

Efficacy of nicarbazin (Ovistop®) in the containment and reduction of the populations of feral pigeons (*Columba livia* var. *domestica*) in the city of Genoa, Italy: a retrospective evaluation

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Columba livia var. *domestica*,
Control,
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Reduction.

Summary

This study describes the results of a retrospective evaluation (8 years: 2005-2012) of the efficacy of the anti-fertility drug, Ovistop® nicarbazin (800 ppm) added to corn kernels used to feed non-migratory feral pigeon colonies, *Columba livia* var. *domestica*, in the city of Genoa, Italy. The observation interested 4 non-migratory feral pigeon colonies located into well-defined areas of the city of Genoa, Italy. Three of these colonies were treated for 12 months, with 10 g of drug (Ovistop®) provided per bird per day for 5 days each week; the other colony was treated in the same way but with a placebo (control station). Each colony and the relative area where the colony was located were both monitored with the same daily examination. Statistical analysis techniques were applied to the findings recorded - both descriptive (indices of central and dispersion trends) and comparative (one-way variance analysis). In the colonies treated with the drug, following an initial increase in the population ('magnet effect'), a reduction was observed over the following 4 years (-35%>x> -45%) and a further decrease (-65%>x> -70%) was observed over the subsequent 4 years (statistically significant one-way ANOVA p<0.01). This phenomenon was recorded across the board in the 3 treated stations, compared to the overall unstable trend observed for the control station. As no external or exceptional anthropic or natural factors were observed, it can be stated that, given the results observed, the drug seemed effective in reducing the treated bird populations.

Valutazione retrospettiva dell'efficacia della nicarbazina (Ovistop®) per il contenimento e la riduzione delle popolazioni di *Columba livia* var. *domestica* nella città di Genova

Parole chiave

Columba livia var. *domestica*,
Controllo,
Gestione,
Genova,
Italia,
Nicarbazina,
Riduzione.

Riassunto

Questo studio di coorte caso-controllo ha avuto l'obiettivo di valutare retrospettivamente i risultati di 8 anni (2005-2012) di somministrazione di nicarbazina (Ovistop®), addizionata a granella di mais nel rapporto di 800 ppm, come antifecondativo in colonie stanziali di *Columba livia* var. *domestica* nella città di Genova al fine di verificarne l'efficacia. Lo studio ha interessato 4 colonie stanziali, 3 delle quali trattate per 12 mesi, somministrando 10 g di prodotto, a capo, al giorno, per 5 giorni alla settimana e la rimanente colonia è stata trattata con le stesse modalità ma sottoposta alla somministrazione di un placebo (stazione di controllo). I dati raccolti sono stati elaborati con tecniche statistiche descrittive (indici di tendenza centrale e di dispersione) e di confronto (analisi della varianza ad una via). Nelle colonie trattate con il farmaco, dopo un iniziale aumento della popolazione (effetto calamita) si è osservata una prima riduzione nei primi 4 anni (-35%>x>-45%) e un'ulteriore diminuzione (-65%>x>-70%) nei 4 anni successivi, anch'essa statisticamente significativa (one-way ANOVA p<0,01). Il fenomeno registrato nelle 3 colonie trattate con il farmaco ha mostrato un andamento omogeneo a differenza dell'andamento complessivamente instabile della colonia di controllo. In assenza di altri fattori esterni o eccezionali, sia naturali sia antropici, è possibile affermare che nel caso osservato durante questo studio il prodotto impiegato ha dimostrato efficacia nella riduzione della popolazione aviaria trattata.

Introduction

Feral pigeon, *Columba livia* var. *domestica*, is a bird that lives freely in the squares of the historical cities around the world (Lever 1987) and in particular, in cities with important architectonic and urban heritage. The urban environment proves to be favourable to this species and contributes to an excessive presence of pigeons, which in turn creates problems associated to normal anthropic activities and to the difficult relationship between human beings and animals (Haag-Wachernagel 2000) in urban environments.

The risk posed to public health and hygiene consequences, the damage to the architecture and the buildings, the deterioration of the urban decorum (Sbragia *et al.* 2001), the damage to agriculture (Soldatini *et al.* 2006) and, last but not least, the economic cost related to the maintenance of the urban areas in which these birds live (Nomisma 2003) are the direct consequences of excessive proliferation of the pigeon populations.

The overcrowding that results from the high reproduction rate (Janiga and Kocian 1985) induces stress in the birds and encourages the diffusion of microorganisms and parasites within the bird populations, which can then weaken and undermine the structure of the pigeon colonies.

In urban areas the reproduction cycle of pigeons is almost continuous (Johnson and Janiga 1995), with the exception of a brief drop from November to January.

The superimposition and the 'demographic explosion' of pigeons in cities are due to the combination of a number of factors that encourage the settlement and their multiplication (*i.e.* the urban layout of the towns and cities, the presence of ecological corridors and free terrain, a lack of predators, availability of food, artificial lighting, the favourable climate, etc.).

Nevertheless, for a number of different reasons – including those based on pathology and parasitology – it has been observed that mechanisms of self-regulation come into play. Such mechanisms act predominantly among fledglings and pullets and can sometimes reduce the size of the population, although such mechanisms do not act as effective natural limitation to the presence of this species in urban area (Haag 1993, Baldaccini 1998).

Pigeons that steadily occupy a well-defined territory, which involves the nesting locations, egg-laying and food-supply, are considered to be a non-migratory population. A colony that persists on a territory and is not subjected to significant modification of the environmental conditions, can provide a long-term source of comparable findings. The homogeneous

environmental conditions of the ecosystem and the demographic dynamics (births/deaths, immigration and emigration of a few individuals) concur to maintain the stability of the colony's demographics until external factors intervene.

In many cities, the experts and the local council administrators have discussed these factors, identifying and experimenting interventions affecting exclusively the animal colonies. Generally speaking, the proposed solutions aiming at a demographic reduction focus on 3 types of interventions:

- invasive interventions: surgical sterilization, capture of the birds and controlled elimination, removal of the eggs, etc.;
- physical interventions (dissuaders: nets, spikes, etc.);
- chemical interventions (drugs).

In relation to the invasive interventions, the field experience has demonstrated that euthanasia of the animals is ineffective and so is vasectomy, simply because of the poor cost/benefit ratio and the logistic difficulties associated with the intervention itself (identification and management of a large number of animals) (Baldaccini 1998, Baldaccini 1999a, Baldaccini 1999b). Removal of the eggs has not been successful either, considering the speed with which the clutch of eggs is replaced (Johnston and Johnson 1990).

A special procedure could be developed in the form of dovecotes to attract and concentrate the birds and control their laying habits (Haag-Wachernagel 2000). However, the installation and maintenance costs of such systems must be taken into consideration. Moreover, these facilities may simply become an additional location where pigeons aggregate.

The physical interventions to contain colony sizes have not always produced satisfactory results; partly because of the ancestral reproduction adaptability of pigeons, *i.e.* the extension of their fertile period (Janiga and Kocian 1985, Johnston and Johnson 1990), and partly because of the difficulty associated with reducing the roosting and nesting places.

These problems can be solved with integrated interventions that produce positive results thanks to the combination of different management techniques.

The application of chemical-pharmacological measures is particularly important and exploits products that have been available on the market for a considerable length of time. In the case of this study, the treatment involves administering corn kernels coated with nicarbazin, a product commercially known as Ovistop®.

The goal of this study was to evaluate the efficacy of this drug, using a trial model for cohorts of colonies

treated with an anti-fertility/contraceptive drug and compare the findings with those observed for a control group with similar characteristics but treated with a placebo. The researcher operators processed the findings relative to the period of administration 2005-2012 of Ovistop® to well-defined and stable pigeon colonies in the city of Genoa, Italy (Figure 1). The results are based on the statistical analysis of the collected data.

Materials and methods

Product

Nicarbazin is an active ingredient with minimal toxicity and free from modifying effects on the main vital organs and parenchyma (Martelli *et al.* 1993), it is also a coccidiostatic drug that is widely-used in poultry production. The pharmacokinetic and toxicity characteristics of this molecule are well-known and have been widely-reported in the international literature (Hurwitz *et al.* 1975, Polin 1978, Hughes *et al.* 1991, Martelli *et al.* 1992).

At appropriate dosages for anti-fertility treatment, nicarbazin exclusively affects the processes associated with the maturation of the egg, as opposed to the fertility; consequently, the product does not interfere with physiological processes including those relative to the reproductive apparatus (hormone balances, etc.) (Bursi *et al.* 1996).

The product used in the protocol for the containment of pigeon populations is a veterinary medicinal specialty formulated as follows:

- active ingredient: nicarbazin, 800 mg per kg of finished product;
- support: corn kernel;
- excipients: stearic acid, BHT (butylated hydroxytoluene) and dimethicone;
- trade name: OVISTOP®.

The quantity of administered drug per bird was defined at the beginning of treatment and updated on the basis of findings on the population while maintaining the recommended doses of 10gr of corn per day for each bird intercepted. The total dose was calculated and periodically updated in relation to the dimensions of the colony. The treatment period was 12 months; 'corn' (Ovistop® or placebo) was distributed on the ground 5 days per week at dawn. The distribution points were selected on the basis of the degree of socialization and habituation of the birds in presence of human beings. Before the start of the trial activity, the staff was trained to guarantee sharing of the project and to define the roles of each individual in the group (Martelli *et al.* 1993).

Observational trial of a cohort with a control group

To evaluate the efficacy of the anti-fertility/contraceptive formulation on the urbanized population of feral pigeons, *Columba livia* var. *domestica*, the experimental model selected 4 feeding stations, 3 feeding stations treated for 8 years with nicarbazin and 1 station treated for the same period of time but with a placebo.

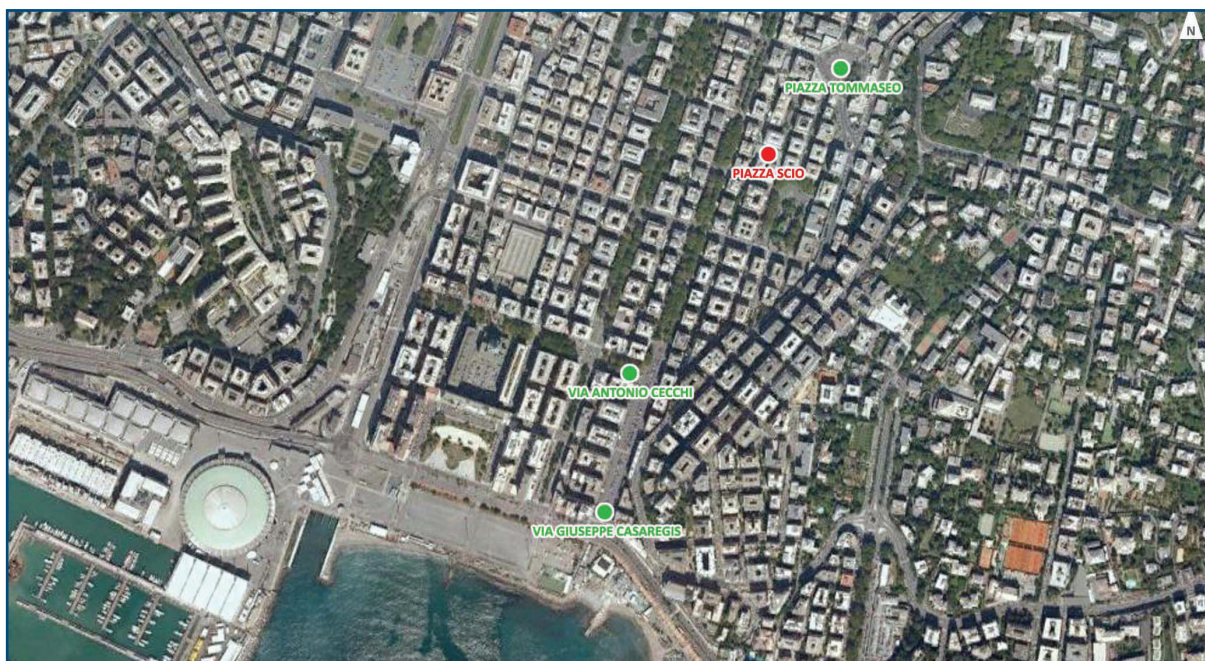


Figure 1. The homogeneous urban district of Genoa, Italy, inside of which the researchers have identified sub-areas occupied by non-migratory colonies.

The findings relative to the 4 stable colonies in the city of Genoa are related to the retrospective experimental model 'study of cohort-control'; with the absence of other elements or detectable and demonstrable causes, the administration of the drug represents the exposure (or lack of) to the active ingredient and its effect.

The numerical measurements were obtained homogeneously across the years according to a shared protocol and in correspondence to the administration that involved counting the number of birds by spotting them in the areas of 'corn' (Ovistop® or placebo) distribution. The findings were initially registered on specific hard copy forms and subsequently transferred onto a digital support to be processed with the descriptive parametric statistic techniques (mean, moving average, index numbers), indices of dispersion and comparison techniques (one-way-ANOVA con $p=0.05$).

Description of the colonies

Urban bird colonies socialise in artificial environment that have been shaped by a number of different anthropic activities. It stands to reason that in urban areas there are no natural situations. Consequently, the colonies of feral pigeons cannot be compared with the wild colonies, nor can they be compared to populations that are kept in confined spaces and controlled inside enclosures such as aviaries. The urban colonies are a hybrid between the wild and domestic populations, which permanently occupy well-defined and easily identifiable areas in the cities and are encouraged by several factors among which, the abundant availability of food, the numerous locations for mating, nesting and egg-laying, the extension of the photoperiod and the increase in the seasonal temperatures.

Method and time schedule for the administration

The treatment and the placebo were administered at dawn for a 12-month period over the solar year for a total of 8 years (2005-2012). In parallel with the distribution, the researchers recorded the findings relative to the sightings of the bird colonies: 'daily contacted birds'.

All the research operators had been given the same training; they recorded the information defined by the protocol on specific forms, 1 for each colony treated. In particular, there was the explicit request to report anomalies in the colony (diseases, migrations, etc.) or in the territory (opening of building sites, any elements that could interfere with or affect the birds' life).

These data, acquired in the same way, with the same schedule and with the same actions, constitute the homogeneous substrate of a reliable statistic analysis.

Counting method

To quantify the population of the specific colony identified for treatment (and for the successive measurements during administration) and to guarantee the correct distribution of the product in the amount indicated, the research operators used a detailed direct counting method. Considering that the biggest problem faced in the planning and completion of this kind of estimate consists in the inaccurate spotting of birds perched on inaccessible roofs, courtyards or gardens and the birds that are incubating the eggs, the counts are performed in conditions determined to maximize the sightings. The measurements were taken in Spring, Summer, Fall and Winter. The counts were performed early in the morning when bird numbers were highest (Ballarini *et al.* 1989).

Results

The statistical methods

The data were grouped on the basis of the colony and time, re-processed statistically with descriptive techniques [mean parametric, mobile average, index of dispersion, standard deviation and non parametric quartile and median, Interval of Confidence (IC) 95% and Index Number], and a comparison technique (one-way ANOVA) with a probability significance threshold of $p = 0.05$.

Findings – such as Index Number with a base of 100 – were also processed; this transformation consents the description of a phenomenon using figures that are immediately comparable as they are expressed on the same numerical scale.

The results relative to the years of treatment are presented in summary tables showing the mean number of pigeons sighted, a box-plot, trend analysis graph, table of the ANOVA results, table of the Index Number with a base of 100, graphs for each year, each feeding station, and for the control station.

Station 1 - Casaregis Street

In this station (Figure 2), research operators observed a reduction in the population of the animals from an initial mean value of approximately 100 pigeons; following an obvious reduction of approximately 45% in the first 4 years of treatment,



Figure 2. Casaregis Street, Genoa, Italy. This is a main road that runs inland from the seafront, in an area with a mixture of commercial and residential properties, with wide, tree-lined avenues. There are 2 parallel rows of sycamore trees and tangentially, numerous private gardens with medium-height plants and shrubs.

there was a further decrease (approximately 65%) with stabilisation after 5 years (Figure 3a). This phenomenon was confirmed by the examination of the transformations into Index Numbers (Figure 3c) and is statistically significant, as shown by the ANOVA (Table I; $p < 0.001$). The obtained results dispute the hypothesis that the mean of the recorded figures during the years of observation are the same, and confirm the trend (Figure 3b).

Station 2 - Tommaseo Square

In Station 2 (Figure 4), a decreasing trend was also observed; in the first 4 years, there was a decrease of approximately 45% and this trend continued to 65% in the following years when it then stabilized (Figure 5a). This trend has been described more directly by the series transformed into Index Numbers (Figure 5c), the trend has also been confirmed by the comparison test (Table II; ANOVA $p < 0.01$) and the trend analysis (Figure 5b).

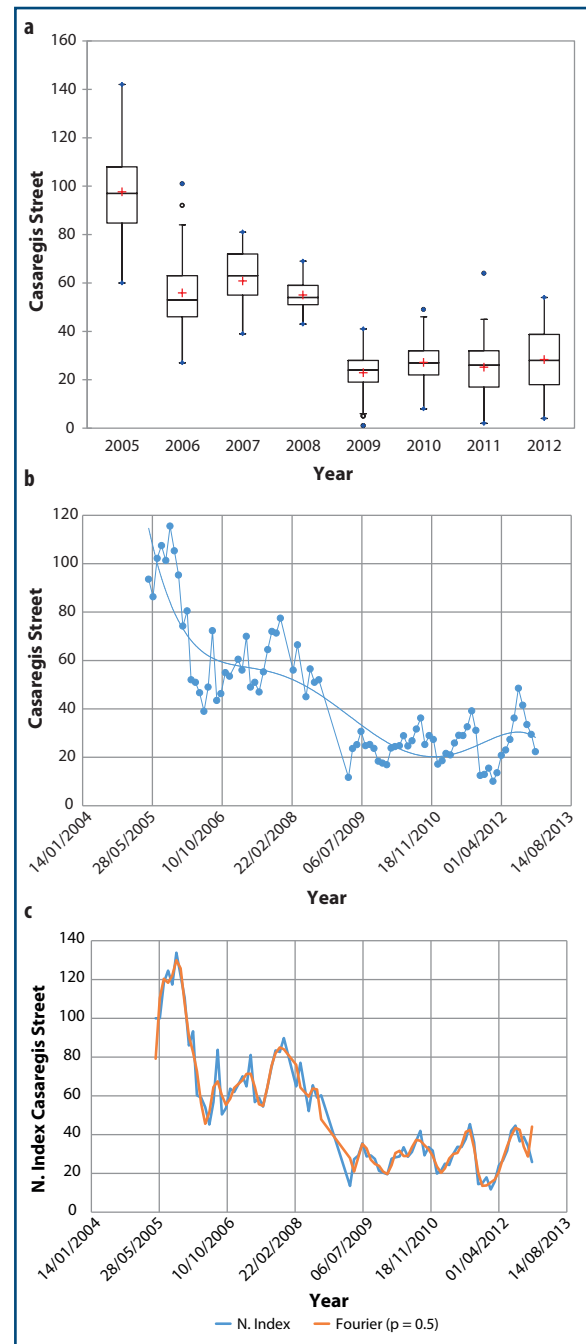


Figure 3. Casaregis Street, Genoa, Italy. **a)** Box-plot of number of pigeon by year; **b)** Trend line of observations in the period 2005-2012; **c)** Number Index with a base of 100 and approximation Fourier series of the trend in the period 2005-2012 referred to yearly means of pigeon population during 7 years of nourishment (2005-2012).

Table I. ANOVA results referred to pigeon populations during 7 years of drug distribution (2005-2012) in Casaregis Street, Genoa, Italy.

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	320031,489	45718,784	371,693	< 0,0001
Error	774	95203,178	123,002		
Corrected total	781	415234,667			



Figure 4. Tommaseo Square, Genoa, Italy. This is a large square with heavy traffic flow; the tall trees are planted in a large garden completed with decorative fountains.

Station 3 - Cecchi Street

In Station 3 (Figure 6), the research operators observed a population trend that could be superimposed on the findings recorded for Stations 1 and 2, though there were differences in the variations. For the first 3 years, the researchers observed a mean reduction of 40%, compared to the range of 35-45% recorded for stations 1 and 2 (Figure 7a). From 2009 onwards, the variation tended to stabilise with a percentage of approximately 70% that corresponds to the variations observed at the other stations (Figure 7b and 7c). In this case also, Variance Analysis rejected the hypothesis (Table III; $p < 0.001$) that no differences exist between the years under examination.

Control station 4 - Scio Square

Observations recorded for the Control Station 4 (Figure 8) (relative to the pigeon colony treated with placebo) produced results that could not be linked to any previously described model or trend apart from the initial 'magnet effect'. During the years in which the colony was observed (Table IV), the research operators actually recorded an increase in the population and a successive stabilisation of the numbers for similar populations (Figure 9a and 9b).

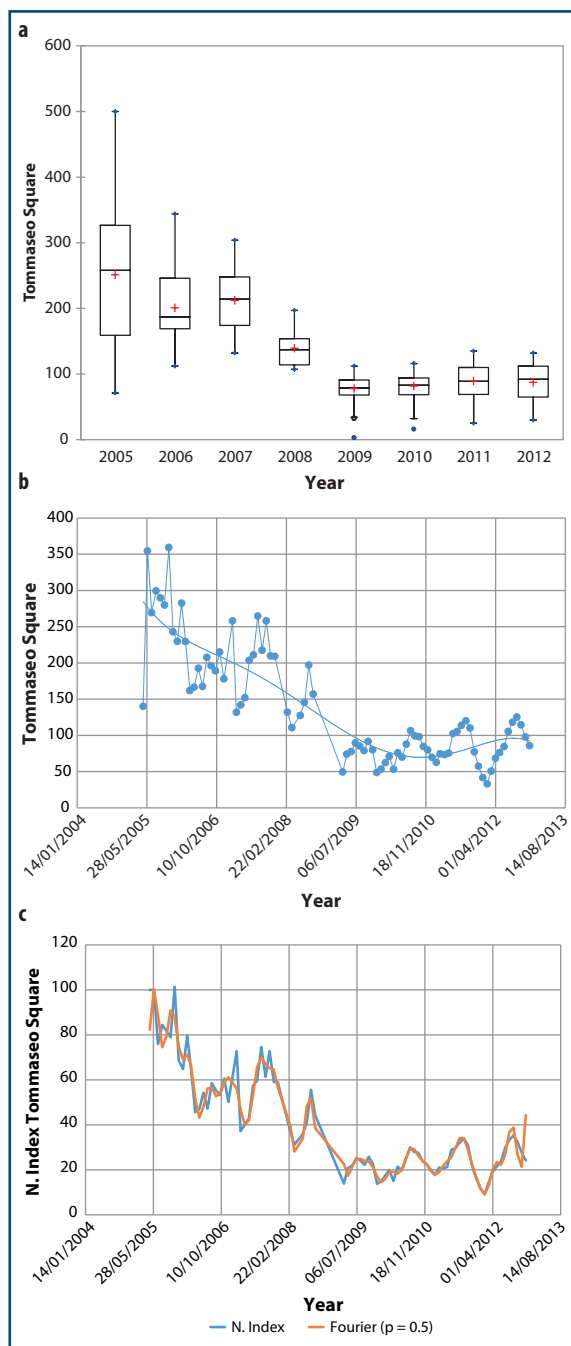


Figure 5. Tommaseo Square, Genoa, Italy. **a)** Box-plot of number of pigeon by year; **b)** Trend line of observations in the period 2005-2012; **c)** Number Index with a base of 100 and approximation Fourier series of the trend in the period 2005-2012 referred to yearly means of pigeon population during 7 years of nourishment (2005-2012).

Table II. ANOVA results referred to pigeon populations during 7 years of drug distribution (2005-2012) in Tommaseo Square, Genoa, Italy.

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	2090218,632	298602,662	214,847	< 0,0001
Error	774	1075733,388	1389,836		
Corrected total	781	3165952,020			



Figure 6. Cecchi Street, Genoa, Italy. This road is wide and runs parallel to the seafront, which lies just a few hundred meters away. There is two-way circulation along the road that is interrupted by traffic islands and lined by double rows of sycamore trees.

The differences – despite them being in the opposite direction of stations 1, 2 and 3 – are not statistically different ($p > 0.001$), with large variations in the 1st and 3rd percentiles (Figure 9a) and an elevated index of dispersion.

Index Number

The findings were subsequently compared in a single table (Table V) with the Index Numbers relative to the period analysed. In this way, it was possible to precisely evaluate the trend of the populations.

Using the Index Numbers with a fixed base (2005=100), the trend observed is superimposable for the 3 stations treated (Casaregis Street, Cecchi Street, and Tommaseo Square) and differs from the results recorded for the control station (Scio Square) (Figure 10).

Records for the first and second year of observation showed that the findings from the 4 stations in 2005 highlighted an initial and stable increase in the population called the 'magnet effect' caused by a greater availability of food; this effect was observed in the following year (2006) in Cecchi Street, Tommaseo and Scio Squares, with a drop in the phenomenon observed at the Casaregis station.

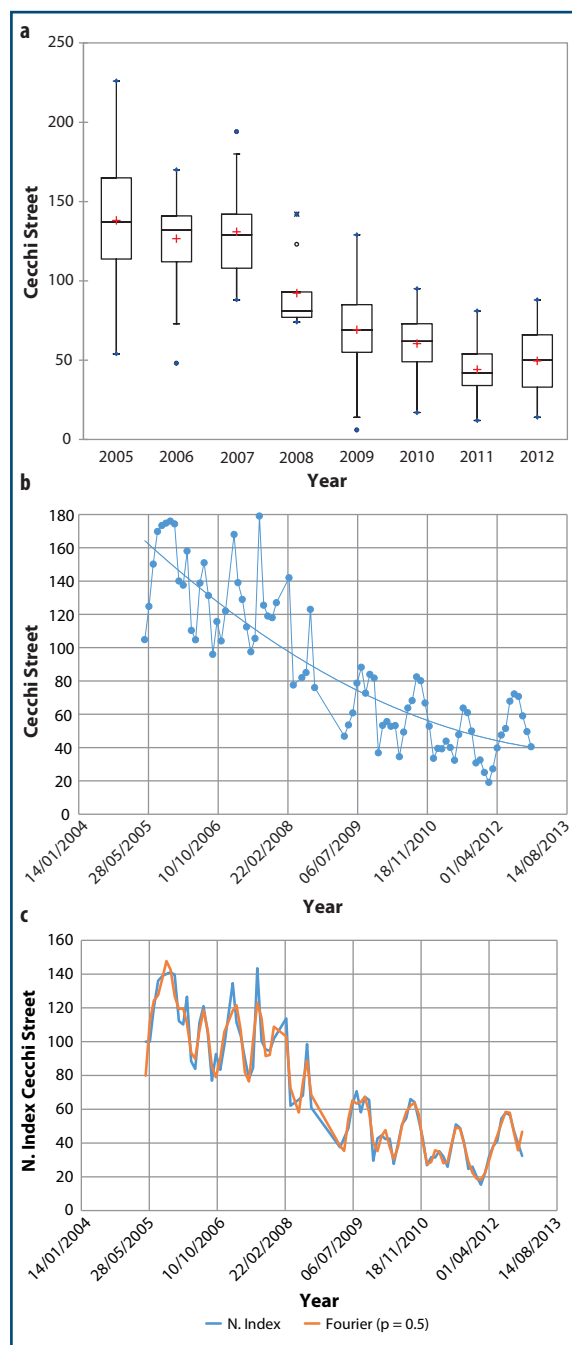


Figure 7. Cecchi Street, Genoa, Italy. **a)** Box-plot of number of pigeon by year; **b)** Trend line of observations in the period 2005-2012; **c)** Number Index with a base of 100 and approximation Fourier series of the trend in the period 2005-2012 referred to yearly means of pigeon population during 7 years of nourishment (2005-2012).

Table III. ANOVA results referred to pigeon populations during 7 years of drug distribution (2005-2012) in Cecchi Street, Genoa, Italy.

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	660464,181	94352,026	217,174	< 0,0001
Error	774	336267,052	434,454		
Corrected total	781	996731,233			



Figure 8. Scio Square (Control station), Genoa, Italy. This rectangular square is adjacent to a 5-road intersection interrupted by traffic islands and public gardens with plenty of trees.

From 2006 onwards, a decreasing trend was also observed for the Cecchi and Tommaseo stations; in 2009, these 3 stations returned a value below the threshold (Index Number on 02.05.2005 was based on 100) and this contrasted with the values recorded in Scio Square, which returned values that persisted at levels above the threshold, with high fluctuations throughout the year.

Overall, a reduction of between 40% and 70% was observed in the populations for stations 1, 2 and 3; in all 3 cases, the differences were statistically significant. In the control station, Scio Square (number 4), no superimposable variation or trend in the results was observed; on the contrary, the overall trend observed was unstable.

Discussion and conclusion

The findings of this study clearly describe a downward trend for stations 1, 2 and 3, which is different from the one observed at the control station number 4. As such the results of this study leave no doubt about the efficacy of nicarbazin for the control and the reduction of the number of birds in the treated pigeon colonies. This drug had been indicated from the outset for being able to negatively interfere with birds' reproductive function and this defined its

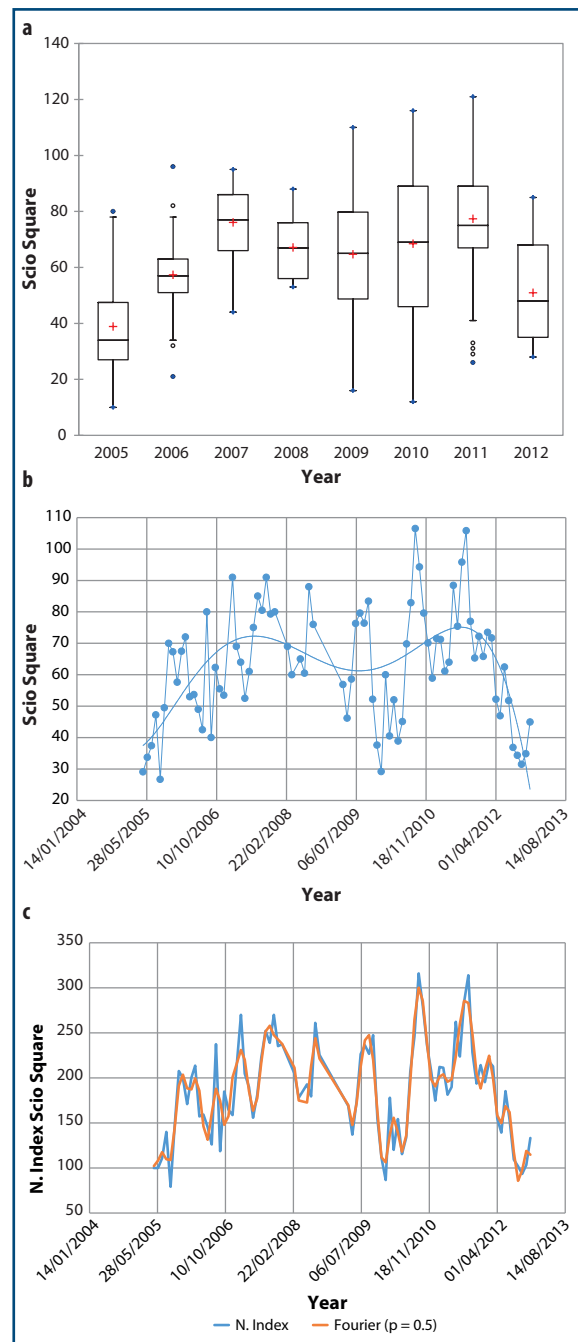


Figure 9. Scio Square (Control station), Genoa, Italy. **a)** Box-plot of number of pigeon by year; **b)** Trend line of observations in the period 2005-2012; **c)** Number Index with a base of 100 and approximation Fourier series of the trend in the period 2005-2012 referred to yearly means of pigeon population during 7 years of nourishment (2005-2012).

Table IV. ANOVA results referred to pigeon populations during 7 years of drug distribution (2005-2012) in Scio Square, Genoa, Italy.

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	105698,266	15099,752	40,727	< 0,0001
Error	774	286967,070	370,758		
Corrected total	781	392665,336			

Table V. Synoptic table of the Index Numbers (I.N.) related to eight years of experimentation for each station. Station 1, 2 and 3, reduce the I.N. heavily between second and fourth year.

Year	Station 1. Casaregis Street	Station 2. Tommaseo Square	Station 3. Cecchi Street	Control station 4. Scio Square
2005	107.8	199.4	148.9	155.0
2006	59.0	143.7	120.0	196.6
2007	65.5	146.5	123.2	258.8
2008	58.2	103.4	93.1	239.7
2009	23.9	53.6	64.0	216.6
2010	28.5	56.0	56.7	220.2
2011	25.9	62.0	40.9	259.6
2012	26.9	59.5	45.3	173.8

exclusive use in birds not destined for reproduction activity (Martelli et al. 1993).

From the analysis of the superimposable trend over the years, 2 reduction phases were observed during the treatment period. The first one was observed in the first 2 or 3 years and led to a significant reduction of about 40%; the second phase was observed in subsequent years with a further reduction of up to 65% with respect to the original dimension of the population.

The repeatability and the reproducibility of the model and the results obtained from the retrospective examination of the case-control cohorts confirm that the shrinking of the pigeon colonies in Genoa for 8 consecutive years is likely a consequence of the ncarbazine treatment.

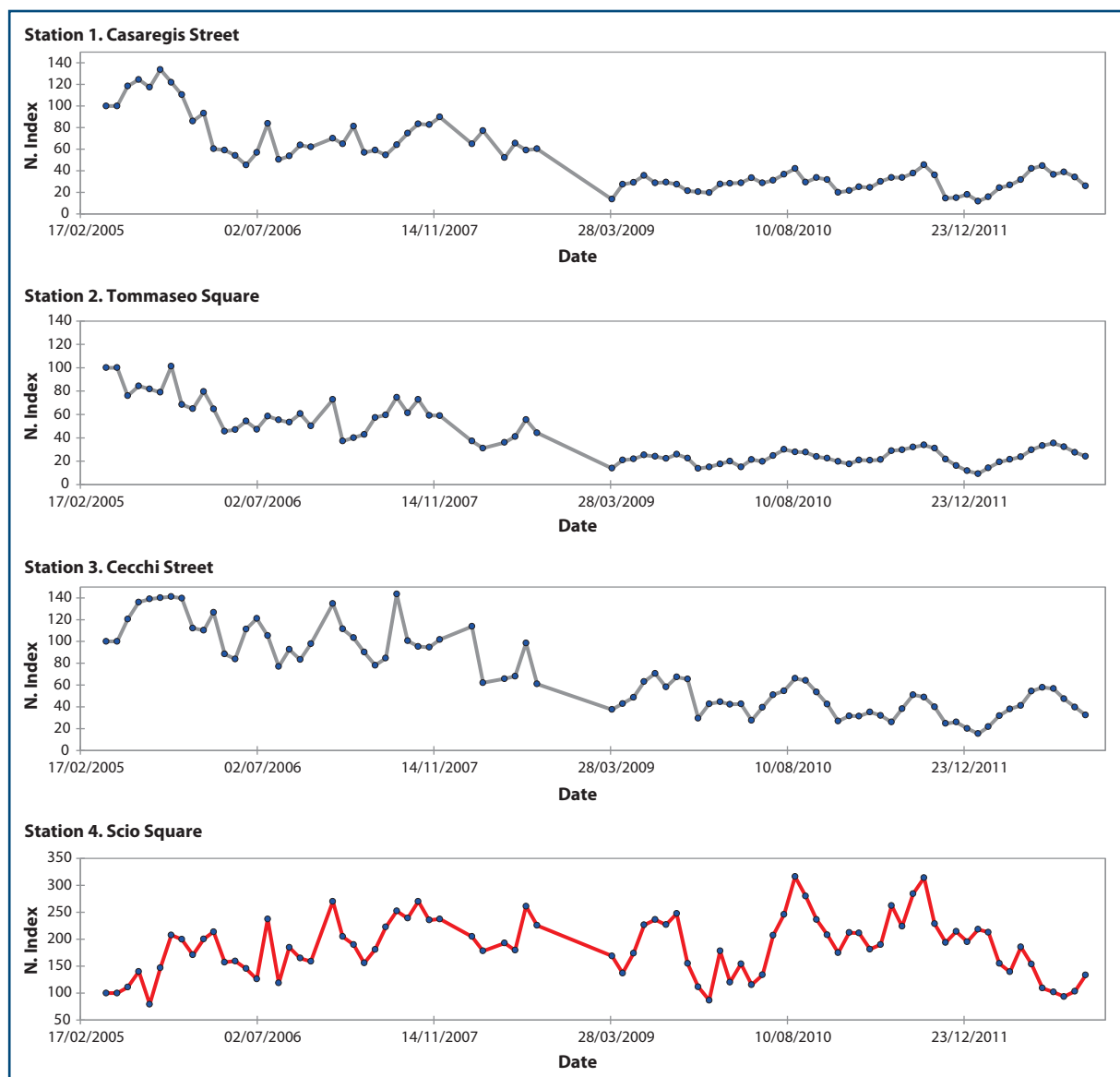


Figure 10. Graphic representation of the standardised values to 100 (Index Number - I.N.) that shows a constant and strong I.N. reduction for all stations except for Scio Square (Station 4).

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