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ON THE FOOD OF THE POUTING (*TRISOPTERUS LUSCUS* L.) IN THE NORTH COAST OF PORTUGAL

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INTRODUCTION

The knowledge of the food and feeding habitats of a fish species is important to understand it's role in the food chain and, consequently, the relationships with other species.

The study of the diet based on the analysis of stomach contents is a routine fish ecology proceeding.

Some simple studies on the feeding of the pouting (*Trisopterus luscus* L.) show that this gadoid is a strong predator since it's larval form (Last, 1978) and that adults choose mainly Crustacea (Chevey, 1930; Oliver, 1949). Quantitative studies in different zones confirm these trends and show some variation in the diet with age (size or wheight) of fish and with the time of the year (Armstrong, 1979; Labarta, 1976).

As a real contribution to the knowledge of the feeding habits and preferences of *T. luscus* in the North Coast of Portugal, we pay attention to the food of the pouting in this region. This attention is especially concerned to the relative importance in individual number and dry wheight of the different prey groups, considering all fishes or dividing them in several size groups.

MATERIALS AND METHODS

During 1986, we examined 17 samples of *T. luscus* (908 individuals) from commercial trawling vessels operating in the North coast of Portugal. The fish was collected at the arrival of the boats and processed in the day of sampling. When this was not possible, the fish was freezed at once and processed not more than two weeks later. We took total length (cm) and weight (g) of all fishes. The aspect of fullness of the stomach was assessed and the ones with abundant and solid content were collected and stored in flasks with buffered 5 % formalin wich also was injected in all 368 stomachs collected. In 48 hours, the gastric content was observed under a binocular stereoscopic microscope. The food items were identified (to the lowest taxonomical group possible), counted and joined in major taxonomic groups to determine dry wheight (48 h at 105°C).

The variation of the diet with size of the prey was tested by dividing all fish in 3 lenght groups, supposed corresponding to age: «A» group (age 0 and I) < 19 cm, «B» group (age II and III) 19 to 27 cm, and «C» group (following age groups) > 27 cm, according to our interpretation of data from several authors as CHEVEY (1929), BENVEGNU (1971), SOBRAL (1983), LABARTA Y FERREIRO (1982).

The feeding overlap of this 3 length groups was assessed by Kulczinski's similarity index (0-100), modified by Shorigin (LABARTA, 1976): Fc = inf (Rip, Riq).

It was calculated too:

- frequency of prey group i — f = ni/e
- abundance per stomach of prey group i — Nm = ni/ei
- relative abundance of prey group i (to N) — Ri = 100 ni/N
- frequency of ocurrence — P = 100 ei/e
- stomach vacuity coefficient — V = 100 ev/E

with:

N = total number of prey items
ni = number of prey items from taxonomic group i
e = number of stomachs analysed for each size group
ei = number of stomachs containing taxonomic group i
ev = number of empty stomachs
E = total number of observed fish

(LABARTA, 1976; HYNES, 1950; HYSLOP, 1980).

RESULTS

1 — *Vacuity coefficient along the year*

From the 908 observed individuals, 149 had empty stomachs. The annual variation of the vacuity coefficient (see table 1) shows little changes, with a maximum of 24.6 %, a minimum of 7 % and a mean value of 16.2 +/− 5.7 %.

2 — *The food in numbers*

Taking all the individuals which stomachs were analysed and considering relative abundance of broad taxonomic groups of prey items (see table 1 and fig. 1), we found that Crustacea is the most important one (73.3 %) in the food of the pouting. Fish is the second major group (16.4 %) followed by Annelida (5.4 %), Mollusca (3.1 %) and Echinodermata (1.7 %). Considering frequency of occurrence (see table 2), the most frequent groups are Crustacea (84.5 %) and Teleostei (45.1 %), followed by Annelida (23.4 %), Mollusca (12.5 %) and Echinodermata (7.6 %).

Detailing (see table 2), the prey items whith more importance in Crustacea (with higher values of f, Ri and P) are Carididae, Brachyura, Galateidae and Amphipoda. In Mollusca,

TABLE 1 — *Trisopterus luscus* diet variation (in number of preys and in mg dry weight) in 1986. AN — Annelids; EQ — Echinodermata; MO — Molluscs; CR — Crustacea; TE — Teleosts. E — Total fish observed; e — collected stomachs; ev — empty stomachs; V — vacuity coefficient

Samples (1986)	E	e	ev	V	NMUBERS AN	EC	MO	CR	TE	DRY WEIGHT (mg) AN	EC	MO	CR	TE
27/01	61	25	15	24.6	3	—	1	68	16	367	—	737	3167	4085
13/03	51	32	5	9.8	8	7	12	137	19	482	122	240	4377	2495
28/03	54	33	7	13.0	2	—	1	162	88	308	—	39	6794	25254
17/04	49	26	12	24.5	6	14	10	55	8	458	470	359	5566	786
22/04	43	26	4	9.3	4	—	3	74	65	238	—	320	6613	13754
28/05	48	34	5	10.4	8	—	7	105	16	564	—	426	11210	13206
17/06	42	16	5	11.9	4	—	1	77	2	588	—	285	10498	893
26/06	57	35	4	7.0	19	4	7	56	18	5723	160	592	6072	10877
18/07	62	19	12	19.4	12	4	2	231	21	1102	29	22	4016	3059
29/07	55	7	7	12.7	1	—	—	17	—	79	—	—	3492	—
16/09	50	13	9	18.0	3	—	—	94	5	85	—	—	542	663
24/09	62	20	9	14.5	6	—	1	46	1	121	—	5	5259	567
22/10	56	15	10	17.9	3	—	2	34	13	22	—	103	4355	4948
30/10	43	17	7	16.3	8	1	—	129	18	108	8	—	2913	12885
12/11	51	14	12	23.5	10	—	8	76	12	434	—	11	2096	9046
26/11	57	18	11	19.3	3	1	3	98	16	261	33	192	6157	1802
10/12	66	18	15	22.7	9	3	5	9	10	1069	850	206	990	10138
TOTALS	908	368	149	—	109	34	63	1468	328	12009	1672	3537	84117	114458
%	—	—	—	—	5.44	1.70	3.15	73.33	16.38	5.57	0.77	1.64	38.18	53.04

Cephalopoda are the most important items and in the Teleostei, Bleniidae are the fishes whith more importance, mainly the species *Lesueuria friesii.*

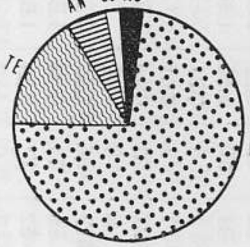

Fig. 1 — Relative abundance of prey groups in *T. luscus* diet. See table 1 for labels

Considering the number of individuals per stomach (Nm) some groups of Crustacea are well represented, as Galateidae (4.56), Schizopoda (3.83) and Carididae (3.22), all them with more than three individuals per stomach.

3 — *The food in weight*

By pooling the content (dry weight) of all stomachs in broad taxonomic groups, we found that the major contributor in weight (see table 1 and fig. 2) to the diet is the Teleostei group (53.04 %), followed by Crustacea (38.98 %). The other groups, Annelida (5.57 %), Mollusca (1.64 %) and Echinodermata (0.77 %) have small importance.

4 — *Diet variation with the size of* ***T. luscus***

Table 2 and fig. 3 show that the three size groups have no great variations in what concerns Annelida, Echinodermata and Mollusca.

TABLE 2 — *Trisopterus luscus* diet variation (in numbers) for three size groups. N — total number of preys in each size group; ni — number of preys of taxonomic group i; e — number of analysed stomachs; ei — number of stomachs with taxonomic group i; f = ni/e abundance of frey group i; Nm = ni/ei abundance per stomach of prey group i; Ri = 100 ni/N relative abundance of prey group i (to N); P = 100 ei/e frequency of occurrence

	GROUP A (< 19 cm)						GROUP B (19 to 27 cm)					
	e = 105						e = 229					
	ni	ei	f	Nm	Ri	P	ni	ei	f	Nm	Ri	P
ANNELIDA	47	34	0.45	1.38	6.89	32.4	53	46	0.23	1.15	4.62	20.1
ECHINODERMATA	7	6	0.07	1.17	1.03	5.7	22	17	0.1	1.29	1.92	7.4
HOLOTHURIOIDA	1	1	0.01	1	0.15	1	2	2	0.01	1	0.17	0.9
ECHINIDEA	1	1	0.01	1	0.15	1	0	0	0	0	0	0
OFIUROIDEA	5	4	0.05	1.25	0.73	3.8	20	15	0.09	1.33	1.74	6.6
MOLLUSCA	22	17	0.21	1.29	3.23	16.2	34	25	0.15	1.36	2.96	10.9
LAMELIBRANCHIATA	3	3	0.03	1	0.44	2.9	1	1	0.01	1	0.09	0,4
GASTEROPODA	0	0	0	0	0	0	1	1	0.01	1	0.09	0,4
CEPHALOPODA	15	13	0.14	1.15	2.2	12.4	32	23	0.14	1.39	2.79	10
NOT IDENTIFIED	4	4	0.04	1	0.59	3.8	0	0	0	0	0	0
CRUSTACEA	566	90	5.39	6.29	82.99	85.7	813	195	3.55	4.17	70.88	85.2
ISOPODA	3	3	0.03	1	0.44	2.9	18	11	0.08	1.64	1.57	4.8
AMPHIPODA	71	34	0.68	2.09	10.41	32.4	52	27	0.23	1.93	4.53	11.8
STOMATOPODA	1	1	0.01	1	0.15	1	0	0	0	0	0	0
SCHIZOPODA	31	7	0.3	4.43	4.55	6.7	15	5	0.07	3	1.31	2.2
CARIDIDAE	180	52	1.71	3.46	26.39	49.5	364	115	1.59	3.17	31.73	50.2
HOMARIDAE	3	3	0.03	1	0.44	2.9	0	0	0	0	0	0
GALATEIDAE	114	16	1.09	7.13	16.72	15.2	62	22	0.27	2.82	5.41	9.6
ANOMURA	6	2	0.06	3	0.88	1.9	15	9	0.07	1.67	1.31	3.9
BRACHIURA	62	41	0.59	1.51	9.09	39.6	143	98	0.62	1.46	12.47	42.8
LARVAE AND NOT IDENT.	95	35	0.9	2.71	13.93	33.3	144	40	0.63	3.6	12.55	17.5
TELEOSTEI	40	30	0.38	1.33	5.86	28.6	225	112	0.98	2.01	19.62	48.9
BLENNIDAE	17	16	0.16	1.06	2.49	15.2	63	36	0.28	1.75	5.49	15.7
PLEURONECTIFORMES	0	0	0	0	0	0	7	7	0.03	1	0.61	3.1
NOT IDENTIFIED	23	18	0.22	1.28	3.37	17.1	155	82	0.68	1.89	13.51	35.8
Totals (N)	682						1147					

TABLE 2 — *Continued*

	GROUP C (> 27 cm)						TOTAL					
	e = 34						e = 368					
	ni	ei	f	Nm	Ri	P	ni	ei	f	Nm	Ri	P
ANNELIDA	9	6	0,26	1.5	5.2	17.6	109	86	0.3	1.27	5.44	23.4
ECHINODERMATA	5	5	0.15	1	2.89	14.7	34	28	0.09	1.21	1.7	7.6
HOLOTHURIOIDA	1	1	0.03	1	0.58	2.9	4	4	0.01	1	0.2	1.1
ECHINIDEA	0	0	0	0	0	0	1	1		1	0.05	0.3
OFIUROIDEA	4	4	0.12	1	2.31	11,8	29	23	0.08	1.26	1.45	6.3
MOLLUSCA	7	4	0.21	1.75	4.05	11,8	63	46	0.17	1.37	3.15	12.5
LAMELIBRANCHIATA	0	0	0	0	0	0	4	4	0.01	1	0.2	1.1
GASTEROPODA	0	0	0	0	0	0	1	1		1	0.05	0.3
CEPHALOPODA	7	4	0.21	1.75	4.05	11.8	54	40	0.15	1.35	2.7	10.9
NOT IDENTIFIED	0	0	0	0	0	0	4	4	0.01	1	0.2	1.1
CRUSTACEA	89	26	2.62	3.42	51.45	76.5	1468	311	4	4.72	73.33	84.5
ISOPODA	2	1	0.06	1	0	2.9	23	15	0.06	1.53	1.15	4.1
AMPHIPODA	0	0	0	0	0	0	123	61	0.33	2.02	6.14	16.6
STOMATOPODA	0	0	0	0	0	0	1	1		1	0.05	0.3
SCHIZOPODA	0	0	0	0	26.59	0	46	12	0.13	3.83	2.3	3.3
CARIDIDAE	46	16	1.35	2.88	0.58	47.1	590	183	1.6	3.22	29.47	49.7
HOMARIDAE	1	1	0.03	1	1.16	2.9	4	4	0.01	1	0.2	1.1
GALATEIDAE	2	1	0.06	1	0	2.9	178	39	0.48	456	8.89	10.6
ANOMURA	0	0	0	0	19.65	0	21	11	0.06	1.91	1.05	3
BRACHIURA	34	15	1	2.27	2.31	44.1	239	154	0.65	1.55	11.94	41.8
LARVAE AND NOT IDENT.	4	3	0.12	1.33	36.42	8.8	243	78	0.66	3.12	12.14	21.2
TELEOSTEI	63	24	1.85	2.63	4.05	70.6	328	166	0.89	1.98	16.38	45.1
BLENNIDAE	7	4	0.21	1.75	4.05	11.8	87	56	0.24	1.55	4.35	12.2
PLEURONECTIFORMES	7	6	0.21	1.17	28.32	17.6	14	13	0.04	1.08	0.7	3.5
NOT IDENTIFIED	49	23	1.44	2.13		67.6	227	123	0.62	1.85	11.34	33.4
Totals (N)	173						2002					

For Crustaceae, there is a decreasing relative abundance (Ri) in bigger fish sizes (82.99; 70.88 and 51.45 respectively for A, B and C groups).

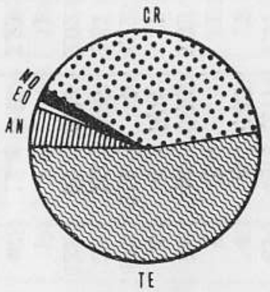

Fig. 2 — Dry weight of prey groups in *T. luscus* diet.

For Teleostei, inversely, there is an increase in relative abundance for bigger fish sizes (5.86; 19.62 and 36.42 respectively for A, B and C groups).

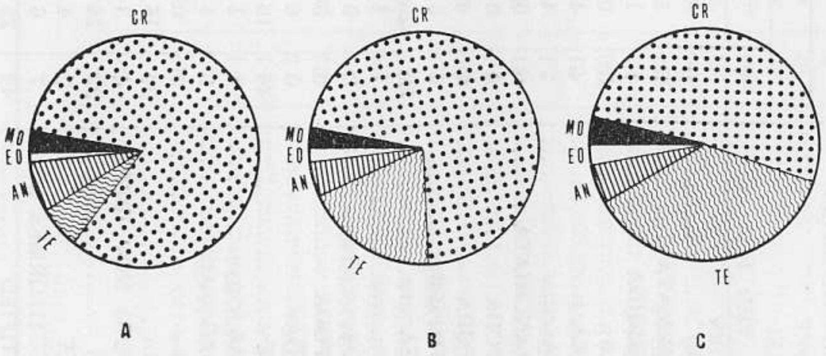

Fig. 3 — Comparison of *T. luscus* diet considering three size groups of this predator (A — < 19 cm; B — 19 to 27 cm; C — > 27 cm) and relative abundance

TABLE 3 — *Trisopterus luscus* diet variation (mg dry weight) for three size groups. e — number of analysed stomachs; w/s — food weight per stomach; %w/s — porcent of each prey group per stomach; AN — Annelids; EQ — Echinoderms; MO — Molluscs; CR — Crustacea; TE — Teleosts

	DRY WEIGHT (mg)														
Samples (1986)	GROUP A (< 19 cm)					GROUP B (19 to 27 cm)					GROUP C (> 27 cm)				
	AN	EQ	MO	CR	TE	AN	EQ	MO	CR	TE	AN	EQ	MO	CR	TE
27/01	62	—	—	681	306	—	—	737	2173	2723	305	—	—	313	1056
13/03	175	—	208	424	24	307	122	32	3460	2286	—	—	—	493	185
28/03	26	—	—	736	1754	282	—	39	4591	20147	—	—	—	1467	3353
17/04	97	16	16	257	—	361	454	343	5308	786	—	—	—	—	—
22/04	—	—	—	406	375	238	—	320	4033	5030	—	—	—	2174	8349
28/05	74	—	215	1017	—	364	—	79	7442	3632	126	—	132	2751	9574
17/06	35	—	285	1003	—	—	—	—	6422	893	553	—	—	3073	—
26/06	1438	—	52	1364	—	4285	—	540	4622	7532	—	160	—	86	3345
18/07	232	13	—	633	66	870	16	22	3383	2993	—	—	—	—	—
29/07	—	—	—	—	—	79	—	—	3492	—	—	—	—	—	—
16/09	—	—	—	501	419	85	—	—	41	244	—	—	—	—	—
24/09	121	—	5	1518	—	—	—	—	3741	567	—	—	—	—	—
22/10	—	—	92	1282	1036	22	—	11	2577	3912	—	—	—	496	—
30/10	50	8	—	708	1050	58	—	—	1005	6975	—	—	—	1200	4860
12/11	434	—	11	958	132	—	—	—	1061	4519	—	—	—	77	4395
26/11	—	—	—	264	150	106	33	139	2701	410	155	—	53	3192	1242
10/12	311	128	185	121	—	419	231	21	869	5627	339	491	—	—	4511
TOTALS	3055	165	1069	11873	5312	7436	856	2283	56921	68276	1478	651	185	15322	40870
e			105					229					34		
w/s	29.1	1.6	10.2	113.10	50.6	3.27	3.8	10	248.6	298.2	43.5	19.2	5.4	450.7	120.2
% w/s	14.23	0.77	4.98	55.29	24.74	5.5	0.63	1.68	41.91	50.27	2.53	1.11	0.32	26.19	69.86

With the increase in the size of the predator, there is a decrease in the diversity of the different groups of Crustacea (9, 7 and 5 groups respectively for A, B and C groups). There are less Crustacea groups, for bigger size of the predator, that show high values of frequency of occurrence: in A group, the important prey groups are Carididae, Galateidae and Amphipoda; in B group only Carididae and Brachyura are important, the others having little importance; in C group only Carididae and Brachyura are significant. Remarkable is the increasing importance of Brachyura as predator increases in size.

TABLE 4 — Kulczinski's similarity index, showing the feeding overlap of three size groups of *T. luscus*. A — < 19 cm; B — 19-27 cm; C — > 27 cm

	B	C
A	74.25	53.27
B	—	71.17

In Teleostei, note higher values for Pleuronectids as the pouting grows.

Table 3 and fig. 4 show that, for bigger fish, the percent of weight of each prey group per stomach increases for Teleostei and decreases for Crustacea. Less clear is the decrease for Annelida and Mollusca. Echinodermata have little importance in all size groups. In bigger fish, the diet is almost exclusively composed by Teleostei (69.86 %) and Crustacea (26.19 %).

Comparing the diet of the three size groups (A, B and C) by the feeding overlap index, we obtained the values of table 4.

We can see that the feeding overlap of the three groups is high (over 50), the groups A and C having the lower value (53.27) and the other groups values over 70 (A-B 74.25 and B-C 71.17).

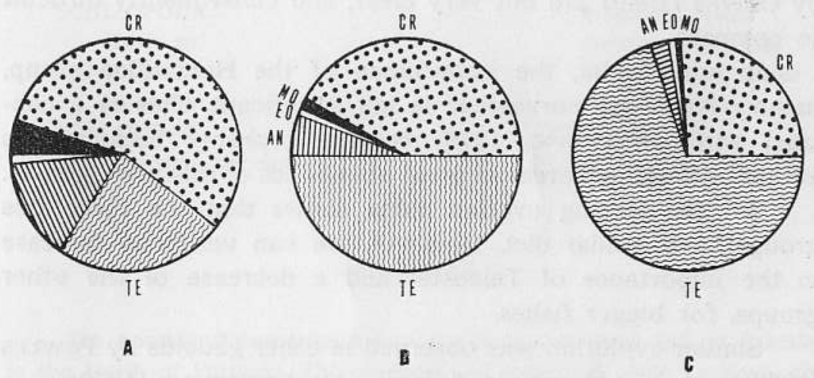

Fig. 4 — Comparison of *T. luscus* diet considering three size groups of this predator (see fig. 3) and dry weight

CONCLUSIONS AND DISCUSSION

As conclusions, we can enfasize the following ones:

1. The rithm of sazonal feeding, as assessed by the vacuity coefficient, doesn't show any period of reduction of feeding activity.

2. Taking all sizes of the pouting, the dominant groups (relative abundance) in the diet, are Crustacea (73.3 %) and Teleostei (16.4 %) if we consider the number of prey items.

Considering the food in weight, the results are reversed, being Teleostei (53.04 %) the dominant group and Crustacea the second one (38.98 %).

3. Annelida, Echinodermata and Mollusca representation in the diet, in numbers or weight, is always low.

The prey groups found here are similar to those identified by Labarta (1976) to the pouting from Galicia (Northwest of

Spain). The main differences are the absence of Euphausiacea and Copepoda in our results. Also the prey lists presented by BENVEGNU (1971) and by SYMONDS and ELSON (1983) show similarity with our results. On the other hand, the ones presented by OLIVER (1949) are not very clear, and consequently difficult to compare.

In our results, the importance of the Homaridae group, namely *Nephrops norvegicus* is not significant. This is a contrast with ARMSTRONG (1979) results, probably because this author investigated areas of great abundance of this prey species.

4. The feeding overlap index shows that the three size groups have similar diet. However, we can verify an increase in the importance of Teleostei and a decrease of the other groups, for bigger fishes.

Similar evolution was observed in other gadoids by POWLES (1958) and, less clearly, in *T. luscus* by ARMSTRONG (1979).

Research on the food of individuals less than 13 cm is needed to have a more complete picture of the diet of this specie. However, this is not possible by utilysing commercial catches.

APPENDIX

Taxonomic groups identified in stomach contents

ANNELIDA
ECHINODERMATA
  HOLOTHURIOIDEA
  ECHINOIDEA
  OFIUROIDEA
MOLLUSCA
  LAMELLIBRANCHIATA
  GASTROPODA
    Cardium sp.
  CEPHALOPODA
    Octopus vulgaris
    Sepia officinalis
    Lolipo sp.

GALATEIDAE
  Galatea strigosa
ANOMURA
  Pagurus sp.
BRACHYURA
  Carcinus sp.
  Macropipus depurator
  Macropodia rostrata
  Inachus dorsetensis
  Portunus sp.
  Ebalia sp.
  Polibius sp.

CRUSTACEA
  ISOPODA
  AMPHIPODA
  STOMATOPODA
    Squilla sp.
  SCHIZOPODA
    Mysis sp.
  CARIDIDAE
    Palaemon sp.
  HOMARIDAE
    Nephrops norvegicus
    Xanto sp.
    Goneplax rhomboides
    Eurinome sp.
TELEOSTEI
  Merluccius sp.
  Lesueuria friesii
  Sardina pilchardus
  Trachurus trachurus
  Belone belone
  TRICHIURIDAE
  PLEURONECTIFORMES

SUMMARY

The pouting (*Trisopterus luscus* L.) is an important fish in fisheries in the North of Portugal. The objectives of this work were to study the diet of the adult stage of this species in order to clarify its position in the food chain and its ecological niche, to know if and how the diet changes with the size of the fish and finally to get more data about the organisms living in our waters.

During 1986, 908 individuals obtained from commercial vessels based in the North Coast of Portugal were examined. There were collected 368 stomachs and their content were identified, counted and weighed. It was calculated the frequency, relative abundance, abundance per stomach and frequency of occurrence of prey items. Stomach vacuity coefficient index was also calculated. The comparison of the diet of different size groups was assessed by Kulczinski's similarity index.

The main results obtained (by pooling all the samples) were: considering the number of preys and relative abundance, it was found Crustaceae (73.3 %), Teleostei (16.4 %), Annelida (5.4 %), Mollusca found Teleostei (53 %), Crustaceae (39 %), Annelida (5.6 %), Mollusca (1.6 %) and Echinodermata (0.8 %).

It was found that, in adult fishes, the size of this predator has considerable effect on the choice of preys. For bigger fish, the importance of Teleostei in the diet increased and, on the contrary, the importance of Crustacea, Mollusca, Annelida and Echinodermata decreased. The feeding overlap of three size groups, as assessed by the Kulczinski's similarity index is high. The pair A-C with the lower value, 53.3, having the other pairs A-B, 74.3 and B-C, 71.2.

From the 908 observed individuals, 149 had empty stomach. The annual variation of vacuity coefficient shows little changes, 16.2 % +/− 5.7, pointing out no reduction on feeding activity, either in summer or winter.

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