that the introduction of *G. affinis* has been also harmful to the species and our distributional data give some support to this hypothesis (high population densities only in Chiliadou springs in the absence of *G. affinis*). However, the data from the examination of the stomach contents of these two species are not yet adequate to firmly confirm or refute this hypothesis. Climatic change constitutes another potential threat. Environments constantly change, and with increasing evidence that climate warming is driving changes in the distribution and abundance of many species, some populations of the species may experience deteriorating conditions in the future.

Given that the probability of extinction is dependent on the fraction of sites occupied, an important management goal is to preserve existing population sites, mainly through prevention of reclamation works in keystone habitats accommodating this species. Conservation efforts should focus more sharply on the protection and maintenance of locations where favourable conditions for the species exist, e.g. spring-fed wetlands, if necessary through site-based habitat management. In this context, the projected reclamation works in the Acheron lowlands and the scheduled increase of water abstraction from the Chiliadou aquifer for irrigation purposes should be reconsidered. Maintenance of habitat quality requires enough good quality water at the *V. letourneuxi* sites and their conservation. Thus, other important management goals are setting minimum hydrological and water standards that ensure good habitat conditions, especially through drought events. Only few of the existing population sites are found in natural zones protected under the Natura 2000 framework. Since the protection provided by the NATURA has a general character, there is a need to define protected site areas, specific for this species, and to design supplementary conservation actions specifically addressing this species, both within and outside the Natura 2000 areas.

In summary, we recommend the following guiding principles for the conservation of *V. letourneuxi*: the conservation and management of existing population sites; the conservation and management of areas that contain suitable micro-habitat sites; the maintenance of the watertables that feed spring-fed systems, occupied by the species; the identification of suitable localities that could be colonized to allow populations to expand; and the maintenance of normal ecological functions within all of these sites, e.g. through prevention of polluting activities. In the longer term, conservation actions should aim to the creation of suitable refugia, if the present-day habitats cease to occur due to climatic change.

From a research perspective, effort should be devoted to improve sampling techniques, in order to arrive at more reliable estimates of population densities, to conduct surveys within and outside the species range (especially in southern Albania) in order to fill the gaps on the distribution of the species and to study more thoroughly aspects of the species’ biology, ecology and life-history, including its interactions with other species. It is also important to perform surveys aiming to locate suitable but unoccupied water bodies, available within or around the species’ current range, for possible translocations. However, translocation operations should be conducted with caution. The species seems to be limited largely by its narrow ecological requirements, and hence it may be useless to introduce *V. letourneuxi* in wetland habitat types that do not have the capacity to support this species.

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6. ANNEX I. Scientific Conference Papers

CURRENT POPULATION STATUS OF *VALENCIA LETOURNEUXI* (SAUVAGE, 1880) IN THE MORNOS RIVER DELTA

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ABSTRACT

Data are provided on the geographical distribution, abundance, length-frequency distribution, species associations and habitat requirements of the freshwater fish *Valencia letourneuxi* (Sauvage, 1880) in the Mornos Delta. The species is endemic to springs and small rivers in the Balkan region of Western Greece and Southern Albania. In the frame of the present study, 16 sites in 5 separate water systems of the Mornos Delta were investigated. *V. letourneuxi* was found in only four sites in two water systems (Gouvos and Koufosouda stream), which were characterised by relatively low water flow, low water temperatures and rich submerged vegetation. The species was found in association with the Greek endemic minnow *Pseudophoxinus stymphalicus* and the goby *Economidichthys pygmaeus*. The restricted distribution, the narrow ecological requirements and the low local densities makes the species vulnerable to extinction.

Keywords: *Valencia letourneuxi*, Greece, Mornos Delta, Distribution, Habitat.

ΤΡΕΧΟΥΣΑ ΠΛΗΘΥΣΜΙΑΚΗ ΚΑΤΑΣΤΑΣΗ ΤΟΥ *VALENCIA LETOURNEUXI* (SAUVAGE, 1880) ΣΤΟ ΔΕΛΤΑ ΤΟΥ ΠΟΤΑΜΟΥ ΜΟΡΝΟΥ

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ΠΕΡΙΛΗΨΗ

Στην παρούσα ανακοίνωση παρουσιάζονται δεδομένα σχετικά με τη γεωγραφική κατανομή, την πληθυσμιακή αφθονία, την κατανομή μεγεθών, τα συμπατρικά είδη ψαριών και τις οικολογικές απαιτήσεις του ψαριού του γλυκού νερού *Valencia letourneuxi* (Sauvage, 1880) στο Δέλτα του Μόρνου. Το είδος είναι ενδημικό των πηγών και των μικρών ποταμών της Δυτικής Ελλάδας και της Νότιας Αλβανίας. Στο πλαίσιο της παρούσας έρευνας ερευνήθηκαν 16 θέσεις σε 5 υδάτινα συστήματα στο Δέλτα του Μόρνου. Το είδος βρέθηκε σε τέσσερις μόνο θέσεις σε δύο υδάτινα συστήματα (Ρέμα Γουβού και Ρέμα Κουφόσουδας) που χαρακτηρίζονται από χαμηλή ροή νερού, σχετικά χαμηλές θερμοκρασίες και πλούσια υδρόβια βλάστηση. Τα είδη που ήταν παρόντα στα ίδια συστήματα με το *V. letourneuxi* ήταν το ενδημικό *Pseudophoxinus stymphalicus* και ο γοβιός *Economidichthys pygmaeus*. Η σποραδική παρουσία του είδους, οι ιδιαίτερες οικολογικές του απαιτήσεις και η χαμηλή του αφθονία το καθιστούν είδος προς εξαφάνιση.

Λέξεις-κλειδιά: *Valencia letourneuxi*, Ελλάδα, Δέλτα Μόρνου, Γεωγραφική κατανομή, Οικότοποι.

CURRENT POPULATION STATUS OF *VALENCIA LETOURNEUXI* (SAUVAGE, 1880) IN THE MORNOS RIVER DELTA

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ABSTRACT

Data are provided on the geographical distribution, abundance, length-frequency distribution, species associations and habitat requirements of the freshwater fish *Valencia letourneuxi* in the Mornos Delta. This species, classified as Endangered by IUCN in 1996 and listed as high priority species according to the Directive for Habitats Protection (92/43/EEC), is endemic to springs and small rivers in the Balkan region of Western Greece and Southern Albania. In the frame of the present study, sixteen sites in five separate water systems of Mornos Delta were investigated. *V. letourneuxi* was found in only four sites in two water systems (Gouvos and Koufosouda stream), being historically present in only one of these. All sites in which *V. letourneuxi* was found, were characterised by relatively low water flow, low water temperatures and rich submerged vegetation. The species associations were fairly consistent, with usually present in the same habitat the Greek endemic minnow *Pseudophoxinus stymphalicus* and the goby *Knipowitschia* sp. The restricted distribution, the narrow ecological requirements and the low local densities coupled with evidence of a serious population decline makes the species vulnerable to extinction.

Keywords: *Valencia letourneuxi*, Greece, Mornos Delta, Distribution, Habitat.

ΤΡΕΧΟΥΣΑ ΠΛΗΘΥΣΜΙΑΚΗ ΚΑΤΑΣΤΑΣΗ ΤΟΥ *VALENCIA LETOURNEUXI* (SAUVAGE, 1880) ΣΤΟ ΔΕΛΤΑ ΤΟΥ ΜΟΡΝΟΥ

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ΠΕΡΙΛΗΨΗ

Στην παρούσα ανακοίνωση παρουσιάζονται δεδομένα σχετικά με την γεωγραφική κατανομή, την πληθυσμιακή αφθονία, την κατανομή μεγεθών, τα συμπατρικά είδη ψαριών και τις οικολογικές απαιτήσεις του ψαριού του γλυκού νερού *Valencia letourneuxi* στο Δέλτα του Μόρνου. Αυτό το είδος, που συμπεριλήφθηκε ως κινδυνεύον στον κατάλογο του IUCN το 1996 και ως είδος προτεραιότητας για προστασία στην Κοινοτική Οδηγία για την Προστασία των Οικοτόπων (92/43/EEC), είναι ενδημικό των πηγών και των μικρών ποταμών της Δυτικής Ελλάδας και της Νότιας Αλβανίας. Στα πλαίσια της παρούσας έρευνας, ερευνήθηκαν δεκαέξι θέσεις σε πέντε διαφορετικά υδάτινα συστήματα στο Δέλτα του Μόρνου. Το *V. letourneuxi* βρέθηκε σε τέσσερεις μόνο θέσεις σε δύο υδάτινα συστήματα (Ρέμα Γουβού και Ρέμα Κουφόσουδας), ενώ ιστορικά είχε αναφερθεί μόνο στο ένα από αυτά. Όλες οι θέσεις που βρέθηκε το *V. letourneuxi* χαρακτηρίζονται από χαμηλή ροή νερού, σχετικά χαμηλές θερμοκρασίες και πλούσια υδρόβια βλάστηση. Τα είδη που ήταν παρόντα στα ίδια συστήματα με το *V. letourneuxi* ήταν το ενδημικό *Pseudophoxinus stymphalicus* και ο γοβιός *Knipowitschia* sp. Η σποραδική παρουσία του είδους, οι ιδιαίτερες οικολογικές του απαιτήσεις και η χαμηλή του αφθονία, σε συνδυασμό με ενδείξεις για σοβαρή πληθυσμιακή μείωση, καθιστούν το *V. letourneuxi* είδος προς εξαφάνιση.

Λέξεις-κλειδιά: *Valencia letourneuxi*, Ελλάδα, Δέλτα Μόρνου, Γεωγραφική κατανομή, Οικότοποι.

INTRODUCTION

Valencia letourneuxi is a freshwater species, endemic to springs and small rivers in the Balkan region of Western Greece and Southern Albania. This species was classified as Endangered by IUCN in 1996 due to water abstraction and competition from introduced species, however, the available information on its geographic distribution, habitat preferences, biology and ecology is very limited (Economou *et al.* 1999, Barbieri *et al.* 2000). These studies, nevertheless, indicate narrow ecological requirements and locally low population densities as well as rapid habitat loss and population decline or even extinction in some systems, due to anthropogenic influences. To assess the current population status and to formulate appropriate conservation measures for this species, a thorough survey covering the entire range of the species distribution in western Greece was undertaken by ZSL and HCMR. The preliminary data presented here from the investigation of the Mornos River Delta, provide some first insights on appropriate methodological approach, the species ecological requirements and the threats faced by it.

MATERIALS AND METHODS

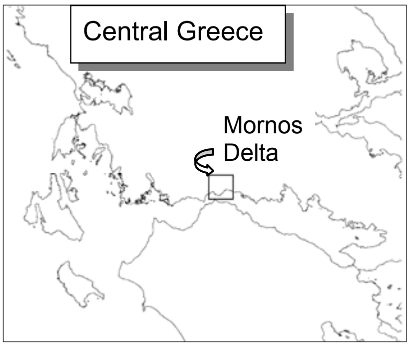
Field data were obtained during a field trip in the Mornos Delta in June 2005. A total of 16 sites, which included springs, irrigation channels, river channels and stream outlets to the sea, comprising five separate water systems (Gouvos Stream, Koufosouda Stream, Giara Stream, Managouli Stream and Mornos River) were sampled (Figure 1). The tendency for the fish to remain hidden in or near dense vegetation in water that was often fairly deep necessitated the use of a combination of sampling methods, such as a D-shaped large net with extendible wooden handle in areas with dense floating vegetation, and smaller dip nets in areas with thick Phragmites reeds that the larger net could not access. In more accessible open sites, seine netting as well as electrofishing where tried.

Records were taken of GPS, water temperature, flow, substrate, depth, width, vegetation, sample method used, species present and number of *V. letourneuxi* caught with sex ratio. Water physicochemical parameters were also recorded and specimens were preserved in formalin or alcohol. At the only site that yielded a sufficient number of individuals, the Chiliadou Springs (Gouvos Stream), all fish were measured and weighed, with a portion of the target and sympatric species kept for further biological examination. All data obtained from field sampling were added to an appropriately designed database.

RESULTS

Of the sixteen sites sampled in this study, *V. letourneuxi* presence was established in four sites in two water bodies at Mornos Delta (Gouvos and Koufosouda Streams, Fig.1) being historically present in one of the two systems (Gouvos stream). Table 1 summarises all records of historical and current occurrence of *V. letourneuxi* in the Mornos Delta, indicating its restricted distribution in the area.

V. letourneuxi was found mostly in deep sites associated with freshwater springs, rich floating vegetation and large numbers of amphibians, crustaceans and insect larvae. In these sites the water quality characteristics were fairly consistent, with pH averaging 7.2, temperature between 17-19º C and dissolved oxygen higher than 8 mg/l. Water was very clear with virtually no suspended sediments. Flow was medium and mostly laminar in the specific biotopes for the targeted species. Substrates were a mixture of rocks, cobbles, sand, gravel and silt in varying percentages.



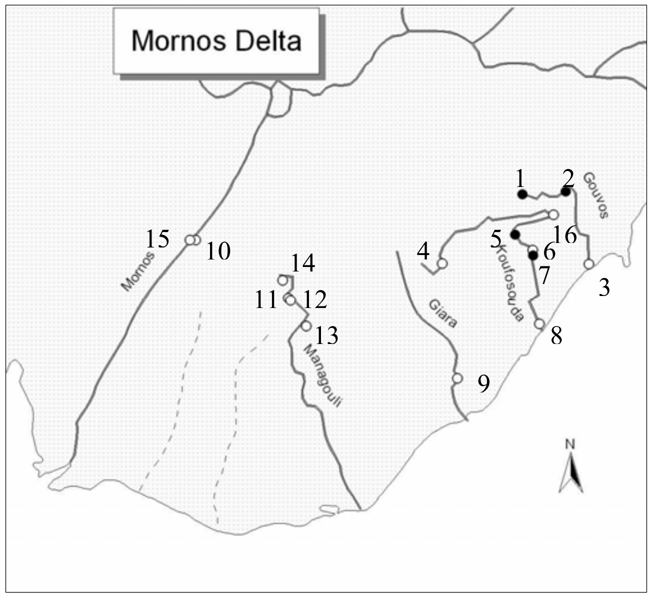


Fig. 1: Sampling stations in the Mornos Delta (o) and localities where Valencia letourneuxi was recorded (•).

Table 1
Records of occurrence of V. letourneuxi in the Mornos Delta.

Water system	*Recorded presence*	*Site N^o*	Sampling Station	*Present in 2005 survey*
Gouvos Stream	Present	1	Chiliadou Springs	Y
		2	Ananti Limnis	Y
		3	Gouvos outlet	N
Koufosouda Stream	No data	4	Koufosouda Springs	N
		5	Bridge Elafia	Y
		16	Irrigation channel	N
		6	Apothiki Sikias	N
		7	Apothiki Elafia	Y
		8	Koufosouda outlet	N
Giara Stream	No data	9	Marathiades	N
Managouli Stream	No data	11	Road bridge	N
		12	Sluice	N
		13	Iron Bridge	N
		14	Springs	N
Mornos	No data	15	Avlaka Mornou	N
		10	River Bed springs	N

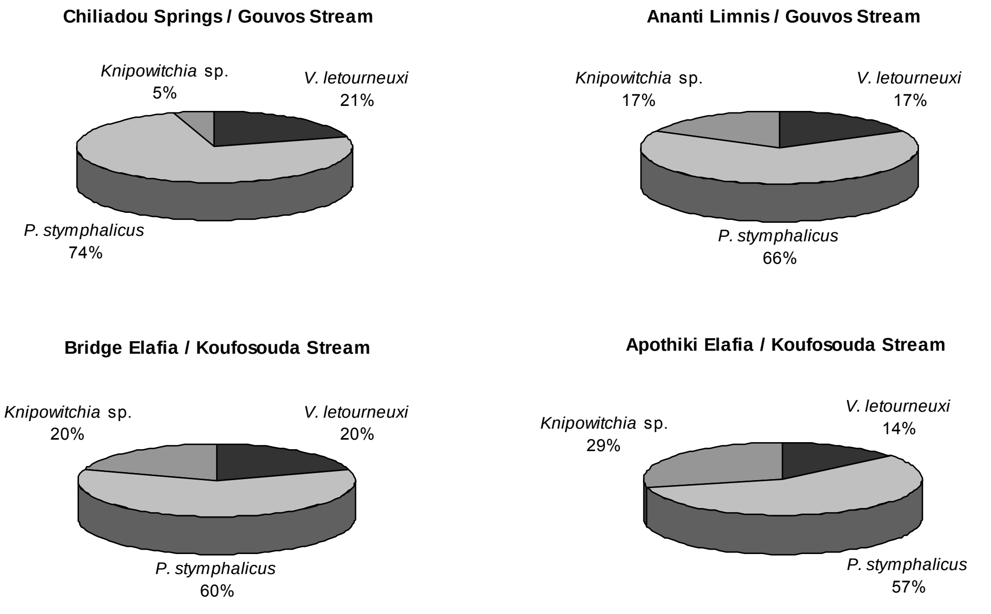


Fig. 2: Percentage (%N) of the V. letourneuxi and its sympatric species in the sampling sites where the species occurred.

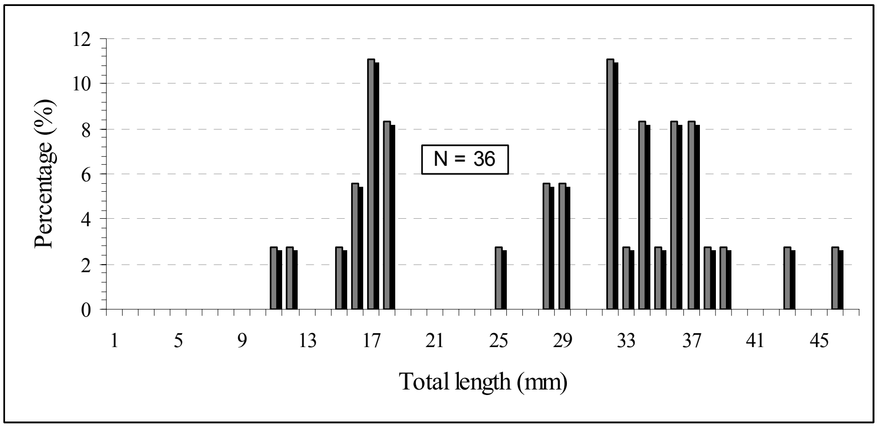
Species associations in the sampling sites were also fairly consistent. The Greek endemic minnow, *Pseudophoxinus stymphalicus* and the goby *Knipowitschia* sp. were usually present in the same habitat *as V. letourneuxi*. Characteristic however was the absence of *Gambusia affinis*, an introduced fish species, present in most systems of Western Greece and regarded as antagonistic to *V. letourneuxi*. Figure 2 summarises the percentage (%N) of the *V. letourneuxi* and its sympatric species in the four sampling sites where the species occurred. In all sites, *V. letourneuxi* was encountered at densities between 14% to 21%, which are among the highest recorded for this species in Greece.

The biological examination of the sample from the Chiliadou Springs, the only site with a sufficient number of individuals, shows three age classes (Fig.3). One age class (11-20 mm TL) represents the new generation of larvae and early juveniles, and two age classes, 25-40 mm and 43-47 mm respectively, represent the adult population. The largest fish sampled was 47 mm TL.

DISCUSSION

Based on our present data, *V. letourneuxi* seems to prefer springs and nearby channels with rich aquatic and floating vegetation, mostly *Lemna* sp., low flow and rich insect fauna, indicating a narrow habitat specificity (Das, 1985, Barbieri *et al.* 2000). The presence of aquatic vegetation and insect fauna, seem to be basic habitat requirements and a restrictive factor in its distribution, since the species deposits its eggs on aquatic plants and feeds on aquatic insects and their larvae. All the above possibly account for both its restricted distribution in the Delta, as well as its low local densities, as reported for other systems too of Western Greece (Das, 1985; Bianco & Miller, 1989).

Fig. 3: Length-frequency distribution of V. letourneuxi in the Chiliadou springs.



The species was usually associated with the widely distributed *Pseudophoxinus stymphalicus* as well as the endemic goby *Knipowitschia* sp. An interesting finding of this study was the absence in the Mornos Delta of the introduced fish species *Gambusia affinis* in all sites sampled. The absence or the low densities of *V. letourneuxi* in other water systems of Western Greece was often attributed, at least partly, to *Gambusia* antagonism. Other factors, however, that probably affect more the population status of *V. letourneuxi* are of anthropogenic origin, such as water abstraction and diversion, agricultural pollution and vegetation clearing evident also in the Mornos Delta.

Our data show that the Chiliadou springs in Mornos Delta supports a rather abundant *V. letourneuxi* population, free from the possible *Gambusia* antagonism, and thus this site is a prime candidate for the application of future localised conservation plans. Furthermore, a comparison of our data from Chiliadou Springs with those reported in Barbieri *et al.* 2000, indicate a relative population decline (from 56,8 % of %N of *V. letourneuxi* in May 97-July 99 to 21% in June 2005 in the current study), a fact that makes even more urgent the need for conservation measures.

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taxa of Cyprus, all new additions, and 17 animal species of Cyprus, out of which 6 are new additions to Annex II. Moreover, a total of 109 bird species occurring in Cyprus are included in Annex I of the Birds Directive, six of which are new additions proposed by Cyprus. To this date, Cyprus has proposed 31 Sites to be included in the NATURA 2000 Network as SCIs and seven sites as SPAs, covering 12.8% of Cyprus' territory. These sites will be managed according to special management plans. Five such plans are being carried out through a LIFE Nature Project. Eight additional plans are under way, within the framework of a relevant call announced recently by the Environment Service of Cyprus. The implementation of the NATURA 2000 Network in Cyprus is monitored by a Scientific Committee, which operates under the Law for the Protection of Nature and Wildlife.

519. TALL WHEATGRASS FIELD AS SOURCE HABITAT OR ECOLOGICAL CORRIDOR?

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The development and use of biomass resources for bioenergy has become critical priority in Europe. Energygrass plantations change the character of agricultural lands; „green islands" of extensive, high-cover monocultures with little disturbance (one crop annually) are created. Two hypotheses were analysed: vast fields meant primarily resource-habitats for small mammals, increasing their populations by autumn, which in turn results higher density. Edge-effect at the boundaries of neighbouring habitats influences the structure of small mammal communities in the tall wheatgrass plantation and also migration between patches. In 2005 capture-recapture surveys were done in tall wheatgrass fields in South-Hungary. Small mammals were monitored in plot P7 (60 ha) using two sampling grids (242 traps), yielding a total of 9 small mammal and 1 carnivore species in four months. The distribution of character populations (M. arvalis, A. agrarius, A. flavicollis) among neighbouring plots and the separating edges showed seasonal variation determined by the coverage of vegetation types and by resource dissimilarities. All these were significantly influenced by tall wheatgrass cutting and by harvesting activities and post-harvesting cultivation of the neighbouring land. The single cutting of energygrass in late August prevented the autumn density growth of small mammals and altered their spatial

520. POPULATION DECLINE OF THE ENDANGERED FISH SPECIES *VALENCIA LETOURNEUXI* IN WESTERN GREECE – STRATEGIES FOR CONSERVATION

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In order to assess the current population status of the endangered freshwater fish *Valencia letourneuxi*, an imperative for the formulation of any future conservation measures, an ichthyological survey was undertaken, with the two-fold objective to assess the species' presence in the aquatic systems of Western Greece and to inventory the current human impacts on these systems. This survey of a total of 98 sites showed that the species original geographical range has been restricted significantly, with the populations of the Ionian Islands and the Peloponnese being extinct or near extinction and those of Western central Greece and Ipeiros in a vulnerable state. Anthropogenic factors seem to contribute at various degrees to the degradation or loss of this species habitat in the different aquatic systems previously encountered, factors such as, in Corfu Island, the exhaustion of the water resources to cover urban water supply, or, in the Peloponnese riverine systems, the operation of dams.
Given the increasing exploitation of water resources for industrial, agricultural and touristic development, the most suitable strategy for the conservation of this species, which exhibits narrow habitat specificity and local rarity, seems to be the initiation of small scale habitat protection plans for the surviving populations.

521. REGIONAL CLIMATIC AND AGRONOMIC CONDITIONS DETERMINE THE SUCCESS OF AN AGRI-ENVIRONMENTAL SCHEME. RESULTS FROM THE SWISS ALPS.

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The persistence of multifunctional services of agricultural landscapes relies largely upon biological diversity. Agri-environmental schemes (AES) achieve the protection of farmland biodiversity with different degrees of success. Does the success of an (AES) depend on climate and regional agronomic conditions? We grouped 12 Alpine municipalities according to altitude and main economic characteristics and mapped plants on randomly selected conventionally managed meadows (CM) and meadows of the AES (EM) (n=216). We compared species richness of CM and EM and quantified the impact of management type and site conditions on species composition. Species richness of EM was higher than of CM in all municipality groups. Variance in species composition was well explained only in municipality groups with important farming. The success of the AES must also be seen beyond species conservation, depending on municipality settings we found: (i) At lower altitudes with important farming the AES preserves species rich and botanical complimentary sites. (ii) At higher altitudes with important farming, AES-payments allow a continuation of traditional low-input farm-ing. Anticipated undesirable polarization of land-use intensity is being prevented. (iii) At higher altitudes with tourism as an important economic activity, payments might be protecting the attractive landscape scenery.

522. CORRELATIONS BETWEEN GREY WOLF (CANIS LUPUS) POPULATIONS IN NEIGHBOURING RANGING AREAS IN SOUTHEASTERN SLOVAKIA AND NORTHEASTERN HUNGARY

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After the general extermination of wolf (Canis lupus Linnaeus, 1758) in Europe in the 20th century only its sporadic occurences could be heard in Hungary. Nowadays the species has been recolonising naturally in this country. Due to protective actions populations of the wolf became stronger and began to expand south. Wolf populations in Southeastern Slovakia are potential source for re-colonisation of Northeastern parts of Hungary. During our research taking hunting statistics, the quantitative and qualitative analysis of big games' populations as a basis. We tried to find answers to that when the recolonisation started, what kind of factors had an effect on it, how strong the correlation with the Slovakian populations. On the basis of our results the presentation gives an overview about changes in habitat use, effects of hunting season, wolf population dynamics (wolf density, ungulate density) predator-prey interactions in Southeastern Slovakia. Researching its relationship with the Hungarian wolf population and prey viability. We also studied whether the observed individuals have already settled down or only migrating ones. If these fascinating animals have settled ultimately down in this region, it would undoubtedly increase the rich biodiversity of Hungary and widen its ecological palette.

POPULATION DECLINE OF *VALENCIA LETOURNEUXI* (SAUVAGE, 1880) IN WESTERN GREECE – STRATEGIES FOR CONSERVATION

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Valencia letourneuxi is a freshwater species, endemic to Western Greece and Southern Albania, restricted to lowland springs and spring-fed streams. The species status was upgraded to Critically Endangered in the 2006 IUCN Red Book for Threatened Species, due to habitat destruction, water abstraction and competition from introduced species. It is also listed by IUCN as one of the 24 most endangered species in Europe.

Methodology

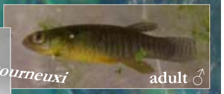
Sampling

Recording water quality parameters

... and habitat characteristics

A fragmented distribution

In a 2005 survey, 14 systems of Western Greece were surveyed for *V. letourneuxi* presence, including 95 sites in both known and suspected *V. letourneuxi* localities. The species was found in 21 lowland sites in 10 systems (blue dots indicate species presence, red dots species absence).

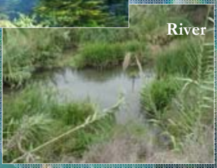


Lowland habitats with clear, slow flowing water and rich aquatic vegetation

Sympatric species

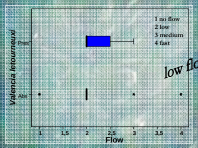
The commonest are the minnow *Pseudophoxinus stymphalicus* or *P. thesproticus*, the goby *Economidichthys pygmaeus* or *Knipowitschia* sp. and the introduced Mosquitofish *Gambusia affinis.*

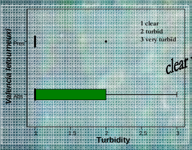
Habitat types

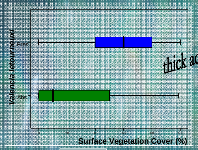


The species was found in *lowland* springs, canals, streams and small rivers.

Habitat specialisation

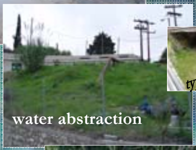






Gambusia competition

Habitat destruction



Urgent need for conservation

Low population densities

Population decline

A comparison with the species' original geographical range shows a severe restriction, with the insular populations of the Ionian (Corfu and Lefkas Islands) and those of the Peloponnese (rivers Alfios and Pinios) being extinct or at near extinction; other populations have also declined or are potentially in decline.

Conservation measures

- Small-scale habitat restoration
- Translocation
- Establishment of protected areas

species population strongholds

7. ANNEX II. Field Protocol

HCMR -Valencia Protocol Site No.____________

Site Name		**2.Date**	/ /2005

Water System	**MORNOS**	
5.Location (distance from bridges...). Points between start & end of site.		**WATER BODY TYPE** (spring, pool, marsh, stream, river,…) **SPRING**
GPS Coordinates		**Altitude**

Time		Start		Finish				
Hydrological regime	Permanent		Summer dry		Winter dry		Episodic	

SITE DIMENSIONS

WIDTH (m)	**19. DEPTH** (m)		**20. VISIBLE DEPTH / Turbidity**
			Estimated
	Mean	Max	

SUBSTRATE (%)

Rock Continuous		Silt	
Boulder 64-256 mm		Clay	
Pebble 16-63 mm		Organic	
Gravel 2-15 mm		Artificial	
Sand 0.06-1 mm		Cobble	

Water Surface SHADEDNESS

%:

22. VEGETATION

RIPARIAN		**AQUATIC**	
TYPE	**%**	**TYPE**	**%**
Area covered		**Area covered**	

FLOW		**% OF OPEN WATER**	**PHYSICOCHEMICAL MEASUREMENTS**	
Fast			Conductivity (mS/m)	
Medium			D.O.	
Low			PH	
No flow			Salinity	
			T^o of water (^{o}C)	

FISH DATA

VISUAL OBSERVATION

SCOOP NET (fish species)	**NUMBER (per scoop)**					
Valencia letourneuxi						

OTHER (i.e. electrofish, net,…) (fish species)	**NUMBERS**	**OTHER FAUNA**
Valencia letourneuxi		

FISH LENGTHS

SAMPLING EQUIPMENT, STRATEGY, ETC

i.e. type of equipment, sporadic scoops, accessibility problems, etc.

PRESSURES

NOTES

B

Sketch:

Upstream Downstream

|---------------|---------------|---------------|-------------|---------------|---------------|---------------|---------------|---------------|-
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