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Trophic characterization of the Prévost lagoon (Mediterranean Sea) by the feeding habits of the European eel *Anguilla anguilla*

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Abstract: This study deals with temporal variations in eel diet *Anguilla anguilla* sampled at each of the four seasons in the Languedocian Prévost lagoon (Gulf of Lion) from Autumn 1998 to Summer 1999. The following feeding indices were calculated based on observations of 12 categories of prey found in the contents of full stomachs: coefficient of vacuity CV, degree of fullness DR, occurrence frequency PP, relative abundance N (in %) and relative weight P (in %). The interpretation of results is also based on the Costello's method (1990) which combines PP and N. *Anguilla anguilla* mainly feeds on benthic organisms, primarily *Gammarus gr. locusta*, Polychaeta, insect larvae, small fish. Based on variations in eel diet, seasonal influence is illustrated by a decrease in feeding activity in summer which gradually increases during the following seasons. The good trophic quality available to eels in the Prévost lagoon depends on its hydrodynamics which is directly related to the movement of water entering and leaving lagoon by a short communication with the sea. This water movement accelerates the enrichment and production processes of this ecosystem. Changes observed during the four seasons illustrate an opportunistic type of feeding behaviour. Eels consume the most available benthic prey. They favour the importance of the prey at a given moment without using a particular feeding strategy like specialisation or generalisation. Thus, eel adapts its diet in adjusting available energy resources in the ecosystem. Because of this, the lagoon-resident species *Anguilla anguilla* is an obvious indirect bioindicator of the trophic capacity and present level of confinement in the brackish water lagoon ecosystem of Prévost.

Résumé: *Caractérisation trophique de la lagune du Prévost (Méditerranée) par l'étude du régime alimentaire de l'anguille européenne* Anguilla anguilla*.* Cette étude traite des variations temporelles du régime alimentaire des anguilles *Anguilla anguilla* vivant dans la lagune languedocienne du Prévost (Golfe du Lion), et échantillonnées aux quatre saisons de l'automne 1998 à l'été 1999. Les indices alimentaires suivants sont calculés à partir de l'observation de 12 catégories de proies dans les contenus d'estomacs remplis: coefficient de vacuité CV, degré de remplissage DR, pourcentages de présence PP, numérique N et pondéral P. L'interprétation des résultats est aussi fondée sur la méthode de Costello (1990) qui conjugue PP et N. *Anguilla anguilla* se nourrit principalement d'organismes benthiques, essentiellement des *Gammarus gr. locusta*, Polychètes, larves d'Insectes, petits poissons. D'après les variations du régime alimentaire de l'anguille, l'influence saisonnière se manifeste par une diminution de l'activité nutritionnelle en été qui s'inverse et augmente au fur et à mesure des saisons suivantes. La grande qualité trophique offerte aux anguilles par la lagune du Prévost dépend de son hydrody-

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namisme directement lié aux mouvements d'eau entrant et sortant par la courte communication avec la mer, ce qui accélère les processus d'enrichissement et de production de cet écosystème. Les variations saisonnières montrent un comportement nutritionnel de type opportuniste. Les anguilles consomment les proies benthiques les plus disponibles. Elles favorisent momentanément l'importance de la proie sans utiliser de stratégie alimentaire particulière de spécialiste ou de généraliste. Ainsi, l'anguille adapte son régime en l'ajustant aux ressources énergétiques disponibles dans le milieu. De ce fait, l'espèce laguno-résidante *Anguilla anguilla* a un caractère de bioindicateur indirect de la capacité trophique et du niveau de confinement présent dans l'écosystème lagunaire saumâtre du Prévost.

Keywords: Anguilla anguilla; Mediterranean; Lagoonal systems; Diet; Opportunism; Bioindicator

Introduction

Although the lagoons along the western French Mediterranean coast have the same origin regarding their formation (Guelorget & Perthuisot, 1983 & 1992), each has its own geomorphologic characteristics with regards to surface area, depth, inputs of fresh or marine water, catchment area and the nature of sediment. These have an influence on some environmental factors, such as salinity, temperature, water renewal which in turn depend on climatic conditions. Fluctuations in these factors during the various seasons bring about significant variability in biological populations present and consequently in fish populations (Bouchereau, 1994 & 1995; Zamora, 1999; Bouchereau et al., 1991 & 2000; Bouchereau & Chaves, 2003; Chaves & Bouchereau, 2004; Garnerot et al., 2004).

High primary production is one characteristic of lagoon environments. Because of this, numerous species of marine origin, especially fish, penetrate the lagoon either by passive migration when entrance takes place during their planktonic stage or actively as soon as swimming against the current is possible, to accomplish a vital part of their life cycle. In the Mediterranean area migration into lagoons is usually related to feeding (Quignard, 1984; Frisoni et al., 1984 & 1986) and development purposes rather than genesis (Joyeux et al., 1991a & 1992; Bouchereau et al., 1991; Bouchereau, 1994 & 1995; Bouchereau & Guelorget, 1999; Pampoulie et al., 1999a). However, sedentary species which can be considered as bio indicators of the environmental conditions can also be found (Tomasini et al., 1991; Bouchereau & Guelorguet., 1998; Pampoulie et al., 1999b).

Fish species representing the most commercially important and the most harvested by traditional fisheries in these lagoons are: the seabass *Dicentrarchus labrax* Linnaeus 1758, the sea bream *Sparus auratus* Linnaeus 1758, the sole *Solea vulgaris* Quensel 1806, the eel *Anguilla anguilla* Linnaeus 1758, the atherine or silverside *Atherina boyeri* Risso 1810 and the mullets *Liza sp*. and *Mugil cephalus* (Linnaeus, 1758). Amongst these, *A. anguilla* is the lagoon-resident occurring the most frequently in space and time in the Languedoc lagoons.

Temporal variations in the feeding regime of the eel were studied over a one-year period by means of feeding indices in order to obtain a better understanding of the trophic organization and level of productivity of the Prévost lagoon.

Material and Methods

The species

The Atlantic distribution of *Anguilla anguilla* spreads out from Morocco to Scandinavia (Bauchot & Pras, 1980). This catadromous migrating species is present in brackish and fresh coastal marine waters. Eels are essentially carnivorous, their principal prey being Crustacea, Mollusca, Annelida and Insect larvae (Lecomte-Finiger & Bruslé, 1983). In the Palavas lagoons, *A. anguilla* is traditionally the main exploited fish species (Lecomte-Finiger & Bruslé, 1983).

The study site

The Prévost lagoon (Fig. 1) is located in the Gulf of Lion and stretches out in a south west-north east direction parallel to the coast near Palavas-les-Flots, south of Montpellier City, and makes up a part of the Arnel-Prévost lagoon complex. It covers a surface area of about 4 km^2 and has a mean central depth of 0.75 m. The main fresh water input enters by the Rhône River-Sète Canal via a communication built in the middle length of the lagoon at the level of Pontils and by the small channel of Palavas in the west. The permanent communication called a "grau" is stabilised as a canal ensuring constant communication between the lagoon and the sea. Salinity varies between 16 and 37g.l^{-1} depending on rain fall and seasons. Sediments are mainly muddy with heavy sand deposits at the mouth of the "grau". These deposits can be directly linked to a drastic decrease in hydrodynamics and the very well calibrated marine sand sedimentation which results. Vegetal production consists of floating algae of the genus *Ulva* and *Enteromorpha* which occupy the entire water column in summer. The paralic

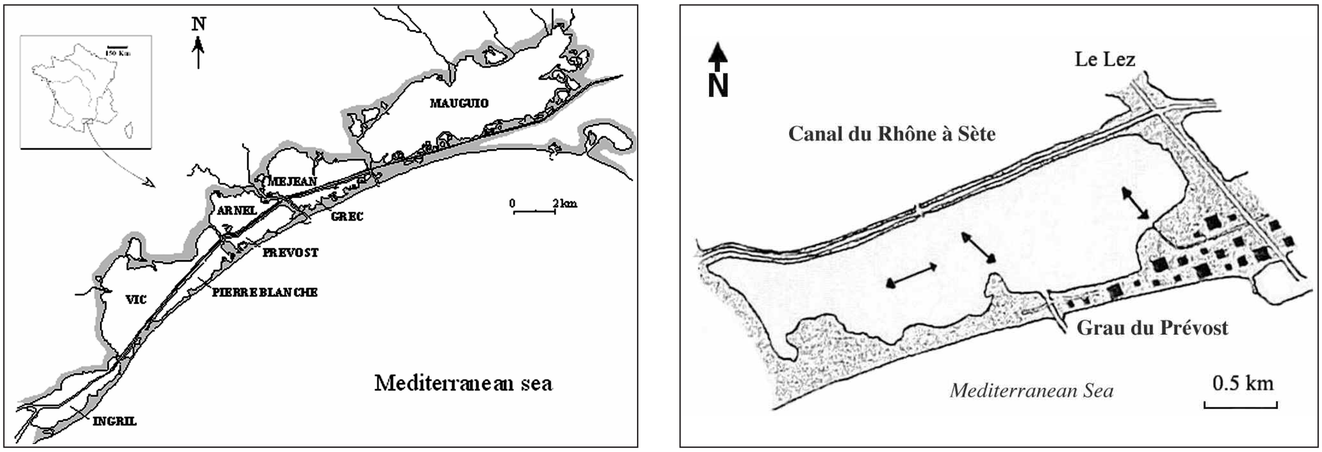

Figure 1. A. The Prévost lagoon, Languedoc (Golfe du Lion, France). **B.** Sampling sites.
Figure 1. A. Localisation de la lagune du Prévost, Languedoc (Golfe du Lion, France). **B.** Lieux d'échantillonnage.

fauna is essentially reduced to Gasteropoda genus *Hydrobia* (*ventrosa, ulvae…*) hosted by algae, and *Cerastoderma glaucum* (Poiret, 1789) and *Abra ovata* (Philippi, 1836).

Sampling

Seasonal sampling took place between the autumn of 1998 and the summer of 1999 and was spread out at a rate of five consecutive days per season. Fishing gear used for sampling consisted of passive fishing gear: the "capéchade" (Bouchereau et al., 1989). This system involves a "paradière", netting acting as a barrier and a tower or triangle towards which fish are directed and are thus trapped in the pot or fyke net". The "capéchades" are generally brought up between 8 and 9 h a.m. daily after 24 hours of fishing effort. It should be noted that certain specimens caught could have digested their feed during captivity in the net. Because of this, empty stomachs have not been taken into account in calculating indices.

Digestive tracts of 185 specimens were extracted and preserved in 10% formaldehyde in view of studying stomach contents (Bouchereau & Vergne, 1999).

Laboratory observations

The digestive tracts of each specimen were examined under a binocular microscope to identify and count prey ingested and present in stomach contents. The degree of taxonomic determination is a function of the time required for digestion of the bolus (Joyeux et al., 1991b). Categories of prey were defined up to the family and when it was possible up to species level (Tregouboff & Rose, 1978), then ranged into large taxonomic groups. Where prey had been badly preserved, the numbers of specimens present were defined by counting cephalic parts and bone pieces when fish were concerned.

Data processing

The feeding regime of *A. anguilla* was studied at each seasonal sampling by means of the five following indices described by Bouchereau & Guelorget (1999):

The coefficient of vacuity (CV): the percentage of empty stomachs (Nv) in relation to the total number of stomachs examined (Nt):

$$CV = 100.(Nv/Nt) \quad (1)$$

The degree of fullness of the digestive tube (DR): this represents the subjective evaluation of the degree of fullness of the digestive tube, consisting of three levels corresponding to $N_1 = 25\%$, $N_2 = 75\%$ and $N_3 = 100\%$ of total volume of the digestive tube:

$$DR_{(1, 2, 3)} = 100.(N_{(1,2,3)}/Nt) \quad (2)$$

$N_{(1, 2, 3)}$ represents the number of digestive tubes divided up according to the three levels of fullness and Nt represents the total number of digestive tubes analysed. Interpretation of this index depends on the evaluation made by the researcher at the moment of observation.

The percentage of presence (PP) of prey in stomach contents : the percentage of stomachs examined containing the category of prey i (Nti) in relation to the number of stomachs containing prey (Np)

$$PP = 100.(Nti/Np) \quad (3)$$

The numeric percentage (N): the percentage of prey counted in one category i (Ni) in relation to the total number of prey counted (Npt)

$$N = 100.(Ni/Npt) \quad (4)$$

The percentage in points (P): the percentage of prey ingested in the category i (Pi) in relation to the total number of points for all prey ingested:

$$P = 100.(Pi/\text{Total points}) \quad (5)$$

To calculate percentages in points (P), the numeric method of points (Hynes, 1950; Pillay, 1952) modified and

Table 1. Points attributed to prey items of *A. anguilla*, adapted from Joyeux et al. (1991b) and Pampoulie & Bouchereau (1996).

Tableau 1. Points attribués aux catégories de proie d'*A. anguilla,* adapté de Joyeux *et al.* (1991b) et de Pampoulie & Bouchereau (1996).

Categories of preys	Points	Categories of preys	Points
Fish	100.0	*Gammarus gr. locusta*	10.0
Polycheta	40.0	*Corophium insidiosum*	5.0
Decapoda	25.0	Insects	5.0
Crustacea	15.0	Molluscs	1.0
Isopoda	10.0	Scales	1.0
Amphipoda	10.0	Copepoda	0.5

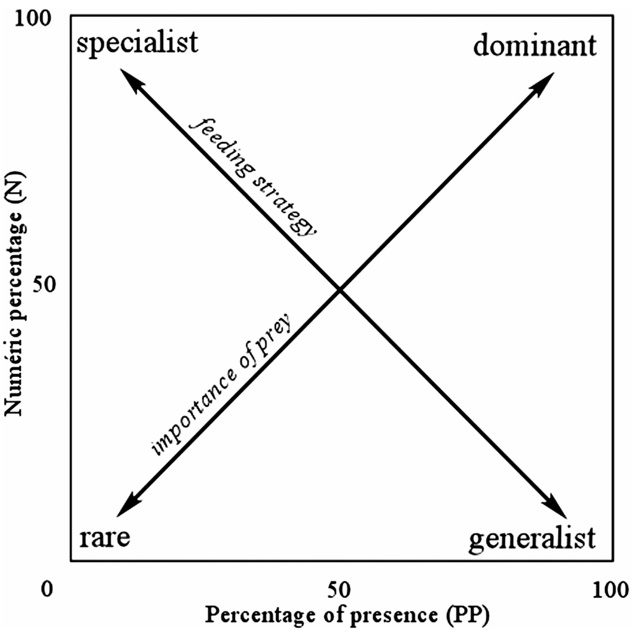

Figure 2. Diagram explaining the Costello's method (1990) according to the feeding strategy: specialist or generalist and the importance of prey: dominant or rare (Amundsen et al., 1996) with the percentage of presence (PP) and the numerical percentage (N).

Figure 2. Diagramme explicatif de la méthode de Costello (1990) selon la stratégie alimentaire de spécialiste ou généraliste, et l'importance de la proie dominante ou rare (Amundsen et al., 1996) avec les pourcentages de présence (PP) et numérique (N).

adapted by Joyeux et al. (1991b) and Pampoulie & Bouchereau (1996) (Table 1) was used. This method assigns a certain number of points as a function of the state of satiety of the predator's stomach and of the mass of prey observed during digestion. In this approach, to each zoological group is given a certain number of points in proportion to the average size (mass) of these animals as if they had not been ingested. This method enables a better evaluation to be made of feed intake based on digested remains. The number of points assigned in this case therefore, reflects the level of satiety at the moment when prey was swallowed (Bouchereau & Guelorget, 1999).

The indices PP, N and P were calculated by season and by category of prey. Indices PP and N illustrate the presence or absence of a given prey and its numeric importance during the season.

Seasonal evolution was tested by the Spearman unilateral non-parametric statistical correlation test (r_s). This test is the most appropriate considering the various characteristics of samples. Values are expressed in percentages and variables do not follow Normal laws. This test is applied to the three indices PP, N and P in order to study possible qualitative and quantitative changes in feeding regime of *Anguilla anguilla.*

Values r_s were compared with critical values for probability levels P = 0.05 and 0.01 (Tomasson, 1995). The null hypothesis Ho : Series 1 = Series 2 is considered; if the calculated value is > to the critical value ($P < 0.05$ or 0.01), Ho can not be accepted and the two series of data are considered to be different.

To facilitate the interpretation of results, the method of Costello et al. (1990) has been used. This graphically combines the percentage of presence (PP) with the numeric or abundance percentage (N) of each prey (Fig. 2).

Costello et al. (1990) suggested that the two diagonals represent respectively the importance of prey (dominant, rare) and the predator's feeding strategy (specialist, generalist). The points close to 100% presence and 100% abundance represent dominant prey. Points which are situated at

Table 2. Relative distribution of the different prey items observed in the stomach contents of *A. anguilla* in the Prévost lagoon.

Tableau 2. Répartition relative des différentes catégories de proies observées dans les contenus stomacaux de *A. anguilla* dans la lagune du Prévost.

0.1 to 1.0%	1.01 to 3.00%	6.01 to 12.00%	12.01 to 24.00%	24.01 to 48.00%
Molluscs, Bivalves and Gasteropoda, Other Crustacea Amphipoda Thalassinidae *Corophium insidiosum* Copepoda and Isopoda Decapoda Crangonidae, Palaemonidae and Portunidae, Insects Diptera cténoïd Scales	Others annelids Polycheta others Crustacea, Fish	Annelids Polycheta Nereide	Chironomidea cycloïd scales	Crustacea Amphipoda *Gammarus gr locusta*

around 100% presence and 1% abundance indicate that predators have a specialized feeding regime.

Results

From September 1998 to August 1999, 185 eels (23 ≤ LT (cm) ≤ 87) were harvested during the year. Extreme seasonal abundance values were observed in winter for the minimum (13) and in spring for the maximum (114) whereas (31) and (27) were respectively present in the samples of autumn and summer.

General feeding spectrum

Anguilla anguilla has a very generalist feeding regime as 12 different categories of prey were counted (Table 2) and were distributed principally between Crustacea, Amphipoda, Fish, Chironoma larvae of Insects, Annelida, Polycheta. This number gradually increased from autumn (4) to winter (6) then reaches a maximum in spring (10) to decrease in summer (6).

Coefficient of vacuity CV

Out of 185 eels harvested, 58 were observed to have empty stomachs and 127 had full stomachs, i.e. a CV of 31.4%. (Fig. 3). This was at a minimum (0.0%) in winter and maximum (51.9%) in summer.

Degree of fullness DR

In winter and spring (Fig. 3) stomachs were the best filled (15 ≤ DR3 ≤ 24; 38 ≤ DR2 ≤ 42). In summer and autumn, DR1 varied between 61% and 81%, and no stomach was completely full at that time.

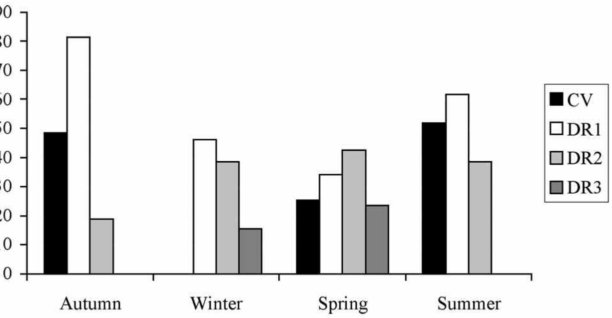

Figure 3. Seasonal variation of the A. anguilla vacuity index CV and stomachs filling index DR1, DR2 and DR3 (in %) in the Prévost lagoon.

Figure 3. Variation saisonnière du coefficient de vacuité CV et du degré de remplissage DR1, DR2 et DR3 (en %) des estomacs d'*A. anguilla* dans la lagune du Prévost.

Temporal variations in feeding indices PP, N and P

Based on the frequency of presence PP in autumn and with a prey diversity of 4, the *Gammarus gr. locusta* and Insects larvae were the most often observed in the stomachs (Table 3) with a percentage of presence PP between 24 and 48%. In winter Insects occurred in important quantities (Table 3). Polycheta and *Gammarus gr. locusta* were also present with a frequency of 52% for a prey diversity reaching 6. Wide diversity of prey (10) was found (Table 3) in spring. The species consumed were Polycheta, *Gammarus gr. locusta* and Insects with a frequency varying respectively between 7.7 and 9.4%, 9.1 and 56.3%, 9.1 and 31.7%. During this season, the most represented preys in stomach contents were *Gammarus gr. locusta* (41.4%) and Insects (31.%),

Table 3. Seasonal variation of *A. anguilla* diet index in the Prévost lagoon; PP: Occurrence frequency in %; N: numerical frequency in %; P: Points Frequency in % of prey items.

Tableau 3. Variations saisonnières des indices alimentaires de *A. anguilla* dans la lagune du Prévost; PP: Pourcentage de présence; N: Pourcentage numérique; P: Pourcentage en points P, des diverses catégories de proies.

Categories	Occurrence **PP**				Numeric **N**				Points **P**			
of preys	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum
Polycheta	-	8.00	7.69	5.26	-	13.73	2.21	2.50	-	13.11	8.90	11.40
Molluscs	-	-	0.96	5.26	-	-	0.18	1.25	-	-	0.02	0.14
Copepoda	-	-	0.96	-	-	-	0.18	-	-	-	0.01	-
Crustacea	-	-	4.81	-	-	-	2.21	-	-	-	3.34	-
Isopoda	-	-	1.92	5.26	-	-	0.55	3.75	-	-	0.56	1.14
Amphipoda	4.00	4.00	1.92	5.26	1.33	1.96	0.37	2.50	5.26	1.64	0.74	2.87
Gammarus gr. l	48.00	52.00	41.35	26.32	62.67	58.82	73.99	56.25	63.16	49.18	74.38	64.66
Corophium ins.	4.00	-	-	-	1.33	-	-	-	2.63	-	-	-
Decapoda	-	12.00	5.77	-	-	5.88	1.11	-	-	12.30	2.78	-
Chironomidae	44.00	2-	31.73	52.63	34.67	17.65	18.27	33.75	28.95	7.38	9.18	19.40
Fish	-	4.00	-	-	-	-	1.96	-	-	16.39	-	-
Scales	-	-	2.88	-	-	-	0.18	-	-	-	0.01	-

others were Crustaceans and Polycheta. In summer, from six prey categories, the most consumed were mainly Insects (52.6 %) and *Gammarus gr. locusta* (26.3 %). Other Amphipoda, Isopoda Polycheta and Molluscs represented 5.3%.

When considering the numerical percentage N whatever the season, *Gammarus gr. locusta* were the most captured prey (56.3% < N < 67.2%) by eels living in the Prévost lagoon (Table 3), followed by Insects (17.7% < N < 34.7%). In winter, Polycheta represented an important item (13.7%). Except in autumn, this prey was captured all the year long.

Whatever the season, *Gammarus gr. locusta* represented (Table 3) clearly the principal prey making up the bolus in biomass ingested by the eels expressed as a percentage in points P (49% < P < 74%), followed by Insects (9.2% < P < 29%) making up a non negligible complement in autumn, or the Polycheta in winter (P = 13.1%).

Discussion

The feeding regime of *Anguilla anguilla* residing in the Prévost lagoon was based essentially on benthic organisms grouping together 12 important categories of different classified prey. These consisted essentially of Amphipoda Crustacea, Chironoma larvae and Polycheta Annelida. This spectrum confirmed, for the essential, that observed by Lecomte-Finiger (1983) and enabled *A. anguilla* to be given the status of a second order carnivorous species. Schneider et al. (1987) also described very similar feeding spectrums. Scales were only observed in spring and did not make up a complement in the diet of the eel living in this lagoon. However, Echinodermata were not observed in the stomachs of *A. anguilla* as they occur very infrequently in this type of lagoon which is very confined in the sense according to Guelorget & Perthuisot (1983 & 1992). The presence of urchins is limited to the mouth of estuaries and in zones under permanent marine influence. *A. anguilla* is more active in the warm season than in the cold season. Its capturability by passive fishing gear is higher in spring-summer.

The evolution of the coefficient of vacuity in the stomachs of *Anguilla anguilla* in function of the seasons revealed either a variation in feed uptake or in feeding choice. In the Prévost lagoon, in spite of an opposite abundance in catches with the passive fishing gear in winter and spring seasons, the good stomach feed uptake is the same, when it was weak in summer and spring (Fig. 3). The eel's condition improved between the winter-spring period and the summer-autumn period. The eels may feed less often.

In the Prévost lagoon, maximal diversity was observed for preys in spring (10 items). Preys which were apparent were Isopoda, Copepoda and other Crustacea, Molluscs and Fish scales. This enlarging of the feeding spectrum could be related to the warming up of water which in turn influences the reproductive cycle of these species: increase in temperature accelerates the larval development phase leading to the apparition of these species in the environment (Duperchy, 1998). Reduction in the diversity of prey which was observed in autumn and winter was followed by an increase in the number of available prey consumed.

In autumn, high vacuity (CV > 50%) (Fig. 3) and low stomach fullness rates (DR1 > 60%) showed a clear reduction in feeding activity of eels in the Prévost lagoon. This was more probably due to feeding sufficiency during this season than to any particular difficulty. With a feeding spectrum reduced to a minimum (Table 3; Fig. 4), *Gammarus gr. locusta* and Chironomidae occurred the most frequently and were the most consumed preys.

In winter, the Prévost eel has a specialized feeding strategy based on *Gammarus gr. locusta* and *Chironomidae*. *Chironomidae* and *Gammarus gr. locusta* were the most dominant prey items in stomach contents (Table 3; Fig. 4) perhaps due to their abundance in the lagoon during this season. Environmental changes in the lagoon due to climate during this season could cause differences in trophic availability to be studied. To compensate for this, the eel enlarges its feeding spectrum to include Fish, Polychaeta and Decapoda; since we observed that eels fed well in winter and spring and moved as much as during the other seasons. The eel targets more specifically species which are present and mainly benthic such as Crabs (*Carcinus mediterraneus*) (Czerniavsky, 1884), or crypto benthic species such as Annelida or Gobiidae such as *Pomatoschistus*, which are very abundant in the Mediterranean and east Corsica lagoons and consumed by eels (Casabianca & Kiener, 1969).

In spring feeding indices (Table 3; Fig. 4) of *Gammarus gr. locusta* were all high and clearly illustrated the fundamental role played by this prey in the eel's diet. It can not be ascertained that scales observed were the remains of fish digestion or scales taken from fish, and in which case would concern lepidophagous fish (Blaber, 2000). Scales and fish were observed in both spring and summer. In this season however *Mugil cephalus* are recruited in the lagoon as well as *Sparus auratus* and *Dicentrarchus labrax*. Numerous estuarine fish are known to remove scales for feeding purposes such as *Arius felis* (Linnaeus, 1766) in the Gulf of Mexico which feeds (Hoese, 1966) on the scales of *Mugil cephalus*.

In summer a slight decrease in the occurrence of *Gammarus gr. locusta* became apparent corresponding to an increase in the presence of Insects. This opposition of *Gammarus gr. locusta/Chironomidae* suggested that Amphipoda were the most widely available prey year long and certainly the favorite prey of *A. anguilla*. High vacuity values of stomachs, 51,9%, and the degree of fullness,

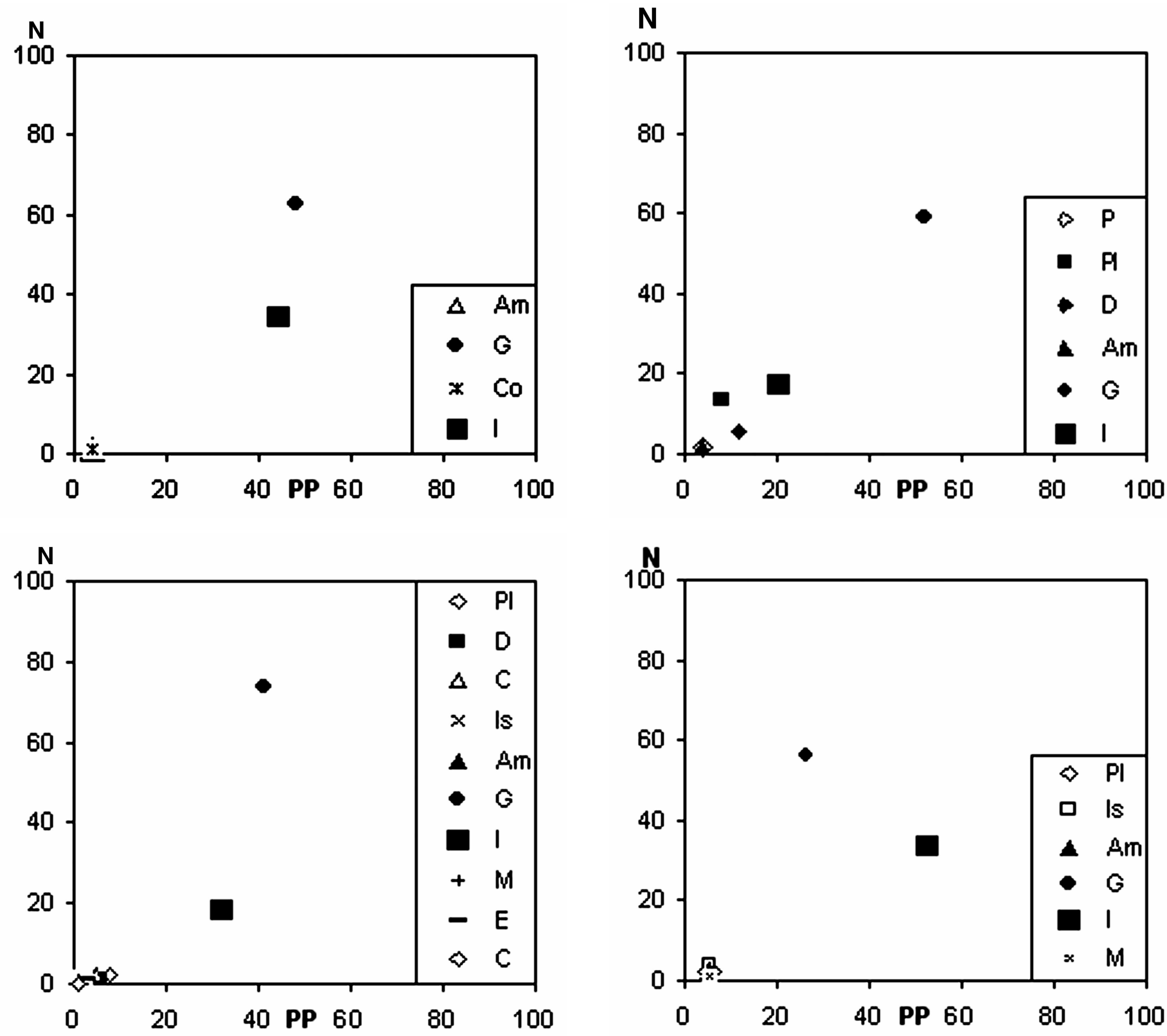

Figure 4. Relationship, according to Costello (1990), between the Numerical Index N, Occurrence Index PP of prey items of *A. anguilla* diet in the Prévost lagoon during the 1998/99 seasons: **A**: Autumn; **B**: Winter, **C**: Spring; **D**: Summer.

Am: Amphipods; C: Crustacean; Co: *Corophium insidiosum*; D: Decapods; E: Scales; G: *Gammarus gr. locusta*; I or In: Insects (Chironomidae); Is: Isopods; M: Molluscs; P: Fishes; Pl: Polychetes.

Figure 4. Relations, selon Costello (1990), entre indices numérique N et de présence PP des catégories de proie du régime alimentaire de *A. anguilla* dans la lagune du Prévost aux quatre saisons 1998/99: **A**: automne; **B**: hiver, **C**: printemps; **D**: été.

Am: Amphipodes; C: Crustacés; Co: *Corophium insidiosum*; D: Décapodes; E: Écailles; G: *Gammarus gr. locusta*; I ou In: Insectes (*Chironomidae*); Is: Isopodes; M: Mollusques; P: Poissons; Pl: Polychètes.

61.5%, showed that decreased availability of *Gammarus gr. locusta* was compensated for by a new category of prey being consumed i.e. Insects (Table 3; Fig. 4). Quantitatively, *Gammarus gr. locusta* remained the major prey item with slightly more Insect larvae, a consequence of increased availability of this prey in summer and autumn. Altered environmental conditions linked to variations in climatic conditions (Quignard, 1984) can generate situations more favourable for their development. Based on conditions previously described, it can be concluded that in autumn and in spite of a different feeding regime, eels feed less whilst reducing their feeding spectrum, to a certain extent, than in spring.

Dominant prey in this lagoon does not vary during the year (Fig. 4). The Prévost lagoon appeared to be stable and homogeneous with regards to its biological organization and functioning, providing the eel with regular supplies of its principal food consisting of Amphipoda *Gammarus gr. locusta* coupled with *Chironomidae* larvae. Furthermore, according to Costello's diagrams (Fig. 4), the status of *A. anguilla* is that of a species with a less generalist than specialised feeding strategy focusing exclusively on dominant prey with a diet based on *Gammarus* species and mosquito larvae. In this ecosystem which provides a constant opportunity for qualitative and quantitative food supplies, *A. Anguilla* does not employ any alternative other than targeting *Gammarus gr. locusta* and *Chironomidae* larvae. Other categories recorded, apart from Annelidae, can be considered as occasional in its feeding spectrum. The eel's fidelity to the same type of prey throughout the year can be related to a certain homogeneity of the lagoon's trophic qualities and its ability to produce resources in synergy with its hydrodynamics (confinement) and the life cycle of micro and macro benthic species and small lagoon-sedentary fish which are present.

In the Prévost lagoon, *A. anguilla*'s food is not fundamentally different from that of *A. anguilla* found in the Roussillon lagoons situated further west. Its feeding regime is carnivorous and based on benthic prey (*Gammarus gr. locusta*, insect larvae, polycheta, other crustaceans and small fish). Changes observed during the four seasons demonstrate opportunistic type feeding behaviour already observed by Lecomte-Finiger (1983) in elver and young eels in the Roussillon. Eels consume the benthic prey which is the most available preferring temporarily the abundance of prey without any specific feeding strategy focusing on specialisation or generalisation. Behaviour such as this demonstrates the eel's high adaptability to the Prévost biotope. There is no selection of prey in the Prévost lagoon as the prey the most often consumed is equally accessible whatever the season. If seasonal influence in the Prévost lagoon exhibited a feeding spectrum going from reduced in autumn to enlarged in spring with decreased feeding activity in autumn, it is only due to phenomena specific to the species and not to the ecosystem where biological organization is managed principally by hydrodynamics of marine origin linked to tide rhymes, even if they are weak in the Mediterranean domain, and to winds.

The entire central part of the Prévost lagoon (Fig. 1B) to the right of the pass is permanently under the influence of sea water, placing the whole of the median region of the lake in zones II and III of the confinement scale established by Guelorget & Perthuisot, (1983 & 1992). The western and eastern parts on each side of this central corridor with low confinement are situated in zones IV and V and characterized by marked confinement (Bouchereau et al., 2000). The biodiversity of benthic or necto-benthic macrofauna which is the base of *A. anguilla*'s food, decreases with increasing confinement. Thus the most confined zones (IV and V) are colonized by a very small number of strictly paralic species (particularly, *Nereis diversicolor* O.F. Müller, 1776, *Cerastoderma glaucum* Poiret, 1789 and *Abra ovata* Philippi, 1836, and *Chironomidae* larvae). On the other hand, in zones with low level confinement, the ecosystem maintains so called "mixed" species as they can subsist in both sea and paralic environmental conditions. In these zones of moderate confinement, there is a much wider range of diversity in populations and these are dominated by filtering Molluscs. The species whom genus are always present in the Prévost lagoon, contrary to other shallow hypertrophic lagoons like *Chironomus plumosus* Linnaeus, 1758 and *Gammarus tigrinus* Sexton, 1939 are not overexploited like were eels and bream compete to the growth eels detriment (de Nie, 1987 & 1988). If the coastal system as a whole is considered these little confined zones sustain the largest biomass and are certainly the most productive in the biosphere. Trophic resources in this basin do not appear to vary significantly and biological organization remains very stable in time. Trophic resources of the Prévost lagoon for *A. anguilla* appear to be constantly rich all year long. This lagoon ecosystem appears to be one of the most stable amongst all those present along the French coast of the Gulf of Lion and the least influenced by environmental and human pressure. The Prévost lake is little influenced by inputs from the catchment area and its functioning is essentially managed by the regular penetration of sea water transiting via a stabilized pass. In addition there is no aquaculture in the lagoon which could cause the environment to become enriched in organic matter and biological organization and functioning to be perturbed in the more or less long term (cf. the Thau lake which maintains over 2900 intensive shellfish farm platforms).

This study confirms the capacity of *Anguilla anguilla* to adapt and demonstrates its character as a bioindicatory species in lagoon ecosystems.

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